Rurality and the People-Centric Approach to Public Service Delivery in the Digital Age–A Study of South African Rurality as a Proxy for Low- and Middle-Income Country Contexts

by

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DEDICATIONS

To the memory of my late parents, Mr Petros and Evas Pashapa

who passed on during the years of my commencement of this study.

Your love, prayers, and goodwill continue to push us on.

To my grandparents, your empathy, love, joyfulness, prayerfulness, and handwork inspire.

PUBLICATIONS

During the study, three research articles were published.

The first paper reviewed literature on information communication technologies for development (ICT4D) in South Africa and applied logistics regression based on 2014 South African Community Survey data to assess the determinants of household access to the Internet in the country's settlements. The education level of the household head, household income, and household access to electricity were the most influential factors that determined access to the Internet. Female-headed households were more likely to have Internet access in rural settlements than female-headed households in informal urban settlements. The paper was presented at the 9th International Development Informatics Association Conference (IDIA) in Zanzibar, Tanzania, in May 2015. The details of the publication are as follows:

> Pashapa, T., & Rivett, U. (2015). The Context of ICT4D and Development in Rural Areas: A Case Study of South Africa. In *Beyond development. Time for a new ICT4D paradigm? Proceedings of the 9th IDIA conference*, 8-9 November 2015, Nungwi, Zanzibar: 266-285, ISBN: 978-0-620-68395-1

The second publication investigated the use of female-headed household headship as an indicator of limited access to information communication technologies in South African settlements. Based on the 2011 Census data and Community Survey data from 2011 to 2014, Tetrachoric Correlation Analysis showed that for some technologies, female household headship was more closely associated with access to the technologies in tribal, rural areas than compared to the same households in economically advanced settlements than expected. The income of the household head was revealed as a more likely determinant of household access to ICTs compared to female household headship. The research article was published in the Gender, Technology and Development Journal. The details of the publication are as follows:

> Pashapa, T., & Rivett, U. (2018). Gender of household head and the digital divide in South Africa's settlements. *Gender, Technology and Development*, *21*(3), 232-249. https://doi.org/10.1080/09718524.2018.1434994

The third publication examined the role of ICT proliferation in enhancing public services within rural South Africa. The study, based on interviews with rural stakeholders, explored community development priorities, digital access and skills, and the role of ICTs in service accessibility. Development priorities were framed in terms of access to public services. Due to varying socio-economic conditions, ICTs in rural households were primarily used for information dissemination, communication, and as knowledge repositories. The paper was presented at the 10th African Conference on Information Systems and Technology, 12-13 September 2024 in Harare, Zimbabwe

> Pashapa, T., & Rivett, U. (2024). e-Service Delivery and People-Centric Development in the Digital Age: A Case of Rural South Africa. 10th *African Conference on Information Systems and Technology, 12-13 September 2024,* Harare, Zimbabwe. https://digitalcommons.kennesaw.edu/acist/2024/presentations/23

ABSTRACT

Based on a pragmatist worldview, I employed an exploratory sequential mixed-methods research design to enhance our understanding of the public value of information and communication technology (ICTs) and the nature of services delivered in low- and middle-income settings. Understanding the intricate relationship between rurality, ICT expansion, and service delivery in low- and middle-income settings is imperative for tailoring technology-driven strategies to rural areas within the constraints of limited resources. While some e-service delivery initiatives have succeeded, their overall effectiveness remains mixed. Further research is needed to achieve universal coverage and enhance functionality beyond basic communication for more meaningful use. This study is motivated by the need to explore how the quality of rural amenities—an indicator of rurality—intersects with the proliferation of ICTs as a driver of transformation and development. Additionally, recent studies have pointed to the importance of rurality measures that reflect peripherality, adjacency, contextuality, and demographic characteristics. South African rurality measures in particular could be enhanced by incorporating factors such as contiguity, flows, poverty, and service accessibility.

In the qualitative phase of the study, I gleaned insights from official documents, reports, research articles, and interviews. The study was grounded on service-dominant approaches to new public management (NPM) models, based on theoretical underpinnings drawn from public value and information asymmetry theories. NPM underscores the significance of understanding the role and impact of ICTs on service-dominant approaches. I adopted the digital divide model and the communication for development (C4D) framework to develop data collection instruments and to evaluate development communication. Despite challenges posed by the sparse population distribution hindering the effectiveness of digital service provision and discouraging service providers from establishing relevant communication infrastructure, I found that the value of digital service provision in rural areas primarily manifests in reduced distances and the time required to access intangible services. Utilising the 2011 South African census data and other contemporaneous datasets, I developed spatial rurality indexes using JRC-EC's index development procedure and the procedures used in other studies. Underdeveloped and remote regions exhibited significantly greater access to public healthcare and education services, which were particularly well-suited to the advantages offered by ICTs.

In the context of ICT proliferation, my findings suggest that the economics of service delivery information tend to favour service providers and those who are socioeconomically advantaged, resulting in varying benefits, particularly for service consumers. This information imbalance arises from the power wielded by service providers, stemming from their ownership of ICT-based C4D spaces and advantages in overseeing service delivery processes. Affordable, user-friendly, and accessible technologies,

particularly mobile phones, mobile-based applications, and mass media, primarily functioned as information disseminators, repositories of knowledge, and communication tools for marginalised rural service consumers. Hence, I argue that the benefits of information asymmetry for consumers are minimised. These benefits are not directly tied to their utilisation of publicly available service delivery information, which is meant to provide transparency and enhance their participation and oversight of service delivery processes. Instead, access to the information by other actors such as central government may enforce these advantages. It is crucial to acknowledge that ICT-based development communication in low- and middle-income contexts primarily facilitates a top-down information flow, with service consumers mainly participating in service delivery by providing information to support service delivery processes.

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ACRONYMS

PROVINCE

EC	Eastern Cape
FS	Free State
GP	Gauteng
KZN	KwaZulu Natal
LIM	Limpopo
MP	Mpumalanga
NP	Northern Cape
NW	North-West
WC	Western Cape

GOVERNMENT DEPARTMENT

CoGTA	Republic of South Africa Department of Cooperative Governance and Traditional Affairs
DBE	Republic of South Africa Department of Basic Education
DGCIS	Republic of South Africa Department of Government Communication & Information Systems
DOE	Republic of South Africa Department of Energy
DoH	Rep Republic of South Africa Department of Health
DoT	Republic of South Africa Department of Transport
DPSA	Republic of South Africa Department of Public Service and Administration
DRDL	Republic of South Africa Department of Rural Development and Land
DRDLR	Republic of South Africa Department of Rural Development and Land Reform
DTPS	Republic of South Africa Department of Telecommunications and Postal Services
DWS	Republic of South Africa Department of Water and Sanitation
KZN DoE	KwaZulu Natal Provincial Department of Education
NPC	Republic of South Africa National Planning Commission
NT	Republic of South Africa Department of National Treasury
RSA	Republic of South Africa
SALGA	South African Local Government Association

ORGANISATION

CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of South Africa
EMIS	Education Management Information Systems
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
ITU	International Telecommunications Union
JRC-EC	Joint Research Centre-European Commission
OECD	Organisation for Economic Co-operation and Development
OWI	OneWorld International
PMG	Parliamentary Monitoring Group
SABS	South African Bureau of Standards
SACE	South Africa Council of Educators
SACN	South Africa Cities Network
SAHO	South Africa History Online
SAHRC	South African Human Rights Commission
SAPA	South African Press Association
SAPS	South African Police Service
SASSA	South African Social Security Agency
STAOEC	Statistical Office of the European Communities
STATS SA	Statistics South Africa
UNDESA	United Nations Department of Economic and Social Affairs
UNECE	United Nations Economic Commission for Europe
UN-Habitat	United Nations-Habitat
USDAERS	United States Department of Agriculture Economic Research Service

ABBREVIATION

C4D	Communication for Development
NDP	National Development Plan
NSDF	National Spatial Development Framework
SRI	Spatial Rurality Index

1 RURALITY IN THE DIGITAL AGE

1.1 Introduction

Rural areas are associated with sparse population distributions, remoteness from service centres, abundant farmland, and lower standards of public services relative to urban areas (Waldorf, 2007; Caschili, De Montis, & Trogu, 2015). Rurality is the extent to which an area bares the contextual characteristics of rural places defined in a study context. Comprehensive and updated rurality measures are crucial to tailor programmes to area needs (DNT, 2012; Eagar Versteeg-Mojanaga, & Cooke, 2014; Jamal, 2015). For example, South Africa's national treasury emphasises differentiating support and fiscal payments to municipalities by giving greater precedence to less developed municipalities (DNT, 2012). Global trends have led to increased levels of access and adoption of information communication technologies (ICTs) to support inclusive public service delivery and other development activities (OECD, 2010; Dickinson & Bostoen, 2013; Estevez, Janowski, & Dzhusupova, 2013; Ma, Qiu, & Rahut, 2023).

ICTs facilitate monitoring interventions and enable evidence-based decision-making for equitable and sustainable services (Schouten, 2013; Tchamyou, Erreygers, & Cassimon, 2019). On the other hand, the digital divide is viewed as a threat to the performance of rural partnerships, rendering rural development outcomes unsustainable, lopsided, and non-participatory (Erdiaw-Kwasie & Alam, 2016). Established ICTs include radio and television while emerging ICTs encompass mobile phones, the Internet, mobile networks, data collection and analysis tools, and the technology (including hardware, software, and services) that facilitates data flow (Schouten, 2013). The proliferation of ICTs refers to the widespread acceptance and use of these technologies (Baliamoune-Lutz, 2003; Karlsson et al., 2008). The digital age has opened new opportunities, including non-agricultural activities for rural communities (Diao, Magalhaes, Silver, 2019; Fahmi & Sari, 2020). The South African setting provided a context where social inclusion and public participation were the main development goals for balancing a local government landscape that was skewed against rural areas (Reddy, 1999).

At the commencement of the democratic era in 1994, the country's public administration models were primarily determined by the prevailing management style administration models and later consumer-centric models (Cameron & McLaverty, 2008; Cloete, 2008; Chipkin & Lipietz, 2012). In the country's earliest ICT white paper of 1997, titled 'Batho Pele' (people first), the South African government sought to use ICT systems to build a socially inclusive society by facilitating public participation in the provision of services (DTPS, 2017). The presented study contributes to the knowledge of rurality in the digital age and also contributes knowledge on the public value of ICTs in service-centric public service delivery models.

1.2 Historical, Demographic, and Service Delivery Background

The prevailing rural landscape in South Africa primarily stems from settlement patterns established during the apartheid era (Coovadia, Jewkes, Barron, Sanders, & McIntyre, 2009). Following the changes in settlement dynamics after 1994, some administrative boundaries became strained by substantial development goals (Parnell, 2002; Powell, 2012). According to the authors, the rapid transition to an inclusive society redefined municipal boundaries to include underdeveloped rural areas but overlooked resource allocation and governance, leaving some municipalities with vast mandates and inadequate resources.

1.2.1 Historical Context

The period before 1994 was characterised by legislation that confined the Black South African population to congested and less fertile settlements. Rural homelands with inadequate living conditions became the designated spaces for women, children, the elderly, and the unemployed. SAHO (2009) provides a chronology of key legislation governing settlements and land ownership as follows:

i. In 1913, the 'Black' Land Act Number 27 prohibited 'Black' South Africans from owning or renting land outside designated reserves.

ii. In 1950, the Population Registration Act Number 30 categorised individuals into four racial groups from birth and the Group Areas Act Number 41 allocated specific areas for exclusive use by each racial group.

iii. The 'Black' (Native) Laws Amendment Act 54 of 1952 mandated 'Black' South Africans in urban areas to carry passes (Work Permits). Those who had not been born or worked in urban areas were restricted from these regions.

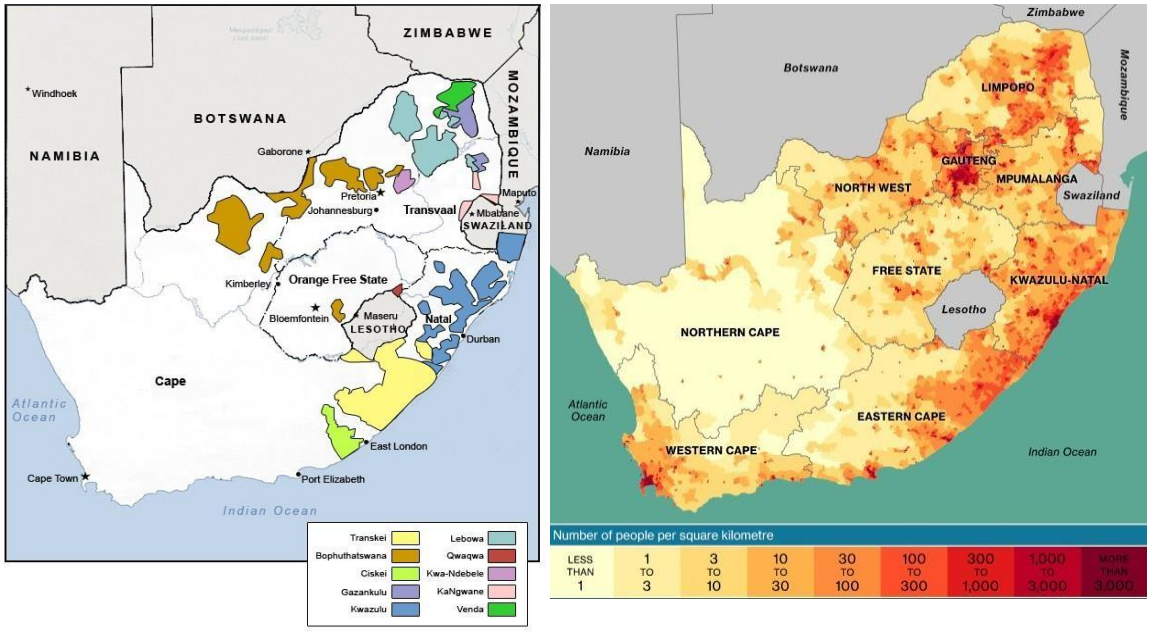
iv. In 1970, the Bantu Homelands Citizenship Act Number 26 compelled 'Black' South African homeland residents to be citizens of these areas, stripping them of South African nationality and the right to work in the designated 'White' South African land.

Figure 1.1 (left map) illustrates former homeland areas which are primarily situated in LIM, MP, NW, KZN, and EC provinces. Figure 1.1 (right map) showcases high population densities around former homeland areas and major cities in present-day South Africa.

The enduring impact of pre-1994 legislative measures is evident in contemporary settlement and demographic patterns, such as labour migration to farms, mines, cities, and major centres in search of better livelihoods. A feminisation of migration has also emerged, propelled by increased female labour market participation. This is mirrored by the growing trend of women migrating to urban centres (Camlin, Snow, & Hosegood, 2014). Camlin, Snow, & Hosegood noted a significant presence of older women in rural households and observed that the absence of older men and husbands facilitated the migration of working-age women. These migration dynamics have led to socioeconomic challenges in departure and destination areas. For

instance, the influx of urban migration might have alleviated the socioeconomic pressures on rural communities while potentially exacerbating issues associated with informal settlements in urban areas (Pashapa & Rivett, 2018).

Figure 1.1 Former Homeland Areas of South



Map Sources: http://overcomingapartheid.msu.edu/listmaps.php; http:// wikipedia/commons

1.2.2 Demographic Profile

As per the 2011 census report for South Africa (STATS SA, 2012), the country's population surged from 40.5 million in 1996 to 51.8 million in 2011. The report highlights a decline in the population aged between 5 and 14, attributed to elevated mortality rates linked to HIV/AIDS. Between 2001 and 2011, the population of the GT province increased from 18.8 percent to 23.7 percent of the national population. South Africa's rural populace displayed a notable preponderance of females, particularly in communal rural areas. Gender ratios indicated that both the LIM and EC provinces recorded sex ratios below 90 males per 100 females in the years 1996, 2001, 2007, and 2011.

Drawing from the 2011 census data, Table 1.1 delineates the demographic traits of South Africa, categorised by province, geographical location, sex, and average household size. Provinces such as EC, KZN, LIM, MP, and NW exhibited significant proportions of inhabitants residing in communal rural settings. Conversely, FS, GT, NC, and WC provinces showcased substantial populations concentrated in urban areas. The census data of 2011 further underscored that commercial farm regions predominantly housed male populations, whereas communal rural zones featured a pronounced presence of the female demographic. Moreover, communal rural areas were characterised by larger average household sizes and a notable prevalence of female-headed households. The findings also highlighted a higher incidence of child mortality that was attributable to HIV/AIDS in primarily urban provinces such as GT, WC, and FS, in contrast to largely communal rural areas encompassing the MP, LIM, and EC provinces.

Table 1.1 Population Distribution by Province, Sex Distribution of Population, and Sex Distribution of Household Head

		Area Type			Overall
		Urban	Communal	Commercial Farms	
		Distribution by Province			
		%	%	%	%
Percentage population	EC*	46	52	3	100
	FS	84	9	7	100
	GT	97	1	2	100
	KZN	48	46	7	100
	LIM*	18	78	4	100
	MP*	43	49	8	100
	NW*	44	46	10	100
	NC	76	16	8	100
	WC	92	--	8	100
	Overall	63	32	5	100
		Sex Distribution for Overall Population by Area Type			
		%	%	%	%
Sex	Male	49	46	53	49
	Female	51	54	47	51
		Sex Ratios by Area Type			
	Sex Ratio	97.6	86.7	113.5	94.8
		Sex Distribution of the Household Head by Area Type			
		%	%	%	%
Household Head	Male	62	47	73	59
	Female	38	53	27	41
		Average Household Size by Area Type			
	Mean size	3.3 people	4.2 people	3.6 people	3.6 people

Source: STATS SA (2011)
Note: * Predominantly contain communal rural areas

1.2.3 Service Delivery Context

Service delivery pertains to the governmental responsibility of furnishing citizens with public infrastructure, household amenities, and communal services such as schools, roads, hospitals, police assistance, water supply, sanitation, electricity, and similar provisions (Reddy, 1999). In line with this objective, the South African government embarked on a mission to narrow the socioeconomic gap (as explored in Section 1.2.1) by ensuring the availability of essential services at no cost to citizens. This encompasses the provision of certain vital provisions, such as:

- Six kilolitres of free basic water (FBW) within 200 meters of each household.
- Free basic sanitation (FBSan) offered through a ventilated pit latrine toilet (VIP) as the minimum acceptable sanitation facility per household.
- Allocation of 50 kWh of free electricity per household every month (BEEng) (SAHRC, 2014).

Moreover, the government introduced the RDP aimed at rectifying spatial and gender inequalities (O'Malley, 2019). The RDP sought to offer marginalised communities access to complimentary and affordable public amenities, including formal housing, potable water, electricity, healthcare facilities, and various public services.

Despite these concerted developmental initiatives, approximately 11 percent of the nation's households, primarily concentrated in rural settlements within KZN, NW, and EC provinces, continued to experience inadequate service provision (SAHRC, 2014). Table 1.2 displays the proportion of households with access to water sources meeting RDP criteria.

Table 1.2 Percentage Distribution of Households with Access to RDP-Acceptable Water per South African Province (October 2011)

	RDP Acceptable			Not RDP Acceptable	
	Piped Water Within Yard	Piped Water Within Stand	Piped Water Within 200m of Stand	Piped Water More than 200m from Stand	No Access to Piped Water
Province	%	%	%	%	%
EC*	33	17	19	10	22
FS	45	44	6	3	2
GT	62	27	6	3	2
KZN	40	24	15	8	14
LIM*	18	34	21	13	14
MP*	36	36	9	7	13
NW*	29	40	14	8	8
NC	46	32	13	7	3
WC	75	13	8	2	1
	46	27	12	6	9

Source: SAHRC (2014)
Note: * Predominantly contain communal rural areas

Table 1.3 outlines the percentage of households within each province that adhere to satisfactory RDP-sanctioned sanitation. These tabulations (Table 1.2 and Table 1.3) are rooted in the established benchmarks for acceptable communal provisions (FBW, FBSan, and BEEng). EC, KZN, LIM, MP, and NW provinces registered the highest percentages of households lacking access to water sources and sanitation facilities meeting the prescribed minimum standards.

Table 1.3 Percentage Distribution of Households with Access to RDP-Acceptable Sanitation per South African Province (October 2011)

	RDP Acceptable			Not RDP Acceptable		
Province	Flush	Chemical	VIP Latrine	Pit Latrine	Bucket	None
	%	%	%	%	%	%
EC*	43	3	14	20	2	13
FS	67	1	87	14	6	3
GT	85	1	2	7	2	1
KZN	45	8	14	21	2	6
LIM*	22	1	15	53	1	7
MP*	44	1	12	34	1	6
NW*	45	1	11	34	1	6
NC	66	1	9	11	4	8
WC	90	1	1	1	4	3
OVERALL	60	3	9	13	2	5

Source: SAHRC (2014)
Note: *Provinces with former homeland areas

1.3 Study Motivation, Research Question, and Thesis Structure

1.3.1 Motivation

Understanding the relationship between rurality and ICT proliferation in low- and middle-income contexts is crucial for tailoring technology-driven service delivery strategies to rural areas within the context of limited resources. In that regard, in the current context of the digital age, there is a growing demand for comprehensive investigations into the public value of ICTs in low- and middle-income country contexts, especially in remote rural areas, within service-centric models of public management (Twizeyimana & Anderson, 2019).

Following South Africa's post-1994 transition, new management styles and service-dormant models emerged, leading to a landscape shaped by e-government models that leverage ICT benefits, though their effectiveness in developing contexts and marginalised populations remains debated (Cameron & McLaverty, 2008; Chipkin & Lipietz, 2012; Verkijika & de Wet, 2018; Twizeyimana & Anderson, 2019). Osborne, Radnor & Nasi (2013) stress the importance of studies that contribute to our understanding of the impact of ICTs in service-dominant approaches to public service delivery. Furthermore, Paletti (2016) and Cordella & Paletti (2018) emphasise the significance of comprehending the correct implementation of co-production practices through ICTs and the implications in terms of possible structural changes in public administration.

Rural areas encompass a variety of communities, including affluent, deprived, agricultural, industrial, stable, mobile, and other potential futures (Rousseau, 1995). South Africa's settlements comprise of prosperous commercial lands and communal lands that are not adequately captured by urban-rural dichotomous classifications (Schmidt, 2012). The country's presidential commission (NPC, 2012) has stressed the importance of recognising the differentiated nature of rural areas and the need for varying resource allocation. South Africa's constitution categorises settlements into three types: metropolitan, local, and district (RSA, 1996). These classifications were further developed by CoGTA and DBSA into seven categories that define two types of rural settlements (DNT, 2017). While these categories are straightforward and align with information on municipality boundaries and censuses, they do not take into account differences in the areas of settlements and international best practices amongst other concerns (Schmidt & du Plessis, 2011).

The current South African context reflects various development efforts that have improved access to healthcare, education, and social grants (Pauw & Mncube, 2011; DBE, 2011; Fusheini & Eyles, 2016). Post-1994, expanded transport and communication networks further influenced rural areas. Additionally, advancements in technology, affordable ICTs, and mass media have created new channels for communication and information dissemination. The need to develop rurality measures for South Africa arises from evolving contextual characteristics over time (Prieto-Lara & Ocaña-Riola, 2010; OECD et al., 2021). Existing sector-specific measures are limited, as they were designed for organisational or sectoral purposes, such as allocating allowances in education and health (Schmidt & du Plessis, 2011; Eagar et al., 2014). Creating effective measures requires understanding the value of ICTs in rural contexts. While rural

typologies, such as CSIR's, align with most government planning frameworks, they require enhancements for better synchronisation with census data, adherence to international best practices, and improved usability (Schmidt & du Plessis 2011).

Recent studies reflect the importance of rural indicators that reflect peripherality, adjacency, contextuality, and demographic characteristics (Neumeier, 2011; Pagliacci, et at., 2016; Borders, 2017; Nelson, et al., 2021). Additionally, indicators should focus on addressing the lack of data on vital rural aspects—such as cultural characteristics, environmental quality, and infrastructure quality—while considering factors like the replicability and accessibility of data and methods used. Schmidt & du Plessis (2011) suggest that CoGTA's classifications, which are the most widely used South African rurality measures, could be enhanced by incorporating factors such as contiguity, flows, poverty, and service accessibility. It is also crucial to develop rural measures independently, rather than basing them solely on urban characteristics (Martin et al., 2000; Chigbu, 2013).

More crucially, the South African National Spatial Development Framework (NSDF), as outlined in NSDF, Government Gazette 47999 (2023) and mandated by the Spatial Planning and Land Use Management Act of 2013, serves as a strategic plan aligned with the NDP, extending up to 2050. The NSDF emphasises the importance of delivering services in locations where they will have the greatest developmental impact, ensuring adherence to universal access and design principles, and benefiting the largest possible number of inhabitants. This highlights the need to understand the unique needs of diverse rural populations and develop robust rurality measures capable of identifying such areas effectively.

1.3.2 Research Question and Objectives

The primary question examined in this study was: '*What is the relationship between rurality and ICT proliferation in the service-dominant approach to public service delivery in low- and middle-income contexts?*' Given the substantial socioeconomic disparities prevalent in the country, the study explored how rurality, as indicated by enhanced quality of service delivery, can be attributed to the context of ICT proliferation, and people-centric transformation and development. The study was guided by the following objectives:

i. *To elucidate the underpinnings of the current state of access to improved public service delivery (including infrastructure, household amenities, and public services) within the South African rural context.*

   Section 1.2, Chapter 2, and Chapter 3 provide a comprehensive review of the background regarding rurality and access to public services within the framework of existing public service delivery models. These reviews focus on rural development, the distinctive nature of these areas, and the evolution of service delivery models.

ii. *To expound upon the impact of ICT proliferation on public service delivery in the South African rural context.*

   Chapter 6 undertakes an exploration of the role played by ICTs in facilitating rural transformation, drawing from interview responses of rural stakeholders. Sections 6.1 and

6.2 delve into an examination of ICT proliferation and its correlation with the enhanced quality of public services within rural households.

iii. *To elucidate the concept of rurality in the digital era by updating the country's rurality measures in accordance with the prevailing context of ICT proliferation.*

Building upon insights gleaned from the reviewed literature and interviews (Chapter 2 and Chapter 6, respectively), Chapter 8 formulates rurality measures tailored to the studied context.

A sequential exploratory mixed methods research design was employed to conduct this study, with the theoretical foundation rooted in the service-dominant approach to public service delivery. In the qualitative component, the study utilised the C4D framework to comprehend the nature of development communication facilitated by ICTs and in the quantitative component, a spatial rurality model was adapted to delineate South African settlements (AvRuskin, 2000; OWI, 2004; & Lennie and Tacchi, 2011; Tacchi, 2020).

The choice of a mixed methods approach was ideal due to the necessity of acquiring a contextualised and holistic perspective on the research topic. Qualitative data were gathered through interviews with rural stakeholders, while the quantitative component of the study relied on data from the 2011 South African census and other sector-specific data sources. The 2011 census data were used because the data for 2021, especially for other sectors (schools and healthcare data), were not yet been publicly released or easily accessible during the course of the study. However, the research methods employed are adaptable to new data sources when they become available, and they provide a basis for comparison with the analysis of the later data.

Studies have highlighted a shift in the approach to categorising places, moving from the question 'Is a place rural or urban?' to 'To what degree is a place rural?' and more comprehensive measures (Waldorf, 2006; Pagliacci, Esposti, Camaioni, & Sotte, 2016; Nelson, et al., 2021). The synthesis of findings from the literature review, interviews, and the derived rurality measures culminates in a discourse on rurality in the digital age and the role of ICTs in the service-dominant approach to public service delivery in low- and middle-income countries.

1.3.3 Thesis Structure

The thesis commences with a literature review (Chapter 2), encompassing publications concerning the characteristics of rural areas in South Africa and the plans aimed at their transformation and development. Chapter 3 offers an examination of the theoretical foundation underpinning the study's subject based on further review of literature that expounds on the study's knowledge contributions. Chapter 4 delineates the research design, whereas Chapter 5 expounds upon the data collection process and the utilisation of secondary data in the investigation. The presentation of qualitative data analysis is in Chapter 6. Subsequently, the follow-up quantitative analysis in Chapter 8 is derived from a review of methodologies and approaches to measuring rurality, discussed in Chapter 7 Chapter 9 outlines the study's findings and engages in discussion, culminating in the study's conclusion in Chapter 10.

2 SOUTH AFRICAN RURALITY IN THE DIGITAL AGE

The conventional standardisation of deprivation measures has often led to a bias that neglects specific dimensions of deprivation prevalent in rural settings, vulnerability related to age, and proximity to essential service centres (Martin, Brigham, Roderick, Barnett, & Diamond, 2000; Chigbu, 2013; Peterson, Turgesen, Fisk, & McCarthy, 2017; Bernard, 2018; Fecht et al., 2018). In this era of digital advancement and consumer-centric service delivery initiatives, there is a growing expectation for policymakers to facilitate knowledge sharing among rural community members rather than allocating scarce resources to introduce new information and technology that may not yield benefits for rural populations (Chaminuka, Belete, & Moholwa, 2004; Chigbu, 2013; Maunganidze, 2016; Tharakan, 2017; Mudemba, Taruvinga, & Zhou, 2021). The objective of the literature review presented in this chapter is to examine the concept of people-centric service delivery in the digital era based on the South African context.

2.1 South African Rural Transformation Post-1994 Era

2.1.1 Political Influences on Rurality

After 1994, two phases of the transition of municipal demarcation laws occurred. The first phase, guided by the Local Government Transition Act of 1993, was concerned with the political unification of previously divided municipalities, and the second focused on developmental local government, which merged some urban and rural areas without regard for regional differences (Atkinson, 2003). The Municipal Demarcation Act Number 27 of 1998 and the Municipal Structures Act Number 117 of 1998 were promulgated, with the former act created to demarcate boundaries for 284 new municipalities, and the latter for structural, political, and functional institutions for metropolitan, district, and local municipalities (district and local municipalities shared jurisdiction over rural municipalities, with the former also having jurisdiction in several adjacent municipalities) (Nyalunga, 2006; Powell, 2012). In essence, the new constitution gave municipalities the central role of reducing poverty, providing basic services, and supporting economic growth goals under conditions of budget contraction and tighter treasury controls (Powell, 2012). The haste with which the transition was attempted meant that insufficient consideration was given to the ideal form of local government required to cater to the most under-serviced areas (Parnell, 2002; Powell, 2012). In hindsight, minimum attention was given to the enormous challenges of fulfilling huge development mandates since municipal functions were mainly driven by the need for social inclusion and redress (Atkinson, 2003; Perret, Anseeuw, & Mathebula, 2005; Nyalunga, 2006; Jeeva & Cilliers, 2022). In later years, huge inter-provincial service delivery backlog disparities still existed for municipalities that absorbed former homelands (Powell, 2012).

Figure 2.1 Constitutional Act number 155 of 1996

Establishment of municipalities

155. (1) There are the following categories of municipality:
- (a) Category A: A municipality that has exclusive municipal executive and legislative authority in its area.
- (b) Category B: A municipality that shares municipal executive and legislative authority in its area with a category C municipality within whose area it falls.
- (c) Category C: A municipality that has municipal executive and legislative authority in an area that includes more than one municipality.

(2) National legislation must define the different types of municipality that may be established within each category.

Source: RSA (1996)

In addition, as outlined in Figure 2.1, constitutional classifications implemented after 1994 did not clearly distinguish between municipalities in urban and rural areas. The primary differentiation made was between local (Category B) and district municipalities (Category C) (CoGTA, 2009b). Subsequently, CoGTA introduced a refined classification system (Table 2.1) aimed at providing more comprehensive insights into municipalities (Schmidt & du Plessis, 2011). District municipalities (C1 and C2) provided bulk regional services to B1, B2, B3, and B4 municipalities while metropolitan (A) municipalities executed both municipality and district municipality duties (Nel & Minnie, 2022). According to DNT (2012), CoGTA's rural classifications utilised variables that included the number of impoverished households (based on household income), the percentage of households with access to water, sanitation, and electricity, and information concerning municipalities' capital and operating budgets. In essence, CoGTA characterised South African regions based on indicators such as agriculture, former homeland status, population distribution, dependency on social grants, housing conditions, and deficiencies in public amenities. These classifications did not account for differences in the sizes of municipalities, and they were perceived as subjective and outdated by scholars (Schmidt & du Plessis, 2011; Jeeva & Cilliers, 2022).

Table 2.1 Municipal Classification Framework by CoGTA and DBSA

Class	Characteristics	*N*
Metros (A)	Category A municipalities	6
Secondary cities (B1)	All municipalities referred to as secondary cities	21
Large towns (B2)	All municipalities with an urban core. There is a huge variation in population sizes amongst these municipalities, and they do have a large urban-dwelling population	29
Small towns (B3)	These municipalities have a relatively small population, a significant proportion of which is urban and based in one or more small towns. Rural areas in this category are characterised by commercial farms, as these local economies are largely agriculturally based. The existence of such critical rural areas explains its inclusion in the analysis of rural municipalities	111
Mostly rural (B4)	These are characterised by the presence of at most one or two small towns in their areas, communal land tenure and villages or scattered groups of dwellings and typically located in former homelands	70
Districts (C1)	District municipalities that are not water services providers	25
Districts (C2)	District municipalities that are water service providers	21

Source: DNT (2012)

2.1.2 Rural Development Initiatives

2.1.2.1 RDP

Immediately after 1994, the RDP served as an initial endeavour to construct a unified, non-racial, and non-sexist nation guided by the principles of inclusivity (NPC, 2011). The RDP bestowed upon local governments a broad mandate to advance people-centred governance and elucidated the fundamental tenets of democratic local government. These principles included a unified tax base, participatory governance, cross-subsidisation of service delivery, and cancellation of debts accumulated by previously 'non-South African' local authorities (Powell, 2012). A fundamental principle of the RDP was to unify growth, development, reconstruction, and redistribution into a cohesive program bolstered by infrastructure initiatives aimed at delivering access to modern and effective services encompassing electricity, water, telecommunications, transport, health, education, and training services (Adelzadeh & Padayachee, 1994).

2.1.2.2 NDP

According to NPC (2012), subsistence agriculture was expected to promote the self-sustenance of rural households to boast commercial-scale agriculture to produce food for rural and urban areas. Consequently, NPC proposed the development of infrastructure and services to support agriculture. DRDLR (2013) outlined the country's rural development vision of building vibrant, equitable, and sustainable rural communities that were guided by the medium-term strategic framework (MTSF) as an ongoing cycle of the nation's development plan, NDP. The objectives of the initiative were as follows:

i. *Facilitate Rural Livelihood Development:* support rural communities in prioritised rural districts to improve their livelihoods by 2020.
ii. *Infrastructure Development to Support the Rural Economy:* Facilitate infrastructure development to support rural economic transformation by 2020. Rogerson & Nel (2016) explain that in 2012, South Africa launched a national infrastructural plan to transform the economic landscape, galvanise new job opportunities and strengthen the delivery of basic services. The program was grounded upon building and strengthening social (healthcare, schools, water, sanitation, schools) and economic infrastructure, including support for investment in new power stations.
iii. *Support for Rural Enterprises and Development of Rural Industries:* Support rural enterprises and industries in areas with economic development potential and opportunities towards the year 2020.
iv. *Job Creation and Skills Development in Rural Areas:* Increase job opportunities and ensure skills development through a comprehensive rural development programme (CRDP) and land reform initiatives towards the year 2020.

South Africa rural development quarterly in the national infrastructure plan (DNT, 2012) summarised rural development as 'positive advancement in rural areas through the improvement of rural institutions and systems, expansion of rural infrastructure, and growth in rural economic activities.' According to DNT, the policy on rural development informed the comprehensive rural development strategy, which established

agricultural transformation and land reform as pillars of rural development alongside infrastructure provision (schools, clinics, boreholes, and water reticulation systems) that would support both agrarian development and service delivery to rural households.

2.1.2.3 National Spatial Development Framework (NSDF)

The NSDF presents a theory of change to shift the nation away from its unsustainable spatial development pattern and eliminate its detrimental impact on the government's ability to achieve national development objectives (National Spatial Development Framework, Government Gazette 47999, 2023). The NSDF, mandated by the Spatial Planning Land Use Management Act of 2013, is a strategic plan aligned with the NDP and extends up to the year 2050. The framework provides a visual representation of the desired national spatial development pattern, establishes national spatial directives for infrastructure investment and development across the country, and outlines national strategic spatial areas for targeted investment.

Among its nine shapers of national development, the NSDF identifies ruralisation as a key factor, emphasising the need for decisive and sustainable rural development and agrarian reform. NSDF (2023) further explains that rural land reform will make underutilised commercial agricultural and state-owned land available for new entrants in the farming and wildlife sectors and that municipalities must ensure new and appropriate land management in these areas. Rural communities will increasingly demand better levels and higher speeds of connectivity—both by road and rail, as well as through broadband. At the same time, there will be growing demands on the government for quality social, educational, health, and police services. The NSDF emphasises the importance of providing services where they have the greatest developmental impact, adhere to the principles of universal access and design, and serve the largest number of inhabitants. Priority will be given to serving the youth, particularly young women and people with disabilities, as well as retirees.

Among its levers of development, '*Productive Rural Regions as Drivers of National Rural Transitions*' and '*National Transport, Communications, and Energy Infrastructure Network*' outline key initiatives for rural spaces. The '*Productive Rural Regions as Drivers of National Rural Transition*' lever, under the Regional-Rural Development Model, aims to:

i. Develop transport networks linking rural areas to rural hubs and urban centers,
ii. Propose the preparation of rural regional development plans,
iii. Fast-track land reform under a rural-regional development plan that ensures the optimal location of agricultural land and housing stands in towns,
iv. Promote the wise management of natural resources,
v. Provide social services in villages, towns, and regional development anchors in the most efficient manner,
vi. Preserve rural areas and empower rural inhabitants to become agents of change.

The '*National Transport, Communications, and Energy Infrastructure Network*' aims to establish a well-functioning and well-managed national transport and connectivity infrastructure network that ensures and

enables the following: safe and efficient movement and transport of people, rapid and reliable flow of information and communication, efficient transportation of goods, provision of essential services, and active participation and interaction in the global economy.

2.1.3 Advancements in Public Service Delivery

While communal rural areas within former homeland regions may be densely populated in comparison to commercial farming areas, population density alone was found to be an insufficient criterion for identifying rurality because of the contrasting socioeconomic conditions between former homeland areas and emerging pockets of densely populated urban settlements (Rivett, Champanis, & Wilson-Jones, 2012). Some rural regions had scattered and densely populated town centres with limited economic base apart from transfer payments (Rural Development task Team and the Department of Land Affairs Republic of South Africa, 1997; DNT, 2012). There were also improvements observed in terms of domestic access to water and sanitation in former homeland areas between 2001 and 2009 (SACN, 2011; DNT, 2012). However, an ongoing debate surrounds the notion that former homeland areas experienced a lack of capital investment in public services for an entire generation. Consequently, there is a need to adequately comprehend the current state of rurality by considering any progress that may have transpired over the years (NPC, 2012).

2.1.3.1 Household Services

Water and Sanitation

As an example, inadequate access to household water and sanitation had adverse effects on the educational opportunities of girls in rural schools, as they often had to spend extended periods fetching water for their families (Devnarain & Matthias, 2011). Consequently, it became imperative to establish the right for households to have free access to six kilolitres of water (FBW) and basic sanitation services (BSan), all within a 200-meter radius of each household dwelling (Section 1.2.3). Between 2001 and 2011, substantial progress was made, particularly in enhancing services, with a notable focus on improving access to water due to the lower installation costs associated with water services in comparison to sanitation (Gool, 2013). However, despite the implementation of large-scale programs aimed at enhancing water access, the primary challenge remained the consistent and uninterrupted delivery of this service (Sherwill & de Coning, 2004; Majuru, Jagals, & Hunter, 2012; Majuru, 2015; Lebek, Twomey, & Krueger, 2021).

Housing

In post-apartheid South Africa, housing provision encompassed three main streams of services: private sector housing (provided and financed by the public sector), state housing (government-subsidised housing for low-income earners), and self-help housing (where communities pooled resources and labour for construction) (Landman & Napier, 2010). Household dwellings, as defined by STATS SA (2014b), include brick housing structures, traditional dwellings, flats or apartments, cluster houses, semi-detached houses in complexes, semi-detached houses, dwellings or houses or flats in the backyards, shacks in backyards, shacks not in the backyards,

granny flats, caravans, and any other types of dwellings. STATS SA utilised four area classifications: formal urban, informal settlements, formal rural, and tribal rural areas. These classifications are often associated with the predominant type of dwelling in each area. For instance, informal urban settlements were characterised by a prevalence of shacks, traditional family dwellings were dominant in tribal rural areas, and planned formal building structures were the primary feature of formal urban areas (Musango, 2014).

Electricity

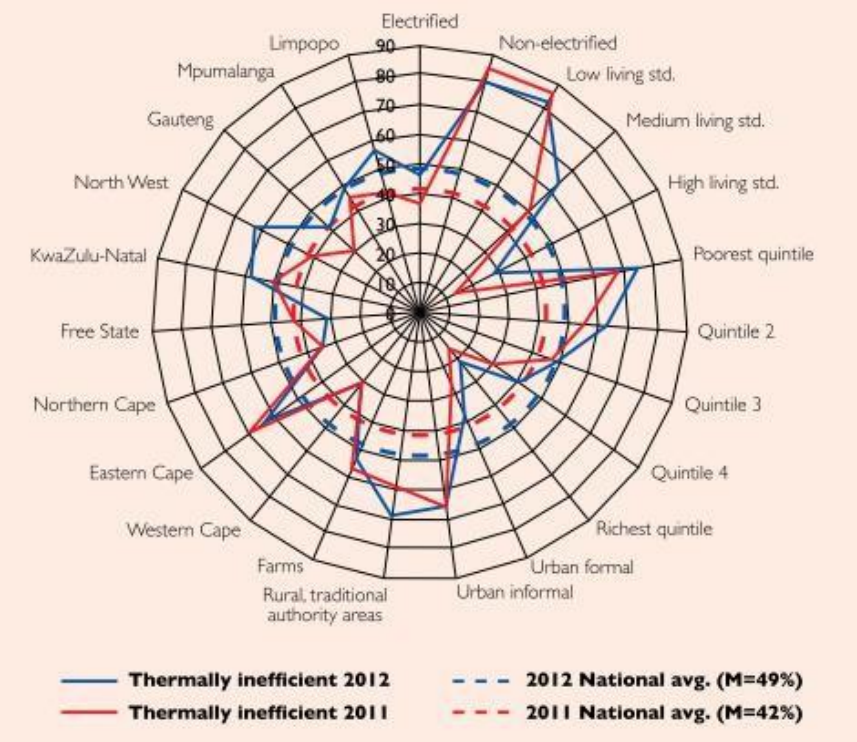
Electricity plays a crucial role beyond being a household energy source for cooking, heating, and lighting; it is essential for facilitating services such as education and healthcare. For instance, the electrification of clinics and schools has resulted in significant benefits, including improved healthcare services, expanded opportunities for evening adult education at schools, and enhanced efficiency in school operations through the use of equipment such as photocopiers, printers, computers, and the Internet (Davidson & Mwakasonda, 2004).

Back in 1993, only 36 percent of the population was connected to the national electricity grid. However, with the introduction of the National Electrification Programme (NEP), the target of 66 percent electrification was surpassed by the year 2001 (Davidson & Mwakasonda, 2004). This substantial expansion can be attributed in part to the lower electricity costs enabled by the country's abundant coal deposits (Eberhard & Mtepa, 2003). Financial models for the national electrification program informed the ambitious goal of achieving 2.5 million household connections by 1999 (Davidson & Mwakasonda, 2004).

Despite the progress, the provision of electricity to rural households did not generate profitable revenue, as it required heavy subsidies (DNT, 2012; Jamal, 2015). It was noted that connecting rural households to the national grid required expensive transmission and distribution systems (Jamal, 2015). Therefore, establishing off-grid alternatives, such as renewable energy sources like solar and wind, near the most underserved rural areas, would ensure efficient electricity access to the country's most deserving regions (Mannak, 2018; Baruah & Enweremadu, 2019). Additionally, feasibility studies noted that the suitability of off-grid electricity varied between provinces (for example, EC, NC, and WC provinces are better suited to wind-generated energy due to their proximity to the coastline) (Jamal, 2015).

DoE (2013) used the expenditure-based, subjective, and thermal inefficiency approaches to determine energy poverty. Energy poverty is the lack of adequate, affordable, reliable, quality, safe, and environmentally sound energy services to support development (Habitat for Humanity, 2021). Living standards and the household dwelling type were important attributes that determined household energy poverty (DoE, 2013). As shown in Figure 2.2, residents of the EC and NW (65 percent and 62 percent, respectively), people who resided in rural traditional authority areas (69 percent), informal urban settlements (66 percent), or on rural farms (54 percent) were likely to suffer from thermal inefficiency (DoE, 2013).

Figure 2.2 Percentage of Thermal Inefficient Homes per Province



Source: DoE (2013)

More recently, the country has experienced electricity shortages largely attributed to mismanagement, debt, and unpaid services (Baker & Phillips, 2019). The electricity supply commission (ESKOM) accounted for over 90 percent of the country's electricity supply (Davidson & Mwakasonda, 2004).

2.1.3.2 Public Infrastructure and Services

Access to Healthcare

To overcome socioeconomic barriers to accessing healthcare, South Africa reformed its health system by developing a national health insurance (NHI) programme designed to pool funds to provide affordable health services for its citizens (Fusheini & Eyles, 2016). As a reflection of the country's public healthcare focus, the country has one of the most extensive HIV/AIDS antiretroviral programmes in the world, and approximately 84 percent of the county's population relied on public health services (Mayosi et al., 2012; Naidoo, 2012).

For South Africa, geographic accessibility, the distribution of healthcare workers in rural and urban areas, a shortage of healthcare facilities and supporting infrastructure such as roads, piped water and electricity, service acceptability, and financial accessibility were barriers to accessing health services (Coovadia et al., 2009; Eagar et al., 2014; Mayosi & Benatar, 2014; Sewell, Desai, Mutasaa, & Lottering, 2019). Poor living and working conditions, and inadequate personal development opportunities needed to be addressed to retain South African medical staff (Mburu & George, 2017). Even though financial and socioemotional support was provided to return

medical students in their home areas, the students also valued the availability of jobs in their home communities upon completing their studies (Mbemba, Gagnon, & Hamelin-Brabant, 2016). Studies in other countries reiterated that opportunities for professional advancement, professional support networks, and rural financial incentives affected the retention of medical professionals (Mbemba et al., 2016).

Differences in population health status and service delivery between districts and the possible tensions between the ideologies of universal health coverage (UHC) and decentralisation implied that service readiness and availability should be based on the unique needs of South African districts (Fusheini & Eyles, 2016). For example, in the FS province, staff shortages, infrastructure, and budget constraints negatively impacted effective and efficient service delivery, and in the LIM province, the lack of sufficient doctors, poor infrastructure, and poor living conditions had a negative impact on health service (DoH, 2014a). Over half of NC and MP's medical practitioner posts were vacant (George, Quinlan, Reardon, & Aguilera, 2012).

Information on the spatial distribution of health services is paramount for informing coordinated, evidence-informed responses to migration and morbidity (Vearey, 2014). Due to the unavailability of advanced health services in the immediate locale, rural dwellers generally travelled long distances to service centres, especially for advanced referrals available at district, provincial, and national hospitals. Rural-urban labour migrants who got sick for extended periods, particularly due to HIV/AIDS, were observed to migrate back to their areas of origin (Vearey & Nunez, 2010). Thus, a comprehensive response was needed to maintain the health of migrants in urban areas while supporting rural areas in times of high burden of disease (Vearey, 2012). Table 2.2 presents a summary of literature on South Africa rural public healthcare.

Table 2.2 Summary of Literature on South Africa's Public Healthcare and Rurality

Publication	Relevance
Research Article	
Healthcare disparities across districts in relation to health profiles/demographics, health delivery performance, management of health institutions or district management capacity, income levels, socioeconomic status and social determinants of health, compliance with quality standards and above all, the burden of disease can only be minimised through positive discrimination by paying more attention to underserved and disadvantaged communities (Fusheini & Eyles, 2016).	The necessity to direct services towards underprivileged communities
This review synthesises the significant factors impacting healthcare professionals' recruitment and retention in South African rural and remote areas (Mbemba et al., 2016).	Factors influencing recruitment were rural background, rural origin, and career development. Opportunities for professional advancement, professional support networks, and financial incentives
This paper utilises empirical studies conducted in South Africa to explore linkages between migration into urban areas and health, focusing on HIV. The relationship between migration and HIV is complex. Both internal and international migrants move to urban areas for reasons other than seeking healthcare, and most migratory movements into urban areas involve healthy individuals (Vearey, 2012).	Migration and healthcare
Improvement in quality of care means fewer errors, reduced delays in care delivery, improvement in efficiency, increased market share and lower cost. The decline in quality healthcare has caused the public to lose trust in the country's health system. The study identifies challenges that compromise quality in the health sector, including strategies employed by the government to improve the quality of health delivery (Maphumulo & Bhengu, 2020).	Characteristics of quality healthcare in the South African context
South Africa's troubled past has inexorably affected health and health services. In 1994, when apartheid ended, the health system faced massive challenges, many of which persist. Macroeconomic policies, fostering growth rather than redistribution, contributed to the persistence of economic disparities between races despite a large expansion in social grants. The public health system has been transformed into an integrated, comprehensive national service, but failures in leadership and stewardship and weak management have led to inadequate implementation of what are often good policies (Coovadia et al., 2009).	Historical and current context of South African public health systems
The study reviewed the human resource needs of the South African health sector (George et al., 2012).	Skills need and area differentials

An understanding of migration is poor within sectors responsible for developing appropriate responses; negative, unsupported assumptions relating to the prevalence of cross-border migration, the spread of disease, and the burden on receiving health systems prevail. In SA, public health responses fail to address internal and cross-border mobilities, and non-nationals face challenges in accessing healthcare (Vearey, 2014).	Migrant's healthcare. Migration and public health services
Reports and Government publications	
Targeted policy and resourcing will only be possible if rural is clearly defined and if this definition has practical utility for policy development and implementation. An examination of the evidence from outside South Africa has demonstrated that due to vast contextual diversity within rural settings, identifying a single definition of rural is impossible in practice (Eagar et al., 2014).	Importance of rurality definition and public health service provision
Documentation of the DoH's policies and development plans (DoH, 2014a).	Policies and development plans
Seven hundred forty million people are estimated to have moved within their countries of birth, and 214 million people (3.1% of the global population) are estimated to have crossed borders. Regional, national, and local governance structures must find ways to manage migration within a public health framework (Vearey & Nunez, 2010).	Demography and healthcare Migration and healthcare

Basic Education Services

In the years after 1994, to move away from the apartheid-era legacy, the country was determined not to treat 'rural education' as a distinct category, but at local government levels, the realities of rural schools were later directly confronted (Gardiner, 2008). Rural communities were still difficult to reach; the physical conditions in schools were inadequate, communication network coverage was poor, and learner performance compared to urban schools was weak (Gardiner, 2008; Hlalele, 2014; Muhuro & Kangethe, 2021). Hence, a study by the Nelson Mandela Foundation (2005) argued that basic schooling in rural areas depended on the context within which schooling took place and how rural communities experienced education. Seroto (2012) recommended a rethink of strategies for reconstructing rural communities and increasing involvement in providing resources to learners in rural schools.

A major problem was the lack of secondary schools (Nelson Mandela Foundation, 2005). To minimise the distances learners travelled for secondary schooling, a strategy was implemented where primary and secondary education were offered at combined or intermediate schools (KZNDoE, 2012). DBE (2011) defined the following terminology to describe South African schools:

i. Special schools (delivered education to learners who had physical, intellectual, or sensory disabilities),
ii. Ordinary schools (schools that are not special schools),
iii. Primary schools (offered learning from Grade R to Grade 7),
iv. Combined (offered a selection of grades between Grade R and Grade 12, but such a selection was not in line with the grade limits of either primary or secondary schooling),
v. Intermediate (offered a selection of grades between Grade R and Grade 12, but such a selection was not in line with the grade limits of either primary or secondary schooling),
vi. Secondary (offered the lowest level of Grade 8 and the highest level of Grade 12. There were also institutions included in this group that provided a selection of grades within these limits).

Combined schools were characterised by poor service quality as a result of overpopulation. As such, there have been advances to separate primary and secondary schools to cater for learners' social well-being in different age groups, specialist teaching and learning practices, avoiding overcrowding, availing appropriately qualified educators, and focused management (KZN DoE, 2012).

The provision of basic services and the availability of school infrastructure were some of the factors cited concerning the education standards of rural areas (Nelson Mandela Foundation, 2005). DBE (2011) presented data on access to school facilities in ordinary South African schools. The services studied were access to basic amenities (electricity, water, and toilet), school security, access to libraries, access to computer centres, access to laboratories, sports facilities, and the Internet (Table 2.3). There were lower access levels to services and infrastructure for predominantly communal rural provinces (EC, KZN, LIM, NW, and MP). Access to libraries, laboratories, computer centres, and the Internet were comparatively lower than the levels for water, sanitation, fencing (school security), and access to sports facilities. Table 2.3 illustrates provincial differences in basic education infrastructure. Schools in provinces with former homeland areas had less developed supporting infrastructures such as roads, water, sports facilities, and electricity.

Table 2.3 Percentage Distribution of Ordinary Schools with Access to Amenities per South African Province

	Electricity	Water	Toilet	Fencing	Library	Science Laboratory	Computer Laboratory	Sports	Internet
Province	%	%	%	%	%	%	%	%	%
EC*	20	19	65	20	90	91	89	7	96
FS	15	15	45	8	74	79	78	39	85
GT	1	0	4	3	41	60	25	15	62
KZN	27	11	50	8	80	88	83	32	95
LIM*	6	7	74	8	93	94	89	13	98
MP*	12	7	52	20	83	89	84	6	99
NW*	5	3	49	7	81	84	78	8	96
NC	4	1	24	4	71	71	49	19	70
WC	0	0	1	7	47	65	39	11	14

Source: DBE (2011)
Note: * Predominantly contain communal rural areas

South Africa's education system has experienced a lack of science, mathematics, or qualified teachers in rural areas. Rural or remote schools were usually left with teachers who were desperate for jobs or those who would have failed to acquire employment in other sectors (SACE, 2011). Table 2.4 summarises literature about the peculiarities of basic education in the country.

Table 2.4 Rurality and Basic Education in the South African Context

Article and Summary of Publication	Relevance to Study
"Obligation to address rural education as a social justice issue. The attributes of rurality that adversely affect the quality of education include a lack of qualified teachers, multigrade teaching, unreasonable teacher-learner ratios, irrelevant curricula, and competing priorities between accessing education and domestic chores, while the teaching staff seem to be imbued with poor morale and motivation" (Hlalele, 2012; 2014).	Qualified teachers, Multigrade teaching unreasonable teacher-learner ratios, irrelevant curricula, domestic chores, teacher motivation
"Given the huge backlogs that prevailed due to the legacy of apartheid and the tremendous amounts of money needed to address those backlogs, the government was expected to take a central role. Economic policies ignored the link between the provision of education and the social and economic needs of poor households in rural areas. The relocation of the RDP office to the Department of Finance may also be understood as reinforcing the government's "fiscal discipline" approach, which was not favourable for addressing the imbalances created by the apartheid legacy. Government's rural development strategies	Vocational training, and training for communities

should include providing technical and vocational education and training for rural communities" (Kallaway, 2001).	
The education which will serve the citizens of a democratic state most adequately, which will promote equity and empower the young most effectively, will be the curriculum which manages to bridge the gap between developing "primary, analytic and critical thinking skills which teach students through a curriculum which teaches people how to recognise, analyse, and criticise the larger system" of economic, social and political relations and at the same time allows for the empowerment of those who are marginal to the modern economy, like rural youth" (Kallaway, 2001).	Curriculum Development: Develop primary, analytic, and critical thinking skills, which teach people to recognise, analyse, and criticise the larger system. Empowerment of those who are marginal to the modern economy
When the most marginalised participants in rural contexts, for example, act as protagonists in their own lives and are engaged in identifying the issues that affect them and possible solutions, the resulting interventions stand a better chance of succeeding. We urgently need studies focusing on identifying existing resources and assets in communities and schools, individuals and groups, and how we might harness them to effect the desired social change (Moletsane, 2012).	The need for studies focused on identifying existing resources and assets in communities and schools. Engagement of rural dwellers
Reports and Government publications	
This book graphically illustrates the conditions that make the dreams of a better life for all virtually unrealisable in rural areas. Through the voices of rural people, we are told what the problems are and what can and should be done. This book is a richly documented portrait of the lives of communities in selected rural areas, specifically their thoughts and feelings about education (Nelson Mandela Foundation, 2005). The poverty of education in rural areas is integrally linked to inadequate employment, infrastructure, nutrition and health, rest, exercise and entertainment of the rural poor and vulnerable groups in rural areas (Nelson Mandela Foundation, 2005).	The relationship between rural education and rural poverty Inadequate employment, infrastructure, nutrition and health, rest, exercise, and entertainment
Rural education is connected to South Africa's history, and in recognising the country's progress, not enough attention had been given to rural education. These challenges translate into rural schools, which experienced vast inequalities and were confronted with poor infrastructure, inadequate resources, and a shortage of qualified teachers (Parliamentary Monitoring Group, 2015).	poor infrastructure, inadequate resources, and a shortage of qualified teachers

In summary, the provision of basic education in the South African rural context was determined by the following:

i. The availability of qualified teachers in relation to the learners
ii. Average distances travelled for schooling by learners.
iii. Access to amenities at the schools (water, sanitation, and electricity).
iv. School security in the form of school perimeter fencing and other security devices.
v. Science and technology education facilities in the form of science laboratories and computer laboratories
vi. Access to sports and recreation facilities.
vii. Access to communication networks as represented by access to the Internet.
viii. The availability of vocational training services and the adoption of context-specific curricula.
ix. Separation in terms of age group learning focus (primary or secondary).

Road and Transport

Road and transport services were essential for linking rural communities to service centres (Development Support Monitor, 2012; Desai, Mutasaa, & Lottering, 2019). For example, increased median travel time to the nearest clinic resulted in a significant logistic decline for homesteads with travel times of more than an hour (Tanser, Gijsbertsen, & Herbst; 2006). Accessibility studies were essential in determining how people reached the nearest

government service centres using existing road networks and transport modes (DPSA, 2009). The need to accelerate service delivery and economic development in South Africa faced challenges inherent in the diverseness of South Africa's rural areas (DoT, 2007). According to DoT, the challenges were:

i. The diversity of the country's rural areas as characterised by widely varying climatic differences, population densities, and a combination of structural differences.
ii. Historical backlogs and continuing under-investment in certain areas and types of infrastructure.
iii. Reactive responses to the historical backlog problems–especially the provision of reticulation or infrastructure such as streets, basic water reticulation, electricity, and sanitation.
iv. Sheer physical remoteness and low population densities of some areas, and the attendant transport provision, accessibility, and logistical difficulties such as long distances, vast networks of poor roads, and low demand thresholds.
v. Spatial dispersal of investment in central-place or nodal facilities (e.g., schools, clinics, multi-purpose centres), transport, and telecommunications, thereby aggravating the logistical difficulties of service delivery.

Travel time and distance to service centres were major determinants of access and utilisation of services. For example, reduced travel times to maternity hospitals increased the likelihood of child delivery within a maternity hospital by 24 percent (Masters et al., 2013). Reduction of travel times or the need to invest in road infrastructure was deemed to be dependent on the development of service centres that would limit the need for investment in the infrastructure (Chakwizira & Mashiri, 2009). On the other hand, a study by Mahapa & Mashiri (2001) in Tshitwe (NC) showed that investments in infrastructure in sparsely populated areas had marginal increases in the economic well-being of the inhabitants of the areas, with rural dwellers opting to resettle in areas with better opportunities. Travel times and distance were directly related to affordability, which was cited as the main reason determining the decision to travel by rural households (Venter, 2011). Hence, government departments needed to consult each other to ensure the provision of integrated service centres: existing government departments, parastatals (Post Offices), and the private sector were to use whatever means possible to provide services to the people, including ICTs (DPSA, 2009).

Police Services

A safe and secure environment is vital for rural activities such as agriculture, ecotourism, and cultural tourism, which present opportunities for overcoming poverty and sustaining the South African economy (SAPS, 2018). High levels of poverty, unemployment, and poor socioeconomic factors in isolated rural areas often led to increased crime rates and posed significant challenges for policing (SAPS, 2018). SAPA (2011) reported that nine of the ten district municipalities with the highest murder rates were in rural areas. In that regard, NPC

(2012) outlined the importance of providing police services in rural areas, with a particular emphasis on ensuring safety for farming activities. According to SAPS, the common crimes in the areas were violence against women and children, stock theft, and poaching. SAPS (2015) explained that since the country did not have a formal definition for rural spaces, they defined rurality based on the following criteria:

i. Areas located outside big cities or towns.
ii. Land dedicated to commercial or subsistence agriculture.
iii. An area that lacked infrastructure development such as water, sanitation, electricity, tarred roads, public transport, communication networks, and build-up areas.
iv. An area encompassed by large areas of former homeland areas that depended more on labour migration and remittances.
v. An area with a population of fewer than 150 000 people.

SAPS (2018) points out the importance of improving safety and security in South African places as primarily dependent on the country's poverty divide. In that regard, a holistic solution to safety and security required the involvement of all rural stakeholders (South African National Defence Forces, Agricultural Unions, Departments of Agriculture, Department of Rural Development and Land Reform, and Traditional Affairs). The solution was to go beyond improving policing infrastructure in rural areas to addressing the core source of the prevailing poverty context.

In summary, the characteristics of ruralness in terms of policing were as follows:

i. *Human Resources Capabilities:* Increasing the number of police recruits, level of training, and expertise.
ii. *Increase the Equipment Available for Policing Services:* For example, police bakkies, firearms, and advanced technologies such as drones.
iii. *Diversity of Services Offered:* For example, victim-friendly services for children and women and stock theft units.
iv. Reduced Distance Travelled by Rural Dwellers to Police Stations.
v. Population Size and Areas Served by a Police Station.
vi. *Improved Communication and Marketing:* Communication amongst policing service providers and communication with community members

The challenges of rural policing were compounded by ineffective communication mechanisms and networks, including ineffective communication with rural communities (SAPS, 2018). In this way, the importance of road and communication infrastructure was illustrated in terms of maintaining communication networks for policing and the ability of rural communities to interact with police through communication technologies.

Social Service Grants

South Africa's population, particularly communal rural dwellers, depend on social grants administrated by SASSA (CoGTA, 2009b; Pauw & Mncube, 2011). Grant dependency was positively related to low-income levels and high population dependency ratios (Mutyenyoka & Tsheola, 2017). Sixty percent of the population of the Polokwane Municipality (2 315 499) depended on various types of social grants as the primary source of household income: 1 699 494 were child support grants, 430 368 old age grants, and 93 428 disability grants (Mutyenyoka & Tsheola, 2017). Social grants were shown to improve the economic well-being of rural households (Nhlangulela, 2021). It was also shown that the presence of pensioners in the households allowed prime-aged adults to migrate for work as the remaining household members were sustained by social grants (Ardington, Case, & Hosegood, 2009; Neves, Samson, & Van Niekerk, 2009). The country's social grant services have had a positive social transformative effect on individuals in restoring a sense of dignity, autonomy, and increased decision-making powers for primary caregivers, who were predominantly mothers or grandmothers (Reddy & Sokomanie, 2008; Pauw & Mncube, 2011; Granlund & Hochfeld, 2020). Grants are disbursed through SASSA, MasterCard branded debit cards linked to bank accounts, ensuring that they can be accepted as a non-cash means of payment. Accessing the funds necessitates access to banks, point-of-sale terminals (in shops), and automated teller machines (ATMs), notwithstanding the limited accessibility of ATMs due to their insufficient numbers and the distances rural households must travel to reach them (Mashigo, 2019).

2.2 ICT Initiatives for Public Service Delivery

E-Governance is defined as the innovative use of communications technologies (including mobile devices), websites, and other ICT services and platforms to link citizens and the public sector to facilitate collaborative and efficient governance (National e-Government Strategy and Roadmap, Government Gazette 538, 2017). E-Government encompasses the public sector's use of ICTs to improve information and service delivery, citizen participation in decision-making, government accountability, transparency, and effectiveness (Albert, 2009). The Batho Pele (People First) White Paper on Transforming Public Service Delivery published on 18 September 1997 include eight principles: consultation, service standards, access, courtesy, information, openness and transparency, redress and handling of complaints, and value for money (Jakoet-Salie, 2020). According to Jakoet-Salie, the Batho Pele Principles align with e-government by promoting a proactive, transparent, and service-oriented approach. The principles guided the implementation of e-government in South Africa (DTPS, 2016). That is, e-government information and services were to be made available to the public through Internet connections whereby a standard website template for departments and municipalities would be adopted for e-service provision, mobile technology, and its capability to connect to the Internet and the fact that most South Africans have access to the devices, and call centres for providing technical support internally and to the citizens. According to DRDL (2018), ensuring that all parts of the country progressed was contingent upon a strategic approach involving the nationwide

deployment of broadband, commencing with the most densely populated areas before extending it to the more sparsely populated regions.

2.2.1 Computer Centres, Libraries, and e-Learning

In the South African context, the establishment of multi-purpose community centres (MPCCs) was a vital component of the rural development initiative, aimed at providing rural communities with access to information, facilities, and training in both paper and electronic formats (Nassimbeni, 1998). These MPCCs were initiated in 1999 and later renamed Thusong Service Centres (DGCIS, 2018). The primary goal of these centres was to enhance communication and streamline government services in rural areas, with a specific focus on empowering disadvantaged individuals by granting them access to information services and government resources. By the end of March 2012, a total of 171 Thusong centres were still operational, and they had brought significant benefits to communities through technology and computer training, as well as the utilisation of the Batho Pele Gateway (BPG), which provided information on service delivery and government services (DGCIS, 2018). Additionally, initiatives to deliver Internet services to high school learners and disadvantaged community members included providing free computer and Internet services in libraries. Successful projects in this domain encompassed the Cape Gateway Project, the Cape Information Technology Initiative (CITI), and the establishment of Internet portals in rural libraries (Maumbe, Owei, & Alexander, 2008; Matavire et al., 2010). More recently, notable successes have been observed in implementing free public Wi-Fi projects in rural areas within the EC, KZN, and WC provinces (Geerdts & Gillwald, 2017). In rural areas, ICTs play a pivotal role in providing education to marginalised segments of society, including women, children, and people with disabilities (Joseph, 2012). Maphiri-Makananise (2015) highlights the case of university students and young learners in the Vhembe rural district of the LIM province, where many women utilised the Internet for educational purposes and social networking. One notable educational technology is the Dr Maths application, as explained by Butgereit & Botha (2011). Dr Maths utilised the MIXit social media platform to assist learners with mathematics topics, facilitating interactions between learners and tutors. Vosloo, Deumert, & Town (2008) also discuss the mobile for literacy (M4Lit) pilot project, which was established to encourage writing among learners.

2.2.2 Mobile Phone-Based Public Service Delivery

2.2.2.1 Public Service Delivery Applications

In comparison to traditional media like radio and television, mobile phone ownership has been demonstrated to empower women in making decisions related to reproductive health (Iacoella, Gassmann & Tirivayi, 2022). A notable example of this empowerment is the South African mobile-based maternal monitoring system known as MomConnect, which plays a crucial role in reducing infant mortality by providing education and healthcare support for mothers and infants (DoH, 2014b). Given the widespread use of voice and text-based mobile phone communication throughout the country, MomConnect is easily accessible and has led to enhancements in clinical information systems (Thlabela, Roodt, Paterson, & Weir-Smith, 2006; Heekes et al.,

2018). The topics covered by the MomConnect system encompass nutrition, HIV/AIDS, hypertension, breastfeeding, immunisation, and mother-child bonding. Additionally, it offers a text message-based helpline and a clinic rating system. Importantly, the system was designed to be compatible with low-end mobile devices (Seebregts, Barron, Tanna, Benjamin, & Fogwill, 2016). However, it is important to note that the system does have limitations in terms of accessibility, particularly for individuals who cannot afford it or those residing in rural or other disadvantaged areas with a higher risk of adverse pregnancy outcomes (Heekes et al., 2018).

2.2.2.2 Other Online Applications and Services (Tax e-filling and Online Vehicle Licensing)

In addition to the aforementioned initiatives, South Africa's e-government strategy encompassed several other applications, including the South African Revenue Service's (SARS) tax self-service electronic filing for tax management, the Department of Home Affair's smart identification card, the Integrated National Transport System (NATIS) for online car and license registration, South African Social Security Authority's (SASSA) electronic processing of grant applications from remote sites, government departmental websites and mobile innovations such as the Find and Fix mobile application, which allowed users to report potholes to the City of Johannesburg (Thornhill & Cloete, 2014; National e-Government Strategy and Roadmap, Government Gazette 538, 2017).

2.2.2.3 Mobile and Internet Banking

Mobile phones provide banking services via text message services and banking applications. Brown & Molla (2005) explained that the lack of skills and the negative perception of mobile banking made it less successful in rural areas. In addition, there was a lack of knowledge, skills, and mistrust of online banking systems (Redlinghuis & Rensleigh, 2010; Thinamano & Mokwena, 2018). Despite high mobile phone penetration rates, mobile banking was less successful than Internet banking (Brown & Molla, 2005). Mobile phones offer banking services through text message services and banking applications. Brown & Molla (2005) pointed out, the lack of skills and negative perceptions surrounding mobile banking have hindered its success, particularly in rural areas. Furthermore, issues such as a lack of knowledge, skills, and mistrust of online banking systems have also been identified (Redlinghuis & Rensleigh, 2010; Thinamano & Mokwena, 2018). Despite the widespread use of mobile phones, mobile banking has not been as successful as Internet banking (Brown & Molla, 2005).

2.2.3 Television and Radio

The ITU's mandate for member countries to transition from analogue to digital broadcasting services resulted in an enhancement of the quality of television and radio reception and an expansion in the number of channels provided by South Africa's Broadcasting Commission (SABC) (Langmia, 2005). Television was the most preferred mode of receiving government information, especially in rural areas (Vivier, Wentzel, & Sanchez, 2015).

2.3 Digital Government Evolution in South Africa

Janowski (2015) outlines four stages of the Digital Government model:

- Digitalisation – Automating government operations without reform.
- Transformation – Reforming internal processes and administrative systems.
- Engagement – Enhancing interactions between government, citizens, businesses, and other entities.
- Contextualisation – Improving development conditions based on the outcomes of the previous stages.

South Africa's e-government platforms were rated second in terms of the usability of government websites among African countries (Verkijika & de Wet, 2018). A country's stage is measured using the Online Service Index (OSI) and e-Participation Index. According to UNDESA (2018), South Africa's e-Participation Index is 0.5593, e-Government Index is 0.5546, and OSI is 0.5580. Since the OSI exceeds 0.5 (Janowski, 2016), the country is at least in the Transformation stage. Key e-government challenges include skill shortages and infrastructure gaps, exacerbating the digital divide, especially in rural areas (Jakoet-Salie, 2020).

Figure 2.3 Successful e-Government Initiatives in South Africa

Initiative	Purpose
Presidential Hotline platform (17737)	This platform is used when all attempts to obtain assistance from a government department, province, municipality or state agency have failed. This deals with complaints about unresolved service delivery issues. This e-government system also serves as a forum where citizens are able to call and communicate their opinions or provide resolutions to the challenges in their community.
Crime Stop	A 'tip-off' service that has been in existence since 1992, whereby those citizens who are aware of information that can assist in exposing people involved in illegal activities are able to share this information anonymously. Geoghegan and Van der Walt (2019:144) state that within the community policing perspective, community policing involves "...not only increased police involvement with the public, but promotes partnerships, co-operation and involvement where the local community can identify and participate in solving issues related to crime." Simultaneously, there is no longer a need for direct or even indirect participation by police officials in providing the service to citizens because of the presence of technologies.
South African Revenue Services (SARS)	In 2003, SARS launched its online submission of tax returns as a replacement for the manual submission of tax returns. This free service allows individual taxpayers, tax practitioners and businesses to register and submit tax returns and make any SARS-related queries within a secure online environment. The number of individuals registered for income tax increased to 21.0 million on 31 March 2018 from 20.0 million in the previous year (SARS 2020).
Department of Home Affairs	Implemented an electronic identity verification system to verify the identity of prospective and current clients using their fingerprints. This initiative promotes the vision of reinforcing the relationship between government and citizens (G2C). Furthermore, this will improve service delivery as citizens will no longer be required to complete detailed forms or stand in long queues as the smartcard identity document will enable citizens to confirm their identity by simply placing a finger on a biometric reader which will read the fingerprint against the Home Affairs database. Through its Home Affairs National Information System (HANIS) project, citizens will be able to access birth and death registration forms online. This will eliminate the frustration of having to spend many hours at the Department of Home Affairs.
Department of Communications	The National Department of Health, the Medical Research Council (MRC) and the National Health Information Systems Committee on South Africa (NHIS/SA) have developed a strategy that is aligned with the World Health Organisation (WHO). This e-Health strategy covers areas that include electronic health records and computerised registrations.
Independent Electoral Commission (IEC)	In collaboration with cellular phone service providers, the IEC has made it possible for voters to text their identity numbers and receive feedback on their eligibility to vote at their assigned voting stations (Farelo & Morris 2006:6). This will alleviate the problem of voters standing in long queues at the wrong voting stations.

Source: Jakoet-Salie (2020).

2.4 Rurality and People-Centric Approaches to Service Delivery in the Digital Age

Rural areas require digital connectivity to mitigate the challenges posed by their remote locations (Salemink, Strijker, & Bosworth, 2017). Philip, Cottrill, Farrington, Williams, & Ashmore (2017) identified a significant barrier to mobile network coverage in rural settlements, which stemmed from their sparse population, discouraging Internet service providers and mobile phone service providers from establishing telecommunication infrastructure in these regions. Earlier, Langmia (2005) posed the question of how technological progress can occur when essential infrastructure like basic telephone lines remains a distant

aspiration for many South Africans. Langmia also recommended the integration of indigenous South African languages into the country's ICT systems. Dzidonu (2010) emphasised the potential of ICTs in the educational sector while underscoring the lack of educational resources, particularly in rural schools, as a major impediment. In the context of South Africa's diverse rural areas, characterised by varying economic well-being and demographic composition, service delivery encompasses the provision of essential services and social inclusion. Consequently, the effectiveness and sustainability of e-government initiatives in improving the lives of rural populations, reducing poverty, and combating social exclusion remain essential questions, as highlighted (Perret et al., 2005; Kaisara & Pather., 2009; Ochara & Mawela., 2015; Nkgapele & Mokgolobotho., 2024). There is also a need to re-evaluate the definitions of rurality in terms of population density and former homeland status and their continued relevance in characterising South African rurality in particular (Rivett, Champanis, & Wilson-Jones, 2012).

3 THEORETICAL BASIS OF A SERVICE-CENTRIC APPROACH TO PUBLIC SERVICE DELIVERY IN THE DIGITAL AGE

Current service delivery approaches were influenced by the global emergence of consumer-based approaches to service delivery (Osborne et al., 2013). Service-dominant approaches have foundations in the public value and information asymmetry theories, and additionally, in the current study, the C4D framework was used to assess service-related communication achieved by ICTs (OWI, 2004; Tacchi, 2020; Buhai, 2021). C4D is based on diffusion and participatory models, and it has been conceptualised through power, space, and capability models (Opu, 2019).

3.1 Evolution of Public Management Models

Current service delivery models are based on service-centric models, for example, the new public governance (NPG) model, which explains service delivery as a process with multiple systems and actors (Osborne, Radnor, Kinder, & Vidal, 2014). NPG evolved from managerial and market-oriented forms of service delivery, with market-oriented frameworks emerging as replacements for administrative or top-down public service delivery models (Hood, 1991; Mongkol, 2011; Osborne et al., 2013).

Traditional approaches to public governance were characterised by a top-down and elitist approach, wherein, public officials were imbued with values of hierarchy, independence, and integrity (Robinson, 2015). Robinson said such administrative approaches were based on command-and-control service delivery models. Three forms of criticism were directed towards administrative governance models, namely: the large scale of government operations which consumed many resources, the enormous scope of government activities, and bureaucratic tendencies in government operations (Mongkol, 2011). NPM emerged from a shift to neoliberalism and private sector approaches of free-market-oriented governance (Shamsul Haque, 2004; Doorgapersad, 2011).

NPM originated from new institutional economics and managerialism streams of thought (Hood, 1991). Hood adds that new institutional economics was based on the post-World War II ideas of public choice, transaction cost theory, and principal-agent theory and its movement generated reform ideas of contestability, user choice, transparency, and incentive structures. Managerialism was based on professional management, paramount over technical expertise, freedom to manage, development of organisational cultures, and the use of output measurement to achieve better organisational performance. Hood (1991) describes the seven doctrines of NPM as follows:

i. *Active and Visible Management:* Top-level individuals actively and visibly manage the organisation, exercising discretionary control.
ii. *Explicit Performance Standards:* Clearly defined, quantitative goals, targets, and success indicators are emphasised.

iii. *Enhanced Output Control:* Resource allocation closely tied to measured performance.

iv. *Aggregation of Public Units:* Utilising contract or franchise arrangements, both inside and outside the public sector, to gain efficiency benefits.

v. *Increased Competition in the Public Sector:* Encouraging competition using term contracts and tender procedures.

vi. *Private-Sector Management Practices:* Include management practices such as hiring, rewards, and the use of public relation techniques.

vii. *Resource Use Discipline:* Reducing direct costs and constraining compliance costs for businesses.

NPM was related to the emergence of four thought trends: efforts aimed at curbing government expenditure, privatisation of government service provision, automation in the production of services, and pressures to follow internationally prevailing norms of service provision (Hood, 1991).

NPM governance systems were implemented in some developing countries because they were set as preconditions for funds by financial institutions and donors such as the World Bank (Mathiasen, 2014). Due to its origins in developed countries, NPM's relevance to underdeveloped and developing country contexts became contestable (Hood, 1991). For example, developing countries were limited in terms of the capacity of their Information Systems to implement NPM principles (Polidano & Hulme, 1999). NPM principles also bred corruption by giving managers in the public sector greater autonomy without scrutiny (Mongkol, 2011). It was also evident that the priorities of developed countries differed from those of developing countries. For example, privatisation in the Tanzanian context did not have clear, long-lasting financial benefits because the funds generated from the process were spent on recurrent and urgent expenditures (Mathiasen, 2014). Due to the differences in contextual appropriateness, it was recommended to adopt context-relevant aspects of the approach because the approach could not be a solution to all public administration problems in modern governments (Mongkol, 2011; Islam, 2015). For example, NPM implementation in the United States of America's political system could not stamp out corruption in the country's public systems (Pfiffner, 2004). Due to these factors, approaches that placed citizens at the centre of reforms emerged (Robinson, 2015). Stoker (2006) and Doorgapersad (2011) outlined the appropriateness of a shift to public value management approaches that are based on practices of dialogue and exchange systems that characterise networked governance.

3.2 Theoretical Basis of a Service-Dominant Approach to Service Delivery in the Digital Age

3.2.1 Evolution of NPM

NPM had been criticised for being overly market-oriented and for treating service provision as a manufacturing process, amongst other concerns (Osborne et al., 2013). According to Osborne et al. (2014), NPM faced numerous challenges, and some changes had to be considered. These are:

i. NPM primarily focused on improving internal efficiency, overlooking the complex web of actors involved in service delivery and their diverse interactions. It neglected the imperative of meeting the expressed needs of both the service providers and users.

ii. NPM failed to adequately address the unique challenges posed by knowledge-based service delivery in the digital economy, leaving a gap in terms of adapting to this evolving landscape.

iii. Service-centric models contended that public entities are not akin to factories producing tangible products; instead, they are engaged in delivering intangible services. Thus, service centric models stressed the significance of refining service delivery processes and nurturing relationships with service users.

iv. Service-centric approaches challenged the conventional notion that a product-centric approaches were effective. Instead, they emphasised that the production and consumption of services were simultaneous processes.

v. Within service centric paradigms, service users began to assume an active role in the service delivery process. Consequently, service professionals were no longer the exclusive participants in delivering services.

In this way, the NPM model evolved to recognise the collaboration of a range of actors in the service delivery system (NPG) (Osborne et al., 2014). NPG was described by Milward & Provan (2000) as the increased use of third parties for service delivery. The service-dominant approach to service delivery, as an extension of NPG, conceives public services as a comprehensive ecosystem that encompasses not only public service organisations but additionally, service users and stakeholders such as households, communities, technologies, tangible assets, and products (Osborne, Radnor, Kinder, & Vidal, 2015). The evolved approach emphasised moving from the efficiencies of rolling out products to the consumer's consumption experience. Three characteristics of the service-dominant approach are the intangibility of services, simultaneous service production and consumption, and co-production of the services (Osborne et al., 2015). The fundamental propositions of the service-dominant paradigm, as outlined by Osborne et al. (2013), are:

i. Both citizens and service providers play vital roles as key stakeholders in shaping public policy and influencing the service delivery processes, underscoring the importance of their active engagement in these processes.
ii. The adoption of a service-dominant marketing approach is crucial for translating the strategic intent of public services into tangible and specific service commitments.
iii. Acknowledging co-production as an integral aspect of public service delivery highlights the significance of placing user experience and knowledge at the forefront of effective public service provision.

iv. In the absence of a public service-dominant approach, operational management within public services may result in greater efficiency but less effective service delivery, emphasising the need for an approach that ensures the fulfilment of service promises.

In line with the evolution of public service delivery models, the advantages at each state remained relevant as public service models evolved. For example, the use of success indicators to monitor organisational performance in the NPM model (Hood, 1991). In that regard, Dahler-Larsen (2014) points to the importance of public service indicators in showing the reality they are meant to illustrate. According to Gruening (2001), based on various aspects of the model, NPM was mainly explained in terms of the public choice theory and managerialism, but information technologies had no theoretical roots.

3.2.2 The Theoretical Basis of Service-Dominant Approaches to Service Delivery

Service-dominant approaches involve consistently monitoring and incorporating consumer needs into processes. The public value and information asymmetry theories have been used to explain the approach (Buhai, 2021).

3.2.2.1 Public Value Theory

Public value is a collective consensus which reflects the majority's opinions on public services as characterised by economic, political, cultural, social, ecological, and improved effectiveness and efficiency of processes (Li, 2019). Li explains that economic value aspects are the material benefits people lose or benefit from a product or service, as reflected by employment levels, economic inequality, and other economic indicators. Political items refer to people's value judgements of political phenomena as indicated by democracy indexes, corruption indexes, and human rights indexes. Cultural aspects indicate resonance in education, social systems, and other factors embedded in education, transition, and tourism. Social characteristics are concerned with social needs and the quality of life, as reflected by happiness indexes and gender gap indexes. Ecological aspects reflect the relationship between the inhabitants, their environment, and ecology. Public value is related to achieving the objectives set by government programs and delivering public services to citizens (Cordell & Bonina, 2012). Figure 3.1 shows the quantitative measures of the public value account explained by Moore (2013). The account assigns value to economic, political, cultural, social, and ecological factors. Even though Moore's account has been used to assess value in public entities, it was primarily developed to measure public value for services that are provided by private entities, and it did not offer a means to measure public value loss for cultural aspects (Cordella & Bonina, 2012; Li, 2019).

Figure 3.1 Moore's Public Value Account

Public Value Account	
Public Value Loss (–)	Public Value Creation (+)
Economic value	*Economic value*
Unemployment Rate (UR)	Ln GDP per capita (GDP)
Economic Inequality (EI)	Global Competitiveness Index (GCI)
Political value	*Political value*
Human Rights Loss (HRL)	Corruption Perception Index (CPI)
Public Services Failure(PSF)	Democracy Index (DI)
Cultural value[a]	*Cultural value*
–	International Tourism Arrivals, million (ITA)
–	Tertiary Enrolment Ratio (TER)
Social value	*Social value*
Population Structure Imbalance (PSI)[b]	Happy Life Years (HLY)
Suicide Mortality Rate (SMR)	Gender Gap Index (GGI)
Ecological value	*Ecological value*
Ecological Footprint per person (EF)	Biocapacity per person (BC)
Energy Intensity Level (EIL)[c]	Alternative & Nuclear Energy (ANE)

Source: Li (2019)

For developed country contexts, Twizeyimana & Andersson (2019) depicts the public value of e-government and associated key performance indicators in six dimensions: improved public services, improved administrative efficiency, open government capabilities, improved ethical behaviour and professionalism, improved trust and confidence in government, and improved social value and wellbeing. The current study seeks to provide insight into the public value of ICTs for low- and middle-income country contexts by extending the knowledge that is available on the public value of ICTs to public service delivery.

3.2.2.2 Information Asymmetry

Information asymmetry is a pivotal concept in economics and information systems, influencing the quality of goods and services available to consumers and providers alike (Akerlof, 1970, 2002; Salhi, 2020). This imbalance in information can bestow a distinct advantage upon the party possessing the relevant knowledge, as illustrated when a seller discreetly offers a used car without the buyer's awareness (Akerlof, 1970). By their very nature, public services often fall prey to market failures, as service providers wield significant control due to their monopoly over the services they provide, potentially leading to inadequate service provisions (Besley & Ghatak, 2007). Furthermore, it is worth noting that the magnitude and types of information asymmetry vary significantly, with certain sectors, such as education and healthcare, characterised by persistent and heightened levels of information imbalance (Batley & McLoughlin, 2015).

In healthcare, the issue of information asymmetry is particularly pronounced, manifesting itself through instances of healthcare professionals offering inaccurate diagnoses or patients concealing crucial medical information (Bloom, Standing, & Lloyd, 2008). Often, this concealment is driven by the desire for financial gain through manipulative practices related to medical insurance. In a broader context, Lightfoot and Wisniewski (2014) illuminate the role of media, propaganda, exclusive information networks, and

surveillance as tools exacerbating information asymmetry. Government authorities may wield exclusive access to citizen information, deploying it with minimal restrictions. This data can be commercialised, sold to third parties for business purposes, or even shared with law enforcement and security agencies without the express consent or awareness of the individuals being monitored. Lightfoot and Wisniewski (2014) further caution that seemingly innocuous features of the digital age, such as Wi-Fi zones and product barcodes, hold the potential to unveil individuals' locations and consumer behaviours.

The current study contributes to our understanding of the burgeoning information economy, particularly within rural service delivery processes in low- and middle-income economies. It sheds light on how information imbalances intertwine with the services provided, shaping the landscape of access and equity. While some stand-alone e-service delivery initiatives have demonstrated success, the overall evaluation of their effectiveness remains mixed (Mechael et al., 2010). There is also a need for further research and a deeper understanding to achieve universal coverage, ensuring these services reach a wider audience (van Olmen, et al., 2020). Additionally, efforts should be made to understand and enhance their functionality beyond basic communication purposes, enabling more comprehensive and meaningful utilisation (Murphy, 2014). Within the framework of Information Asymmetry Theory, there are several critical facets, including adverse selection, moral hazard, signalling, screening, and market failure (Akerlof, 1970; Stiglitz, 1975; Besley & Ghatak, 2007; Devos, Van Landeghem & Deschoolmeester, 2012). Each of these components is elucidated as follows:

i. Adverse selection denotes a precontractual scenario where the buyer unknowingly selects an unsuitable seller, resulting in suboptimal product quality. The buyer's lack of information about the product's features or the seller's capabilities can lead to erroneous decisions and, ultimately, market failure.

ii. Moral hazard is a post-contractual construct arising from the seller's fraudulent behaviour or incapacity to deliver a promised service or product. This can manifest when sellers take advantage of buyers need to avoid substantial switch costs.

iii. Signalling entails transmitting credible information by sellers to reduce information gaps. This often includes customer ratings, curriculum vitae, profiles, reviews, and ratings designed to reduce information asymmetry among stakeholders.

iv. Screening involves the comparative assessment of product qualities available in the market.

v. Market failure transpires when a market is unable to efficiently provide or undersupplies goods or services, primarily due to information asymmetry and related factors.

3.2.3 Service Delivery Models and the South African Context

Before the democratic era, South Africa's public sector hinged around the traditional models of bureaucratic governance and the evolution after that followed the prevailing global trends towards NPM via the introduction of structural adjustment programs that were recommended to developing countries by international institutions (Cameron & McLaverty, 2008; Cloete, 2008; Chipkin & Lipietz, 2012).

Due to the persistence of spatial and socioeconomic differentials within the South African context well after 1994, Chipkin & Lipietz (2012) suggest that instead of changing course and following international trends, existing bureaucratic systems (administrative models) could have been maintained by simply being deracialised to consolidate the existing bureaucratic governance structures in 1994. However, NPM was seen as an administrative agenda that would privatise, deregulate, and re-conceptualise the appropriate role of a government, with the 'Batho Pele' (People First) framework aligning itself with the philosophy (Louw, 2012).

Globally, NPM evolved by carrying over some of its advantages (Cloete & De Coning, 2011). The service-dominant approach to service delivery recognised the potential benefits of ICTs in delivering public services but required evaluation of the impact of ICTs, particularly in low- and middle-income country contexts (Polidano & Hulme, 1999; Osborne, Radnor, & Nasi, 2013). Considering the success and shortfalls of NPM in various contexts, Doorgapersad (2011) pointed out the importance of leaders in African countries being conscious of the political and social cultures that add value. They should also identify the indigenous beliefs to maintain to avoid maladministration.

3.2.4 Digital Divide Theory and C4D

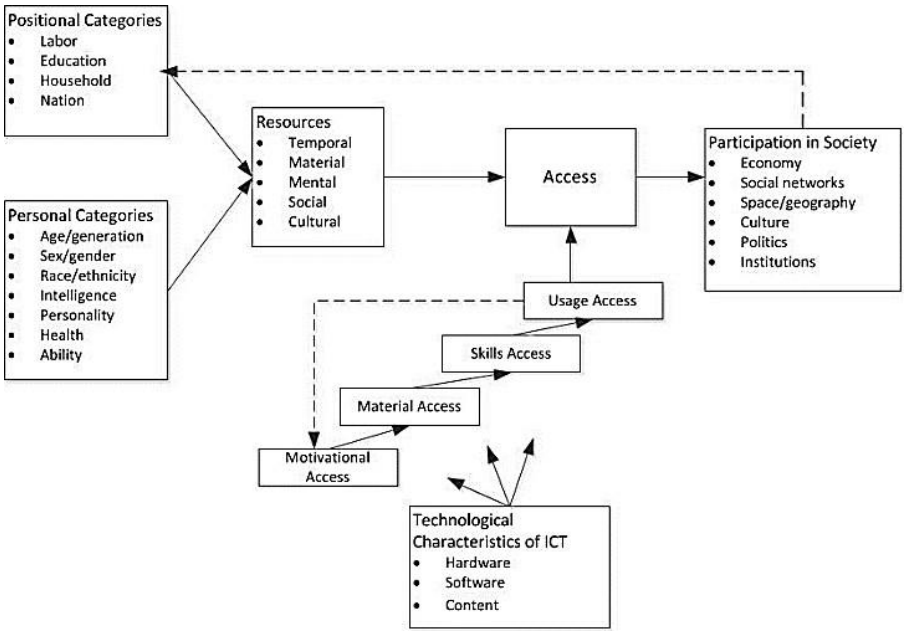
In this study, the theory of digital divide and the C4D framework were used to develop data collection tools and to assess development communication.

3.2.4.1 Theory of the Digital Divide

Wilson (2006) defines the digital divide as disparities in access, distribution, and utilisation of ICTs. Contributing factors to this divide encompass limited ICT access, insufficient skills and support, attitudinal barriers, and the relevance of available content (Cullen, 2001; Dijk & Hacker, 2003; Bornman, 2016). Figure 3.2 illustrates the digital divide theory as outlined by van Dijk (2008), which revolves around differences in positional and personal backgrounds resulting in unequal access to resources, leading to disparities in ICT access and participation in the information society. Personal characteristics, including age, gender, well-being, knowledge, and skill level, influence technology access and use, while positional characteristics encompass social, economic, governmental, and societal openness qualities (Pick & Nishida, 2015). These combinations of personal and positional characteristics impact the resources individuals can access, including time, material, social, cultural, and knowledge aspects. According to Pick & Sarkar (2016), the access process is conceptualised as a circular progression involving motivation for access, access to hardware and software, development of ICT skills, and gaining access to usage. Scheerder, van Deursen, & van Dijk (2017) highlight differences in the divide from a 'first-level divide' - which refers to access to the Internet and other ICTs, a 'second-level divide' - referring to

ICT use skills, and a 'third level divide' in which tangible outcomes of ICT uses are highlighted. The third level of the divide relates to the expected benefits of Internet use, which are economic, social, cultural, and personal.

Figure 3.2 The Digital Divide Theory



Source: Pick & Sarkar (2016)

The digital divide theory was used to understand the digital context for schools in rural South Africa by breaking down the phenomenon into three levels of the divide, determined by personal and positional characteristics (Dixon, 2019). The theory has also been used to understand digital inequalities between the regions of various countries (Gonçalves, 2016; Pashapa & Rivett, 2017; Lembani, Gunter, Breines, & Dalu, 2020).

3.2.4.2 Theoretical Elaboration of C4D

C4D is based on diffusion and participatory models whereby the former derives from modernisation theory, and the latter asserts that development communication is based on horizontal communication with information exchange and interaction (Morris, 2003). C4D evolved from modernisation theories after World War II when mass media transferred new ideas from developed countries to the developing world (McCall, 2011). Opposition to the original modernisation theories led to pressure for balanced information flow on national and international scales (McCall, 2011). OWI (2004) explain that C4D is based in modernisation theories and diffusion of innovation theories (participatory diffusion and opinion leader theories) in which communication is viewed as a route to increased participation in development, empowerment, and increased articulation of social relations.

Modernisation of diffusion models privileges the instrumental dissemination of information to bring about social change (Opu, 2019). Modernisation suggests that societies progress from being traditional to modern forms of social, political, and economic organisations (Hout, 2016). Economic growth occurs as societies industrialise and adopt new technologies, social change occurs with a shift in social values and norms, and the model is administered by western style development (considered the ideal development). Participatory theory is concerned with the active involvement of communities and stakeholders in the paths of development (Morris, 2003). The key ideas of participatory theory include the empowerment of marginalised groups and communities by giving them a voice, prioritising community knowledge, and the inclusion of all stakeholders which leads to context specific development. Outcomes identified with diffusion models include changes in knowledge, attitude, and practice, while changes in participatory models include empowerment, community building, and social equity (Morris, 2003).

At the highest level of communication, C4D describes two-way communication systems that enable dialogue, with communities speaking out, expressing their aspirations and concerns, and participating in decisions about development (*United Nations Resolution 51/172*, 1997). It is people centred and concerned about how people make use of the broad range of communication tools available to them to further their development communication aims (OWI, 2004). OWI defines C4D as an integral part of a broader concept within ICT4D, consisting of three key components:

i. *Access or Knowledge:* This component involves the delivery of information to the public with the goal of promoting economic empowerment and enhancing citizen participation and rights.

ii. *Voice:* This facet emphasises more assertive communication by the public towards dominant nodes, typically the government, while also encouraging diverse localised peer-to-peer communication among individuals.

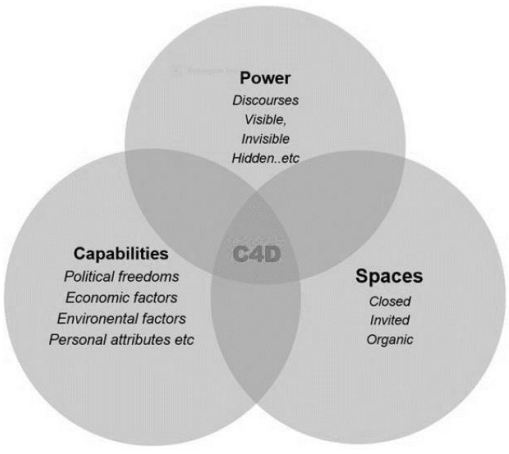
iii. *Networking or Communication:* This component focuses on connecting C4D communicators with other nodes of communication, facilitating discussions, dialogues, and debates to influence and advance developmental objectives.

Similarly, Manyozo (2012) delineates C4D into three essential elements: media development, media for development, and participatory community communication. Media development underscores the fundamental role of media infrastructure in enabling C4D, a connection highlighted by contemporary developments in mobile phones and the Internet (Tufte, 2014). The C4D framework aims to achieve outcomes characterised by a more substantial influence and impact wielded by individuals on policymakers and dominant communicators, including governments, non-governmental organisations (NGOs), media, and the private sector. Additionally, it seeks to foster increased expressive communication and networking among people worldwide (OWI, 2004).

C4D communicators, who are often public service consumers, may seek to influence or have an impact on various facets of policy. These include matters related to freedom of expression and a wide array of development concerns such as peacebuilding, diversity, livelihood issues, environmental protection, economic policies, welfare initiatives, rights, and legislation, as well as decision-making processes across all levels of government and within every sphere of society (OWI, 2004). Hoque & Sorwar (2015) used the C4D framework to determine the impact of ICTs on development by studying the context of communication intervention, behavioural change, and development results. In a study conducted by Opu (2019), C4D was similarly employed to evaluate the character and significance of communication among stakeholders involved in the management of natural resources in the context of climate change.

In addition to the traditional models of modernisation and participation that underpin C4D, Opu (2019) offers a conceptualisation of C4D as an intricate interplay of capabilities, power dynamics, and spatial considerations. In this framework, power is viewed through two dimensions: discursive power, which pertains to the means by which power is constituted and the practices associated with this knowledge, and material power. Power operates at multiple levels—global, national, and local—within various spaces, categorised as closed, invited, and organic, and assumes various forms, including visible, hidden, and invisible manifestations. Capabilities, influenced by Sen's capability approach, encompass the freedom for actors to be who they aspire to be and engage in the activities they desire (Wells, 2012). These capabilities are central to shaping their roles and contributions within society. Spaces, within this context, represent the arenas where social actors engage in public deliberations and social interactions, confronting diverse ideas and viewpoints as they collectively navigate the complexities of C4D. Besides accessing and using ICTs, there is a need to understand the type of communication achieved by ICTs, especially in underdeveloped contexts. In the study, the C4D framework is used to assess communication for participation, inclusion, and empowerment of communities in terms of development issues (OWI, 2004; Lennie & Tacchi, 2011).

Figure 3.3 Intersectionality of C4D



Source: Opa (2019)

With service providers and users as essential stakeholders of public service delivery processes, modern ICTs are argued to support the participation of marginalised communities in the service delivery system (Osborne et al., 2013). In that regard, the current investigation determined the public value of ICT proliferation to the public service delivery process.

4 RESEARCH DESIGN

Based on a pragmatist worldview, an exploratory sequential mixed-methods research design was used to gain understanding of the public value of ICTs and the nature of services delivered in low- and middle-income settings. The qualitative research component explored participants' perspectives which informed the quantitative phase.

4.1 Research Philosophy

4.1.1 Ontology, Epistemology, and Methodology

Methodology refers to the philosophical sense as an overall strategy of conceptualising an inquiry and constructing scientific knowledge; it involves epistemological assumptions that link methods to theory, norms, and rules about knowledge production (Cecez-Kecmanovic, 2005). Ontology concerns a researcher's perspective on reality, while epistemology delves into how knowledge is acquired, encompassing the nature of knowledge, its sources, and the methods of understanding it (Mack, 2010). Ontology studies the nature of existence and what constitutes reality, while epistemology defines the ways of generating knowledge or knowing based on the philosophy of reference (Gray, 2013). One's view of reality (ontology) influences what one seeks to observe, what one observes, and how findings are interpreted.

Table 4.1 Research Paradigms and their Ontologies, Epistemologies, and Methodologies

	Ontology	Epistemology	Methodology	Methods
Positivism	Realism (objects exist independent of the knower)	Objectivism (discovery of absolute knowledge of objective reality)	Experiments and observations in research involve empirical testing, utilising random samples, manipulating controlled variables, & incorporating control groups to ensure scientific rigour & reliability.	Quantitative data and methods: Standardised tests and closed-ended questionnaires. Descriptive and inferential statistics
Interpretivism	Relativism (a subjective reality which differs from person to person)	Subjectivism (human beings create reality. Meaning is constructed by awareness of something)	Case studies, Phenomenology, Hermeneutics	Qualitative data and methods encompass using open-ended questions, conducting focus groups, and employing open-ended observations to explore and analyse subjective, in-depth information and insights.
Critical Paradigm	In historical realism, reality is perceived as being shaped by a complex interplay of social, political, cultural, economic, ethnic, and gender values. Within this framework, realities are regarded as socially constructed entities that are continually influenced by internal dynamics.	Subjectivism posits that knowledge is socially constructed and subject to the influence of power relations emanating from within society.	Critical discourse, Critical ethnography, Action research, Ideology critique	Qualitative data and methods encompass the use of open-ended interviews, conducting focus groups, employing open-ended questionnaires, and making observations to explore and analyse subjective, in-depth information and insights within a research context.

Source: Scotland (2012)

The three reality views are objectivism (a reality which exists even without consciousness), constructivism (meaning constructed by individuals in different ways to observe the same phenomenon by the subject's interactions with the world), and subjectivism (subjects construct meaning from within collective

unconsciousness, from beliefs and dreams and hence meaning does not emerge from the interplay between the subject and the outside world) (Gray, 2013). Epistemological assumptions elucidate the processes of creating, acquiring, and communicating knowledge, essentially delving into the essence of what it means to 'know' (Scotland, 2012). Ontological and epistemological assumptions make up a paradigm (Mack, 2010). As an illustration, positivists hold that the world exists independently of our awareness of it, whereas constructivists argue for the existence of multiple realities and diverse approaches to accessing them (Gray, 2013). Table 4.1 outlines research paradigms and their ontological, epistemological, and methodological basis as explained by Scotland (2012).

4.1.2 Pragmatism

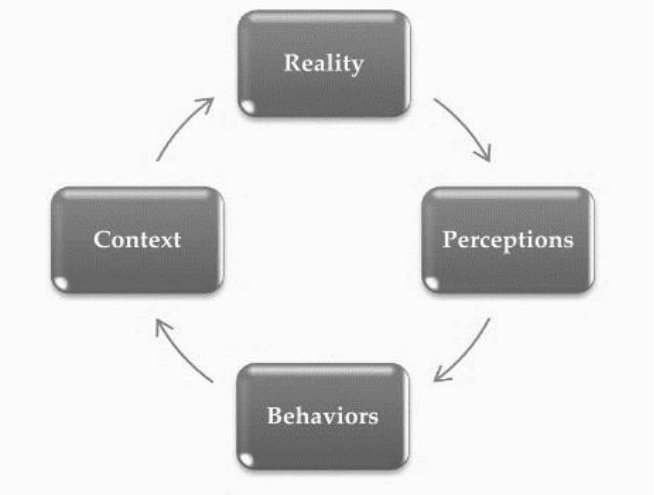
The study adopted a pragmatic worldview and utilised a mixed-methods research design. Pragmatism as a research philosophy is rooted in actions, situations, and consequences rather than being primarily concerned with antecedent conditions (Morgan, 2007; Bryman, 2011; Creswell & Creswell, 2014). Pragmatism orients itself towards solving practical problems in the real world, prioritising research questions over philosophical considerations (Kaushik & Walsh, 2019). Pragmatism is not tethered to a specific worldview, enabling the utilisation of diverse methods and data, and therefore, it is often linked with mixed methods research (Brierley, 2017). Cherryholmes (1992), Morgan (2007), and Creswell & Creswell (2014) outline the character of the pragmatist worldview as follows:

i. Pragmatism remains unaligned with any specific philosophical or ontological stance, permitting mixed-methods studies to freely incorporate both qualitative and quantitative research assumptions.
ii. Researchers operating within pragmatism have the flexibility to employ research procedures, methods, and techniques that align with their specific needs and research objectives.
iii. Pragmatists embrace diverse approaches to data collection and analysis, avoiding strict allegiance to a single methodological path.
iv. Truth, according to pragmatists, is contingent on what proves effective at a given time, and they advocate that multiple methods offer the most comprehensive understanding of research issues.
v. Pragmatists acknowledge that research always unfolds within social, historical, political, and various other contextual dimensions.
vi. Pragmatism opens the door to a multitude of methods, diverse worldviews, varied assumptions, and a range of data collection and analysis techniques.

Pragmatism, by welcoming multiple methods and prioritising the effectiveness of approaches in addressing research questions, has faced criticism for lacking explicit philosophical underpinnings that rigorously support its methodological flexibility (Creswell & Clark, 2017; Maarouf, 2019). In response, it is argued that pragmatism follows an intersubjective stance, which means that it is both objective and subjective

simultaneously (Morgan, 2007). Maarouf (2019) proposed that pragmatism should clarify its philosophical position by specifying its stance on ontology within the continuum of objective and subjective aspects of the reality cycle, as depicted in Figure 4.1. In other words, this clarification would involve considering the idea of a singular reality with various perceptions or interpretations of that reality. Figure 4.1 shows the reality cycle.

Figure 4.1 The Reality Cycle



Source: Maarouf (2019)

'Reality is perceived by humans differently. Human beings' perceptions of reality control their behaviours. Interactions among these behaviours construct a new context over time, and constructing a new context generates a new reality. The reality cycle adopts a practical, pragmatic point of view, assuming that reality is always stable and changes periodically. The reality cycle assumptions allow the pragmatic researcher to switch between the two views of the one external reality and the multiple perceptions of reality in social actors' minds, and thus between the quantitative and qualitative research approaches and methods' (Maarouf, 2019, p. 7).

Pragmatism is an abductive research process which moves between induction and deduction (Morgan, 2007). Inductive reasoning is used to make broad generalisations from specific observations. For the deductive component, the generalisations are adapted to the quantitative research component. In the current study, the findings of the qualitative research process were used to model rurality. Therefore, the findings from the qualitative part of the study informed the quantitative study component. Further, a central focus of mixed methods research is the integration of quantitative and qualitative findings rather than solely assessing the individual merit of each approach in isolation (Molina-Azorin, 2016).

4.2 Research Methodology

4.2.1 Mixed Methods Research Approaches

The main difference between qualitative and quantitative research approaches is cited in narrative descriptions generated using data from open-ended interview questions versus numbers from data collected using closed-ended questions. In qualitative research, data collection within the participant's setting often generates emerging questions and procedures, while data analysis progresses from specific details to general themes in an inductive manner, with researchers actively interpreting the data's meaning (Patton, 2005; Qu & Dumay, 2011; Creswell & Creswell, 2014). Quantitative research tests theories by examining relationships between measurable variables whereby the data are analysed using statistical procedures, and assumptions are mainly about deductively testing theories, protecting against bias, and generalising and replicating findings (Sukamolson, 2007; Creswell & Creswell, 2014). Mixed-methods research encompasses the collection of both quantitative and qualitative data, the integration of these two types of data, and the utilisation of distinct designs, which may incorporate philosophical assumptions and theoretical frameworks (Creswell & Creswell, 2014).

Based on an assessment of the research question and objectives, this study develops rurality measures. Following the studies by Venkatesh et al. (2013), the purpose of applying a mixed-methods design is developmental. Furthermore, considering the arguments presented by Venkatesh et al., the assessment of the research questions and objectives, and the unclear relationship between ICT proliferation and rurality measures, the study employs qualitative methods to provide a holistic picture of rurality and ICT proliferation. This approach ultimately leads to the development of rurality measures and reinforces the appropriateness of applying a mixed-methods research design. Creswell (2014) outlines the three main models of mixed methods design as follows:

i. *Convergent Parallel Mixed Methods:* This approach involves merging qualitative and quantitative data to offer a comprehensive analysis of the research problem, with data collected simultaneously and discrepancies addressed during the interpretation phase.

ii. *Explanatory Sequential Mixed Methods:* In this method, quantitative analysis is followed by a detailed explanation using qualitative research, common in fields with a quantitative focus, but it may pose challenges due to potential differences in sample composition.

iii. *Exploratory Sequential Mixed Methods:* This approach begins with qualitative research to explore participants' perspectives, and the findings inform the subsequent quantitative phase, potentially aiding in the development of research instruments and specifying variables.

Combining qualitative and quantitative approaches offers a more comprehensive understanding of the research problem compared to using each approach in isolation (Creswell & Creswell, 2014). Mixed methods research entails a synthesised presentation of findings that integrates both qualitative and quantitative components of the study, without requiring them to be in direct conflict or tested against each other (triangulation) (Bryman, 2007).

4.2.2 Exploratory Sequential Mixed Methods and a Study of Rurality

An exploratory sequential mixed methods research design was used for the study. The approach began with a qualitative research phase that obtained input from literature and interview participants. That information was used in the quantitative phase of the research. Based on the same reasoning, JRC-EC (2008) index development procedure also uses exploratory research as a precursor to develop indexes. A study by Myers & Oetzel (2003) used an exploratory mixed methods design to quantify newcomers' assimilation into organisations. Enosh, Tzafrir, & Stolovy (2015) also used the same design to build an instrument for measuring client violence by generalising information about client violence encountered by social workers across different contexts. Rurality is a complex and dynamic phenomenon whose character evolves. Hence there is a need to explore the context of a study by using qualitative research approaches.

Creswell & Clark (2011) outline four steps of conducting exploratory sequential mixed methods research. The steps are as follows:

> *Step I* involves designing and implementing the qualitative component, including stating research questions, obtaining ethics approvals, identifying the qualitative sample, collecting data, analysing qualitative data to address research questions, and identifying information needed for the quantitative phase.
>
> *Step II* focuses on strategies to build upon the qualitative study, encompassing the design and testing of a quantitative data collection instrument based on qualitative findings, refining quantitative research questions or hypotheses, and determining how participants will be selected for the quantitative sample.
>
> *Step III* centres on designing and executing the quantitative strand, involving stating quantitative research questions that build on qualitative results, obtaining necessary permissions, selecting a quantitative sample that generalises or tests qualitative findings, collecting closed-ended data using the instrument derived from qualitative results, and analysing data using descriptive and inferential statistics.
>
> *Step IV* involves interpreting the connected results by summarising and interpreting both qualitative and quantitative findings and discussing how quantitative results either generalise or test the qualitative results.

Creswell & Clark (2017) elucidate that in exploratory mixed-method designs, there is a greater emphasis on qualitative techniques during the initial phase, rooted in constructivist theory, to appreciate multiple perspectives and attain deeper insights. Constructivism is a philosophy of how people learn and their thinking processes (Liu & Chen, 2016). Then, during the quantitative phase, assumptions move to post-positivism to guide the measurement and identification of statistical trends. It states that knowledge is generated from human intelligence and experiences form reality (Elkind, 2004; Carson, 2006). Post-positivism and positivism are based

on the fact that knowledge comes from scientific research and observation, while post-positivism posts uncertainty in the results of scientific research (Chilisa & Kawulich, 2012).

4.3 Operationalising Exploratory Sequential Mixed Methods Design

This section outlines the steps of the exploratory sequential mixed-methods design that the study followed.

4.3.1 STEP I: Design and Implementation of the Qualitative Strand

4.3.1.1 Research Questions and Qualitative Approach

The first step of an exploratory sequential mixed method design identifies the research's qualitative questions or objectives. For the current study, the goals were as follows.

i. *To elucidate the underpinnings of the current state of access to improved public service delivery (including infrastructure, household amenities, and public services) within the South African rural context.*

ii. *To expound upon the impact of ICT proliferation on public service delivery in the South African rural context.*

Review of Literature

A literature review was conducted as part of this study. The review was guided by established place classification frameworks, particularly the CoGTA and DBSA framework (Section 2.1), which served as the basis for comparing places within the study. Various publications have thoroughly documented the characteristics of South African places, considering the country's historical context, which played a pivotal role in shaping its spatial, demographic, and service delivery landscape (Section 7.2). As a result, we conducted a narrative literature review to provide a chronological account of South African rurality, spanning the pre-1994 era, the immediate changes following 1994, and subsequent developments (Paré, Trudel, Jaana, & Kitsiou, 2015). Aloini, Dulmin & Mininno (2007) effectively conducted a narrative literature review by classifying publications to analyse enterprise resource planning project risk management approaches and their impact on project successes without providing explicit explanations of the review's searches, article selection, and coding processes. A narrative literature review was conducted as an initial step of the study, aiming to complement data from interviews. It continued throughout the development of the rural assessment approach.

Sample Selection

According to STAS SA (2011), in 2011, South Africa had 14 341 210 households, and approximately 4 683 245 households lived in traditional rural areas or farms. The 2011 South African census had 112 category B3 municipalities and 70 category B4 municipalities (DNT, 2012). Households in B3 and B4 municipalities across the country's provinces were targeted. In each municipality, prominent places like towns or villages were identified and targeted for the interviews. The interviewers had no prior knowledge about the households except the likely demographic characteristics described by prior statistical presentations or reports. The

researcher was assisted by the research assistants or community development workers to select and identify households for the interviews. In summary, the research set the following guidelines for participant selection:

i. All rural households in the country were eligible for the study.
ii. At least one B3 municipality and one B4 municipality were targeted for the interviews in each of the country's province.
iii. For each municipality where interviews were conducted, prominent places (towns) and villages were identified, and households were interviewed from the targeted sites.
iv. Households were to undergo interviews contingent upon their willingness to participate in the study.

Thus, households were purposively sampled from predefined South African rural municipalities (i.e., commercial farm areas (B3 areas) and communal rural areas (B4 areas)). Purposive sampling was chosen for qualitative data collection to ensure that the intricacies of the rural context in the country were adequately addressed as addressed by Martin (1996). Further, the representation of respondents from the two types of rural areas across the country's nine provinces was an important factor for sample representativeness. The study's sample representativeness is described in greater detail in Section 5.2.3 and Section 5.3.

Interviews

The interviews sought to determine rurality characteristics from rural stakeholders' experiences (rural dwellers and community leaders). The questioning structure was based on semi-structured questions and contained themes adapted from the service dominate approach to public management, the digital divide theory, and prior rurality studies.

Regarding the digital divide, the questions interrogated households in terms of three levels: access to ICTs, ICT use skills, and development outcomes of the technologies (Section 5.2). The digital divide theory provided a basis to interrogate the development outcomes of ICT proliferation by presenting the divide based on physical access, the skills divide, and development outcomes (Figure 3.2). The theory defines physical access in terms of personal and contextual characteristics that determine access. The outcomes of the digital divide were important in representing the importance of ICTs to the study context. Interview questioning was drafted around access and use purposes of ICTs.

Household interview questions sought to determine access and service delivery satisfaction levels. The topics discussed with the participants were: distance and proximity to essential services and service centres, community development priorities, access to service delivery, technology access and exclusion, connection and disconnection, and e-service delivery. The responses to the questions were captured using voice recorders and subsequently transcribed, with notes also taken on questionnaire forms during the interviews.

4.3.1.2 Research Ethics Application and Permission from Municipalities

The study was conducted as part of studies towards a Doctorate in Information Systems at University of Cape Town. Part of the study entailed applying for research ethics clearance from the University's Commerce Faculty Ethics in Research Committee (EIR). In addition, approval was required from municipality managers to interview municipal officials and to notify them of the interviews with households in their municipalities. Ethics clearance obtained from EIR required specifications about the following:

i. In the ethics application form, the researcher confirmed that he would obtain consent to interview all the participants. This means that all potential participants had the right to decline to respond to any of the questions.

ii. Any personal information gathered during the interview would be securely maintained and kept confidential.

iii. The data collection would not discriminate by gender, ethnicity, or other factors.

iv. The ethics application clarified the existence and continuation of services provided to participants before and after data collection.

v. The ethics application also specified the organisations (municipalities) where the researcher collected data.

vi. Conflicts of interest were declared between the researcher, research sponsors, or the academic institution.

vii. Finally, the researcher declared whether the study posed any risk to the participants (socially, mentally, physically, economically, legally, or otherwise).

For each interview, a questionnaire featuring a section for the participant's signature was employed to document their consent to participate in the study.

4.3.1.3 Data Collection and Sample Size

Household interviews were designed to represent the development priorities of South African rural dwellers and the role of ICTs in fulfilling these priorities. Purposive sampling was employed to select specific locations while balancing cost and time constraints, ensuring that as much of the study area as possible was covered (Sections 5.2.3 and 5.3). Despite these constraints, sample sizes were determined by the need to capture a diversity of perspectives. Therefore, the sample needed to be large enough to allow meaningful comparability across different groups while ensuring that the data collected remained rich and detailed.

4.3.1.4 Qualitative Data Analysis

The initial phase of the analysis involved a three-stage coding process aimed at developing data themes, as outlined by Aronson (1995). The process is detailed as follows:

Stage I: Data Collection, Transcription, and Preliminary Theme Identification

During household interviews, responses were recorded using an audio recorder, and pertinent information was noted on each questionnaire. Following the interviews, transcriptions of the audio recordings were generated and subsequently imported into NVivo software for analysis. The initial themes concerning development priorities were drawn from existing reports, studies, and literature.

Stage II: Identification and Categorisation of Data into the Themes Identified in Stage I

The second stage focused on recognising patterns in the data, as specified in Stage I. Within the NVivo software, descriptive coding was applied based on the categories of initial themes established in Stage I. Descriptive coding involves labelling data with words or phrases to succinctly summarise the qualitative content (Saldana, 2016). Each transcript was carefully reviewed, and responses were sorted into relevant categories.

Stage III: Aggregating and Organising Data into Sub-Themes

In the third stage, initial responses and additional themes were refined, expanding upon the initial categories created in Stages I and II. Additional themes emerged from the interview transcripts through descriptive coding (by devising appropriate codes). The frequency of descriptive codes was employed to establish a hierarchy for the main and sub-themes discussed by the participants (as indicated in Table 6.1 and Table 6.3).

This three-stage coding process was instrumental in structuring and extracting meaningful themes from the collected data, providing a comprehensive foundation for subsequent analysis and interpretation.

In the second phase of the analysis, magnitude coding was employed to enhance the depth of the already coded data. This method aimed to provide more refined insights into the nature of development communication facilitated by ICTs. As described by Saldana (2016), magnitude coding involves the use of supplementary alphanumeric or symbolic subcodes to capture and convey the intensity, direction, presence, or evaluative content of a phenomenon. This process serves as a means of both quantifying and qualitatively assessing various aspects of the communication. The criteria for establishing these magnitude codes were assumed from the three communication phases delineated by OWI (2004): i) Accessing Information, ii) Voicing Community Concerns to Dominant Nodes (such as municipal or government officials), and iii) Two-way Communication, which encompasses networking and discussions within communities, and interactions between community members and government officials. By applying magnitude coding based on these criteria, the analysis aimed to provide a more nuanced understanding of the development communication achieved through ICTs.

4.3.1.5 Identification of Information to be used for Quantitative Analysis.

Potentially critical quantitative variables were revealed in the literature review—for example, the existing settlement classifications outlined by DNT (2012). The classifications provided details of South African

settlement's characteristics, and the variables used to classify places. For example, descriptions were provided regarding public amenities such as formal housing, water, sanitation, and land use. Analysis of the household interview data provided an outline of the South African rural landscape's current context from the rural dweller's perspective, especially concerning critical rural indicators and the context of ICT proliferation. Rurality variables and their significance were further investigated by statistical methods.

4.3.2 STEP II: Design of Quantitative Data Collection Instruments based on Qualitative Findings

The quantitative data were obtained on online data portals (Section 5.4). Hence, there was no need to develop quantitative data collection instruments because the data custodians provided descriptions of population representativeness and collection procedures followed to obtain the quantitative data (discussed in Section 5.2).

4.3.3 STEP III: Implementation of the Quantitative Strand

4.3.3.1 Formulating Quantitative Research Questions that Build Upon the Qualitative Findings and Specifying the Quantitative Approach.

The quantitative objective or question addressed by the study is as follows:

> *'To elucidate the concept of rurality in the digital era by updating the country's rurality measures in accordance with the prevailing context of ICT proliferation.'*

That is, rurality indexes were developed based on the findings of the qualitative phase of the research.

4.3.3.2 Secondary Data Sources and Permission for Use

The 2011 South African census data were the focal data set used in the study (STATS SA, 2011). The data were obtained on the University of Cape Town's DataFirst website (https://www.datafirst.uct.ac.za/). The South African Hospital Survey 2011-2012 data (Code for South Africa, 2018b) was obtained on the Code for South Africa online data portal and DoH website. SAPS and Code for South Africa also provided data on the South African Police Station locations (Code for South Africa, 2018a). DBE's Education Statistics in South Africa 2011, EMIS data were also used.

4.3.3.3 Analysis of Quantitative Data: Adaptation of the SRI

The SRI, a multidimensional rurality measure (Mountrakis, AvRuskin, & Beard, 2005), was adopted to represent rural connectivity to cities, service centres, and access to public amenities (Chapter 7). An added incorporation to the procedure was the inclusion of route distances between municipalities (distances between centroids). For that purpose, the Google Maps Internet application provided route distances of municipalities to services using the Google Distance Matrix application programming interface (API). APIs are procedures or programming code that accesses the features or data of an operating system, application, or other services by simplifying the procedure of airing the data (Google Incorporated, 2018). The distances were measured as the shortest national road distance between municipalities.

Google APIs retrieved distances by querying the Google Maps application. Specifically, the Google Distance Matrix API was utilised to acquire travel distance and time information for a grid of starting and

ending points (Google Incorporated, 2018). This API was accessed via HTTP by submitting a URL request containing the coordinates or place names for the origins and destinations (Appendix E). The URL executed and provided time and distances for a pair of origins and destinations. Microsoft Power Business Intelligence (MS BI) software was used to connect a database of source and destination pairs to the Internet, where the URL searches relayed back distances and times to MS BI. The URL was coded in MS BI by indexing origins and destinations.

Development of the index included determining the variables, their corresponding weights and the application of statistical methods of principal component analysis, correlation analysis, sensitivity analysis, and JRC-EC's index development procedures (JRC-EC, 2008) (Chapter 8). Spatial Autocorrelation analysis used to assess the space patten of indexes.

4.3.4 STEP IV: Integration of Qualitative and Quantitative Components

The research culminated in the integration of both qualitative and quantitative findings, as detailed in Chapter 9. Integration of the two approaches involved discussing the extent to which the quantitative analysis generalised the qualitative analysis findings (Creswell & Clark, 2017).

5 DATA EXPLORATION

The research drew upon interview data, a diverse range of publications (including journals, books, and government documents), and secondary quantitative data sets, including census data among others. To accomplish the study's objectives effectively, two interview questionnaires were meticulously crafted: one tailored for households and another for community leaders. Furthermore, the attainment of the third objective was predicated on the utilisation of quantitative data sets, complemented by insights gleaned from the first two objectives, with the overarching aim of understanding the relationship between rurality and ICT proliferation in the service approach to public service delivery.

5.1 Summary of the Literature Review Focus

During the initial phases of the investigation, an extensive array of literature sources was consulted, including journals, government publications, reports, and guidelines. These resources collectively contributed to establishing a contextual profile of South Africa. An annotated bibliography was diligently maintained to catalogue pertinent articles throughout the study. Online research was conducted primarily through search engines such as Mendeley, Google Scholar, and JSTOR, while traditional library materials such as books and documents were also thoroughly reviewed. Table 5.1, Table 5.2, and Table 5.3 encapsulate the key literature sources that formed the foundation for the study's inception. In-depth reviews of the literature are presented in Chapter 2 and other sections of the thesis (Section 1.2, Chapter 3, and Chapter 7).

5.1.1 Rurality and Service Delivery

Various search terms, including 'Rurality and Service Delivery,' 'Rural Definition,' 'Ruralness,' and 'South African Rurality' were employed in online search engines to initially source pertinent literature. The publications identified and highlighted a significant shift in development plans after 1994, with a clear focus on inclusive and participatory policies (Perret et al., 2005; Kanyane, 2011; NPC, 2011). Emphasising the critical need for identifying areas requiring infrastructural development, these publications noted that the restructuring of municipal boundaries after 1994 might have placed undue burdens on certain rural municipalities, exacerbating pre-existing development challenges (Table 5.1) (Parnell, 2002; DPSA, 2009).

Table 5.1 Annotated Bibliography on Rurality and Service Delivery in South Africa

Publication	Summary description
'Democratising local government: the South African experiment' by Parnell (2002)	South Africa's efforts to decentralise and democratise local government, and the haste with which the transition from apartheid was attempted meant that insufficient consideration was given to the form of local government that should operate within rural areas. The net effect of post-apartheid policies was that the government set up **huge developmental targets for the new municipal bodies**.
'Measuring Access to Government Services in the Rural Poverty Nodes of South Africa' by DPSA (2009)	South Africa's constitution states that the national government should provide legislation to ensure equal opportunity and equal government services access. The Batho Pele White Paper emphasised the need to improve **geographic access to public services**. Government departments were required to develop access norms and standards while the citizens' input determined the services' optimal location.
'The Revitalisation of Local Government in South Africa' by Nyalunga (2006)	Local governments stand to inherit growing responsibility for service delivery, primarily because South Africa has inherited a public sector marked by **fragmented and gross inequalities at all state activity levels**. Municipalities face enormous challenges in fulfilling the developmental mandate given to them by the new constitution.

'Financial viability of Rural Municipalities in South Africa' by Kanyane (2011)	**Low revenue base** results from poor recording systems, an excessive number of disadvantaged households, ratepayer boycotts, accounts not sent or delivered to customers, unwillingness to pay for utilised services, and economic fallouts.
State of Local Government in South Africa by CoGTA (2009a)	Rural municipalities are very vulnerable in terms of **revenue** generation and institutional development. They are in economically depressed areas and have challenges **attracting skilled managers, professionals, and technicians**. Municipalities in remote areas experience difficulty accessing **qualified professionals,** and there is a limited understanding of their spatial and economic realities.
'Imperfect transition-local government reform in South Africa 1994-2012' by Powell (2012)	The reconstruction and development programme (RDP) gave the local government an expansive mandate to meet basic needs and promote people-centred government and outlined the fundamental principles of democratic local government-such as a **single tax base**, **participatory government**, cross-subsidisation of **service delivery**, and writing off the debts accrued by black local authorities. The net effect was that as municipal boundaries were expanding to include under-serviced rural populations and national policy was giving local government a vast developmental mandate, the new sphere was being asked to do more with **limited resources** and a **crumbling skills base**.
'Poverty and livelihoods in rural South Africa. Investigating diversity and dynamics of livelihoods. Case studies in LIM province' by Perret et al. (2005)	Service delivery in South Africa included providing users with services needed or demanded and providing a sense of **redress and social inclusion**. The question remains as to what extent development policies and programmes have effectively and sustainably improved rural people's life out of poverty.
National Development Plan: Vision 2030 By NPC (2011)	**Typologies should be developed to support policies that allow for more sensitive and differentiated interventions**, responsive to **social, economic, and demographic** conditions, anticipated population shifts, and governance arrangements, particularly traditional authorities' roles. The question is not whether infrastructure should be provided **but what levels and forms of infrastructure should be provided, where it should be located** and how it should be funded.
2011 Local Government Budgets and Expenditure Review by DNT (2012)	South Africa's rural development establishes **agrarian transformation and land reform** as pillars of rural development alongside **infrastructure provision** (such as. Schools, clinics, boreholes and water reticulation systems) that can support agricultural development and **essential service delivery** to rural households.
Connecting transport, agriculture and rural development: experiences from Mhlontlo local municipality integrated infrastructure atlas by Chakwizira, Nhemachena, & Mashiri, (2010)	The South African Department of Social Development has also developed norms and standards for social grant pay points. The major factors to be considered are **travel time/distance, mode of transport, facility capacity, and access to other infrastructure** (banks, post offices, taxi ranks).

5.1.2 Rurality Classifications and Measurement

The publications summarised in Table 5.1 underscore the prevailing issue of spatial inequalities as a defining characteristic of rurality within the South African context. Consequently, the literature exploration aimed to gain a comprehensive understanding of rural classifications within both the South African and international contexts. Table 5.2, is an annotated bibliography detailing various rurality criteria. This compilation highlights that, in studies conducted in different contexts, several critical points emerged from the literature. These included the recognition of the heterogeneous nature of rural areas (Muula, 2007; Chigbu, 2013). Additionally, the literature underscored the significance of factors such as access to essential amenities, as well as the proximity of rural areas to services and urban centres (Mountrakis et al., 2005; Muula, 2007).

Table 5.2 Annotated Bibliography of the Literature on Rural Classification Methods

Article (Journal Paper/Report/Book)	Description	Important Variables
'Why Some Rural Places Prosper and Others Do Not' by Isserman et al. (2009)	The prosperity definition includes advancements in education, income, the nature of the economy, employment, and other variables. Other factors, such as population homogeneity, ethnicity, and race, are also noted. **Location and accessibility to urban areas** were also investigated as agents of prosperity.	Education, income, nature of the economy, employment, accessibility to urban centres
'Defining and measuring rurality' by Goss (2013)	'Area approaches' define municipalities or counties as rural or urban by **population density**. 'Settlement approaches' classify individual **settlements by size**. Eurostat uses a definition based on the population density of 1km grid squares. The other classifications are **settlement classifications** based on size or administrative classification by the national authority. Another form of classification is the **remoteness/accessibility** classification.	Population density, settlement size, settlement classifications, remoteness

'Rurality index for small areas in Spain' by Ocaña-Riola & Sánchez-Cantalejo (2005)	It is essential to establish an appropriate theoretical framework for each country and select the correct variables to develop an optimal rurality index. The selection of the variables that provide an operational definition for a rurality index is no easy task. The components making up the **rurality concepts vary by space and time**.	Variability of principles over time
'Updating Rurality index for Small Areas in Spain', by Prieto-Lara & Ocaña-Riola (2010)	The concept and definition of rurality may evolve through time. Therefore, the **variables used to make up the rurality index should be reviewed and updated periodically**.	Regular review of variables
'The (mis)representation of rural deprivation.' by Martin et al. (2000)	The standard deprivation indicators are predominantly urban-based measures that do not reflect the different types of deprivation experienced in rural areas. **People's deprivation in rural areas is least nominally like that experienced by urban populations** and includes unemployment and vulnerability due to age.	Difference between rural and urban deprivation
MSU Rurality index: Development and Evaluation." by Weinert & Boik (1995)	The MSU index is constructed in four steps, namely: distance and population measures are transformed to normalise them, the **distance and population measures** are standardised so that the standard deviation is one, the standardised measures are weighted to produce an initial index of rurality that assigns high scores to rural families and low scores to urban families, and the rurality measure is standardised to a mean of zero and a standard deviation of one.	Distance to urban centres and Population size
'Different practice patterns of rural and urban general practitioners are predicted by the General Practice Rurality Index.' by Olatunde, Leduc, & Berkowitz (2007)	The GPRI index scores six community factors: **remoteness from advanced referral centres, population size, number of general practitioners, number of specialists, and the presence of acute-care-hospital**. The GPRI index is a healthcare measure rated from 0 to 100.	Remoteness from referral centres, population size, number of practitioners, number of specialists
'Definition of Rural: A Handbook for Policy Makers and Researchers' by Ricketts, Johnson-Webb, & Taylor (1998)	Census Bureau bases its definition on **population density, relationship to cities, and population size**. The management and Budget (OMB) office classifies counties based on population size and integration with large cities. United States of America's Economic Research Service (USA ERS) has a rural typology that provides US nonmetropolitan counties with important economic and policy traits. The six economic activities are farming, mining, manufacturing, government, service, and non-specialised. The Handbook is crucial because it describes the development process of rural classifications.	Population density, relationship to cities, Population size
'Rural Classifications' by the USDAERS (2021)	ERS uses rurality measures such as the rural-urban continuum codes, urban influence codes that classify counties based on **population size, adjacency to metropolitan areas, and commuting flows**. Other measures are the commuting zone, Labour market area codes, and the Population-Interaction Zones for Agriculture.	Population size, adjacency to cities, and commuting flows
'Rural Development Indicators and Diversity in the European Union' by Bryden (2002)	OECD set of fundamental indicators by four main development concerns: **Population** and migration (density, change, structure, households, communities), **social well-being and equity** (income, housing, education, health, safety), **economic performance** (labour force, employment, sectorial shares, productivity, investment) and **environment and sustainability** (topography and climate, land-use changes, habitat and species, soil and water, air quality).	Population, social well-being, economic performance, environmental sustainability
'Wye Group Handbook: Rural Households' Livelihood and Well-Being' by UN (2007)	The two main definitions of rurality are: based on **administrative** areas such as municipalities or larger areas. **Settlement-based** definitions look at built-up areas/urban land irrespective of administrative boundaries. There are two main approaches for selecting indicators that depict some conditions of ruralness. The two approaches, in turn, rest upon two different conceptualisations of rurality-the **sectoral** and the **territorial**. In the sectorial approach, rural households are defined according to their main economic activity (agriculture, forestry, mining etc.). In the territorial approach, rural areas are identified relative to their spatial characteristics that describe distances and population density.	Administrative, settlement characteristics,
'How do we define 'rurality' in the teaching on medical demography?' by Muula (2007)	Even when a formal definition cannot be used, the following possible characteristics may alert the reader to the "depth" or context of the situation: **i) population size ii) availability of basic amenities; iii) main economic activity in the area; and iv) common public health problems.** In Malawi's health research, rural areas are defined as areas outside of district headquarters, designated town centres, and the three cities (Blantyre, Lilongwe and Mzuzu.) **An important aspect inherent in this categorisation is that rural areas, like urban areas, are heterogeneous**	Population, basic amenities, main economic activity
'A County-Level Measure of Urban Influence' by Ghelfi & Parker (1997)	Broad economic opportunities accrue to a place by size and access to larger economies. **Population size**, **urbanisation**, or **access to larger communities** are often central in research dependent upon county-level datasets. Nonmetro counties are divided into groups by their adjacency to metro areas, adjacency to a small metro area, and no metro area adjacency. **Urban influence codes** measure the importance of adjacency to large and small metro areas.	Population size, urbanisation, access to communities

'Modelling rurality using spatial indicators' by Mountrakis et al. (2005)	The index consists of two clusters, a connectivity cluster and an access-to-service cluster which employ spatial relations of topology and proximity to create a novel measure of rurality. The underlying concept is that rural and urban are distinguished by the degree of **infrastructure, connectivity** and **proximity to services**, which are captured through metrics based on spatial relations of **connectivity and proximity**.	Infrastructure, connectivity, proximity to services
'How rural is the EU RDP? An analysis through spatial fund allocation' by Camaioni, Esposti, Lobianco, Pagliacci, & Sotte (2013)	The multidimensional nature of rurality involves socio-economic characteristics, the economy's structure, remoteness, and peripherality. **Composite and comprehensive indicators must capture these features to allow a more accurate and insightful analysis of the link between support and the degree and nature of rurality.**	Importance of measure of the degree of rurality
'Rurality as a choice: Towards ruralising rural areas in sub-Saharan African countries' by Chigbu (2013)	Rurality is a natural and unique condition that can be experienced in rural areas. Rurality involves people-to-people and people-to-place relationships within rural geographies. We view the rural place as the domain of natural activities. A rural location is a place for rural activities: **traditional, cultural, social, economic, environmental,** and **political activities** that distinguish them from urban areas.	Traditional, cultural, social, economic, environmental, and political

Table 5.3 provides a concise summary of the key recommendations for defining South African rurality indicators, which have been gleaned from various studies. These sources collectively emphasise the significance of administrative definitions of ruralness, accessibility to essential services, proximity to urban centres, and the distribution of the population. As highlighted in Table 5.1, South Africa's rural areas generally exhibit traits such as limited access to amenities and considerable distances from service centres. These findings reinforce the importance of addressing these challenges and considering these factors when defining and understanding rurality within the South African context.

Table 5.3 Annotated Bibliography of Important Considerations for the Classification of South African Rural Places

Article	Summary of Publication contents	Relevance to Study
'An Assessment of Incentivising Community Engagement in Drinking Water Supply Management' by Rivett et al. (2013)	The study sites were chosen using a rurality criterion based on the commonly defined criteria for rural environments, such as population density. Other variables are female/child-headed households, social grant dependency, and access to water and sanitation. **The use of population density is problematic because of the inequalities generated by the homeland system**.	Confounding of population density by inequalities of former homelands
'Local government democratisation and decentralisation: A Review of Southern African Region' by Reddy (1999)	The history of ethnic local authorities was one of political controversy, administrative constraints, and financial shortfalls. Most municipals did not have adequate **revenue bases** and the **administrative capacity** or **legitimacy to govern** their areas. Protest actions took place at a local level, targeting racially-based local government structures as symbols of apartheid. The protest included rent and service charge boycotts which added to the challenges already experienced by financially vulnerable local governments.	Revenue bases, administrative capacity, legitimacy
'2011 Local Government Budgets and Expenditure Review' by DNT (2012)	Outside of metropolitan municipalities (category A), the only distinction is between local (category B) and district (category C) municipalities. Urban municipalities such as eThekwini and Tshwane metros contain functionally rural areas. This method used by the Department of Cooperative Governance uses indicators such as the **number of poor households**, the proportion of households with **access to services** (water, sanitation, and electricity), and information on **capital and operating budgets** to group municipalities into seven different categories.	Number of poor households, access to amenities, operating budgets
'Rural Development Framework' by the Rural Development task Team and the South African Department of Land Affairs (1997)	Rural areas are **sparsely populated areas** where people farm or depend on natural resources. They have villages and small towns **dispersed** within their area. In addition, "rural clusters" in the former homelands, for example, large settlements without an economic base except for transfer payments, are also included.	Population distribution

'Urban and rural trends in South Africa' by Laldaparsad (2011a)	Several definitions are used to classify areas based on the application of the definition. For example, the department of **water and sanitation** services formerly used former homeland status as the basis for identifying rural areas. In the case of STATS SA, enumeration areas (EAs) demarcated for the censuses were assigned geographical characteristics that describe the type of geographical location it resided in, mainly based on administrative boundaries and aerial photograph interpretation (called EA-types and Geography-types).	Water and sanitation, location in former homeland areas
'Rural-urban linkages and urbanisation: the origins and definitions of rural-urban linkages and the urbanisation process in South Africa' by Simkins (1990)	It is sensible to classify settlement types according to the following scheme: **(1) Proclaimed urban areas and peri-urban settlements within metros (2) other proclaimed urban areas and adjacent peri-urban regions; (3) dense settlements, and (4) rural areas.** The mechanism which has underpinned this phenomenon has the contract labour system. The paper recommends possible place classification criteria	Administrative, adjacency to urban areas, population density
'Urban and rural trends in South Africa' by Laldaparsad (2011b)	The author proposes areas of possible future study. That is, to explore the opportunity of including a third classification for tribal rural areas, to find appropriate methodologies that break down urban and rural areas into subcomponents or segments, and the inclusion of other data sources like **deeds and municipal and property value data**.	Deeds and municipal property value
'Discussion Document: Defining rurality within the context of health policy, planning, resourcing, and service delivery: complexities, typologies, and recommendations' by Eagar et al. (2014)	In terms of health, the following factors all prove to be significant barriers in a rural context: - **Geographic accessibility**: high average distances to facilities and the lack of transport to and from facilities - **Availability of healthcare**: inequitable distribution of healthcare workers between rural and urban areas, and a shortage of healthcare facilities and supporting infrastructures such as roads, piped water, and electricity. - **Acceptability**: services are often not of an acceptable quality or acceptable based on the social and cultural norms of the people accessing them - **Financial accessibility**: Socio-economic disadvantage of rural populations, additional and higher costs in seeking care, and lower health insurance levels.	Geographic accessibility, availability of services, quality of services, financial accessibility

5.2 Interviews

The interviews were conducted with the primary objective of investigating the role of ICTs in enhancing communication and their impact on advancing the developmental priorities of rural communities, as delineated in the study's second objective. This section elaborates on the questionnaire design, the process of obtaining ethical approval, and the subsequent collection of data.

5.2.1 Design of Data Collection Instruments

Two distinct sets of questionnaires were meticulously developed for the interviews. The first was designed for household interviews, while the second set was tailored for interviews with community leaders. The community leaders interviewed encompassed a range of roles, including councillors, community liaison officers, and other community representatives. The questioning format employed was semi-structured in nature. The household questionnaire was designed for interviews with household heads or their proxies, or individuals appointed by the household to represent them. In accordance with the study's definition, a household was considered a group of individuals who cohabitated and collectively provided for their sustenance, or alternatively, a single individual living alone (STATS SA, 2014a). The concept of the household was especially pertinent, as it served as the basis for the allocation of public funds, contingent upon the proportion of economically disadvantaged households within municipalities (DNT, SALGA, & CoGTA, 2012). The interview questions were formulated based on constructs derived from the digital divide theory, encompassing personal characteristics, positional characteristics, and the ICT access sub-model (Figure 3.2).

This comprehensive approach aimed to capture a holistic understanding of the factors influencing ICT access and its implications within the context of the study.

5.2.1.1 Interview Questioning

The digital divide theory, as expounded in Section 3.2.4.1, delineates the digital divide into three distinct levels. Within the theory, positional and personal categorical inequalities exert a significant influence on the distribution of resources, leading to differential access to ICTs and varying levels of social participation (Pick & Sarkar, 2016). Positional characteristics encompass indicators recognised in the context of the digital divide, which influence access to technology. These include social, economic, governmental, and societal openness factors that impact technological utilisation. In the context of this study, the literature review explored the positional attributes specific to the South African context. Furthermore, interviews with community leaders provided valuable insights into the positional characteristics relevant to the study's context. For example, community development workers were questioned about municipal operations and the use of ICTs for communication, dialogue, or networking within rural communities. Personal characteristics, on the other hand, encompass individual factors that affect resource allocation, including age, gender, race, intelligence, personality, health, and ability. The steps involved in the access process are delineated as a circular process, encompassing motivation for access, access to the requisite hardware and software, the development of ICT skills, and gaining proficiency in ICT usage (Pick & Sarkar, 2016). These personal characteristics played a pivotal role in shaping the questions incorporated into the household questionnaires.

5.2.1.2 Household Interview Questioning Guide

The Household Interview Questioning Guide, provided in Appendix A, served as the basis for collecting responses in accordance with the interviewees' consent. The questionnaire encompassed several key topics, as outlined below:

i. *Household Characteristics:* Household proxies furnished details about the household, including its size, gender composition of household members, ages, employment statuses, and education levels.

ii. *Service Delivery:* This section delved into the level of access to and satisfaction with service delivery, including service priorities. Participants were asked to provide information about their access to household amenities (water, sanitation, electricity for cooking and lighting, and other appliances). They also described their place of residence in relation to essential services.

iii. *Community Development Priorities:* Participants were invited to express community development priorities, highlighting urgent development needs in their residential areas.

iv. *Access to ICTs, Motivation, and ICT Use Skills:* This segment explored access to various ICTs, including computers, televisions, radios, landlines, and mobile phones. It also inquired about the location

of access (within the household or at community centres), the purposes for which ICTs were used (communication, networking, research, e-learning, service access, management, and information), individuals' proficiency in using ICTs, and the frequency of ICT usage. ICT use skills and the utilisation of public and private ICT facilities in libraries, community centres, or Internet Cafes were also discussed.

v. *Service Delivery via ICTs:* Participants were asked about their access to essential services through ICTs, their utilisation of ICTs to manage and monitor service delivery, and their perceptions of the effectiveness of ICTs for the delivery of services.

vi. *Technology Access and Exclusion:* Interviewees shared information about the types of ICTs and technologies available to them, as well as those they considered essential but inaccessible within their context.

Two interview test runs were conducted to refine the interview process, and adjustments were made accordingly. All interviews were recorded using a voice recorder to ensure accuracy and completeness of the data.

5.2.1.3 Community Leader's Questionnaire Guide

The Community Leader's Questionnaire Guide, available in Appendix B, was structured to encompass various sections, each focusing on specific aspects of community leadership and ICT-related matters. These sections are outlined below:

i. *ICTs and Community Interaction:* This section involved discussions regarding the impact of ICTs on interactions among community members and the municipality. It explored the various ICT channels used for communication between municipal officials and community members.

ii. *ICTs and Community Participation:* Here, the questionnaire investigated the positive changes brought about by the proliferation of ICTs, particularly in terms of community members' involvement in decision-making processes and participation in community discussions.

iii. *ICTs and Service Provision:* This section delved into the role of ICTs in facilitating the provision of services and assessed the effectiveness of such ICT-based mechanisms in enhancing service delivery.

iv. *Rurality:* This part aimed to provide a description of rural areas, their distinctive characteristics, and how they compared to urban areas.

v. *Development:* Community leaders were queried about the development priorities of rural communities they represented.

Upon the completion of the questionnaire guides, they underwent a formal review process by the University of Cape Town's Faculty of Commerce Ethics in Research (EIR) committee to ensure compliance with ethical research standards and guidelines.

5.2.2 Research Ethics Approval Process at UCT

The submission to the EIR Committee comprised several critical documents, including the ethics application form, the two questionnaire guidelines, the interview time schedule, and the research proposal. The research interviews were scheduled to commence in April 2016 and conclude in June 2016, defining a specific timeframe for data collection. The EIR ethics application form demanded specific details concerning various aspects of the research, including:

i. *Study Description:* A comprehensive description of the research project.
ii. *Participant Rights:* The rights and protections afforded to research participants.
iii. *Provision of Services:* The provision of services, if any, during and after the research.
iv. *Organisational Permissions:* Permissions sought from relevant organisations involved in the study.
v. *Research Sponsorship:* Information regarding any sponsorship or funding sources for the research.
vi. *Potential Risks to Participants:* An evaluation of potential risks to participants.
vii. *Declarations by the Researcher:* Declarations made by the researcher regarding data use, confidentiality, and other ethical considerations.

The EIR application form provided an abstract of the research, while the research proposal presented a detailed explanation of the study. A primary ethical consideration was the obligation to thoroughly explain the research's purpose to potential participants, ensuring their full understanding. Participants were also assured of their right to decline to answer any questions during the interviews. Additionally, each interviewee was asked to confirm their willingness to participate in the study, either orally or through written consent.

In the context of data usage, the researcher pledged to use the collected data exclusively for academic purposes, with a commitment to safeguarding participants' identities. Importantly, the research did not involve the provision of any services. The researcher acknowledged the need for individual municipalities' permission to conduct the interviews, indicating a proactive approach to ethical research practices. Furthermore, it was affirmed that the study had no conflicts of interest with any research sponsors, and it was clarified that the study presented no risks to the participants' well- being. Following the initial submission, the EIR committee provided feedback and requested amendments to the submitted application as follows:

i. In response to this feedback, an option 'Prefer Not to Answer' was incorporated for sensitive questions related to race in the household questionnaire.
ii. To ensure explicit participant consent, two forms of consent were introduced for the interviews, that is, written and oral.

iii. Consideration was to be given to seeking approval from traditional leaders, recognising their pivotal role in facilitating community members' participation.

Due to time constraints, contacting traditional leaders in the areas under study during the interviewing process was not feasible. Nevertheless, the research successfully obtained ethical approval from UCT on April 28, 2016. Following this approval, the researcher initiated the process of seeking consent from municipalities to conduct the interviews. These rigorous ethical procedures and considerations underscored the research's commitment to ethical conduct, ensuring the protection of participant rights and adherence to ethical guidelines throughout the study.

5.2.3 Selection of Municipalities and Municipal Approval Processes

The research interviews aimed to encompass all households within South Africa's rural municipalities (based on the CoGTA's settlement classification shown in Table 2.1). In the FS and WC provinces, only B3 municipalities were present. The selection of municipalities was purposeful and based on their categorisation as B3 or B4 areas(Table 2.1), ensuring the inclusion of study participants from both types of areas for comparison. Within these selected municipalities, specific prominent places and remote centres were identified. Subsequently, households for the interviews were randomly chosen from these locations. Several preconditions were established to meet the sample requirements:

i. *Eligibility of Rural Households:* All rural households in the country were eligible for participation in the study. A total of 32 application letters were sent to municipalities to request permission for conducting interviews. These letters were submitted along with the UCT's EIR clearance form.

ii. *Province-Based Selection:* In each province, at least one B3 and B4 municipality were targeted for household interviews, promoting diversity, and enabling comparisons between municipalities. However, during the actual data collection, only the LIM province had interviews in both B3 and B4 municipalities (Table 5.4).

iii. *Identification of Main Places and Villages:* Within each municipality where interviews were conducted, key places (towns) and villages were identified, and households were selected for interviews from these designated locations to ensure diverse responses.

iv. *Consent-Based Interviews:* Household proxies were interviewed based on their consent to participate in the study.

The initial batch of letters was dispatched in April 2016 to 32 municipalities. Theewaterskloof municipality in the WC province was the sole municipality to grant approval and respond via email. Subsequently, the strategy for contacting municipalities was modified to include follow-up letters and phone calls to Municipal Managers. While contacting other municipalities to obtain clearance, the researcher proceeded with interviews in Theewaterskloof municipality. Over the course of the year, permission letters were sent to an additional 18 municipalities. In 2017, application letters were sent to three more municipalities. Table 5.4

provides an overview of the municipalities in which interviews were approved and conducted. This comprehensive approach to municipality selection and the meticulous approval process ensured the study's representativeness and adherence to ethical standards.

5.3 Summary of Collected Data

The first round of interviews took place in Theewaterskloof municipality. Subsequently, the interviews in other municipalities were temporarily halted due to municipal elections held in August 2016. Following the election period, interviews resumed in several municipalities, including Intsika Yethu, Engcobo, Greater Tzaneen, Phalaborwa, Thaba Chweu, and Ratlou. During the interviews, a flexible approach was adopted to accommodate the respondents' language preferences, with interviews conducted in English, Afrikaans, Xhosa, Sepedi, Sotho, Shangaan, and Tswana, as required. The interview questions were open-ended, allowing participants to provide detailed responses. Each interview typically lasted between 20 to 30 minutes. The interviews were conducted by a team consisting of the researcher, research assistants, and community development workers. This collaborative effort ensured the effective administration of the interviews and facilitated data collection in a diverse range of languages and locations.

Table 5.4 Frequency Distribution of the Households and Officials Interviewed per Municipality

Province	Municipality	B4 Municipality		B3 Municipality	
		Households	Officials	Households	Officials
KZN	uMzimkhulu (UMZ)	13			
	Ubuhlebenzwe (UB)	16			
MP	Thaba Chweu (TCW)*			8	1
LIM	Greater Tzaneen (GT)	8			
	Ba-Phalaborwa (PHA)*			6	
EC	Engcobo (ENG)	6	2		
	Intsika Yethu (INT)	9	2		
WC	Theewaterskloof (TWK)*			10	3
NW	Ratlou (RAT)	9			
Total		61	4	24	4

Note: 1) Interviews were conducted in six provinces and nine municipalities (six B4 municipalities and three B3 municipalities). A total of 93 interviews were conducted (61 in B4 households, 4 for B4 municipal officials, 24 for B3 households, and 4 for B3 municipal officials). Two preliminary interviews were conducted, the first with a rural household proxy and the second with a municipal official. 2) The naming convention of each respondent used the Provincial abbreviation, Municipality abbreviation, and the respondent interview number in each province. For example, the third respondent interviewed in Engcobo municipality is EC_ENG_03. * Indicates formal rural areas (B3).

A total of 24 households were interviewed in formal rural municipalities, including Theewaterskloof, Phalaborwa, and Thaba Chweu. In communal rural areas categorised as B4, 61 households were interviewed across Engcobo, Intsika Yethu, Ratlou, Greater Tzaneen, uMzimkhulu, and Ubuhlebezwe. In B3 areas, 24 households were interviewed in Thaba Chweu, Ba-Phalaborwa, and Theewaterskloof. A total of eight officials were interviewed due to logistical limitations that restricted the number of interviews in each municipality. In particular, two interviewers—the researcher and an assistant—conducted the interviews in each municipality. Each round of interviews took place over a two-day visit, during which the pair travelled to different locations within the municipalities. This also limited the researcher's ability to schedule appointments with municipal officials who were occupied or out of their offices on assignments. However, the eight officials interviewed, including councillors and community development officers from diverse

municipalities, provided valuable and detailed insights. A detailed description of the interviews is provided in Appendix A (Section 12.1.2). The collected data can be accessed on ZivaHub Open Data UCT (Pashapa, 2022).

5.4 Secondary Data

The quantitative component of the study relied on nationally representative secondary data sources, with the primary data source being South Africa's 2011 census data set (STAS SA, 2011). Data for the study were obtained from the DataFirst online portal (DataFirst University of Cape Town, 2021).

Table 5.5 Descriptions of Secondary Data Sets

Survey Name	Variables of Interest	Size
2011 South African Census Data	Household Data: Location of residence Province, District, Municipality, Urban or rural Household composition: size, gender. Access to services and amenities: Water, Sanitation, Electricity, Housing. Access to household goods, including ICTs: Television, Radio, Mobile phone, Internet, and Computers. Individual-level demographic Data: Age Sex Education level	National
Education Statistics in South Africa 2011: Education Management of Information Systems (EMIS)	School Data: Location: Municipality Number of teachers Number of pupils Level of service: Primary, Secondary, Combined	National
DoH, 2011 Health Survey Data	Hospital Data: Location: Province, District, Municipality) Level of service: Clinic, District Hospital, Regional, Tertiary, Central	National
Municipality Distance Matrices	Driving route distances between the centroids of the South African municipalities	National

A summary description of the data used in the study is provided in Table 5.5. The data sets are described as follows:

i. *STATS SA's Census 2011 Data:* This data were downloaded in the STATA statistical software package format from the DataFirst web portal. The census data set contained information on household goods and access to services. Specifically, it included variables related to access to piped water, sanitation facilities, and electricity. The water data were presented in terms of the type of water source and its distance from the household's dwelling. Sanitation data indicated the type of sanitation facility used per household (e.g., latrine, VIP latrine, chemical, and others). Electricity data included the type of power source used for cooking, lighting, and heating (electricity, gas, solar, or others). Additionally, the data covered household access to telephones, television, radio, mobile phones, computers, and the Internet. Most importantly, the data provided information of municipalities' population and household sizes.

ii. *School Location Data (EMIS):* This data were obtained from the DoB's website (DBE, 2018). It provided information about the location of schools categorised as Primary, Secondary, High Schools, and others. The data also included details about the number of pupils, teachers, and some facilities at schools.

iii. *2011 Health Facility Location Data:* This data were sourced from the Code for South Africa (2018b) web portal. It included information about the locations and levels of health facilities, such as clinics, central hospitals, district hospitals, regional hospitals, and tertiary hospitals. The data provided insights into the distribution of healthcare facilities at provincial, district, and municipal levels. Additionally, it included ratings of the quality of service offered by these facilities, as assessed by health experts and the public.

These diverse data sources collectively contributed to the study's comprehensive analysis of various factors related to service delivery and accessibility in South Africa within the context of the digital age.

6 INTERVIEW DATA ENQUIRY

This chapter presents the findings on ICTs and service delivery in the rural areas of South Africa, aligning with the second objective of the study.

6.1 ICT Proliferation and Rural Development Priorities

In this section, the study focused on the relationship between ICT proliferation and rural development priorities, as described by household heads or their proxies during interviews. The proliferation of ICTs refers to the widespread acceptance and use of these technologies (Baliamoune-Lutz, 2003; Karlsson et al., 2008). The analysis of data from interviews (Section 5.3) was carried out in two phases:

i. The initial phase aimed to establish rural development priorities before exploring the connection between ICT proliferation and rurality. In this phase, development priorities were derived from the literature review (for example, topics like water, sanitation, and electricity mentioned in Section 2.1.2) and served as preliminary priorities. Descriptive coding was then employed to identify additional themes in addition to those identified in the literature. Descriptive coding involves summarising the fundamental topics found in qualitative data using concise words or short phrases, typically nouns (Saldana, 2016). The frequency of these descriptive codes helped determine the predominant subjects discussed by the participants. Sub-coding was utilised to provide more descriptive and comprehensive descriptions of primary codes (Saldana, 2016).

ii. In the second phase, the study explored the role of ICTs by establishing correlations between the development priorities identified in the first phase and responses regarding ICT use in rural households and communities. During this stage, the C4D framework (Section 3.2.4.2) was employed to characterise the nature of communication facilitated by ICTs. Evaluation coding was utilised to assess the impact of ICT proliferation and rurality by examining the activities, the nature of service, outcomes of the relationships under study, and providing recommendations for action (as described in Section 4.3.1.5) (Saldana, 2016). Evaluation coding incorporated magnitude coding, which defined three categories of communication: access and knowledge (AC), voice (V), and network and communication (NC). NC represents the highest level of interaction achievable and encompasses dialogues and discussions between consumers and service providers. The three categories are elaborated upon in Section 3.2.4.2. Additionally, data from municipal officials were analysed to gain insights into the role and impact of ICTs in service delivery processes and municipal ICT initiatives.

6.1.1 Developments Priorities

The most prominent priority cited by respondents in both B3 and B4 areas was household access to water (as shown in Table 6.1). Sub-themes that emerged from these discussions included the need for connection to the municipality's piped water system, the reliability of water supply, improved service management, and proximity to water sources. In the most severe cases, some respondents reported resorting to using river water for domestic purposes, as indicated by respondent KZN_UMZ_B4_12 (Table 6.1).

Despite the presence of piped water systems in B4 areas, the reliability of water flow from these systems was a significant concern. Some communities experienced extended periods without access to water from these systems. Common phrases used to convey the value of water services over other services included 'still need,' 'huge problem,' and 'especially water.'

Conversely, residents interviewed in B3 areas generally emphasised the importance of service providers responding promptly to service complaints, particularly regarding water service interruptions. In less developed B3 municipalities, such as Phalaborwa and Ratlou, challenges with water services were exacerbated by the local arid climate. The significance of water services is highlighted by the highest recorded data incidence, which reached 26, as reflected in Table 6.1.

Household access to minimum acceptable sanitation was a priority addressed under the RDP (Reconstruction and Development Programme) initiative. In the current study, household sanitation access emerged as a major priority. Sub-themes that were identified included access to minimum acceptable sanitation services and the necessity to upgrade existing sanitation systems, particularly in B4 areas. In B4 regions, respondents described existing sanitation services as 'too old.' A sizable number expressed their desire for 'flushable' or 'proper' toilets. One respondent highlighted the need to develop sewage system infrastructure in their town. This was due to the existing system being overwhelmed by their town's population growth (WC_TWK_B3_04). In B4 areas, the focus was primarily on increasing the number of households with access to minimum acceptable sanitation standards.

In contrast, the development of road networks was a minor concern in B3 areas. However, as indicated in Table 6.1, the development of road networks was considered a crucial development requirement in rural B4 locations. Two sub-themes were identified: improving the quality of road networks and maintaining existing road systems. In B4 areas, respondents strongly needed roads connecting their communities to towns and urban centres. In some B4 areas, villagers had to travel long distances on foot to reach the nearest roads, as illustrated in the following extract.

> '... [The road network for] some rural locations around Engcobo are bad....when I was assisting a sheriff...[I observed that] the roads were in bad condition...so you need to leave your car at a certain place and start to walk a long distance (to access the areas).' (EC_ENG_B4_01)

Formal housing was provided as part of the RDP program (as discussed in 1.2.3), which also included provisions for basic amenities such as water, sanitation, and electricity. Due to poverty, some rural households

were unable to afford the construction of formal housing structures. As depicted in Table 6.1, participants interviewed in B4 municipalities expressed concerns about whether they would still benefit from the government's RDP project (EC_INT_B4_03). These participants conveyed their continued expectations that the government would construct formal dwelling structures under the RDP program, citing examples of other rural communities that had benefited from the initiative. Common expressions regarding housing included: 'For me personally it's housing, we have a large household (family),' 'they said long ago they would build,' 'they have not yet delivered,' '...houses that we have not received yet,' and '...[formal] houses. Make sure you write that down'. In towns situated in B3 areas, there was a need for housing, particularly for those living in emerging informal settlements (such as Grabow in Theewaterskloof and Mashishing in Thaba Chweu). The population growth in these areas had strained the town centre's infrastructure (WC_TWK_B3_03).

Other critical themes identified in the analysis were related to improved public infrastructure, services, and facilities. Sub-themes included access to street lighting, community halls, recreation and sports centres, libraries, computer centres, and free Wi-Fi connectivity. Street lighting was deemed essential, particularly in less developed B3 areas (such as Phalaborwa town). Community halls were vital for hosting social events (EC_ENG_B4_04). Access to libraries was emphasised as important for rural residents, particularly school children in B4 areas. Access to computer centres and free Wi-Fi connectivity were mentioned in B3 communities (Theewaterskloof). The key aspects identified within this theme pertained to access to ICTs and Wi-Fi connectivity in towns.

ICT infrastructure and facilities were of significance to rural residents in B3 areas. Interviewed respondents highlighted the need for computer centres for school children. Additionally, there was a need for improved mobile phone coverage in B3 areas (WC_TWK_B3_10). The information and communication needs of farming communities and schools drove the demand for enhanced mobile network coverage in B3 areas. The following data extracts illustrate the situation for some farming communities.

> **Interviewer: What are the major limitations in terms of using mobile phone communication?**
>
> 'Reception, (major limitation to using mobile phones) that's number one...Telkom (telecommunications service provider) does not put wires [here] anymore... [they were] stolen six times until they said, "Listen, we are not putting on any more wires. You have to put on a wireless system" the wireless system, ...does not work very well.... our cellphones... need towers... [for connection]. We need a couple of towers, but they will not put them up because there are not enough people (for the service).'
>
> **Interviewer: What are some of your uses of cellphone technology or any form of technology based on your business?**
>
> '[We use cellphones and other technologies for] communicating on the farm [and] communication with people outside the farm. Communicating [and business] here has everything to do with the Internet: Internet banking, emails, everything. Huge problem! Huge problem! What wouldn't I give for fibre optic? I am always trying to get all of us on this road (area of residence), 50 to 60 of us, to pay more than normal for fibre optic... but it is... too expensive. Infrastructure problems, exactly!'
>
> **Interviewer: In terms of development in the area, especially in terms of services provided by the local government (interrupts)**
>
> 'Very poor (service provision by the municipality), they haven't got the money, we can't get proper Internet service. They are starting to get it in Grabow (town centre) itself but come out a couple of miles outside Grabow, nothing. (Mobile phone service providers) will not put up a tower here. Maybe they will. I hope that by getting everyone here to sign up, they might give us a fibre (optic).'
>
> (Respondent: WC_TWK_B3_10)

The analysis also identified other important aspects that were priorities for the respondents. These included connection to electricity grid lines, proximity to schools, access to social grants and aid, land for farming activities and housing, shopping malls, and employment opportunities. In Table 6.1, respondents from both B3 and B4 municipalities expressed a need for youth empowerment initiatives. In B4 municipalities, participants were particularly concerned about education and employment opportunities for young people. For example, there were suggestions to empower youth with agricultural skills. Additionally, there was a desire to connect high school graduates to bursary opportunities in higher education institutions. Respondents also prioritised access to schools and universities.

Table 6.1 Rural Area Development Priorities as Specified by Rural Household Representatives

Theme (*n*)	Sub-Theme (*n*)	Area (*n*)	Data Extract of the Development Priorities of Rural Dwellers
Water (26)	Piped water system (15)	B4(15)	'And water because you may find that others still need water because they [still] get their water from the river.' (KZN_UMZ_B4__12).
	Reliable water supply (8)	B3(2); B4(6)	'We struggle with… Yes, there were tapes before, but now, we do not use them because there is no water [flowing out].' (LIM_GT_B4_05)
	Water service management (2)	B3(2)	'…Here is a different story...[when] water just gets cut off with no communication...I wish they can be able to communicate especially in rural areas...' (EC_INT_B4_02)
	Distance to piped water (1)	B4(1)	'I would like to see more tarred roads which lead to [all] the houses in the village [with] taps in the yard' (NW_RAT_B4_08)
Housing (15)	Formal Housing (15)	B3(4); B4(11)	'Delivering the promises which they made to the community (They promised to install electricity, RDP houses etc.)' (MP_TCW_B3_02)
Roads (13)	Quality & New (12)	B3(2); B4(10)	'It's the roads because we travel on muddy roads.' (KZN_UMZ_B4_14)
	Maintenance (1)	B4(1)	'If they can fix the roads, it would be a lot more convenient for us to be able to find transport to travel to town. From town to this site, it costs R20, and if you are going past the bridge, it will cost you another R10 because they say [that]…our roads damage their vehicles.' (KZN_UB_B4_04)
Sanitation (11)	Minimum acceptable service (10)	B4(10)	
	Maintenance/Upgrade (1)	B3 (1)	'[The town] sewerage system needs to be upgraded urgently because when the weather is hot, the whole town stinks.' (WC_TWK_B3_04)
Public Infrastructure (11)	Streetlights (3)	B3(2); B4(1)	'We need Apollo lights (streetlights) because there is a lot of crime in the area.' (LIM_PHA_B3_02)
	Community Hall (3)	B3(1); B4(2)	'We would like municipality halls….and it has been our wish for a long time...' (EC_ENG_B4_04)
	Recreation Park/Sport Centre (3)	B3(3)	The park is not safe for the kids to play in. We need a sports centre for the youth to hang around.' (LIM_PHA_B3_07)
	Library (2)	B4(2)	'They have built the Museum, library, and computer centre even though they have not begun to function yet. I would just like to see these facilities operational and freely available to the community.' (NW_RAT_B4_09)
Malls (5)	Malls (5)	B3(3); B4(2)	'There is no bank. There is no proper shopping complex (shopping mall).' (MP_TCW_B3_06)
ICTs (4)	Computer Centre (1)	B3(1)	'I think if they can set up a place nearby, children go and do their stuff (work) on the computers [for free].' (WC_TWK_B3_05)
	Free Wi-Fi (1)	B3(1)	'If we could have free Wi-Fi, that would be very nice.' (WC_TWK_B3_03)
	Mobile phone coverage (2)	B3(2)	'I think we should have more cellphone receivers…most of the cellphone companies would put on better receivers in the rural areas… I think that would be a good thing because I think most people are on Facebook and WhatsApp and they can easily receive messages.' (WC_TWK_B3_01)
Schools (4)	Distance (4)	B3(2); B4(2)	'Small children ... walk about 5km to school. We do not have schools close by.' (KZN_UMZ_B4__10)
Electricity (3)	Connection (3)	B3(1); B4(2)	'Delivering the promises which they made to the community (They promised to install electricity, RDP houses etc.)' (MP_TCW_B3_02)
Land & Farming (3)	Housing/Farming (3)	B3(1); B4(2)	'Though I am not sure if this would fall under government issues, we do not have grazing fields for our livestock. So, they end up in the forest and get stolen there.' (KZN_UB_B4_10)
Social Issues (11)	Employment (7)	B3(2); B4(5)	'Our children are not working. They cannot find employment.' (KZN_UMZ_B4__13)
	Social aid/Bursary/Food Aid (4)	B3(3); B4(1)	'They must provide bursaries for those who do not have money to pay school fees.' (MP_TCW_B3_01)
			'Our main concern is with our household and the fact that we struggle to get food. So, it would be more important for us to access food because other municipalities help with food. That way, we can use the pay (grants) for other needs within the community.' (LIM_GT_B4_01)

Note: i) Data extracts were drawn from the respondents' narrations of development priorities, and each respondent was not limited in terms of the number of responses they provided.

B4 areas were typically characterised by limited access to basic services, including water, sanitation, and housing, in comparison to B3 areas. The town centres in formal rural areas (B3) faced unique development challenges, which were a blend of both rural and urban settlement issues related to urbanisation.

6.1.2 ICT Proliferation and Development

Table 6.2 provides an overview of how ICT proliferation contributes to the realisation of the development priorities discussed in Section 6.1.1, as per the C4D framework (Section 3.2.4.2). Furthermore, this section also highlights variations in the development priorities between municipalities categorised as B3 and B4. The findings presented in this section are based on distinctions in the impact of different types of ICTs examined (such as mass media, mobile phone voice and text services, Internet applications, social media, and platforms) across different types of areas (B3 as opposed to B4 areas).

6.1.2.1 Mobile Phones (voice and text messaging)

Mobile phone technologies took centre stage in South African rural areas, with a clear emphasis on voice and text-based communication, and Internet applications for various forms of interaction and transactions. The findings related to mobile phone voice and text communication are succinctly summarised in Table 6.2. Beyond their primary functions, mobile phones also facilitated communication and access to information via social media and other platforms. The key findings pertaining to mobile phones are outlined as follows:

i. *Service Delivery Communication:* Mobile phone voice and text communication played a crucial role in enabling health personnel to monitor patients residing in remote B4 communities. In B3 municipalities, it was equally significant for service providers to disseminate information and for consumers to voice service-related grievances.

ii. *Payments and Public Service Transactions:* Mobile phones were instrumental in facilitating payments and transactions for public services, such as electricity and water, through mobile banking systems.

iii. *Community and Family Connectivity:* Mobile phones served as vital tools for maintaining communication with family members residing in urban areas, and they were also utilised for money transfer services.

The primary purpose of mobile phone communication was information dissemination and access, its role in facilitating development communication predominantly aligned with the 'Access and Knowledge' aspect of the C4D framework. Health personnel employed mobile phone communication to share information with rural residents and to monitor patients in remote B4 communities (refer to KZN_UB_B4_08 in Table 6.2). In the more developed B3 rural communities, inhabitants frequently

received text messages regarding service interruptions from electricity and water service providers (see LIM_PHA_B3_03).

Table 6.2 Characterisation of Communication Using the C4D Communication Cycle (data incidence counts are given in the brackets)

ICT Type	B3 Areas	C4D Stage	B4 Areas	C4D Stage
Mass media (Television/Radio)	Educational/Informative Programmes (1) 'I **listen to educational stuff**...They brief us on how to study.' (MP_TCW_B3_03)	**AK**	Educational/Informative Programmes (1) 'I **listen to** Modiri and Metsweding [radio stations] … I listen to short stories, news, kids' educational programmes, and church sermons.' (NW_RAT_B4_08)	**AK**
	National/International/General News (3) 'I **listen to the news**, weather forecasts, and job advertisements.' (LIM_PHA_B3_02)	**AK**	National/International/General News (13) 'With the television, I can follow and see what is happening around the world. It helps to know what is happening in other parts of the world. The radio helps with **hearing news and music**.' [NW_RAT_B4_04]	**AK**
	Local/Community News (5) 'There is one (community station) in Phalaborwa…Sometimes **I listen to it**...they usually have news about children who have gone missing or complaints about water.' (LIM_PHA_B3_05)	**V**	Local or Community News (9) '[I listen] to Capricorn FM, which is a Polokwane (Provincial Capital City) radio station. [On the station] **we heard** that our municipality wanted to build a plaza...' (LIM_GT_B4_03)	**AK**
	Community Dialogue/Voice (2) 'Community problems such as housing are **discussed** [on our local radio stations].' (WC_TWK_B3_02)	**NC**	Community Dialogue/Voice (1) 'They broadcast information about the community, and people use the platform to **voice their concerns**. They usually complain about water cuts, especially if there has not been water for over a week.' (NW_RAT_B4_09)	**V**
Internet/Email/social media (On all devices)	Educational Research/Information (2) [When] I had some health issues, I had **to check (research about it) on the Internet**. I am getting information about tertiary studies [over the Internet].' (WC_TWK_B3_07)	**AK**	Educational Searches/Information/Research (2) 'Those who go to school use it a lot. They **search on the topics** they are given at school…to expand their knowledge.' (NW_RAT_B4_01)	**AK**
	Municipal Online Enquiries (1) 'The only contact with the municipality was by my aunt via email to apply for a plot to build a crèche.' (WC_TWK_B3_7)	**NC**		
Mobile Phone voice and text	Water Service Management (2) 'Sometimes they send messages to **notify us** about water… service disruptions.' (LIM_PHA_B3_03)	**AK**		
	Electricity Service Management & Information (4) 'When there are problems with electricity Eskom (electricity service provider) sends us text messages. **I get a message sometimes.** I call them when I have problems with electricity as well.' (WC_TWK_B3_01)	**NC**	Electricity Service Management & Information (2) 'When there is going to be a power cut or problems with electricity**, they send messages** ahead of time.' (NW_RAT_B4_07)	**AK**
			Emergency (Police/Hospital services) (3) 'My grandmother **receives calls** and messages from Ixopo town clinic to [inform her to come and] collect her pills (medication).' (KZN_UB_B4_01) 'When the mobile clinics or immunisation programme teams are scheduled to visit our village, they send us messages to **inform us**.' [KZN_UB_B4_08]	**AK**

Note: C4D presents a communication cycle evolving from i.) access and knowledge of the information delivery tools (AK), ii.) stronger communication by the people to the dominant nodes (government) referred to as the voice (V), iii.) and finally networking and dialogue amongst communicators and policymakers for broader development impact (NC) (OWI, 2004). AK, V, and NC are used as magnitude codes for the type of communication achieved by ICTs. The column labelled 'C4D stage' represents the C4D communication phase based on development communication revealed in the data. iv) Incident counts should be compared with caution per theme between the two types of areas since the total number of respondents for the two areas differ, and the respondents gave as many responses as they wanted.

Moreover, in B3 municipalities, electricity and water service providers routinely communicated with community members via text messages (WC_TWK_B3_01 in Table 6.2). Respondents conveyed service-related complaints through a dedicated telephone number, particularly concerning electricity interruptions (see Table 6.2).

> 'Most people here would call the municipality for any service (water, electricity etc.) cuts. If I had a problem here, I would call them.' (WC_TWK_B3_04)

> 'Only Eskom (electricity service provider) sends bulk text messages to tell us when electricity will be off so that we prepare and so forth.' (WC_TWK_B3_01)

This form of communication is categorised as the 'Voice' communication mode within the C4D framework. In communal rural areas (B4), the data revealed that certain communities opted to report service-related matters to their traditional leaders, who would then liaise with the service providers. An illustrative example is provided in the following extract:

> 'There are people that we communicate with when we have challenges…we have traditional structures that report on our behalf to the municipality.' (EC_INT_B4_01)

The data demonstrates that mobile phone communication emerged as the most cost-effective and convenient means for maintaining connections within families and communities. Additionally, mobile phone services were commonly employed to receive financial remittances from family members employed in urban areas. For instance:

> 'Yes, I do receive and send money transfers through my phone. At times we use the Spar retail shop [money transfer system].' (KZN_UB_B4_05)

> 'We communicate with our mother because our mother works (in the city), so she is always away.' (KZN_UB_B4_07)

Data from both B3 and B4 areas indicated that rural residents in both regions occasionally utilised mobile banking and other mobile phone purchasing systems. Electricity emerged as the primary service procured through these mobile purchasing systems, including text messaging systems and Internet banking services. Responses revealed that some households in B4 areas were more inclined to use mobile phone banking systems to purchase or pay for electricity in situations where they unexpectedly ran out of the service (Respondent NW_RAT_B4_01). The limited proficiency in digital skills and concerns about bank account fraud were identified as factors impeding the adoption of such services.

Due to the migration of labourers to cities and rural areas for employment opportunities, mobile phone communication played a crucial role in connecting rural-urban migrants with their home communities and facilitating the transfer of income to rural locales. Security also held significant importance in safeguarding agricultural activities in rural areas, primarily due to elevated levels of poverty and subsequent crime. In this context, mobile phone communication served as an essential link for connecting with law enforcement agencies and healthcare services. The following examples illustrate these scenarios:

Communication in B3 Areas (5 data incidents):

'In my household, [cellphone communication] is very important because that is how I stay connected to my family and children who work in the city [Cape Town].' (WC_TWK_B3_03)

Communication in B4 areas (24 data incidents):

'... a lot of people and relatives work far from home, so you are able to contact them.' (KZN_UB_B4_04)

Communication for Emergency Services (Police/Health) in B3 Areas (3 data incidents):

'For me, if I (must) contact the police station...I [would] call them on their emergency number.' (WC_TWK_B3_06)

While mobile phones offered numerous advantages, certain limitations were evident in terms of mobile phone usage skills, affordability (particularly in B4 areas), and network connectivity in sparsely populated, remote, or mountainous regions. The following data excerpts provide insight into these scenarios:

'It (phone network coverage) only gives us problems when there is no electricity...Our parents experience challenges more often. They do not even realise it when their phones are off... We have a [community] WhatsApp group, but we found that it was not so effective because many community members were not connected to WhatsApp (they do not have suitable phones).' (NW_RAT_B4_01)

'...because of the area that we are in, we find it difficult to connect to the [cellphone] network...When I am down at the [farm] office, I will not get connected.' (WC_TWK_B3_03)

Despite the overall effectiveness of mobile phone communication and Internet access in connecting rural residents in both categories of rural areas under study, it was evident that these technologies posed limitations for individuals with disabilities. For instance, one respondent articulated the challenges as follows:

'My dad is blind, so we do not have a phone which talks to him or a phone which uses a speaker to talk to him.... I mean, a phone which would read messages out loud for him when we are not around. The phone would just say the name of the person who sent the message and speaks the message in his language.' (MP_TCW_B3_01)

Therefore, in addition to fostering connectivity within rural communities, it is crucial to address the distinctive requirements of individuals with disabilities, the elderly, those with other health conditions, in addition to catering to diverse language needs.

6.1.2.2 Internet Use on Desktop Computers, Laptops, Mobile Phones, or Other Devices (social media, websites, and email services)

In both types of rural municipalities, libraries and telecentres were typically situated in main towns, which often proved to be quite distant from the rural communities they were intended to serve. This situation was especially challenging for communities with poorly developed road infrastructure. Consequently, rural residents relied on Internet connectivity via mobile phones as a more practical alternative. The Internet served various purposes, including:

i. Accessing educational content by learners in remote rural areas (B4).

ii. Obtaining information about job opportunities and healthcare

iii. Making service payments or purchases

iv. Facilitating money transfer services for rural-urban labour migrants

Despite libraries and telecentres offering free access to these technologies for those who could reach them, there were additional limitations related to the number of available connection points at these centres. The following data excerpt illustrates this scenario:

> 'I know in the town there is a place… on the main road where you could do your staff on the computer or print your CV… if my daughter, who is in high school, wants to check something on the Internet, she must go to the library… she must walk alone [to get] there. There are a lot of children here in high school… most of the staff they do at school must be searched on Internet… maybe two of them must walk [together, to get] there…, the children cannot just walk alone, it is not safe… On school days [because] there are just four computers, they must wait [for their turn to use the free computers and Internet].' (WC_TWK_B3_05)

In the context of development communication in B4 areas, the data indicated that social media usage was primarily confined to serving as platforms for social interaction, with a predominant user base among the younger generation. Moreover, some households either lacked access to the Internet or were occupied by elderly individuals who were not proficient in using these technologies (as evidenced by NW_RAT_B4_01). In contrast, there was a higher probability of B3 residents utilising their municipality's social media pages and websites (as indicated by WC_TWK_B3_07). The following excerpts provide insights into the use of social media in both areas:

> 'All three of us (children in the household) connect to the Internet. The elders are not interested in WhatsApp and Facebook. We do have a [community] WhatsApp group, but we found that it was not so effective because you would find that many other members of the community were not connected to WhatsApp…It is more recreational… like what is happening regarding parties.' (NW_RAT_B4_01).

> 'I use my phone more for social networks (and) they (other members of your house, e.g., parents) use theirs to communicate with their family members. We get that kind of information (Information about events in the municipality) on Facebook and the community page. It is run by the community. Maybe it's because we do not know if the municipality has their municipal webpage or something.' (WC_TWK_B3_07)

Mobile phones offered a readily accessible means to connect to the Internet for educational content, news, business transactions, and other informational purposes. The following data excerpts illustrate this scenario:

> '[We use cellphones and ICTs for] communicating on the farm, communication with people outside the farm. Communicating with the Internet here has everything to do with the Internet.' (WC_TWK_B3_10)

> 'I do not have access to the Internet often because my phone does not have Internet, but I usually ask someone with a smartphone if I need to get information for school [work] on the Internet.' (NW_RAT_B4_09)

Internet connectivity via mobile services or computers played a crucial role in facilitating payments to the municipality and conducting various online financial transactions. The following data excerpts provide an illustration of this situation:

> Electricity Bill Payments and Purchases (5 data incidents):
> 'We normally do it online (electricity bill payment). My wife likes to do it online, especially buying electricity.' (LIM_PHA_B3_01)
>
> Electricity Bill payments and Purchases (6 data incidents):
> '…we [have] only used it about 4 to 5 times. We only use it when we are desperate and cannot go to town… I normally do it.' (NW_RAT_B4_01)
>
> Online Shopping (1 data incident):
> 'When I want to buy a phone. I buy it online. [I do the same when I buy] my furniture as well.' (LIM_PHA_B3_01)

In summary, for most rural residents in B4 areas, community libraries or telecentres were typically situated in main towns, often quite distant from most rural dwellings. Moreover, these centres had a limited number of desktop Internet portals. Consequently, high school students in remote communal rural

communities relied heavily on mobile phones to access the Internet for conducting school research (NW_RAT_B4_09). In contrast, B3 areas exhibited higher levels of digital skills and economic status. In these areas, mobile phone Internet was additionally used to access health-related information (as exemplified by WC_TWK_B3_07 in Table 6.2).

6.1.2.3 Mass Media (Television and Radio Services)

Primarily observed in B3 areas, community radio emerged as the sole technology exhibiting communication characteristics aligned with 'Networking and Communication' within the C4D framework (as exemplified by NW_RAT_B4_09 and LIM_GT_B4_03 in Table 6.2). In this context, radio stations and television fulfilled the following purposes:

i. *Receiving, sharing, and discussing community issues* (B3 areas).

ii. *Communicating obituaries, traffic news, and transmitting community development discussions*

iii. *Receiving community, national and international news (mainly acknowledged in B4 areas)*

iv. *Transmitting educational content (B3 areas)*

The following data extracts illustrate the scenario:

> '…they provide information such as a truck breaking down on the N2 highway (traffic news) … People also send messages about illnesses, birthdays, and the like.' (WC_TWK_B3_06)

> '[There is] just one [local radio station, Radio] DISA. I listen to it when I am at work. I listen to it … throughout the day… community problems [are] discussed on the station, especially the housing problems… It is not generally effective (in the community) because it is like a Christian radio station…' (WC_TWK_B3_02)

Radio and television were acknowledged as valuable learning platforms for students in formal rural areas (as indicated by MP_TCW_B3_02). In deep rural (B4) municipalities, these mediums found popularity primarily among the older generation. Broadcasts in vernacular languages via radio and television were particularly well-received among the elderly. The following data excerpts provide a demonstration of these trends:

> 'Sometimes I listen to… Mash FM. I listen to the educational stuff. They brief us on how to study. [On television] I only watch Mindset because they help me with the revision of the work that we have covered in class.' (MP_TCW_B3_02)

> '…the old lady in this house prefers television more than the radio…and she is in her 60s… I think it is because it is difficult to get reception for the radio…They listen for entertainment…elderly women listen to church services and stories on Thursdays…I do not think it is more than that…' (EC_INT_B4_02)

Many participants indicated that they frequently followed national news broadcasts on radio and television. While respondents in B4 communities generally reported the absence of community radio stations exclusively dedicated to their areas of residence, they regularly tuned into regional or national channels. As demonstrated in the following data excerpts, television and radio played significant roles in facilitating social, religious, and entertainment activities:

Entertainment/Social Activities (2 data incidents):

'...there is a radio station called DISA. My mother listens to it. It is a gospel [station]. I have never heard them talking about community-related issues.' (WC_TWK_B3_07)

Entertainment/Social Activities (2 data incidents):

'I listen to it (radio) in the morning for entertainment because, during the day, I will be working.' (EC_ENG_B4_01)

6.2 Municipal Official's Interviews

The analysis presented in this section assesses the acceptance, utilisation, and significance of ICT proliferation and e-government services in enhancing the delivery of public services by municipal officials in rural areas.

6.2.1 E-Government Systems

The data in this section provides first-hand accounts of the use of e-government systems in rural municipalities. The following data excerpts highlight e-government and ICT initiatives pertaining to municipal operations:

'I work as the link between the community and councillor... we communicate by mobile phones. If it happens, we do not visit the ward...the municipality donated mobile phones to the ward committee members. There are ten ward committee members, and they work hand in hand with the ward councillor. They make use of mobile phone communication.' (LD_EC_ENG_B4_01)

'I am not into cellphones .... most of the time I use my tablet because the municipality gave us tablets....so we use it to communicate with the community. I also bought a printer to print the minutes after our meetings. The tablet has been 100% effective for communicating.' (LD_EC_ENG_B4_01)

'I think (yes) the municipality has installed a text system... When I refer a problem to the municipality, they report to that person to say that their issue is being addressed.' (LD_ WC_TWK_B3_02)

'There is a website for Thaba Chweu municipality. You can check it out. It's like as in (you can find) by-laws, statements, all information, and all that.' (LD_MP_TCW_B3_01)

The full utilisation of ICTs and e-government systems faced challenges due to insufficient skills, resistance to adopting these systems, and limitations in network coverage. For instance, despite Thaba Chweu municipality's status as a formal rural area (B3), the implementation and effectiveness of ICT initiatives were hampered by issues related to network coverage, a lack of proficiency in ICT usage, and a reluctance to embrace these technologies (Respondent LD_MP_TCW_B3_01). The following data extract depicts a situation where hand-delivered mail continued to be a prevalent communication method:

'Enormous! Enormous influence! Enormous! (the impact of ICTs). The problem is that people are using ... these things for the wrong purposes... In my mind, I sometimes think people (in the municipality) are withholding information deliberately. Withholding perhaps training deliberately. In a broad sense, we have a municipality with 27 councillors... Now the role of ICTs is wonderful. The idea is brilliant, but to get it to work is a problem, especially in rural areas. We have a few councillors in Matibi, Leroro...there ... are...canyons [there]...I would say all the areas haven't got access [to mobile phone network coverage or Wi-Fi service coverage]. Every month 27 notices of meetings are hardcoded [and hand delivered]. All of these 27 guys and ladies have got a laptop, but anyway, the problem is accessibility, the service providers' number two, and the training number three. ... Internet is only limited to certain areas like Lindenberg, Graskop, and Sabie...I am saying that they are working towards that (e-Government and ICT initiatives), but they are not there at all.' (LD_MP_TCW_B3_01)

Every South African municipality must have a website and social media presence (DTPS, 2016). Websites served as a platform for conducting municipal business, disseminating information about the municipality's activities to keep community members informed, and enhancing accountability by publishing reports. Furthermore, websites offered contact details or blogs through which citizens could communicate with municipal officials. The following extract illustrates the effectiveness of these websites:

'Government departments and local governments have their websites, but they are not using these media to communicate their business. They are still operating on their [own] publicity versions… of handing out documents.' (LD_WC_TWK_B3_01)

The context of the data extract (LD_WC_TWK_B3_01) highlighted that the adoption of these systems was hindered by a lack of skills, resistance to embracing new technologies, and difficulties in accessing the Internet, especially in remote areas. In summary, the data underscored that municipalities had made efforts to implement ICT systems and communication channels (as evidenced by LD_WC_TWK_B3_01, LD_MP_TCW_B3_01, LD_EC_ENG_B4_01). Nonetheless, overarching challenges still required resolution for e-Governance systems to thrive, with the issue of network coverage persisting as a significant impediment, even in the more developed B3 regions.

6.2.2 E-Government Systems and Public Interaction

Table 6.3 presents data on various e-government initiatives to enhance e-service delivery and promote community participation. These initiatives encompass online billing systems, Internet projects designed for schools, telecentres, and community libraries. However, the effectiveness of e-governance was hampered by resistance from consumers to register on these systems, which led to attempts to evade service bills. Furthermore, it was evident that the systems may not have been adequately publicised. Additionally, despite efforts to establish Internet access points within libraries or telecentres, these facilities faced limitations due to the challenges posed by increasing population sizes in the main towns of municipalities which served as service centres.

Table 6.3 E-Government Systems and Public Service Delivery

e-Government Systems for Public Service Management	Reported Challenges/Hindrances
Internet Billing System 'They have got a system like that (text messaging system). I know this municipality (Theewaterskloof), Overberg municipality, and Cape Argulus have got a [online] billing system. That is the only thing they use. Sometimes they make announcements on that system, but mostly for billing, your account, etc.…I don't think it's generally used because I don't hear people speaking about it.' (LD_WC_TWK_B3_01)	'So, you still have the postman coming and dropping off the bill. So, they have that capability but are not using it. People are not willing to pay their accounts. They are not in a hurry to register on the system.' (LD_WC_TWK_B3_01)
Internet in Some Schools 'Masonwabe Senior primary school has some computers……Nyanga senior secondary school has computers, and we are lucky there because the Deputy Minister of Communications donated 60 computers...' (LD_WC_ENG_B4_01)	
Computer Centres: '..the ward that has computers is ward 11...it is what we call Isilulo Computer Centre...otherwise, other wards do not have [one]…. including my ward…. Isilulo training centre trains people on computer skills... even if we want to email or print things, we go there…' (LD_WC_ENG_B4_01)	
Cape Access Project: '…we are still in the baby steps of ICTs. We must have grown (to accommodate) all these people because you think of 36000 people in this town, and you have six computers, the other library has five, and Cape Access has about ten. So, 36000 people against that... [means] we are [still] doing baby steps now in terms of libraries and these things. So, it's also something new because Cape Access only started last year or the year before.' (LD_WC_TWK_B3_01)	'So, 36000 people against that…. we are doing baby steps now in terms of libraries and these things.' (LD_WC_TW_B3_01)

The data indicated initiatives to implement e-government systems such as self-service online billing systems, municipality websites, and telecentre projects. However, the effectiveness of these systems was constrained by factors such as population growth and a lack of accountability. Furthermore, the data highlighted the challenges posed by a lack of computer skills and network coverage limitations. Despite the South African government's aim for ICTs to foster dialogue and create an inclusive society, the evidence revealed that these technologies were not fully operational.

6.3 Summary of Findings

The interview data revealed the following rural development priorities which were combined with the findings from the literature review to represent South African rurality:

- Ensuring household access to safe, reliable, and easily accessible water sources, including piped and purified municipal water.
- Providing households with dignified sanitation facilities, such as VIP latrines or better options.
- Enhancing road infrastructure and transport services to connect rural areas with urban centres, schools, and hospitals.
- Addressing the need for improved rural housing.
- Meeting the demand for food assistance, social grants, and creating employment opportunities, especially for the youth.
- Offering resettlement opportunities for housing and agricultural purposes.
- Ensuring that more rural households have access to electricity connections.
- Providing essential public amenities like streetlights, community halls, recreation centres, and libraries.
- Reducing the distance between rural areas and shopping centres, malls, and service centres, including schools, hospitals, and police stations.

Regarding public services, the study underscored the importance of improving access to service centres, which necessitated prioritising transport and communication services to establish connections between rural and urban areas. In this context, mobile phones emerged as the central technology, serving as the most efficient and affordable means for accessing the Internet for knowledge, personal research, and educational purposes.

Geographical terrains that were challenging to access and the sparse population distribution in rural regions were found to be significant barriers to ICT proliferation and rural connectivity in terms of mobile phone services and Internet access. Conversely, in some commercial rural areas (B3), mass media, particularly radio, played a crucial role in facilitating community discussions and serving as an easily accessible channels

for acquiring information and knowledge. Digital use skills and the acceptance of technologies were factors in municipal officials' full adoption and utilisation of e-government services. Additionally, rural stakeholders also avoided electronic systems to evade accountability.

6.4 Data Validation

The methods employed for validation of the interview data in this study encompass the following techniques: triangulation involving a comparison between the literature review (Chapter 2) and the interview data, data saturation, credibility checks, comprehensive descriptions, and methodological transparency (Barbour, 2001; Thurmond, 2001; Aguinis, Ramani, & Alabduljader, 2018).

First, the sampling method (purposive) used for participant selection ensures that no responses are overlooked during the interviews, thereby enhancing the reliability and representativeness of the collected data (Barbour, 2001). The researcher presented a thorough description of the study's contextual setting (Section 1.2 and Chapter 2), specifically the South African rural context, which is characterised by B3 and B4 areas, their historical context, state of service delivery, and household economic conditions. The researcher elucidated that the former is primarily marked by commercial farming regions, while the latter is characterised by communal rural areas. B3 areas encompass socioeconomically disadvantaged households with service delivery backlogs. Detailed descriptions of the data collection areas are also provided. Furthermore, the researcher outlines all methods, interview question structure (Appendix A), and the publication of audio recordings and interview transcriptions (Pashapa, 2022). The process of analysis is thoroughly documented within the write-up (Section 4.3.1.4).

In addition to the above methods, data saturation was employed as an additional means to validate the responses collected, particularly concerning the validity of responses related to rural development priorities. The responses consistently emphasise the significance of water, sanitation, and housing in all the interviews. These findings are consistent across both B3 and B4 areas, as well as within each of the two types of areas (Table 6.1, Table 6.2, and Table 6.3). These findings align with the reviewed literature, which underscores the importance of the same services (water, sanitation, and roads) in rural contexts (Section 1.2 and Chapter 2). In that regard, the reviewed literature emphasises the necessity of maintaining household amenities, particularly ensuring a continuous water supply and the uninterrupted function of water points. Thus, the reviewed literature served as an independent source for data validation.

7 EXPLORING APPROACHES TO ASSESSING RURALITY

This chapter presents methodologies employed in measuring rurality and introduces a detailed metric for assessing South African rurality. The chapter also summarises the study context's rurality indicators based on the reviewed literature.

7.1 Rurality Measurement Approaches

Variables incorporated into rurality measures should be accessible, quantifiable, obtainable with a reasonable cost-benefit balance, straightforward to update, and aligned with the theoretical framework under examination (Ocaña-Riola & Sánchez-Cantalejo, 2005; JRC-EC, 2008; Prieto-Lara & Ocaña-Riola, 2010). Contemporary research highlights the growing complexity of methods for evaluating rural areas, aiming to address the multifaceted aspects of rurality (Neumeier, 2011; Pagliacci, et at., 2016; Borders, 2017; Nelson, et al., 2021).

7.1.1 Rurality Measurement Approaches

7.1.1.1 Sectorial and Territorial Approaches

UN (2007) delineate two conceptualisations of rurality known as sectoral and territorial approaches. In the sectoral approach, rural households are defined by their primary economic activity, and they are predominantly applied in developing countries where rurality is largely associated with the prominence of agriculture, forestry, and fishing activities (UN, 2007; Beluhova-Uzunova & Hristov, 2020). Territorial approaches, on the other hand, identify rural areas based on spatial attributes such as infrastructure and employment (De Ferranti, 2005; Beluhova-Uzunova & Hristov, 2020). Neumeier (2011) points out that there has been a shift from sectoral towards territorial approaches to rural development, supporting the notion that rural dwellers know the problems their regions have to deal with firsthand. Thus, highlighting the importance of context relevance in rurality measures.

7.1.1.2 Descriptive, Sociocultural, and Disembodied Cognitive Structure

Halfacree (1993) presents three approaches to defining rural places: descriptive definitions, sociocultural definitions, and disembodied cognitive structures. Descriptive definitions classify rural areas based on sociospatial characteristics, with examples including classification schemes in England and Wales utilising census variables related to employment, population, migration, housing conditions, land use, and remoteness. Other descriptive definitions encompass statistical, administrative, built-up areas, functional regions, agriculture, and population size or density, though they are subject to criticisms related to historical relativism, variable definitions, data quality, and statistical techniques. Halfacree suggests that descriptive definitions are more useful as research tools for specific aspects of rurality rather than definitive rural classifications. Sociocultural definitions explore how sociocultural characteristics vary with population density, assuming

that density influences behaviour and attitudes (Hoggart, 1988). Disembodied cognitive structures employ rules and resources to interpret the everyday world through both discursive and non-discursive actions.

7.1.1.3 Area and Settlement Approaches

Area-based approaches categorise municipalities or counties as rural or urban depending on population density and size, while settlement-based approaches classify individual settlements as urban or rural primarily based on spatial characteristics (Goss, 2013). The intricate relationship between population and spatial dimensions can blur the lines between these two perspectives.

7.1.2 Rural Classification and Rural Indexes

Continuum scale classifications measure rurality on an ordinal scale, while index measures employ a ratio measurement scale. Continuum codes are used by USDA-ERS (2013) for rural areas in the United States of America while examples of indexes include the Index of Relative Rurality (IRR), the General Practice Rurality Index (GPRI), and the Montana State University (MSU) index (Weinert & Boik, 1995; Waldorf, 2007; Olatunde et al., 2007).

7.1.2.1USDAERS' Continuum Code Classifications

USDAERS (2021) determine rural status and the level of rurality by considering federal law and various criteria. They employ measures such as rural-urban continuum codes, which categorise counties based on their proximity to metropolitan areas, and urban influence codes, which classify counties based on the population size of cities within them. Additionally, rural-urban commuting area (RUCA) codes are used to classify census enumeration areas across the United States of America, and they account for urbanisation and population density. Other criteria include urban commuting zones (which consider daily commuting volume), labour market area codes (measuring local labour markets), and population interaction zones for agriculture (based on the size and proximity of population concentrations).

7.1.2.2 Rural Indexes

Indexes can be calculated by considering various aspects of rural populations as explained in the following examples.

i. The IRR measures the level of rurality in a location using a score ranging from 0 to 1, where 1 signifies the highest degree of rurality, and 0 denotes the highest level of urbanisation (Waldorf, 2007). According to Waldorf (2007) the IRR measures were originally developed for counties in the United States of America and are based on factors such as population size, population density, urbanised area extent, and proximity to the nearest metropolitan area. These dimensions are weighted to calculate the overall ruralness score.

ii. Olatunde et al. (2007) explain that the GPRI is a healthcare-related index that takes into account six community factors, including distance from advanced and basic referral centres, population size, the number of general practitioners, the number of specialists, and

the presence of acute-care hospitals. The GPRI is designed to align rurality measures with their specific intended use.

iii. MSU indexes assign a quantitative measure of rurality to each family on the urban-rural continuum (Weinert & Boik, 1995). This measure considers factors like population size and the availability of healthcare services, including tertiary care and radiation treatment centres. The construction of the MSU index involves several steps:
   - First, distance and population measures are normalised and then standardised.
   - Next, the standardised measures are weighted to generate an initial rurality index that assigns high scores to rural families and low scores to urban families.
   - Finally, the rurality measure is re-standardised to a mean value of zero and a standard deviation of one.

7.1.3 Degree of Urbanisation

OECD recommended the degree of urbanisation to enable comparability and standardisation of area classification between countries (European Commission, 2020). This classification procedure is carried out in two steps:

Step I: Identifying cities, towns and semi-dense areas around the cities, rural areas, and uninhibited areas.

Step II: Adding commuting zones around each city to create functional metropolitan or urban areas.

Such a method would have challenges for the South African context because the country has pockets of densely populated areas (former homelands) that result from historical settlement patterns (van Huyssteen, Biermann, Naudé, & le Roux, 2009).

Recent advancements in this method provide a standardised rural classification approach, facilitating the uniform definition of ruralness across countries (European Commission, & United Nations Human Settlements Programme., 2021). The method defines rurality using standard population and density thresholds for a universal definition of ruralness. Although the method is an important measure for international comparability it mainly characterises rural spaces as areas outside urban zones, which might as well provide limitations for classifying rural areas in a country such as South Africa with two types of rural areas: communal rural areas, which are densely populated, and formal rural areas, which are relatively sparsely populated due to extensive commercial farming activities. The measure provides important characteristics for a context-based measure, that is, contiguity, density, settlement patterns, and population size which should be the building blocks of any context-based measure.

7.2 Review of South African Rurality Classifications and Definitions

Previous research in the South African context has identified four distinct settlement typology groupings, each characterised by primary variables used for classification: administrative, morphological, demographic, and functional (Schmidt & du Plessis, 2011). Administrative classifications primarily rely on government decisions rather than the inherent meanings and functions of the areas. Morphological definitions are centred around urban forms, such as formal urban layouts and structures. According to the authors, the most employed approach is the demographically defined typology, which classifies settlements based on size and population density. Functionally defined typologies, on the other hand, consider how space is conceptualised and utilised and are based on various variables, resulting in a range of classes, such as the GPRI (Olatunde et al., 2007). Different South African government departments utilise various criteria to classify and define rural areas, and the measures discussed here are employed by CoGTA, DWA, STASSA, and CSIR.

7.2.1 DWS's Urban-Rural Typologies

Schmidt & du Plessis (2011) elaborate on the classification methodology employed by the DWS, which categorises areas based on several criteria, including population size and density, historical background (including whether an area was designated as a former homeland or township), and economic activities. The typologies were originally developed to facilitate the monitoring and expedited delivery of water and sanitation services in marginalised areas (Schmidt & du Plessis, 2011). However, these classifications were criticised for their failure to accurately reflect the current water and sanitation service delivery status of areas. They primarily relied on former homeland status to determine service delivery backlogs, assuming similar conditions for areas within the same category and lacking a straightforward linkage to STATS SA's census data.

Table 7.1 DWS's Urban-Rural Typologies

Code	Description
A1	Metropolitan area
A2	Urban formal town
A3	Urban former township
A4	Working towns, mining etc.
B1	Urban fringe informal settlement
B2	Urban fringe ex-homeland
C	Rural dense village > 5000
D	Rural small village < 5000
E	Rural:
	Rural scattered
	Rural scattered dense
	Rural scattered low density
	Rural scattered very low density
	Informal settlement rural
F	Farming
O	Other (service centres, mines, prisons)

Source: Eagar et al. (2014)

7.2.2 Census 2001 Enumeration Areas (EA) Type Classification

STATS SA (2003) explain that the classification of enumeration areas (EA) into urban or rural places for 1996 and 2001 was based on land use and surveyor-general plans. Table 7.2 shows STATS SA's urban-rural

classifications. STATS SA employed a classification system that categorised EAs into various geographical types, which include urban and rural designations. EAs served as the smallest geographical units used for census enumeration and were classified based on specific criteria that profiled land use and human settlements within a given area (Laldaparsad, 2006).

Table 7.2 South African Census 2001 EA Type Classifications

EA Type	Geography Type	Urban/Rural
0 Vacant 3 Small Holding 4 Urban Settlement 6 Recreational 7 Industrial Area 8 Institution 9 Hostel	Urban Formal	Urban
5 Informal Settlement	Urban Informal	
2 Farm 3 Small Holding 6 Recreational 7 Industrial Area 8 Institution 9 Hostel	Rural Formal	Rural
0 Vacant 1 Tribal Settlement 6 Recreational 7 Industrial Area 8 Institution 9 Hostel	Tribal Area	

Source: STATS SA (2003)

The classification distinguished between urban areas and two types of rural areas: farmlands and tribal lands. Rural farmlands were characterised by various variables, including the race group of household heads, educational attainment (persons with some primary schooling), households utilising borehole water, low-income individuals, and households primarily using gas, paraffin, wood, or coal for cooking. Tribal areas were identified by factors such as the race group of the head of the household, households relying on animal dung or solar energy for cooking, households using river or spring water as the primary water supply, and individuals residing in huts or traditional dwellings. These classifications served as the basis for statistical reporting and research studies pertaining to urban and rural areas in South Africa (Schmidt & du Plessis, 2011).

7.2.3 DoH Classifications

In 2000, the integrated sustainable development programme (ISRDP) identified 13 rural municipalities that needed development. The nodes were selected because of their poverty and lack of infrastructure (Harmse, 2010). Ten district municipalities (Category C) in EC, KZN, and MP provinces with the lowest poverty status were selected based on poverty levels, institutional capacity, infrastructure, and service access. NW, NC, WC, and FS provinces were chosen to ensure inclusivity, geographical spread, and support. The South African DoH used the classifications to allocate allowances to rural health workers working in challenging conditions (Schmidt & du Plessis, 2011). One hundred seventy-eight facilities where a rural allowance could

be paid to health workers were identified across the country (Eagar et al., 2014). Even though the ISRDP criteria were widely used to classify areas, they were limited in their description of South African rurality, particularly for the health sector. In addition to primarily functioning for the allocation of salaries, the demarcations were based on recommendations by provinces, and they did not capture essential factors such as the distribution of health services in rural spaces. The categorisations were discontinued in subsequent years (Schmidt & du Plessis, 2011). Harmse (2010) found highly developed municipalities amongst the ISRDP nodes and an appreciable number of underdeveloped areas that were not included.

7.2.4 CSIR Typologies

CSIR's functional and settlement typologies are considered to be the most reliable rurality measures for the South African context (Schmidt & du Plessis, 2011). The functional classifications are based on population density, settlement size, number and range of services, and the relationship between the typologies. They used the following data: i) Mesozone data set containing information on the population, economic activity, income, and land cover. ii) geo-referenced data of towns and villages and urban function indexes, iii) national road network connecting all mesozones, and iv) data on previously developed mesozones places (van Huyssteen et al., 2009). Settlement classifications had the following classes: cities and regions, cities, regional service centres, service towns, local and niche settlements, and cluster and dispersed settlements (Schmidt & du Plessis, 2011). According to Schmidt & du Plessis, functional urban-rural classifications categorised places into the following classes: i) functional urban nodes, ii) functional linked urban areas, iii) commuter areas, iv) rural nodes and clusters, v) dispersed rural settlement areas, vi) sparse rural production areas, vii) economically marginal and protected areas, and viii) mountainous areas. Even though CSIR's classifications are widely used, the typologies were critiqued for not aligning with census enumeration areas and municipal boundaries (Schmidt & du Plessis, 2011). They needed synchronism with census data and to be adjusted to conform with international best practices to enable ease of use (Schmidt & du Plessis, 2011). van Huyssteen et al. (2009) outline that in conducting a more nuanced reading of spatial and temporal data, the CSIR classifications attempted to identify trends (such as the economic well-being of the population) that could potentially have significant impacts on settlements and the respective governance and service delivery challenges within the areas. The classifications did not adequately describe the rural context in terms of essential factors such as public amenities (water, sanitation, electricity, health facilities, and other factors) that form South African rurality's most essential features (Schmidt & du Plessis, 2011).

7.3 Summary of Rurality Indicators based on Reviewed Literature.

Improved service delivery, social inclusion, and establishing links between rural communities and the most developed parts of the country was an essential component of rural development (DNT, 2012). The development of transport and communication links was important for enabling access to service centres and facilities.

7.3.1 Keys Metrics of Rural Amenities and Services

Delivering services in rural areas and establishing rural-to-urban connections were fundamental elements of South African rurality. The summary characterisation of service delivery presented in this section is derived from the reviewed literature. The review was done before and after the interviews and hence the review findings were refined based on the findings from the interview (Chapter 6).

i. *Household Water and Sanitation*: Access to water and sanitation services was vital in facilitating other essential services like education and healthcare. The proximity to a safe and dependable water source, typically a municipal piped water source, was crucial. Key metrics for assessing water services included access to municipal water points, the reliability of water sources, and the proximity of water sources to households (within the yard or 200 meters of the yard) (DWS, 2006). Sanitation services were characterised by households accessing minimum acceptable facilities, such as flush toilets, chemical toilets, VIP ventilated latrines, or septic tanks (DWS, 2006; STATS SA, 2011).

ii. *Housing*: Rural places were mainly identifiable by the prevalence of traditional dwelling structures. The main type of housing structures presented by STATS SA are brick housing structures, traditional dwellings, flat or apartments, cluster houses, semi-detached houses in complexes, semi-detached houses, house, flats in the backyard, shacks including shacks in backyards, granny flats, caravans, or any other type of dwellings. According to the classifications by CoGTA, B4 areas are identifiable by the higher prevalence of traditional dwellings (DNT, 2012).

iii. *Road and Transport*: Road and transport networks were essential for connecting rural dwellers to services or service centres. Travel time and distance to service centres were major determinants of access and utilisation of services. To illustrate, shorter travel times to maternity hospitals increased the likelihood of choosing a maternity hospital for child delivery by 24 percent (Masters et al., 2013).

iv. *Electricity:* Households without access to electricity typically belonged to the lower-income class (Jamal, 2015). DoE (2013) outline that household living standards and well-being characteristics significantly influence the households' ability to meet their energy needs. The household's dwelling type determines thermal efficiency (the ability to use electricity efficiently by avoiding unwanted use or avoidable overuse). Hence, the two important concepts that were used by DoE (2013) to determine energy poverty were household income and thermal inefficiency (a household was considered energy poor if it had less than 60 percent of South Africa's median per capita monthly income and if it met one or more of the following conditions: i) the household reported dissatisfaction or being very dissatisfied with its

accommodation; ii) the state of repair of the household's accommodation was described as 'poor'; iii) one or more of the following problems were reported about the state of housing: lack of adequate heating, a leaky roof, damp walls, floor or foundations, or damaged or broken windows or doors; iv) the health of a household member had deteriorated due to the housing conditions).

v. *Healthcare:* The following factors were identified in Section 2.1.3.2.
   - Availability of specialist services (availability of specialised services such as maternity, paediatric, and psychiatry)
   - Number of healthcare workers (the availability of skilled staff at a hospital and the ratio of workers to the serviced population)
   - Supporting infrastructure (roads, piped water, sanitation, communication media, and electricity)
   - Migration (the impact of migration on seeking specialised health services)
   - Financial accessibility of services (Distance, cost, and time taken to access the services)
   - Quality of service (consumer's perception of service quality)

vi. *Education:* The provision of basic education in the South African rural context was determined by the following (Section 2.1.3.2).
   - The availability of qualified teachers in relation to the learners
   - Average distances travelled for schooling by learners
   - Access to services at the schools (water, sanitation, and electricity)
   - School security in the form of school perimeter fencing and other security devices
   - Science and technology education facilities in the form of science laboratories and computer laboratories
   - Access to sports and recreation facilities
   - Access to communication networks as represented by access to the Internet
   - Availability of vocational training services and the adoption of context-specific curriculum
   - Separation in terms of age group learning focus (primary or secondary)

vii. *Social Grants and Allowances*: Many rural households in South Africa depended on social assistance programs for their income (CoGTA, 2009b). Regions characterised by low incomes and high

population dependency ratios often exhibit high levels of grant dependency (Mutyenyoka & Tsheola, 2017).

viii. *Police Services*: According to SAPS (2015, 2018), ruralness in terms of providing policing services can be assessed by the following factors:

- The number of police recruits, their level of training, and their expertise.
- Equipment available for carrying out policing services. For example, police bakkies, firearms, and the use of advanced technologies such as drones.
- The diversity of services offered, for example, victim-friendly services for children and women, and stock theft units.
- Distance travelled by rural dwellers to police stations.
- The area and population size of a police station's jurisdiction.
- Communication and marketing capabilities, including communication among police service providers and communication with community members to report crime and criminal activity.

7.3.2 Rationale for Revised Measures

While a significant socioeconomic disparity persists between regions B3 and B4 in South Africa, there are indications of pockets of development within the predominantly underdeveloped B4 areas. For instance, thematic analysis revealed that certain areas experienced improvements in housing and service delivery through the RDP program, including access to water, sanitation, electricity, and housing (EC_INT_B4_03). Additionally, various development initiatives have enhanced access to healthcare, education, and social grants (Pauw & Mncube, 2011; DBE, 2011; Fusheini & Eyles, 2016). The opening of transport and communication links to urban places after 1994 also impacted the rural context. The advent of new technologies, affordable ICTs, and mass media provided additional platforms for communication and information.

The study aims to address the limitations and shortcomings of the initially adopted rural measures. The study recognises the primary importance of developing rural measures that do not hinge on urban characteristics (Martin et al., 2000; Chigbu, 2013). Consequently, the classification of rural areas in the South African context should not be solely based on the absence of services typically found in urban areas. Instead, it should involve a comprehensive characterisation of rural contexts before any specific features are used to describe them.

According to Schmidt & du Plessis (2011), even though CSIR's typologies fit into most government departments' planning frameworks, they still need to be improved in terms of synchronism with census data, conformity with international best practices, and improvements in terms of ease of use. The settlement

classification framework used by CoGTA (Table 2.1) is easy to use and understand. It is easily aligned with municipality data and STATS SA's socioeconomic data. However, even though they rightly differentiate rural places in terms of B4 and B3 status, they do not reflect the apparent differences amongst municipalities of the same category. For example, B3 areas in MP, LIM, NW, and WC provinces. Such differences have been reflected in the qualitative analysis (Chapter 6) and the literature review (Chapter 2). Additionally, CoGTA's classifications do not consider differences in the sizes of municipalities (Schmidt & du Plessis, 2011). Schmidt & du Plessis state that CoGTA's classifications can be improved by considering contiguity, flows, poverty, and access to services. Both the CSIR and GOCTAs classifications were criticised for not being internationally comparable.

The need to develop rurality measures for the South African context is based on changes in contextual characteristics over time (Prieto-Lara & Ocaña-Riola, 2010; OECD et al., 2021). Existing sector measures are limited because they were developed for sectorial or organisational purposes. For example, education and health sector measures were primarily designed to allocate allowances (Schmidt & du Plessis, 2011; Eagar et al., 2014). In addition, as the rural context changes over time, so do new knowledge and methods of area classification.

7.3.3 Selection of Appropriate Measures for the Context

Unlike the interpretivist paradigm, the development of theory—especially in positivist research—requires a thorough understanding of the study context prior to data collection (Andoh-Baidoo, 2017). Furthermore, beyond the traditional IS contexts of technology, usage, and users, Andoh-Baidoo expounds upon considering additional context of culture, socio-political, and geo-political, more so to for novel contributions to studies for the contexts of the marginalised who usually have limited voice so that the findings become relevant to their contexts (Hong et al., 2014).

South Africa's socio-political and geo-political contexts are defined by persistent socio-economic inequalities and ongoing efforts to reduce historical disparities through initiatives such as land reform and infrastructure development (Section 1.2). Such reforms are evident in the evolution of a democratic system of governance, including changes in the constitutional designation of areas. The current South African constitution does not provide specific differentiation or categorisation of rural places, but instead, government departments classify places according to their priorities (RSA, 1996). This constitutional stance was rooted in the country's transition away from its historical context. As an example, initially, after adopting a democratic system in 1994, the DBE did not recognise 'rural education' as a separate category (Gardiner, 2008). However, as the unique circumstances of South African rurality became apparent, there was a growing need to reassess the provision of rural education services (Nelson Mandela Foundation, 2005; Gardiner, 2008; Seroto, 2012).

The rurality measures developed in this study take into account the constitutional standing and go further to differentiate places based on the characteristics of South African ruralness, as described by

interview data. South African municipal boundaries were defined to promote social inclusion, which led to the unification of previously disadvantaged places with developed settlements (Powell, 2012). Additionally, the South African context presents challenges due to the presence of scattered former homeland areas in rural regions, informal settlements in urban centres, and the existence of pockets of developed regions, service centres and towns in rural settlements, which can distort the supposed similarities between areas of the same rural or urban category (van Huyssteen et al., 2009; Rivett, Champanis, & Wilson-Jones, 2012). Factors such as population growth through labour migration have also affected the socioeconomic dynamics of towns and urban settlements. As a result, rural classifications should consider how such population flows impact both the sending and receiving areas.

While CSIR categorisations are widely considered accurate for the South African context, they are criticised for not aligning easily with municipality boundaries and census data. On the other hand, CoGTA classifications are less detailed but more easily aligned with municipality borders and census data. However, this study's findings argue that B3 and B4 areas should be distinguished because some areas within the same category exhibit pronounced differences which can be attributed to climatic, geographical, and historical variations. In summary, the measures developed in this study aim to move away from historical undertones such as 'former homeland' status while still considering underlying socioeconomic disparities between areas. They seek to represent comparisons between areas formerly termed 'former homelands' (B4 areas) and commercial farm areas (B3 areas) based on the changes that have occurred over time.

Given the absence of rural municipality differentiation in the South African constitution (RSA, 1996), this study adopts the development of indexes as the appropriate method for representing South African rurality. The use of index measures as opposed to continuum measures of ruralness has been debated (Weinert & Boik, 1995; Mountrakis et al., 2005). While increasing the number of categories in a typology can capture variations along the urban-rural continuum more effectively, such typologies often lack mutually exclusive categories (Weinert & Boik, 1995). This approach addresses the disadvantages of using categories, dichotomous classifications, or continuum codes, which may obscure differences between places, particularly in the South African context characterised by patches of developed settlements. Recent studies also favour moving from the question 'Is a place rural or urban?' to 'To what degree is a place rural?' (Waldorf, 2006; Pagliacci, et al., 2016).

Despite their limitations, continuum place typologies remain widely used. For example, the ERS's rural-urban continuum codes classify counties based on population size, adjacency to metropolitan areas, and commuting flows (USDA-ERS, 2021). Similarly, the European Commission & United Nations Human Settlements Programme (2021) have developed a settlement-system continuum based on the intensity of human settlements, recognised as the current international standard for comparing settlements. However, these place continuums may not fully capture contextual variations. For instance, in developed countries, rurality is often defined by population density, which closely correlates with the

intensity of human settlements. In contrast, developing countries frequently experience high population densities alongside socio-economic deficits, which do not necessarily indicate urbanisation.

7.3.4 Spatial Rurality Index (SRI)

The current study adapted the SRI by Mountrakis et al. (2005) to quantify rurality. Mountrakis et al's SRIs use two sets of indicators: connectivity and access-to-service cluster indicators. Connectivity cluster indicators measure the degree of infrastructure and isolation based on network connections. A network represents a connected infrastructure that may transport people, distribute, or collect resources or act as a communication link (Mountrakis et al., 2005). The SRI captures the concept of rurality as having less developed infrastructure by measuring the presence of networks or the degree of network connectivity. The access-to-service cluster is concerned with access to services as a measure of presence or absence in a locale or distance from the locale. The method is used because of its flexibility in incorporating the important rural metrics of distance to services, population sizes, and service quality. Interaction factors are included to incorporate the impact of migration and the fact that spaces, even urban and rural spaces, have an impact on each other (Delgado-Viñas & Gómez-Moreno 2022).

7.3.4.1 Connectivity Variables

Connectivity refers to transportation and communication infrastructure. Connectivity between areas is materialised by network infrastructures such as roads, water pipes, airports, and railway lines. Mountrakis et al. (2005) explain that a node could be an airport, while node degree is represented by the number of airlines operating from an airport. First, to compute the overall connectivity cluster index, identify the relationship between an area and the nodes of network indicators.

Table 7.3 Connectivity Variables

		Node Measurement		Attribute Measurement
		Node Count	Max Node Degree	
Utility	Water	Existence of a water network (system) or number of service connections	Number of connecting pipes	size of pipe
	Sewer	Existence of a sewer network (system) or number of service connections	number of connecting pipes	size of pipe
Transportation	Roads	Number of inter-state exits Number of intersections (by class of road)	number of connecting roads	class of road
	Railroads	Number of stations	Number of transfer lines	type of line
	Airports	Number of airports (by type of airport)	number of carriers number of connecting flights	class of carrier
Communication	Internet	number of connections	Number of connecting cables	types of connection speed of connection

Source: Mountrakis et al. (2005)

Then the numbers of contained nodes are summed for each indicator to obtain the node degree—for example, the total number of airports in an area. Alternatively, the node degree is computed as the total number of flights at an airport. The node degree or node counts are normalised by dividing by the maximum nodal or node degree value (across locations). Finally, the overall index is obtained by combining the measures obtained from the indicators.

7.3.4.2 Access-to-Service Variables

Three approaches can be used to measure the degree of access to services. That is the containment of services in an area, the number of service centres, or the distance to service centres.

Table 7.4 Access-to-Service Variables

Service Type	Indicator	Access Measurement
Healthcare	Hospital facilities	Containment, distance, count, and rank of medical services
Education	Schools	Containment, distance, level of education
Safety	Fire Department	Containment, distance, number of fire trucks, type of service (e.g., volunteer)
	Police Departments	Containment, distance, number of police cars
	Sheriff Departments	Containment, distance, number of sheriff cars
Wireless Telephone Service	Wireless towers with broadcasting signal radius	Containment, number of towers

Source: Mountrakis et al. (2005)

Mountrakis et al. (2005) explain that the centroid position of an area is used to compute either distance along a road from a centroid to the service or the euclidean distance to the service. The measures are then used to compute a score for a service type. The access measures are also normalised.

The two sets of indicators, the connectivity cluster and access to service cluster, are aggregated to form one index using weights. JRC-EC developed an index development procedure which explains the development of weights and other procedures for index development. Other aspects of spatial accessibility adapted to the study are provider-to-population ratios and gravitational models of provider influence (Rekha, Wajid, Radhakrishnan, & Mathew, 2017).

7.3.4.3 Adoption of SRI and JRC-EC Index Development Procedure in the South African Context

JRC-EC's procedure for developing indexes has been refined and extensively used in numerous studies (Talukder, Hipel, & van Loon, 2017; ITU, 2019; Gatto & Busato, 2020; Liu & Kontou, 2022). A context-specific SRI for the South African context is based on a literature review and interviews with rural stakeholders (Chapter 2 and Chapter 6). The JRC-EC procedure steps applicable for the study are as follows:

i. Specification of the theoretical framework
ii. Data selection
iii. Imputation of missing data
iv. Statistical analysis

v. Data normalisation

vi. Weighting and aggregation

vii. Uncertainty and sensitivity analysis

viii. Data visualisation (including Spatial Autocorrelation Analysis Explained in Appendix P)

The procedures are also explained in Appendix C.

8 DEVELOPMENT OF COMPOSITE RURALITY INDEXES

SRIs (Spatial Rurality Indexes) (Mountrakis et al., 2005) adapted for the South African context were formulated based on insights derived from an extensive review of the literature and interviews conducted during Chapter 2 and 6 of the study. To create these indexes, an adjusted SRI model was applied, categorising municipalities based on their level of connectivity to essential amenities and accessibility to public services. The variables employed in constructing the index measures were determined through a combination of insights drawn from the literature and data obtained from the interviews.

8.1 Development of Composite Index Measures

The indexes were designed to encompass variables related to both connectivity and access to services. Given that the most rural areas within the context under examination exhibited significant public service delivery deficiencies, the overall indexes were structured such that it could range from a minimum value of zero (0), denoting the most undeveloped rural localities, to one (1), indicating the most developed rural regions.

8.1.1 Connectivity Variables

The connectivity variables considered included access to essential services such as water, sanitation, electricity, ICTs, and formal housing. To differentiate access to household services, specifically water, sanitation, and electricity, weighting was assigned in accordance with nationally defined service delivery standards. Some of them are outlined in Figure 8.1.

Figure 8.1 Minimum Acceptable Service Delivery Standards

Service level	Water	Sanitation	Solid waste	Electricity
1 = None	No access to piped water	No sanitation	No facilities / dump anywhere	No access to electricity
2 = Minimal	Communal standpipe > 200m	Bucket toilets	Communal / own refuse dump	Generator / solar
3 = Basic	Communal standpipe < 200m	Pit toilet without ventilation pipe	Communal container /collection point	Access to electricity don't pay for
4 = Intermediate	Piped water in the yard	VIP, Chemical or ecological toilets	Removed less than once per week	Connected to source and paid for
5=Full	Piped water in dwelling	Conventional water-borne	Removed once per week	In-house pre- and post-paid meters

Source: DWS (2006), SAHRC (2014), and STATS SA (2017)

The established minimum service delivery standards were as follows: each household should receive six kilolitres of free basic water (FBW) within a 200-meter radius of their residence, access to free basic sanitation (FBSan) in the form of a ventilated pit latrine toilet (VIP), and an allocation of 50 kWh of free electricity per household per month (BEEng) (SAHRC, 2014). For the purpose of this study, household dwellings were defined inclusively, encompassing various types of housing structures.

These included brick housing structures, traditional dwellings, flats or apartments, cluster houses, semi-detached houses in complexes, standalone semi-detached houses, standard dwellings, houses, flats in the backyard, shacks in the backyard, shacks not in the backyard, granny flats, caravans, and any other type of dwelling, in accordance with the definition provided by STATS SA (2014b). The content presented in the current section explains the development of each indicator's index.

8.1.1.1 Water Indexes

Piped water accessibility indexes were constructed by considering both the proximity to water sources and the dependability of the accessed water points. Data from STATS SA's 2011 census furnished information about households' access to piped water systems, which was categorised as either indoors, within the yard, within 200 meters, 200 to 500 meters, 500 to 1000 meters, or over 1000 meters away from each surveyed household. Additionally, the 2011 census data provided reliability measures for households, quantifying the frequency of water service interruptions experienced annually. To assign weights to these factors, the distances to piped water sources were normalised by using the average distances to piped water points. The weighting process assumed that the average distance travelled to the water point fell at the midpoint of the distance interval for each access category (Table 8.1).

Table 8.1 Weights for the Accessibility of Piped Water Points

Distance Water (m)	Indoors	Yard	0-200	200-500	500-1000	1000+	No Access
Average Distance (m)	0	0	100	350	750	1000	1000
Weight	1	1	.900	.650	.250	0	0

Note: Distance are based on STATS SA (2011) dataset

Table 8.1 illustrates the weights derived from the average distances of households to water points. The weight allocation was as follows: the category 'greater than 1000 meters' and 'no access to piped water' received the lowest accessibility weight, which was set at zero. In contrast, access to a water point within the yard and access indoors received the highest weights, both equal to one. To illustrate, the following formula was employed to calculate the weight for water points situated 350 m from a surveyed household:

$$1 - \frac{Average\ distance\ to\ water\ point}{Maximum\ distance\ to\ water\ point}$$

$$= 1 - \frac{350}{1000}$$

$$= .650$$

The 2011 census data included information about whether households experienced water supply interruptions lasting two or more days within the year. This data point served as the basis for incorporating a water source reliability factor (R_{im}) into the calculation of area-specific indexes. These indexes were computed as follows:

$$I_m = R_{im} \times \sum_{i=1}^{n} WD_i P_i$$

I_m is the index of water accessibility for municipality m.

WD_i is the weight of the ith average distance (Table 8.1).

P_i is the number of households with access to the average distance corresponding to the weight WD_i.

R_{im} is the reliability measure computed as the proportion of households in the municipality which did not have a water cut lasting more than two days for each distance category of access (inclusion justified by the fact that survey respondents complained about reliable water supply).

P_i values were standardised to correct for differences in population size and area.

Figure 12.16 shows the average accessibility index per province for B3 and B4 areas per province. As expected, the pattern across the provinces shows low accessibility indexes for B4 municipalities. Municipalities with the lowest accessibility indexes were mainly characterised by large proportions of households that experienced more than two days of water cuts (Table 8.2). These municipalities were mainly clustered in the KZN and EC provinces (Moran's Indexes presented in Figure 12.18 and Figure 12.19 of Appendix I). The evidence shown in Figure 12.18 and Figure 12.19 suggests that clusters of municipalities with limited access to water covered smaller geographical areas, indicating potential improvements in access levels within historically marginalised regions of the EC and KZN. However, it is evident that high access levels to water are primarily observed in municipalities within the WC province.

Table 8.2 Percentage Distribution for Proximity to Water Points and the Distribution of Water Cut Duration for Municipalities with the Lowest Water Accessibility Indexes.

Municipality	Code	Province	Piped Water Location Within 200m of Homestead	Piped Water Location Within 1000m of Household	< 2 day	Index
Makhuduthamaga	B4	LIM	59	74	3	.021
Maphumulo	B4	KZN	36	48	4	.020
Imbabazane	B4	KZN	50	74	3	.019
Indaka	B4	KZN	63	68	2	.016
Okhahlamba	B4	KZN	55	67	2	.015
Hlabisa	B4	KZN	40	43	3	.015
Nyandeni	B4	EC	28	45	4	.015
Mbhashe	B4	EC	30	42	4	.015
Port St Johns	B4	EC	23	35	4	.011
Ngquza Hill	B4	EC	21	31	3	.007

Source: STATS SA (2011). *Note*: The table presents households with the lowest accessibility index per municipality by the percentage of households less than 200 metres from a water point and the percentage of households that did not experience a water cut extending more than two days

8.1.1.2 Sanitation Indexes

Sanitation indexes were also developed based on compliance with minimum acceptable sanitation standards. The study identified three types of facilities that met the minimum requirements set forth by the country's Department of Water and Sanitation (DWS, 2006). These included household connections to the municipal sewage system, septic tank toilets, and VIP latrines. Other types of sanitation facilities were categorised under the label 'no access to household sanitation.' A binary weighting approach was employed, where a value of one signified access to at least the minimum acceptable level of sanitation, while zero indicated the absence of access to acceptable sanitation.

Table 8.3 Municipalities with the Lowest Sanitation Accessibility Indexes

Municipality	Province	Code	Index
Intsika Yethu	EC	B4	.189
Fetakgomo	LIM	B4	.184
Elias Motsoaledi	LIM	B4	.180
Blouberg	LIM	B4	.175
Bushbuckridge	MP	B4	.160
Umzumbe	KZN	B4	.155
Mbhashe	EC	B4	.152
Greater Tubatse	LIM	B4	.143
Makhuduthamaga	LIM	B4	.118
Aganang	LIM	B4	.114

Source: STATS SA (2011)

The indexes were then calculated as the proportion of households with access to sanitation, with population distribution values being standardised to account for differences in population sizes. WC and GT provinces had the highest average indexes, while the EC, LIM, and KZN provinces had the lowest values. Figure 12.22, Figure 12.23, and Figure 12.25 in Appendix J show the clusters of municipalities with low access levels to sanitation. In the Figures, the WC province displays municipalities with the highest access levels.

8.1.1.3 Formal Housing Indexes

Analysis of interview data and the literature review showed that formal housing was a prominent rural development priority and characteristic (Table 5.1, Table 5.2, and Table 5.3). In addition, rurality classifications by GoCTA described traditional rural spaces as areas with a high density of traditional dwelling structures (Table 5.1, Table 5.2, and Table 5.3). In the study, the category of 'formal housing' encompassed housing types constructed from concrete and brick, as well as flats or apartments, cluster housing, semi-detached housing, and flats. Specifically, these types of housing were considered under the umbrella of 'formal housing.' Table 8.4 reveals that traditional structures were predominantly found in B4 areas, with only eight percent of households in B3 areas having traditional structures, whereas a much higher proportion of household dwellings in B4 areas consisted of traditional structures. There remained substantial numbers of traditional structures in B4 locations, particularly in the EC and KZN provinces.

Table 8.4 Percentage Distribution of Household Dwelling Types in South African Settlements

	Formal Housing							Traditional & Informal Housing			
	House/ Brick/Concrete	Flat/ Apartment	Cluster House	Town house	Semi-detached House	House/Flat/Room in Backyard	Room/ Flatlet on Property	Traditional Hut	Shank	Shank not in yard	Caravan/ tent
Settlement	%	%	%	%	%	%	%	%	%	%	%
A	59	8	2	3	3	4	1	1	7	12	0
B1	71	4	1	1	1	3	1	3	6	10	0
B2	70	4	1	1	1	3	1	7	4	8	0
B3	72	2	0	0	1	2	1	8	4	9	0
B4	66	2	0	0	0	2	1	26	2	2	0

Note: 'A' Metropolitan, 'B1' Major cities, 'B2' Secondary cities, 'B3' Commercial Farms, and 'B4' Communal rural Data Source: STATS SA (2011)

To formulate the index measures for formal housing, 'informal housing' was defined to include traditional dwellings, shacks located outside of yards, shacks situated within yards, and caravans or tents. This broader definition was used to avoid exclusively focusing on traditional structures, as it would have obscured the prevalence of informal housing, particularly the presence of shacks in B3 settlements and municipalities that were close to urban areas. The weighting for the housing accessibility indexes were established using a binary indicator. A weight value of one indicated formal housing, while a value of zero indicated informal housing. This approach effectively distinguished between those with access to formal housing and those residing in informal housing arrangements. Figure 12.26 displays the average indexes representing access to formal housing across different provinces for both B3 and B4 areas. There was no discernible pattern in terms of whether these housing indexes correlated with B3 or B4 settlements. A plausible explanation is that the percentage of households with formal housing was influenced by the significant presence of informal settlements, characterised by shanty housing, in emerging cities within B3 areas, while such settlements were scarcely present in B4 areas. Figure 12.27, Figure 12.28, and in Figure 12.30. Appendix K present the Formal Housing Indexes and the spatial pattern of the indexes. As shown in Figure 12.26 and Figure 12.30, LIM province had a conglomerate of municipalities with high levels of access to formal housing. As anticipated, there was a cluster of rural municipalities with high levels of access to formal housing in the WC (Figure 12.30); however, it is noteworthy that this cluster's geographical extent was relatively small compared to the high-index clusters observed for Water and Sanitation Indexes. One possible explanation for this observation could be the prevalence of informal settlements in near urban areas or farming regions.

Table 8.5 Municipalities with the Lowest Formal Housing Accessibility Indexes

Municipal	Code	District	Province	Indexes
Port St Johns	B4	O.R.Tambo	EC	.170
Ntabankulu	B4	Alfred Nzo	EC	.196
Engcobo	B4	Chris Hani	EC	.220
Mbhashe	B4	Amathole	EC	.231
Nkandla	B4	King Cetshwayo	KZN	.232
Ingwe	B4	Harry Gwala	KZN	.233
Mhlontlo	B4	O.R.Tambo	EC	.245
Intsika Yethu	B4	Chris Hani	EC	.248
Nyandeni	B4	O.R.Tambo	EC	.248
Umzimvubu	B4	Alfred Nzo	EC	.262
Ubuhlebezwe	B4	Harry Gwala	KZN	.264
Vulamehlo	B4	Ugu	KZN	.271
Ngquza Hill	B4	O.R.Tambo	EC	.272
Umzimkhulu	B4	Harry Gwala	KZN	.278
Elundini	B4	Joe Gqabi	EC	.287
Msinga	B4	Umzinyathi	KZN	.295
Mbizana	B4	Alfred Nzo	EC	.319
Okhahlamba	B4	Uthukela	KZN	.333
Maphumulo	B4	iLembe	KZN	.338
Matatiele	B3	Alfred Nzo	EC	.366

Data Source: STATS SA (2011)

8.1.1.4 Electricity Indexes

Three key characteristics were considered in developing the measure of electricity connectedness:

i. *Household Income Capacity:* This factor assessed the financial capability of households to access and afford electricity services.

ii. *Connection and Use of Electricity from the National Grid:* In the absence of specific data on household connection to the electricity grid in the 2011 South African census, information about the type of energy used for cooking, heating, or lighting was utilised as a proxy. A variable was created to identify households that confirmed the use of electricity for any of these three purposes.

iii. *Thermal Efficiency of Household Dwellings:* This aspect accounted for the energy efficiency of the physical structures where households resided.

Given the absence of a direct question about household grid connection in the census data, the use of electricity for cooking, heating, or lighting served as an alternative indicator of electricity access and usage. Household income and thermal inefficiency were employed to evaluate energy poverty, drawing on approaches

and concepts established and stated by DoE (2013). The detailed steps for computing this index can be found in Appendix D, which offers a comprehensive explanation of the methodology used to assess electricity connectedness while considering the impact of household energy poverty levels. Figure 12.31 presents the average indexes per province. The data showed relatively low index values for B4 areas in KZN and EC provinces. Figure 12.32, Figure 12.33, and Figure 12.35 in Appendix L present the Moran's Index maps for Electricity Indexes. The Figures confirm that municipalities with the lowest Indexes were in EC and KZN provinces, while municipalities with the highest indexes were in the WC province.

Table 8.6 Municipalities with the Lowest Electricity Accessibility Indexes and the Percentage of Households which were Satisfied with their Household's Dwelling per Municipality

Municipality	Code	Province	Index	Statisfied (%)
Ntabankulu	B4	EC	.093	26
Port St Johns	B4	EC	.096	25
Msinga	B4	KZN	.105	33
Vulamehlo	B4	KZN	.127	32
Elundini	B4	EC	.129	34
Mbhashe	B4	EC	.136	32
Umzimkhulu	B4	KZN	.137	34
Ingwe	B4	KZN	.143	30
Intsika Yethu	B4	EC	.144	33
Ndwedwe	B4	KZN	.149	49
Maphumulo	B4	KZN	.150	40
Mhlontlo	B4	EC	.154	35
Engcobo	B4	EC	.155	33
Nyandeni	B4	EC	.159	36
Umhlabuyalingana	B4	KZN	.161	57
Umzimvubu	B4	EC	.170	39
Nkandla	B4	KZN	.174	32
Umzumbe	B4	KZN	.181	47
Mbizana	B4	EC	.186	45

Data Source: STATS SA (2011)

8.1.1.5 ICT Indexes

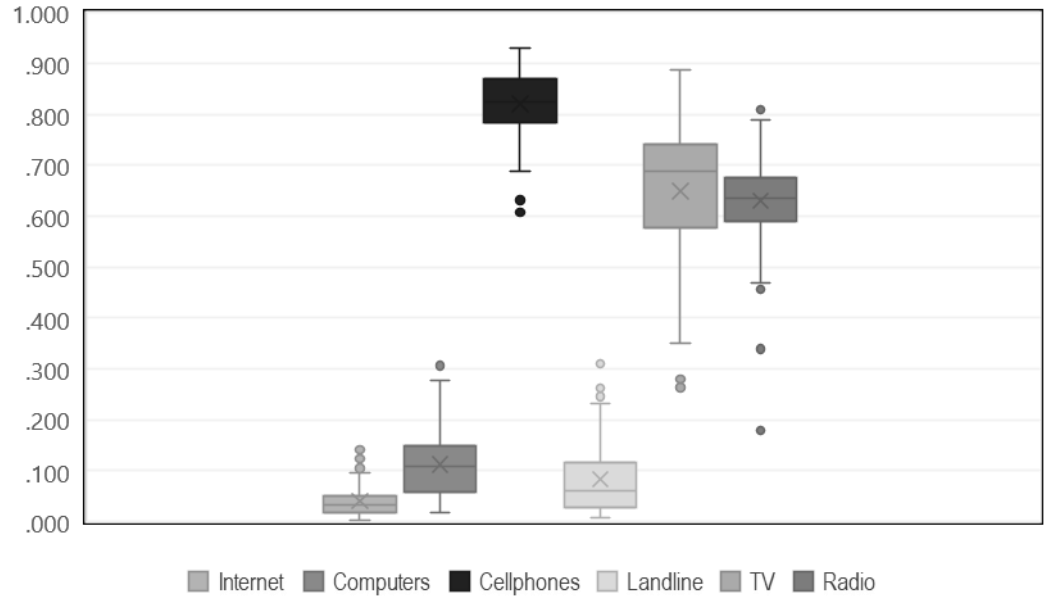
Household access to television, landline telephones, radio, computers, the Internet, and mobile phones were modelled to derive ICT indexes. The procedure employed to develop the index measures was based on the proportion of households with access to the respective ICTs per municipality.

Dispersion of ICT Index Components Before Normalisation

Data normalisation can sometimes be influenced by outlaying data points. Figure 8.2 illustrates the Box and Whisker plots for various ICTs (Internet, computer, mobile phone, landline, television, and radio) before data normalisation. The diagram showcases several data points, including outliers, minimum values, 25th

percentiles, medians, 75th percentiles, and maximum values for each component. Wealthier settlements were expected to have greater access to household goods, including ICTs, leading to the presence of outliers. Specifically, for Internet access, all three outlying municipalities were in the WC province. Similarly, the outlier for computer access was also situated in the WC province. Telephones, on the other hand, had outlying municipalities primarily in the WC and NC provinces. Outliers for television and radio were observed in municipalities spanning the NC, KZN, and EC provinces. For mobile phones, all outlying municipalities were within the NC province.

Figure 8.2 Box and Whisker Plots of the ICT Index Variables Before Normalisation



Data Source: STATS SA (2011)

Outliers and the shape of the box-and-whisker plots indicate skewness in each index. Specifically, the Internet and landline indexes exhibited positive skewness, suggesting that most rural households had limited access to the Internet and landlines. Conversely, the television and cellphone measures displayed negative skewness, indicating a high level of penetration. To further illustrate how household income capabilities influenced technology access, cellphones, televisions, and radios had high median values, while Internet, computers, and landlines had lower values. Table 8.7 presents the correlation matrix of various ICTs. With the exception of the correlations between mobile phones and household Internet access, as well as between mobile phones and computers, all other correlations were statistically significant at the five percent significance level. Notably, there was a negative correlation between landlines and mobile phones, implying that an increase in household mobile phone usage was associated with a decrease in household landline access. This suggests an inverse relationship between mobile phone adoption and landline availability.

Data normalisation was used to eliminate differences in municipality population sizes and to standardise measurement units before developing a composite index measure. Hence normalisation is used to eliminate

differences in measurement units (JRC-EC, 2008). Weights for the indexes were determined using the factor analysis method (Section 12.3.5).

Table 8.7 Pearson Correlation Coefficients Matrix for Internet, Computers, Mobile Phones, Landlines, Television, and Radio

Variable	Internet	Computers	Cellphones	Landlines	Television	Radio
Internet	1.00					
Computers	.91**	1.00				
Cellphones	.05	.11	1.00			
Landlines	.83**	.78**	-.33**	1.00		
Television	.58**	.72**	.20**	.53**	1.00	
Radio	.26**	.27**	.28**	.25**	.45**	1.00

Note: * $p < .05$, ** $p < .01$
Data Source: STATS SA (2011)

The Q-Q plots for the normality of radio, cellphone, and television exhibited approximately straight patterns, suggesting that the data distributions were close to normal (Figure 12.1). However, it is important to note that the corresponding *p*-values for the Shapiro-Wilk tests were less than .05, leading to the rejection of the null hypothesis (Figure 12.1). This indicates that at the .05 level of significance, the indexes are not normally distributed. While acknowledging the potential implications of the Shapiro-Wilk tests to the reliability of comparison in the study, the presence of outliers may have influenced the test results since the test is highly sensitive to outlaying data (Saculinggan & Balase, 2013). Outlaying values were expected because of unequal socioeconomic disparities within the South African context. In particular, the box and whisker plots for Internet, computers, and landlines displayed tailed-off patterns (Figure 8.2), which could be attributed to economic disparities. These disparities might lead to outliers in access levels, especially among the richest and poorest municipalities (primarily B3 versus B4 areas). In addition, to cater for the potential biases that may arises due to violations of the normality assumption that mainly arise due to socioeconomic differences between B3 and B4 areas, study analysis and conclusions are conducted and drawn based on comparisons between the data of the two types of areas.

The calculated Cronbach alpha ($\alpha = .83$) indicates a high level of data consistency or reliability. This coefficient is used to assess the internal consistency of a set of items or variables in a measurement scale or questionnaire. In this context, Cronbach's alpha suggests that the items or variables being measured are consistently related to each other and are effectively assessing the same underlying construct or concept. It suggested that the data collected for the measurement scale were reliable and consistent in measuring the intended construct.

Generation of Weights and Indexes for the ICT Index Using Factor Analysis

The application of the factor analysis method is explained in Appendix C. Table 8.8 presents the factor loadings after the initial component matrix underwent rotation. Rotation was employed to enhance the clarity of differences in the factor loadings and to identify the specific factors that best represent the data.

The right section of the table shows the squared and scaled rotated factor loadings, which were standardised to a factor of one. The maximum scaled result for each variable within each component was utilised to generate the weights presented in Table 8.8. The factor analysis yielded a Kaiser-Meyer-Olkin (KMO) value of .64. The KMO value is a measure of sampling adequacy that assesses the suitability of data for factor analysis. A KMO value above .50 is generally considered acceptable, indicating that the data were reasonably suitable for factor analysis in this case. The maximum loadings were multiplied by the percentage of variance represented by each component and subsequently scaled to one. These weights were then applied to generate indexes for each municipality. The LIN aggregation (Appendix C) method was employed to calculate the overall indexes for each municipality.

Table 8.8 Factor Loadings and Weights for ICT Accessibility based on Factor Analysis

	Factor Loadings (Rotated)			Scaled factor loadings			Weights
Variable	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3	
Internet	.95	.04	.06	**.31**	.00	.01	.246
Computers	.95	.12	.15	**.31**	.02	.04	.247
Cellphone	-.01	.78	.14	.00	**.70**	.03	.169
Landline	.85	-.40	.22	**.24**	.18	.08	.196
TV	.61	.19	.49	.13	.04	**.40**	.067
Radio	.22	.23	.52	.02	.06	**.45**	.075
Explained Varience	2.93	.88	.61				
Explained Varience/Total Varience	.66	.20	.14				

To assess how the independent variables affect the dependent variable of the developed indexes, sensitivity analysis was conducted. This analysis was performed using and the SALib library in Python software (Herman & Usher, 2017), following the outlined procedure provided in Appendix C (Section 12.3.7). Figure 12.3 presents the Python software code used for this sensitivity analysis. Figure 8.3 provides the resultant insights into the first-order indexes, second-order indexes, and overall sensitivity values. Internet and computers exhibited the highest total sensitivity values recorded. Slight discrepancy existed between the total sensitivity values (*ST*) and the first-order sensitivity values (*S1*), indicating the presence of minor interaction factor effects. This suggests that while the primary factors (first-order) had a significant impact on the sensitivity, there were also minor interaction effects that contributed to the overall sensitivity of the indexes.

Figure 8.3 Sensitivity Analysis for the Variables of the ICT Composite Indexes

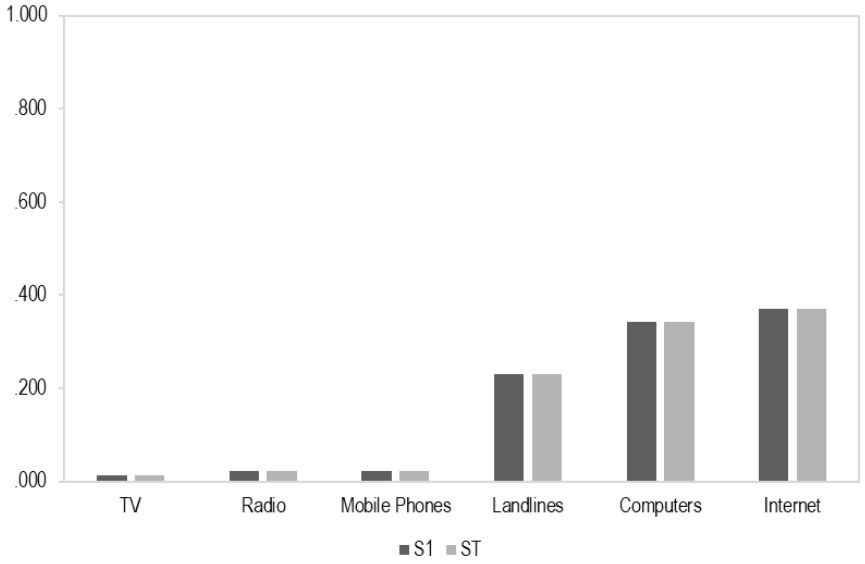


Table 8.9 displays the average indexes for the six ICTs per province. The EC and KZN provinces exhibited the lowest overall indexes, while the GT and WC provinces had the highest measures. Internet and landlines generally had the lowest average indexes, except in the case of the WC and GT provinces. On the other hand, mobile phone indexes recorded the highest average values across all areas, reflecting high rates of mobile phone penetration throughout the country.

Table 8.9 Average ICT Accessibility Index per Province

Province	INDEX	Internet	Computers	Cellphone	Landline	TV	Radio
WC	.754	.770	.657	.726	.867	.739	.894
EC	.398	.407	.210	.242	.839	.225	.673
NC	.530	.542	.326	.487	.819	.432	.771
FS	.480	.491	.255	.373	.893	.269	.830
KZN	.371	.380	.171	.199	.901	.153	.582
NW	.428	.437	.204	.346	.889	.160	.777
GT	.685	.701	.533	.761	.972	.380	.928
MP	.475	.486	.252	.411	.959	.160	.823
LIM	.434	.444	.206	.370	.940	.127	.791

Data Source: STATS SA (2011)

Figure 12.36 provides a comparison of the average ICT accessibility indexes per province for both B3 and B4 municipalities. In the NC, KZN, and EC provinces, B4 municipalities displayed the lowest accessibility indexes for ICTs. Conversely, B3 municipalities in the WC and GT provinces generally had higher indexes. The most pronounced difference between B3 and B4 municipalities was evident in the EC province, where the contrast in ICT accessibility is particularly pronounced. Figure 12.37, Figure 12.38 and Figure 12.40 in Appendix M present the spatial distribution of ICT accessibility Indexes. Municipalities in the EC and KZN provinces are

confirmed to have clusters of municipalities with low access levels, while municipalities in WC provinces have high access levels.

8.1.2 Access to Service Variables

The assessment of access to basic education (primary, secondary, and combined schools), healthcare services, and police services involved examining various factors and characteristics. These included:

i. *Distance to Service:* For municipalities that did not have the services readily available, the proximity or distance to access these services was utilised.

ii. *Quality of Service:* The quality and effectiveness of the service provided were evaluated as an important aspect of access.

iii. *Population Size:* The population size of the municipality receiving the service was used to gauge the capacity of the service to cater to the needs of the population.

These components and characteristics collectively contributed to the assessment of access to these essential services, offering a comprehensive view of the accessibility and quality of services in the studied municipalities.

8.1.2.1 Health Services Indexes

The healthcare services index considered five different forms of healthcare facilities (clinics, district hospitals, regional hospitals, tertiary hospitals, and central hospitals). The data sources used for this assessment were the SAHS (South African Hospital Survey) data from 2011 (Code for South Africa, 2018b) and the South African 2011 census data. The generation of the healthcare accessibility index considered several key factors (assumptions):

i. *Types of Health Facilities:* That is, clinics, district, regional, tertiary, and central hospitals. Clinics provided basic healthcare services at the municipal level, while district hospitals served as referral centres for clinics within a district. Similarly, regional hospitals played a referral role for district hospitals within a province, and tertiary hospitals served as referral hospitals for regional hospitals. Central hospitals, which were often associated with universities, had specialised functions, including medical training and academic research. It was assumed that central hospitals primarily served the provinces in which they were located, even though they also handled national referrals. The study assumed that providing healthcare to international migrants did not pose significant effects on the level of services rendered.

ii. *Focus on Public Facilities:* The study primarily focused on public or government-owned healthcare facilities, as they were generally more affordable and accessible to the rural population. This was a significant factor given that a large percentage of the country's population (approximately 84%) relied on public healthcare (Naidoo, 2012).

iii. *Referral System:* When healthcare centres were not available within a municipality, patients were referred to the nearest health facility outside the municipality but within the province of residence.

Weights were assigned to different healthcare facilities based on their functions, with advanced facilities receiving higher weights since they served as referral centres for less advanced facilities. Additionally, factors such as the distance to referral centres and the quality of service were considered in developing the indexes. The detailed procedure for developing these index measures is outlined in Appendix C. The average index scores presented in Figure 12.6 reveal an interesting pattern where some provinces have B4 areas with higher index scores than their B3 counterparts. This pattern may be explained by the imperative to provide public services in less developed B4 areas, mainly because rural dwellers largely depend on affordable or subsidised public healthcare. Figure 12.7, Figure 12.8, and Figure 12.10 in Appendix C show the Moran's Index maps. As observed in Figure 12.6, contrary to the pattern for other services, access to public healthcare is lower in the WC and NC provinces than in other municipalities (there is a cluster of WC and NC municipalities with low indexes). Another potential explanation for the pattern for WC and NC is the sparse population distribution associated with municipalities in the provinces. A major concern is a cluster of municipalities with low access levels in EC and KZN provinces. To summarise, the developed measurement system considered the following factors and variables:

i. *Availability of Service:* This included an assessment of the presence of various healthcare facilities (clinics, district hospitals, regional hospitals, tertiary hospitals, and central hospitals) within the respective municipalities. Specialist hospitals were excluded due to data quality issues.

ii. *Quality of Service:* The quality and capacity of each healthcare facility were evaluated based on the DoH service quality rating data. This data considered aspects such as human resources capacity, management rating, services provided, infrastructure, and medication availability.

iii. *Population Size Served:* The population size served by each healthcare facility was considered at the municipal, district, and provincial levels.

iv. *Distance to Nearest Service:* The proximity to the nearest available service was the distance to the closest municipality that had the required service.

The developed measures did not account for the distances travelled by rural residents within municipal boundaries. For future updates, the indexes can be refined by incorporating updated population sizes and healthcare centre data from subsequent health surveys. Additionally, the Google Distance Matrix API can be used to provide updated distance to services data, assuming there are new routes and service centres established over time.

8.1.2.2 Basic Education Services Indexes

Data from the DBE, obtained through the Annual Schools Survey 2011, played a crucial role in developing the indexes for basic education in South African municipalities. This data included information on the number of educators and pupils per school. In cases where data were missing or seemed unreasonable regarding the number of pupils or educators per school, these values were replaced with the average values for the respective municipality. Within the dataset, three types of schools were defined: primary schools, combined schools, and secondary schools. Primary schools enrolled pupils from Grades R to 7, while secondary schools covered Grades 8 to 12. Combined and intermediate schools catered to both primary and secondary pupils. A weighting system was applied, where secondary and primary schools received a weighting of one (1.000), while combined schools were assigned a weighting of .750 to account for their mixed-grade curriculum (DBE, 2011).

Based on government education policies and goals, it was assumed that the optimal number of students per educator should be 40 pupils for primary schools and 35 pupils for secondary schools (Motshekga, 2012). Since there were no specified threshold values for combined schools, the study used a maximum of 50 students per educator. Any figures that exceeded this threshold were adjusted to the maximum value of 50. The index development process involved normalising the average number of students per educator within each municipality. These indexes were further adjusted by incorporating the gravity model of attraction, which considered the attractiveness of educational facilities in other municipalities, including facilities located in metropolitan and urban municipalities.

Figure 12.11 illustrates the accessibility index for basic education. Interestingly, the indexes exhibited similar patterns for both B3 and B4 municipalities across all provinces. However, in the NC province, B4 municipalities had significantly higher average index scores compared to their B3 counterparts. The Moran's Index maps and statistics presented in Appendix H (Figure 12.12, Figure 12.13, and Figure 12.15) show a comparatively random pattern of the Indexes relative to the patterns observed for other services.

In summary, the indexes for basic education utilised student-to-educator ratios along with the gravity attraction model to calculate an index score for each municipality. Depending on data availability and to enhance the current measure, additional factors that could be considered include the number of science teachers, the availability of infrastructure, connectivity to the Internet, and access to basic amenities such as water, electricity, and sanitation. These supplementary measures could provide a more comprehensive and nuanced assessment of educational accessibility and quality within municipalities.

8.1.2.3 Policing and Justice Services indexes

Based on the findings from the study (Section 2.1.3.2), the characteristics used to assess rurality in terms of policing were determined to be as follows:

i. *Human Resources:* This factor considers the number of police recruits, their level of training, and their expertise.

ii. *Equipment for Policing Services:* This aspect considered improvements and increased equipment for policing services (police vehicles, firearms, and advanced technologies like drones).
iii. *Diversity of Services Offered:* This factor encompassed the range of services provided, including victim-friendly services for children and women, as well as specialised units such as the stock theft department.
iv. *Reduced Distances Travelled:* The study considered the reduced distances travelled by rural residents to reach police stations or by the police force to attend to cases.
v. *Service Area and Population Size:* This factor considered the area and population size served by each police station.
vi. *Communication and Marketing:* This aspect focused on improved communication and marketing efforts, both among police service providers and between the police and community members for reporting crime and criminal activity.

Due to limitations in data availability, municipality-level data for the study could not be accessed for the year 2011. Moreover, the data only provided information on the number of police stations per municipality. Therefore, access to policing services was omitted from the overall rurality measures produced by the study. To achieve greater accuracy and comprehensiveness, and given the availability of data, the missing variables i) to vi) can be included in future indexes by normalising the scores of each factor per municipality (Section 12.3.4) and determining the weights for each variable (Section 12.3.5) before aggregation.

8.1.2.4 Other Services and Amenities (Social Aid Dependency, Formal Employment, Public Parks, and Libraries)

Dependency on social aid and grants is recognised as a significant characteristic of rural areas, as indicated in the classifications by CoGTA and echoed in the interviews. Unfortunately, data on the number of households dependent on grants per municipality was unavailable for this study. However, the electricity indicator in Section 8.1.1.4 catered for the income capacity of rural households based on the households' sizes. Additionally, the measures used in the study did not incorporate factors like the presence of libraries, shopping malls, and parks, which can also be important indicators of rural development as cited in the interviews.

8.1.3 Development of Composite Indexes Using Factor Analysis

Factor analysis was employed to generate weights that account for the interplay among water, sanitation, housing, electricity, ICTs, health facilities, and education indexes, when calculating the composite indexes. As an initial step in this process, correlation coefficients were calculated, as a prerequisite for applying the factor analysis method. Table 8.10 displays the statistically significant correlations. It was observed that education did not exhibit statistically significant coefficients. On the other hand, healthcare showed negative correlations with water, electricity, and sanitation, although these correlations were not statistically significant. The calculated Cronbach alpha ($\alpha = .81$) indicated good consistency levels for the variables used in the analysis. In other words, the data used in the study demonstrated a high degree of internal consistency, which lends credibility to the results and the composite indexes derived from them.

Table 8.10 Pearson Correlation Matrix of Potential Composite Index Variables

	Water	Sanitation	Housing	Electricity	ICTs	Healthcare	Education
Water	1.00						
Sanitation	.68**	1.00					
Housing	.35**	.47**	1.00				
Electricity	.73**	.78**	.66**	1.00			
ICTs	.79**	.75**	.52**	.91**	1.00		
Healthcare	-.16*	-.08	.10	-.21**	-.24**	1.00	
Education	-.03	-.09	.08	.06	.10	< -.01	1.00

Note: *p < .05, ** p < .01

The Q-Q plots for the water, sanitation, and housing indexes exhibit more pronounced tails compared to the plots for the other variables (Figure 12.2). The Shapiro-Wilk test p-values indicated that all the index variables were significantly not normal at the five percent significance level of testing, as shown in Figure 12.2. These results are likely influenced by the presence of outliers, which are expected from substantial socioeconomic disparities within the context studied. Outliers can significantly affect the normality of data distributions and lead to deviations from statistical patterns. While acknowledging the implications of the Shapiro-Wilk test, it is important to note that the test is particularly sensitive to outlaying values (Saculinggan & Balase, 2013). In addition, to cater for the potential biases that may arises due to violations of the normality assumption that mainly arise due to socioeconomic differences between B3 and B4 areas, study analysis and conclusions are conducted and drawn based on comparisons between the data of the two types of areas.

Table 8.11 displays the loadings and components of the variables used in the analysis. To determine the number of components, a common criterion is to consider individual variable contributions of approximately 10 percent of the component's variance or an eigenvalue of at least one. Four components were ultimately selected, even though only two contributed at least 10 percent of the component's variance.

Table 8.11 Eigenvalues from the Factor Analysis for the Overall Index

Returned Factors	*N*	S^2	Difference	Proportion	Cumulative
Factor 1	181	3.43	2.94	.88	.88
Factor 2	181	.49	.26	.12	1.00
Factor 3	181	.23	.16	.06	1.00
Factor 4	181	.07		.02	1.00

Note: LR test: $\chi^2(21) = 845.90$, p = <. 01

The overall KMO test statistic was .79. This statistic indicated that the data had a sufficient degree of correlation among variables, suggesting that the dataset was well-suited for the application of factor analysis. The KMO test assesses the adequacy of the dataset for factor analysis, and a value of .79 is considered quite favourable in this context. The generation of weights was carried out following the steps outlined in Appendix C (Section 12.3.5). Table 8.12 presents the factor loadings of the variables based on the four identified factors.

Table 8.12 Factor Loadings and Weights for Rurality based on Factor Analysis

	Factor loadings (Rotated)				Scaled factor loadings				Weights
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4	
Water	.81	-.09	-.11	.12	.17	.01	**.29**	.08	.009
Sanitation	.80	.11	-.26	.06	.16	.01	**1.45**	.02	.046
Housing	.53	.54	.04	-.03	.07	**.24**	.03	.00	.208
Electricity	.95	.20	.03	-.12	**.23**	.03	.02	.07	.634
ICTs	.96	.01	.11	.01	.24	.00	**.27**	.00	.009
HealthCare	-.22	.35	-.11	.18	.01	.10	**.25**	.15	.008
Education	.03	.09	.35	-.02	.00	.01	**2.65**	.00	.085
Explained Varience	3.85	1.21	.05	.20					
Explained Varience/Total Varience	.73	.23	.01	.04					

The maximum resultant values for each variable were extracted and rescaled to obtain the weights presented in Table 8.12. The weights derived from this method do not signify the relative importance of variables; rather, they serve as a mechanism for accounting for common factor elements.

8.1.4 Uncertainty and Sensitivity Analysis

8.1.4.1 Uncertainty Analysis

The uncertainty analysis conducted in the study aimed to identify all possible sources of uncertainty in a composite indicator and to consider alternative conceptual scenarios for selecting underlying variables (JRC-EC, 2008). The uncertainties considered in formulating the model were based on the following factors:

i. *Imputation of Data:* The choice between using imputed education data versus using non-imputed education data.

ii. *Inclusion and Exclusion of Variables:* The impact of inclusion and exclusion of each variable from the analysis.

iii. *Weighting System for Water Source Categories:* Choosing between the BA weighting system (Appendix C, Section 12.3.5) and the ordinal ranking of distances to safe water sources.

iv. *Definition of Rural Housing Indicator*: Selecting between the formal housing indicator and traditional structures as an indicator of formal housing.

v. *Weighting System for Sanitation Indexes:* Deciding between the ordinal ranking of sanitation facilities and binary identification of acceptable sanitation.

vi. *Overall Aggregation of ICT Indicator:* Choosing between linear aggregation and geometric aggregation of the ICT indexes.

vii. *Overall Aggregation:* Selecting between overall geometric aggregation and linear aggregation for the composite index.

These sources of uncertainty represent different choices or scenarios that could impact the composition and results of the composite indicator. By considering these uncertainties, the study aimed to provide a more robust and comprehensive understanding of the potential variations and implications of different modelling decisions. Sobol's variance-based uncertainty procedure was applied to the factors and is explained

in Section 12.3.7. Table 8.13, shows that the highest S_i (first-order effect) and S_{Ti} (sum of first-order effect and the interaction effects) values were associated with the inclusion and exclusion of variables, as well as the overall aggregation method. These values indicate the extent to which these factors influence the overall uncertainty in the analysis. The higher the S_i and S_{Ti} values, the more significant the impact of these factors on the study's uncertainty.

Table 8.13 S_i and S_{Ti} Values for the Overall Index

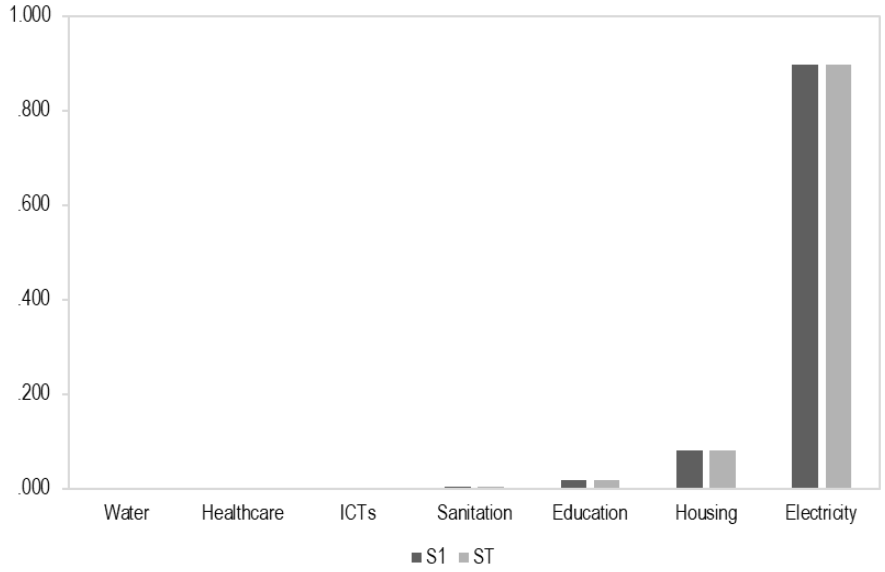
Source of Uncertainty (*i*)	S_i	S_{Ti}	S_{Ti} - S_i
Education variable (Imputed data vs none-imputed data)	.00	.87	.87
Overall index aggregation method (Geometric vs Linear aggregation)	.03	**.94**	.91
Variable inclusion and exclusion (full model and exclusion of each variable)	**.10**	**.93**	.83
Weighting systems for Water Index (BA method vs Ranking)	.00	.87	.87
Housing Indicator (Formal housing vs traditional structure definitions)	.00	.87	.87
Sanitation (Ranking vs Binary weighting)	.00	.87	.87
ICTs (Linear vs Geometric Aggregation)	.00	.87	.87

Note: The indexes are calculated in the 2022_MonteCarlo Microsoft ExcelSheet

8.1.4.2 Sensitivity Analysis

Sensitivity analysis was done to determine how the dependent variable was affected by the independent variables. The analysis was carried out using the SALib library (Herman & Usher, 2017) (Appendix C, Section 12.3.7) and the Python software code in Figure 12.4. The independent variables were the indexes for water, sanitation, housing, ICTs, healthcare, and education. The results of the analysis are presented in Figure 8.4. The first-order effect (S*1*) and total sensitivity (*ST*) values show that electricity and formal housing had the most substantial effect on the variability of the overall index values. Healthcare had the smallest effect. There were minor differences between the *ST* and S*1* values. This suggests that interaction effects, had a minimal impact on the overall sensitivity values observed S_T. In other words, the primary contributors to the variability in the overall index values were the individual factors (S*1*), and the interaction effects had a relatively minor influence on the overall sensitivity.

Figure 8.4 Sensitivity Analysis for the Variables of the Overall Indexes



8.2 Assessment Index Disparities

The LIN method was employed for aggregation to derive the overall index for each municipality. Table 8.14 provides a summary of the indexes per province. Here are some key observations:

i. *Access to Water*: Municipalities in the WC province exhibited high access to water. In contrast, the average accessibility indexes for water were relatively low in the EC, KZN, NW, MP, and LIM provinces.

ii. *Sanitation, Housing, Electricity, and ICTs:* Similar patterns were observed for sanitation, housing, electricity, and ICTs, with the EC and KZN provinces standing out for having notably low access to formal housing.

iii. *Healthcare Indexes:* Provinces with a predominant presence of B4 areas tended to have higher healthcare indexes than expected.

Table 8.14 Average Rurality Indexes for South African Provinces

Province	OVERALL	Water	Sanitation	Housing	Electricity	ICTs	Health Care	Education
WC	.839	.764	.863	.853	.870	.770	.631	.595
EC	.437	.193	.479	.599	.368	.407	.765	.524
NC	.705	.403	.735	.842	.681	.542	.718	.578
FS	.589	.333	.750	.805	.497	.491	.835	.676
KZN	.384	.134	.372	.538	.297	.380	.790	.654
NW	.540	.194	.519	.784	.471	.437	.798	.491
GT	.797	.803	.925	.840	.806	.701	.742	.571
MP	.603	.219	.563	.804	.538	.486	.721	.659
LIM	.584	.167	.380	.896	.488	.444	.819	.684

Data Sources: STATS SA (2011), DBE (2018), and Code for South Africa (2018b)

Table 8.15 presents the analysis of variance (ANOVA) for the overall index as a dependent variable with respect to three factors: province (EC, KZN, MP, LIM, GT, NW, NC, FS, and WC), municipality type

(B3 or B4), and the interaction between province and municipality type. Based on the *p*-values criterion, the null hypothesis was rejected for all three factors, indicating that there are significant differences in the overall indexes based on these grouping factors. The test for the interaction factor indicates that there are differences between categories B3 and B4 municipalities across provinces. This implies that the disparities in overall indexes were not only due to province-specific factors but also relate to the municipality type within and across provinces. For example, differences exist between B3 municipalities in the WC province and those in other provinces, further emphasising the complexity of rural development dynamics in South Africa. Bonferroni pairwise tests were conducted to determine differences between the overall indexes of respective provinces Table 8.16). The overall indexes for WC provinces were significantly greater than those of all other provinces except GT. KZN's Index was significantly lower than the indexes for all other provinces (except GT and EC province).

Table 8.15 Two-way ANOVA of the Overall Indexes

Source	*SS*	*Df*	*MS*	*F*	*p*
Model	5.66	14	.404	43.69	< .01
Province	1.99	8	.249	26.92	< .01
Area Type (B3 or B4)	.54	1	.541	58.46	< .01
Interaction	.37	5	.074	7.98	< .01
Residual	1.54	166	.009		< .01
Total	7.20	180	.040		< .01

Note: N = 181, MSE = .096, R^2 = .79, *Adjusted* - R^2 = .77

These findings highlight significant variations in the overall indexes across different provinces, with WC exhibiting relatively higher development indicators, and KZN and EC having lower development indicators compared to other provinces. To further explore these spatial differences, spatial autocorrelation analysis was conducted (Figure 8.7).

Table 8.16 Bonferroni Pairwise Comparison of the Overall Mean Indexes by Province for One-Way ANOVA of Overall Index per Province

Province	EC	FS	GT	KZN	LIM	MP	NW	NC
GT	.382	-.221						
KZN	-.056	-.218***	-.438					
LIM	.156**	-.006	-.226	.212***				
MP	.176**	.014	-.206	.232***	.020			
NW	.110	-.052	-.273	.165*	-.046	-.066		
NC	.284***	.122	-.098	.340***	.128*	.108	.174**	
WC	.426***	.264***	.044	.482***	.270***	.250***	.317***	.142*

Note: Each cell represents test statistics for the two provinces on the vertical and horizontal axis. *p <.05, **p <.01, ***p <.001.

Figure 8.5 displays the Box and Whisker plots for the overall indexes of B3 and B4 municipalities in 2011, including the minimum, 25th percentile, median, 75th percentile, and maximum values. There are some key observations:

i. *B3 Areas:* B3 areas demonstrated a wider interquartile range compared to B4 areas. This indicates a substantial variability in the level of ruralness among municipalities categorised as

B3. This variability underscores the differences in B3 areas across provinces, signifying that not all B3 municipalities shared the same level of ruralness.

ii. *Skewness:* Both types of municipalities, B3 and B4, displayed negatively skewed index distributions. This implies that the majority of municipalities in these categories tended to have higher levels of overall development, with relatively fewer municipalities exhibiting lower levels of development per municipality type.

In summary, these measures of dispersion and skewness provide insights into the variation in ruralness levels among South African municipalities, emphasising the heterogeneity within both B3 and B4 categories.

Figure 8.5 Box and Whisker Plots of Overall Index per Area Type

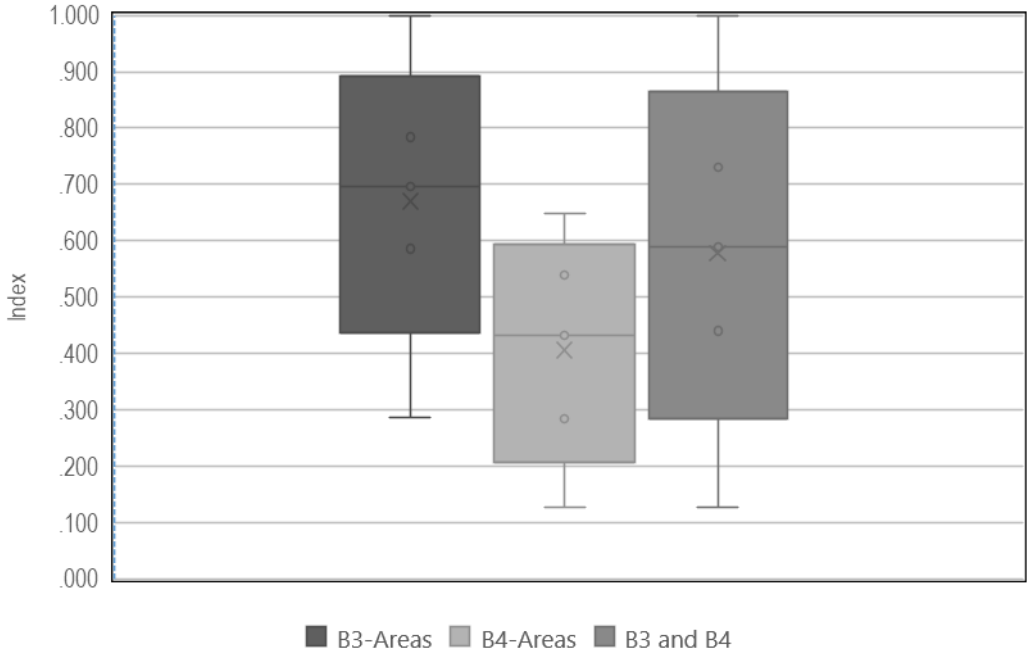


Table 8.17 presents a summary of municipalities with the highest overall indexes. Key observations include:

i. *The Highest Measures are Observed for Municipalities in the WC and NC Provinces:* B3 municipalities in the WC and NC provinces dominate the list of municipalities with the highest indexes. This indicates relatively higher levels of overall development in these municipalities.

ii. *Sub-Indexes:* Despite having high overall indexes, some of such municipalities reported lower indexes for water and healthcare. This suggests that these municipalities may not have been prioritised in terms of public healthcare services, possibly due to lower poverty levels compared to other parts of the country (which meant that they could access the services privately, especially healthcare).

Table 8.17 Municipalities with the Largest Overall Index Values.

CODE	PROVINCE	MUNICIPALITY	OVERALL	Water	Sanitation	Housing	Electricity	ICTs	Health Care	Education
B3	WC	Hessequa	1.000	.653	.919	.936	.993	.932	.706	.660
B3	WC	Cape Agulhas	.994	1.000	.820	.841	1.000	1.000	.625	.790
B3	WC	Swartland	.976	.887	.870	.851	.999	.857	.505	.589
B3	WC	Saldanha Bay	.965	.807	1.000	.808	.986	.936	.457	.598
B3	WC	Bergrivier	.946	.863	.821	.841	.973	.849	.482	.507
B3	NC	Nama Khoi	.941	.129	.774	.959	.925	.719	.360	.650
B3	NC	Gamagara	.941	.445	.904	.699	.987	.735	.779	.673
B3	NC	Kgatelopele	.939	.341	.981	.817	.941	.679	.903	.668
B3	NC	Richtersveld	.927	.328	.900	.727	.923	.724	.255	1.000
B3	WC	Langeberg	.919	.842	.914	.886	.900	.769	.844	.566
B3	WC	Swellendam	.911	.955	.850	.843	.899	.800	.683	.616
B3	NC	Emthanjeni	.899	.282	.882	.956	.856	.576	.853	.598
B3	WC	Witzenberg	.875	.859	.947	.821	.854	.595	.577	.606
B3	WC	Cederberg	.870	.747	.858	.843	.856	.689	.507	.531
B3	WC	Matzikama	.867	.832	.707	.836	.858	.706	.473	.575
B3	WC	Theewaterskloof	.854	.789	.879	.776	.842	.728	.621	.595
B3	WC	Prince Albert	.850	.928	.713	.945	.782	.640	.704	.667
B3	GT	Lesedi	.845	.803	.925	.840	.806	.701	.742	.571
B3	WC	Laingsburg	.842	.705	.844	.823	.824	.736	.654	.509
B3	NC	Khâi-Ma	.834	.365	.840	.770	.802	.464	.494	.792

Data Sources: STATS SA (2011), DBE (2018), and Code for South Africa (2018b)

Table 8.18 provides indexes for municipalities with the lowest overall values, and the findings include:

i. As expected, the municipalities with the lowest overall index values were primarily B4 municipalities.

ii. The low index values in these areas are mainly attributed to limited access to water, sanitation, housing, electricity, and ICTs. However, access to public healthcare and education is relatively higher.

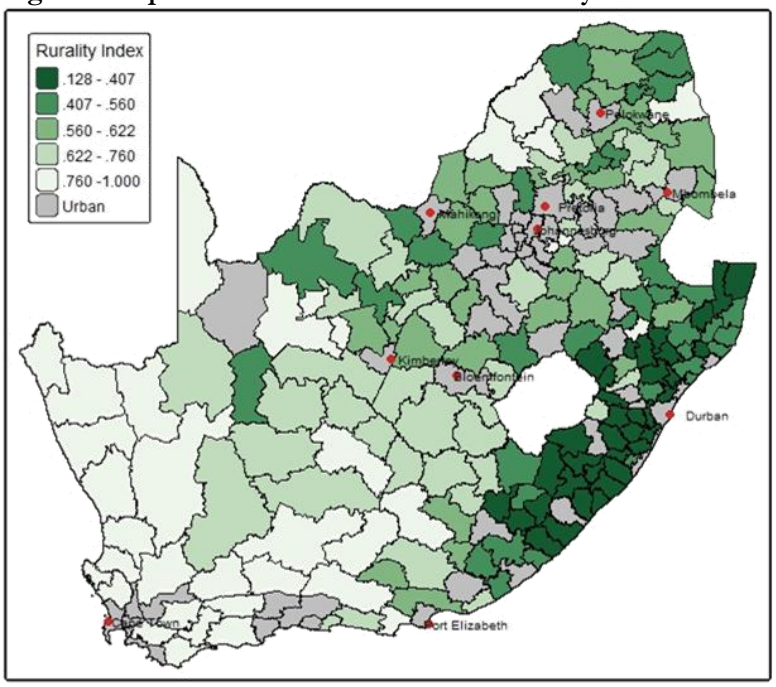
Table 8.18 Municipalities with the Lowest Overall Index Values.

CODE	PROVINCE	MUNICIPALITY	OVERALL	Water	Sanitation	Housing	Electricity	ICTs	Health Care	Education
B4	EC	Port St Johns	.128	.011	.222	.170	.096	.265	.622	.078
B4	EC	Ntabankulu	.148	.029	.244	.196	.093	.227	.581	.259
B4	EC	Nyandeni	.200	.015	.283	.248	.159	.289	.682	.182
B4	EC	Mbhashe	.207	.015	.152	.231	.136	.270	.729	.532
B4	KZN	Msinga	.207	.039	.299	.295	.105	.270	.771	.522
B4	EC	Engcobo	.208	.061	.200	.220	.155	.274	.752	.399
B4	KZN	Umzimkhulu	.216	.099	.230	.278	.137	.300	.725	.450
B4	EC	Ngquza Hill	.222	.007	.224	.272	.201	.284	.596	.090
B4	EC	Mbizana	.234	.024	.268	.319	.186	.296	.526	.191
B4	EC	Elundini	.235	.084	.272	.287	.129	.290	.657	.701
B4	EC	Intsika Yethu	.238	.045	.189	.248	.144	.270	.779	.751
B4	EC	Mhlontlo	.238	.073	.230	.245	.154	.301	.667	.662
B4	KZN	Vulamehlo	.238	.051	.272	.271	.127	.296	.808	.770
B4	KZN	Ingwe	.239	.076	.313	.233	.143	.302	.738	.733
B4	KZN	Nkandla	.259	.048	.247	.232	.174	.300	.866	.756
B4	KZN	Maphumulo	.260	.020	.235	.338	.150	.296	.858	.689
B4	EC	Umzimvubu	.261	.049	.265	.262	.170	.286	.617	.751
B4	KZN	Ubuhlebezwe	.284	.103	.400	.264	.190	.356	.771	.748
B4	KZN	Ndwedwe	.284	.048	.260	.421	.149	.296	.854	.745
B3	EC	Matatiele	.286	.087	.296	.366	.193	.313	.543	.586

Data Sources: STATS SA (2011), DBE (2018), and Code for South Africa (2018b)

The map presented in Figure 8.6 provides a visual representation of rurality in South Africa.

Figure 8.6 Spatial Distribution of Overall Rurality Indexes



The following observations were noted:

i. *Spatial Clustering:* The Global Moran Index value of .762, which is statistically significant at the five percent level, indicates that areas with either low or high index values are significantly clustered. This meant that rural areas with similar levels of development tended to be geographically clustered together.

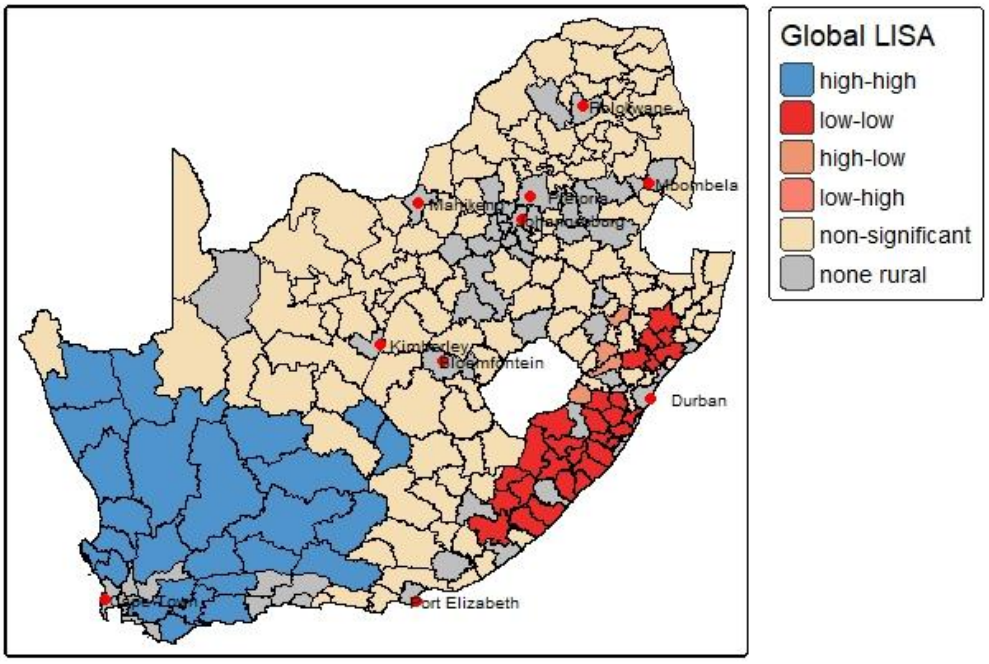
ii. *Least Developed Areas:* The least developed rural areas were primarily concentrated in the EC and KZN provinces, which form the south-eastern region of the country. These areas tended to have lower overall development levels and were characterised by smaller, densely populated municipalities.

iii. *Developed Areas:* In contrast, the WC and FS provinces, located in the western section of the map, was a hotspot for the municipalities with the highest indexes. Municipalities in these provinces exhibited higher index values, greater overall development, and they were large in area.

iv. *Local Indicators of Spatial Autocorrelation (LISA) (explained in Appendix P)*: The LISA is an advanced form of cluster analysis. The analysis confirmed a pattern of low-low (clustered low index scores) clustering (27), primarily in the EC province, and along the coastline of adjacent municipalities in the KZN province. Conversely, municipalities in the WC province exhibit high-high (clustered high index scores) clustering (23), indicating a block of rural areas with higher index values.

Observations of the LISA group maps in Figure 8.7 show clusters of underdeveloped rural municipalities in KZN and EC, a block of developed municipalities in the WC, and a random development patterns through the rest of the country.

Figure 8.7 LISA Clusters for the Overall Rurality Indexes




```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.76159, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

As shown in Table 8.19, municipalities in the EC province were clustered in terms of deficits in all the household amenities that were studied (water, sanitation, electricity, and housing). The pattern for ICTs was notably high for the WC municipalities, all of which were classified as B3 areas.

Table 8.19 Global Moran Indexes per Variable

Index Components		Moran Index	Summary of Spatial Pattern
Sub-Index	Description	(*SD*)	
Water	Distance to piped water	.526 (.003)	High Indexes clustered in WC and FS. Low Indexes clustered in EC and KZN.
Sanitation	Quality of sanitation	.648(.003)	High indexes clustered in WC and FS provinces. Low Indexes in LIM and EC
Electricity	Electricity Grid Connect, Household size, Income, and dwelling type	.716 (.003)	High Indexes clustered in WC. Low indexes clustered in EC and KZN
Housing	Dwelling type	.808 (.003)	High Indexes clustered in FS and LIM provinces. Low indexes clustered in EC and KZN
ICTs	Household Internet, Mobile Phone, Computer, radio, and television	.605 (.003)	High Indexes in clustered in WC province and low indexes in EC province
Healthcare	Distance to service, Quality of service	.728 (.003)	High indexes clustered in NW and FS provinces. Low indexes clustered in WC. A small cluster in EC
Education	Student-teacher ratio	.340 (.003)	Low index clustered in NW province
Composite Index		**.762 (.003)**	**High indexes clustered in WC and FS. Clustering of low Index in EC and KZN.**

Note: $p < .01$ for all sub-indexes. This implies that all Moran's Index values are significant at the five percent test level. Refer to Appendix G to Appendix P for the LISA presentations for each Index (water, sanitation, electricity, housing, ICTs, healthcare, and education)

8.3 Summary of Analysis

The study applied the SRI to the study context, assigning a minimum value of 0 to represent the most underdeveloped rural places and 1 for the most developed rural areas. The variables chosen to quantify ruralness included water services, sanitation, formal housing, household electricity, household ICT connectivity, access to healthcare, and education. Table 8.20 summarises and illustrates the relationship between each variable and the overall rurality index. Access to education services was included in the study, even though it did not show significant correlations with the other variables used to calculate the overall indexes (Table 8.10) and hence findings on the indicator were interpreted with caution. Measures for police services and social grant dependency were not incorporated due to the unavailability of data. Nevertheless, the spending capacity included within the Electricity component of the index reflect the financial capability of rural households to cover expenses related to healthcare travel, access to education, their ability to meet the financial demands associated with accessing these services, and their ability to maintain household well-being.

In terms of the relationship between ICT access and rurality, the Indexes reveal higher scores for previously more developed municipalities in the WC and FS provinces, while municipalities in the WC and KZN provinces exhibit lower scores (Figure 12.36 and Appendix M). These areas have clusters of high ICT indexes and low ICT Indexes (Appendix M). The same clusters are evident for the overall Indexes (Section 8.2). As illustrated, more affordable and less advanced technologies like television, cellphones, and radios have high penetration rates (Figure 8.2). The relationship between ICTs and rurality is summarised further in Section 9.1.3.

Table 8.20 The Relationship between the Overall Index and the Index's Variables

Variable	Explanation	Units	Impact on Index
Piped Water	Distance to a reliable and potable water point	Increased distance to water point (metres)	-
		Increase in water interruptions of more than two days during the year (days)	-
Sanitation	Minimum acceptable sanitation standards	Access to acceptable sanitation (VIP latrine, Flush Toilet, Chemical Toilet, Septic Tank)	+
Electricity	Continuous connection to the national electricity grid in an energy-efficient household dwelling.	Connection to Electricity Grid	+
		Increased household income relative to household size	+
		Household access to formal housing (Informal housing and traditional housing assumed to be inefficient)	+
Formal Housing	Type of household dwellings	Household access to formal housing (Informal housing and traditional housing structures assumed to be inefficient)	+
ICTS	Household access to ICTs (Internet, Mobile Phone, Telephone, television, Radio)	Household access to Internet, Mobile Phone, Computer, Telephone, television, Radio.	+
Health Care Services	Access to public healthcare	Municipal access and level of access to services (Clinic, District, Provincial, Central)	+
		High population size of served area	-
		High quality of service rendered	+
		Longer distance to service	-
Basic Education Services	Access to basic education (Primary or Secondary)	Large students per teacher ratio	-

Note: 1) '+' indicates a factor that decreases the rurality index. '-' indicates a factor that reduces a rurality index. 2) Road Infrastructure is indirectly incorporated as the distance to the nearest service centre.

9 FINDINGS AND PROPOSITIONS

The study sought to answer the question, *'What is the relationship between rurality and ICT proliferation in the service-dominant approach to public service delivery in low- and middle-income contexts?'* The following research objectives guided the study.

- *To elucidate the underpinnings of the current state of access to improved public service delivery (including infrastructure, household amenities, and public services) within the South African rural context.*
- *To expound upon the impact of ICT proliferation on public service delivery in the South African rural context.*
- *To elucidate the concept of rurality in the digital era by updating the country's rurality measures in accordance with the prevailing context of ICT proliferation.*

An investigation of the characteristics of South African rurality was carried out through a literature review and an analysis of interview data. Rurality measures were subsequently developed. The presentations in the current chapter integrate the results of the qualitative and quantitative components of the study.

9.1 Rurality, ICT Proliferation, and Access to Service Delivery

9.1.1 Review of Rurality and Service Delivery in South Africa (Objective 1)

Following the year 1994, South Africa embarked on an effort to make public services accessible across the nation, and local governments were assigned the direct responsibility of delivering services to previously marginalised communities (Powell, 2012). This drive for development was rooted in rectifying historical injustices and fostering social inclusivity (Atkinson, 2003; Perret, Anseeuw, & Mathebula, 2005; Nyalunga, 2006). The country's historical context is elaborated in Section 1.2, the main review of literature is presented in the second chapter, and rurality measurement methodologies are explored in Chapter 7.

9.1.1.1 Findings on Household Amenities

Communal rural areas, referred to as B4 areas, exhibited the most significant demand for household water and sanitation services (Sherwill & de Coning, 2004; DNT, 2012). While comprehensive initiatives like the RDP were to enhance services like water and sanitation, the principal challenge lay in the sustained expansion and maintenance of these services to encompass the entire population (Majuru et al., 2012). Despite its ambitious scope, the RDP faced the obstacle of an insufficient initial assessment of its capacity and mismanagement issues (Atkinson, 2003; Perret, Anseeuw, & Mathebula, 2005; Nyalunga, 2006; NPC, 2011). Furthermore, the limited purchasing power of rural households exerted an impact on the affordability of providing complimentary and subsidised services like electricity (SABS, 2011).

9.1.1.2 Public Services (education, healthcare, and police services)

Regarding education, after 1994, the DBE aimed to integrate the provision of education in rural areas within a broader framework and not as a distinct entity (Gardiner, 2008). However, it soon became evident that the challenges faced by rural learners were unique. Notably, the considerable distances learners had to

travel for secondary schooling emerged as a specific rural obstacle (Nelson Mandela Foundation, 2005). An initial response involved establishing combined and intermediate schools, offering primary and secondary education on the same premises. Such schools encountered issues related to age diversity and difficulties in managing a large student population (KZNDoE, 2012).

Other prominent challenges encompassed the struggle to attract and retain qualified teachers (SACE, 2011). The composition of the rural population included the elderly, the young, and groups dependent on grants and remittances from urban labour migrants (DNT, 2012). Despite police services in rural areas relying on dependable transportation and communication networks, the SAPS contended that addressing rural crime primarily entailed reducing poverty levels (SAPS, 2018). Access to quality education, healthcare, and police services was closely linked to amenities like water, sanitation, and electricity (Nelson Mandela Foundation, 2005).

Table 9.1 South African Rurality and Development Priorities Based on a Literature Review and the Interview Findings

Service	Context (Literature Review)	Development Priorities (Qualitative Analysis)	Rurality Metrics Revealed in Literature or the Survey Interviews
Water	Piped water systems installed within 200 m of households (Majuru et al. 2012)	Development and timeous maintenance of water service points (Table 6.1: LIM_GT_B4_05).	Household access to reliable piped water within 200 m of household.
Sanitation	Sanitation projects are ongoing under the initial initiatives of the RDP (Musango, 2014; SAHRC, 2014)	Completing sanitation projects (FSan) was required in most rural B4 areas (SAHRC, 2014). Maintenance and upgrade of sanitation systems in emerging towns of B3 areas (Table 6.1: WC_TWK_04).	Access to acceptable sanitation (VIP latrine, Chemical, Septic, Flush toilet)
Electricity	The national grid was developed to reach most rural communities (Davidson & Mwakasonda, 2004).	Income capacity of rural households, formal housing, and deficiencies in electricity production (Mannak, 2018; DNT, 2012; Jamal, 2015).	Household connection to the national grid. Solar efficient housing. Household income.
Housing	The provision of formal housing to replace informal settlements under RDP (Landman & Napier, 2010)	Formal housing backlog (SAHRC, 2014).	Type of housing
Roads	Road and transportation networks are well developed, but development is ongoing (James Chakwizira & Mashiri, 2009; Masters et al., 2013)	Reduce travel times to service centres. Maintenance of existing road infrastructure.	Distance to service centres via national roads
ICTs	Internet services were initially made available in Thusong centres and libraries (DPSA, 2009); Provision of other services, i.e. education (DBE, 2011), policing (SAPS, 2018), and healthcare (Table 6.1). The digitalisation of television and radio broadcast systems (Langmia, 2005).	ICT use skills and income levels were the major limiting factors (Langmia, 2005; Dzidonu, 2010). Growing demand for public Wi-fi connection zones (Table 6.1: WC_TWK_B3_03).	Household access to ICTs and Mass media (Computer and Internet)
Healthcare	Poverty and high disease burden in underdeveloped areas (KZN, EC, MP, and LIM) (Naidoo, 2012; Mayosi & Benatar, 2014).	Attracting and retaining trained personnel; Reduced distance to public Health Centres (Coovadia, Jewkes, Barron, Sanders, & McIntyre, 2009; Eagar at al., 2014).	Access to health centres (Distance) Service capacity of centres (Health Personnel, Skills, Quality of Service, Type of Facility)

Education	Provide schooling to previously disadvantaged communities (Nelson Mandela Foundation, 2005). Combined schools were set up to offer primary and secondary schooling in one location (Nelson Mandela Foundation, 2005; KZNDoE, 2012).	Converting combined schools to Primary and Secondary Schools. Return trained and experienced staff. Reduce walking distance by strategically positioning schools. Returning skilled human resources. School infrastructure (science laboratories, Internet, libraries, Computer laboratories, and others). (Nelson Mandela Foundation, 2005)	Distance to centres; Curriculum and skilled educators (Science teachers, age-focused learning); School infrastructure (water, sanitation, electricity, security, ICTs, laboratories). Teacher-to-learner ratio.
Police	High crime (crimes against women and children), stock theft, and poaching. Long-distance to service centres (SAPS, 2018).	Increase the number of police stations, personnel, and skill. Diversity and specialty of services (stock theft, victim-friendly centres). New technologies and equipment (ICTs and vehicles). Transport and communication networks (SAPS, 2018).	Police to population ratio. The number of police stations. Distances to the station. Communication. Diversity of services available. Equipment.
Social Grants	Poverty and a population consisting of the aged, retirees, and the young (Table 6.1) (Coovadia et al., 2009; Eagar et al., 2014).	High poverty levels and high population dependency ratios (DNT, 2012).	Dependent population. Dependency on social grants.

9.1.2 ICT Proliferation and Service Delivery (Objective 2)

Drawing from the interview data, the results on rural development priorities highlighted a prevailing frustration among rural inhabitants due to inadequate access, deficient management, and insufficient water and sanitation services. This section encapsulates the conclusions derived from interview responses assessed in Chapter 6, focusing on the relationship between ICT proliferation and rurality. Among the technologies examined, mobile phone services, radio, and television emerged as pivotal components within the studied context.

9.1.2.1 Mobile Phones and Access to Services

Despite widespread adoption, mobile phones predominantly facilitated top-down communication within the 'Access and Knowledge' phase of the C4D framework provided by OWI. While challenges related to the cost of mobile device Internet connectivity existed, mobile phones still enabled rural learners to access online educational content. This was especially pertinent for learners residing in remote rural B4 areas with limited access to municipal libraries. Additionally, healthcare professionals employed mobile phone communication to monitor patients and convey health-related information within remote B4 communities. This mode of communication played a vital role in scheduling appointments, patient monitoring, and the dissemination of essential details, such as the visiting schedules of mobile healthcare units and mobile child immunisation teams.

The advent of mobile and Internet banking introduced banking alternatives for rural residents to engage in money transfers and service payments. For remote rural inhabitants in B4 areas, mobile banking services were indispensable for purchasing prepaid electricity services. However, challenges concerning technology proficiency and technology trust persisted. While these systems also found use in B3 areas, the convenience they provided was particularly evident for remote rural dwellers, as it helped curtail

travel costs to service centres. Moreover, mobile phone services played a pivotal role in facilitating family communication and enabling money remittances between migrant workers and their rural households.

9.1.2.2 Mass Media and Development Communication

Radio emerged as a particularly effective technology for facilitating community discussions, notably in B3 areas equipped with community broadcasting stations (NW_RAT_B4_09 and LIM_GT_B4_03 in Table 6.2). In such locales, radio platforms also disseminated vital information encompassing traffic updates for town centres, obituary announcements, and social activities, including religious messages. Television also played a role by broadcasting educational content for learners in B3 areas. Television and radio served as vital sources of news and information concerning national and international matters, particularly in the least developed B4 areas. The strengths of mass media technologies were evident in their user-friendliness and cost-effective maintenance.

9.1.2.3 Electronic Service Initiatives

The interviews conducted revealed a range of initiatives aimed at implementing online self-service bill payment systems, municipal websites, social media platforms, and telecentre projects. However, the adoption and utilisation of online billing systems were impeded by consumer payment avoidance, as demonstrated by LD_WC_TWK_B3_01 in Table 6.3. Furthermore, the acceptance of new ICT systems among municipal employees was sluggish due to limited ICT proficiency and resistance to the transparency and accountability ushered in by such systems (LD_MP_TCW_B3_01 in Section 6.2.1). Additional obstacles included challenging geographical terrains marked by mountainous landscapes that disrupted communication signals. Furthermore, the presence of sparsely populated areas made mobile phone and Internet service provision to be financially demanding and non-profitable.

9.1.2.4 ICT proliferation in terms of the C4D

Stakeholder Capabilities

In the rural contexts under study, the stakeholders primarily consist of community municipality leaders and rural residents. 'Capabilities' refers to institutional arrangements (such as political liberties, economic opportunities, and social powers) and personal attributes (like health and education) as they relate to the capabilities approach. Within this context, it's important to note that rural residents tended to have less favourable personal attributes due to lower levels of education and limited economic opportunities. In terms of Sen's capability approach, rural residents typically find themselves in less favourable conditions compared to municipal leaders. Consequently, this discrepancy grants more power to the latter in shaping the types of C4D spaces available to rural dwellers and in influencing the C4D agenda for rural service delivery development.

Types of Spaces Associated with Rural Stakeholders

Regarding service delivery processes, service providers had the capacity to create C4D spaces through mass media and websites. Service providers also set up programming on radios and television through which communities discussed community issues. However, rural residents faced limitations in their socioeconomic abilities to actively participate in such spaces. In addition, community radios could only be set up in the most developed municipalities where the station owners could run viable operations. As a result, service providers and their officials had more influence in creating such spaces and steering the direction of discussions on these platforms. As observed in the study, younger generations could establish spaces for their communities on social media. Nevertheless, these spaces tended to lose focus because of limited participation by older community members who held local power in decision-making. Consequently, these community spaces often became dominated by social interactions rather than productive community development discussions.

Stakeholder Influence and Power

In the study, some rural dwellers showed a reluctance to use modern forms of technology or had the propensity to adhere to existing traditional channels in reporting service delivery-related problems. In this way, cultural and traditional practices exerted 'hidden power' on C4D spaces by determining whether rural residents participated in these spaces or adhered to existing channels based on community norms and practices. Service providers had discursive power regarding the advantages of information and knowledge gained from access to ICTs and their superior abilities to use the technologies (relative to the service users).

9.1.3 ICT Proliferation, Rurality, and Service Delivery (Objective 3)

As would be expected, generally, the overall accessibility index values tended to be higher for B3 areas compared to B4 areas, as depicted in Table 8.17. Notably, municipalities in the EC and KZN provinces exhibited low water and sanitation index measurements.

9.1.3.1 Water and Sanitation

Households within the municipalities of the EC, KZN, and LIM provinces were more prone to facing water supply disruptions lasting over two days, as indicated in Table 8.2. Similarly, deficiencies in sanitation services were observed in B4 municipalities in KZN, EC, and LIM provinces. In the same regions, household interviews showed that municipalities took lengthy periods to fix service interruptions.

9.1.3.2 Electricity

While a significant portion of rural households were connected to the electricity grid lines, sustaining consistent household electricity supply was impeded by factors such as low household income and energy-inefficient housing. Notably, substantial proportions of rural households encountered financial constraints that prevented them from maintaining continuous household electricity throughout the year. Additionally, significant proportions of these households expressed dissatisfaction with their dwellings, as discussed in (Section 8.1.1.4). The electricity indicator had the highest sensitivity score amongst the indicators in the

composite index. Indicating that it had the most significant impact on the dependent variable of interest. This may be attributable to the fact that the variable included household income level (considering household size) which is good indicator of rural household wellbeing.

9.1.3.3 Public Healthcare

The data showed greater access to public health centres in areas historically associated with poverty or service delivery backlogs relative to the levels of access observed for other service indicators (KZN and EC in Section 8.1.2.1). In addition, based on the computed rurality measures, municipalities in LIM and MP provinces near the metropolitan areas of GT province (Bloemfontein, Pretoria, and Johannesburg) had high healthcare accessibility indexes possibly because of their proximity to some of the most specialised national health centres that were concentrated in metropolitan areas. EC and KZN provinces may also have produced higher indexes because the municipalities in the areas occupied smaller geographic area. Hence rural dwellers in the provinces travelled shorter distances for healthcare (especially advanced care).

9.1.3.4 Housing

B4 areas exhibited the largest proportions of traditional housing structures, whereas B3 areas had relatively higher proportions of informal dwellings, as indicated in Table 8.4. In this study, housing structures were classified into categories such as traditional structures, shanties, caravans, and tents, which were all considered informal. A comparison of access to formal housing between B3 and B4 areas, depicted in Figure 12.36, unveiled higher formal housing indexes for B4 municipalities in the NW, MP, and LIM provinces. This discrepancy could be attributed to the prevalence of shanties in the principal towns of B3 municipalities. On a broader scale, municipalities with the lowest formal housing indexes were primarily situated within the B4 municipalities of KZN and EC provinces, as outlined in Table 8.5.

9.1.3.5 Basic Education

While the available data used for generating school indicators lacked the necessary level of detail to facilitate robust area-based comparisons, the aggregated average index values (Figure 12.11) were higher for B4 areas compared to B3 areas in certain provinces— namely, NC, NW, and LIM. Future iterations of these indicators could incorporate additional variables aligned with the DBE's reporting criteria. Such variables might encompass the count of qualified teachers, Internet connectivity status, availability of sports facilities, and presence of science laboratories, as outlined in DBE's documentation (DBE, 2011).

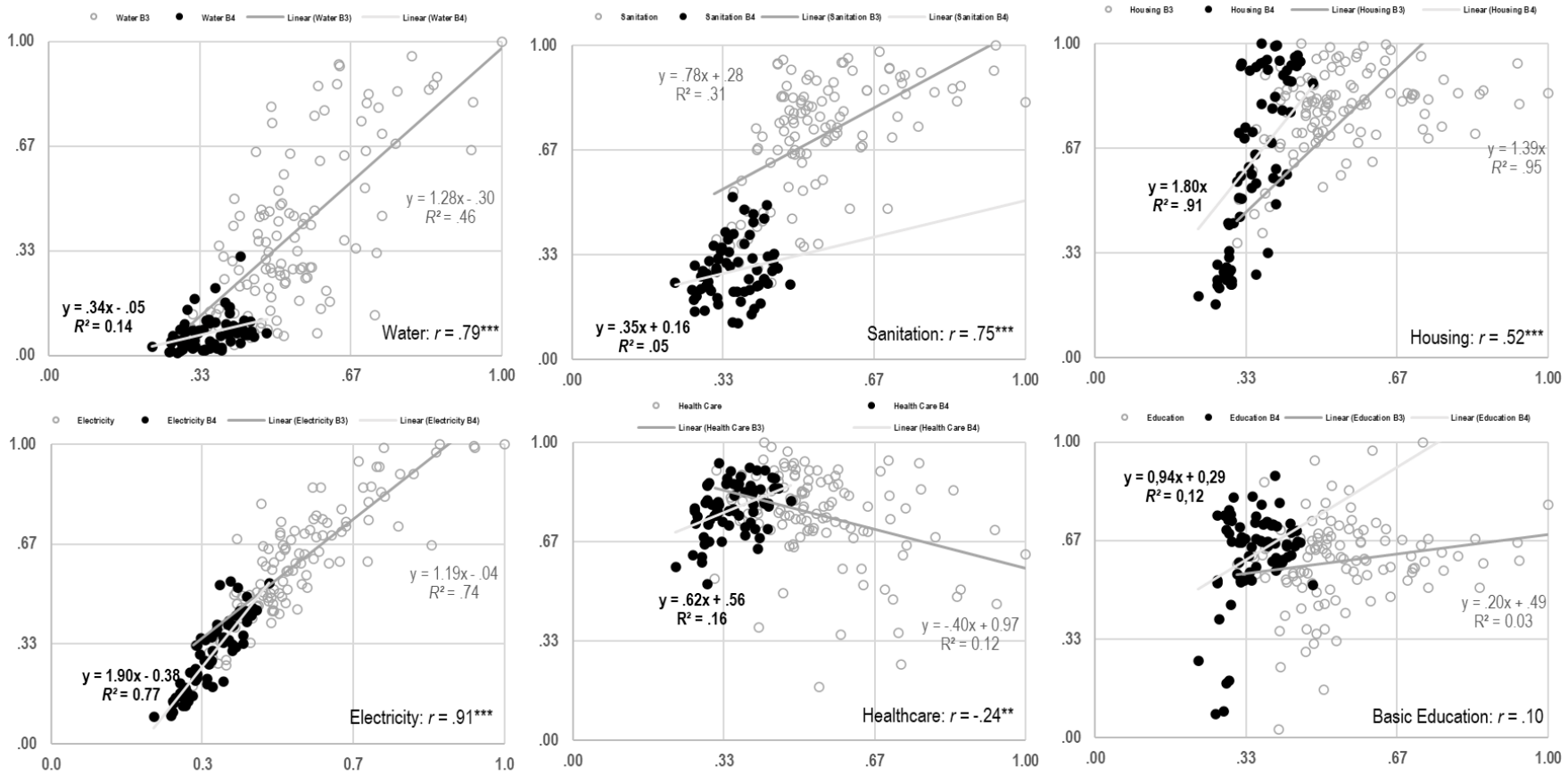
9.1.3.6 Pearson Correlation Analysis Between ICTs with Other Services

Regarding the ICT indexes, municipalities in the WC province exhibited the highest overall ICT indexes, while those in the EC province displayed the lowest ICT indexes, indicating the influence of socioeconomic backgrounds on household access to ICTs. Mobile phone and radio accessibility indexes were consistently high across all provinces. Sensitivity analysis indicated that household access to the Internet and computers stood out as the most critical indicators within the index (Section 8.1.1.5). However,

it was also observed that the impact of household access to ICTs on the overall rurality measures was relatively minor (Section 8.1.4).

In Figure 9.1 and Appendix O (combined Pearson correlation coefficients), the following observations emerged from the correlation between ICTs (horizontal axis) and other service indicators (vertical axis):

Figure 9.1 Pearson's Correlation Coefficients Between ICT Accessibility (horizontal axis) and Other Indexes (dependent variables on the vertical axis) for Both B3 and B4 Areas



Note: ***p <.001, ** p < .01, *p < .05 for Overall Pearson's Correlation Coefficients (r) of each Index. Black dots represent 'B4' areas while grey circles represent 'B3' areas.

i. *Comparative Analysis of Pearson Correlation differences Between B3 and B4 Municipalities:* As anticipated, the graphs illustrate that the indexes for B4 areas are typically lower than those for B3 areas. Indexes for ICTs and the other variables are lower for B4 areas (less than .50). The relationships depicted in the graphs demonstrate that B3 areas exhibit diverse connections between ICTs and the dependent variables (vertical axis variable) compared to the relationships observed in B4 areas. This discrepancy highlights the distinctions among B3 areas throughout the country, particularly between B3 areas in the WC province and those in other provinces. However, Healthcare, Basic Education, and to some extent, Formal housing all fall within the same range of Index values for both types of areas. This can be observed by looking at the vertical axis, where the values for these services are consistently above .60.

ii. *ICTs and Healthcare in B3 and B4 Municipalities:* The graphs generally reveal higher indexes for Healthcare, Housing, and Education, even at lower levels of ICT access, especially for B4 areas. Healthcare and Education exhibit consistently high accessibility levels, even when ICT access is limited. Healthcare Indexes for B4 areas tended to be higher than those for B3 areas, reflecting higher investment in public healthcare in remote rural regions. In that regard, the Healthcare trendline for B3 areas displayed a negative slope, possibly indicating that higher levels of ICT access, associated with municipalities in the WC, were linked to lower levels of access to public health services. Conversely, Healthcare indexes for B4 areas exhibit a positive slope, suggesting the possibility of ICTs enhancing health service delivery in these regions (even though ICT indexes are lower relative to B3 areas). The overall relationship exhibits a statistically significant negative correlation (Appendix O). Education Indexes demonstrate a similar relationship, although the correlation coefficients were all statistically insignificant.

iii. *ICTs and Household Amenities:* A positive correlation, noticeable below the .50 mark on both axes, was observed in the relationship between ICTs and four services—water, sanitation, housing, and electricity. A plateau pattern emerged between ICTs and sanitation, as well as ICTs and housing (at higher values on the ICT axis). This can be intuitively interpreted as a saturation point, indicating that high levels of access to these services are associated with varying levels of access to ICTs. That is, even at high levels of ICT access, there was little variation in terms of the corresponding levels of access to these services (plateau trendline for sanitation and housing in the third column in Appendix O). Similar overall patterns are observed for healthcare and basic education. Hence, interdependency between ICTs and the services has a saturation point.

iv. *Dependency of ICT Access on Formal Housing and Electricity:* The lines of best fit for water, housing, and electricity intersected with the positive range of the horizontal ICT axis. This suggests that high levels of ICT access were achieved even when access to these services was low, meaning households had access to ICTs without access to each of these services. This phenomenon could be explained by the availability of affordable ICTs such as mobile phones and radios that do not rely entirely on access to these services. Thus, households were able to access such ICTs without having access to basic amenities like water, formal housing, and electricity. However, it is important to note that formal housing and electricity indexes had high goodness of fit values (R^2 = .95 and R^2 = .74, respectively) and high correlation coefficients (r = .52 and r = .91, respectively). This indicates that broader access to ICTs was strongly associated with access to formal housing and electricity. Access to housing and electricity are essential for the effectiveness of digital service provision in the digital age.

Consequently, a positive relationship was observed between formal housing and electricity accessibility, and ICT availability. The accessibility of ICTs was contingent on electricity supply for powering the devices, while household access to computers and Internet connections correlated positively with formal housing. The graphical analysis corroborated that healthcare and education services were particularly well-suited to benefit from the access and utilisation of ICTs (especially in B3 areas), a trend further supported by the insights gleaned from the interview data.

To encapsulate, the comprehensive findings from the qualitative and quantitative analyses underscored the interconnectedness of various services. Notably, qualitative scrutiny unveiled that services like healthcare and education were contingent upon connection to water, sanitation, and electricity services. Moreover, access to electricity exhibited a positive correlation with formal housing, as depicted in Table 8.10. In alignment with these insights, both qualitative and quantitative analyses concurred that healthcare and education services were particularly poised to harness the advantages conferred by ICTs (notable by the trendlines for ICTs and the two variables for B4 areas indicating the possibility of marginal gains (Table 8.10)).

9.2 Propositions about ICT Proliferation, Rurality, and the Service-Dormant Approach to Service Delivery in Underdeveloped Contexts

In terms of the characteristics of rurality presented in Table 9.2, the typical characteristics of rural places are manifested in terms of distance to service centres, quality of service delivery, physical geography, settlement characteristics, demographic profile, and culture.

Table 9.2 South African Rurality in the Digital Age

		South African Rurality						
		Geography			Public & Non-Public Services			
		Demography	Socio-Economic	Land Use & Practices	Household Amenities	Public Infrastructure	Public Services	Private & Business Services
		Low population density, High population, High dependency ratios, Rural-Urban labour migration	Social grant dependency, Unemployment, low literacy, Subsistence & commercial activities (crop cultivation, livestock rearing etc)	Farmlands, Mining, Uninhabited Land, (deserts & mountainous areas), Reserves/Game Parks, National Monuments, Heritage Sites, Traditional Authorities	Poor quality services (water, sanitation, electricity services)	Low-quality services - road, rail, communication, libraries, recreation facilities (Halls, Parks, Sports centres) & other government services	Long distances to service centres: schools, health centres, police and justice systems, postal services, social services, entertainment, information, other services	Long-distance to business centres that provide shopping and banking services
Modern ICT Capabilities	Information and communication	Improved communication across a wide geographic area	Provide information on employment, business opportunities, and farming	Improve communication, Showcase rural places/cultures	Access information and report service complaints	Report service complaints	Information &communication with service providers	Provide business information and communication
	Service management/Private business management		Management of commercial farming and other economic activities.		Improve management and monitoring of services via improved collaboration between service consumers and providers	Improve local government management	Improved collaboration and discussion between service consumers and providers	
	Replacement of service provision mode or modification of service provision					Complement service mode (libraries & Information services)	Remote access to services: - e-Learning, Mobile health services. Alternative mode of accessing service: education, health, postal communication services	Alternative service provision mode: - online shopping, bill payment, mobile banking, Internet banking
ICT Impact Assessment	Limitations/negative impact	Dis-economies of scale - High setup costs and low-profit returns for service providers (e.g., mobile phone services)	High cost of connecting and low ICT use skills for the poor	Limit communication reception interference due to mountainous terrain. May compromise cultural practices and heritage sites due to commercialisation and exposure to other cultures.	Depends on the skills and the costs of maintaining connectivity with the service providers.	Depend on ICT use skills and affordability of service connection costs.	Do not replace face-to-face aspects of services such as medical examinations.	High delivery costs and distance barriers for online shopping. Depends on ICT skills and technology trust.
	Effect on rurality	Wide area communication and networking	Support economic activities: - by providing communication, information, knowledge, connections to markets, and management	Support commercial activities, farming, investment, cultural empathy.	Improved service quality: - consistent service run time because of efficient service management	Alternative service access to information and knowledge provided in libraries and computer centres. Therefore, reduced pressure on libraries and transport services due to reduced migration. Improved transport infrastructure services due to improved management.	Alternative service mode: - especially intangible services (health and education) Reduced migration: removes migration to service centres	Alternative service mode: - remote service access - Online banking and shopping services. Reduced migration to service centres

This section presents propositions on the effectiveness of ICTs in the service-dominant approach to public service delivery, also defined as public value governance (Bryson, Crosby, & Bloomberg, 2014). Within the framework of the NPG, service-dominant approaches to public service delivery emphasise the central role of utilising and transforming knowledge and skills to enhance service experience (Osborne et al., 2013). As elaborated in Chapter 3, public value theory elucidates the nature of services generated through value augmentation facilitated by the proliferation of ICTs in the contexts of developed countries. The study employs the information asymmetry theory (Akerlof, 1970), the C4D framework (OWI, 2004), and the digital divide theory (Wilson, 2006) to evaluate the additional value contributed by ICTs in the process of service delivery, particularly within developing country contexts (Hood, 1991; Twizeyimana & Anderson, 2019).

9.2.1 Economic Value

Rural dweller's proximity service centres and sparse population are the primary barriers to improved service delivery and development in the areas. The proliferation of ICT's brings economic value to underdeveloped rural areas by minimising migration for services and supporting economic activities. Communication links between service users and consumers reduce the need for face-to-face interaction, resulting in both time and financial savings. Mobile phone network services connect healthcare, education, police, emergency, and commercial services, reducing the necessity for frequent travel. This also reduces community visits by development officers, medical practitioners, and community leaders. Based on the evidence summarised in Table 9.2, the economic impacts of ICT proliferation in terms of rurality are as follows:

Economic Value to Service Users:

The effect of ICT proliferation adds economic value to rural settings by conveniently providing intangible service delivery aspects, leading to cost savings. Telehealth services, e-learning, and mass media for educational programs are highlighted. Electronic service provision reduces the need for travel to town centres for health check-ups or library visits, contributing to reduced migration for services by rural dwellers.

Economic Value for Service Providers:

Improved communication links between service providers and users and reduce transportation costs during the service delivery process. This extends to community visits by local government leaders. E-Government and e-service provision also lowers expenditures such as stationary, postal services, operations, and human resources. Additionally, e-service platforms reduce management burdens at rural service centres.

Economic Activities:

The communication and information sources offered by these technologies enhance rural-urban links, leading to improved efficiency in rural commercial activities, new businesses,

employment opportunities, and education access. Improved electronic access to banking services allows access to remittances, social grants, and urban markets.

Regarding information asymmetry, service providers have advantages due to their greater technology skills and accumulated user information. These advantages grant them more control over service delivery processes. The growing reliance on ICTs for service delivery depends on emphasising positional factors of the digital divide theory. Educational levels and national approaches to improving ICT access and e-service use are vital positional factors. Despite the benefits, technology access barriers might prevent rural dwellers from fully benefiting from e-service delivery. Communication and information quality primarily serve service practitioners by enabling them to disseminate information and access consumer data through the relevant e-service delivery technology. These findings regarding the economic value of ICT proliferation in low -and middle-income contexts give rise to the following proposition:

> ***Proposition 1:*** *When ICT proliferation and the emergence of e-service provision take place in rural contexts of low- and middle-income countries, they can contribute economic value by alleviating the primary service delivery challenge of distance between service centres and remote or rural dwellers, reducing operational costs for service providers, and fostering economic activities, although their effectiveness hinges on individual and national strategies aimed at addressing digital exclusion.*

9.2.2 Efficiency and Effectiveness in Service Delivery.

Efficiency and effectiveness in service delivery are improved through ICT proliferation in socioeconomically advanced rural areas. Essential components for successful service delivery in rural settings include technology trust, skills, access, and knowledge of e-services. In this context, rural communities with higher levels of socioeconomic development are better poised to benefit from e-services. The study revealed that mobile phone services and radio played a significant role in the interaction between municipal officials and rural community members in the most developed communities or households with access to these technologies. Mobile phone text and voice services were crucial for maintaining the continuous function and supply of vital services such as water, sanitation, and electricity. ICTs exhibit influence in the following ways:

Monitoring, Management, and Reporting of Service Delivery Processes:

Communication through mobile phone internet, voice, and text-based services facilitates updates about service disruptions, ultimately enhancing the uptime and condition of essential services like water, electricity, sanitation, and public infrastructure.

Bill Payment and Service Consumption Systems:

The emergence of e-services introduces systems for processing service payments, thereby improving accountability in the service delivery process.

Communication by Government Officials Across Large Geographical Areas:

The adoption of e-service delivery and ICT proliferation accelerates the execution of processes related to public service provision. Local government websites disseminate information about

services, enhancing transparency in the provision process. They offer channels for user feedback, service access, and local government news.

Substitute Mode of Service Provision:

ICTs serve as pivotal platforms for delivering aspects of services such as information, knowledge, educational content, and banking services. Education services for rural learners can be accessed through the Internet, mobile phone applications, and mass media platforms. Moreover, Internet services replace or supplement information sources such as libraries located at service centres that are typically located far from rural households.

Regarding information asymmetry, in the initial phases of implementing e-services or within underdeveloped rural contexts, e-service systems tend to skew information in favour of service providers due to their technological skills and access advantages. Service providers possess community data that provides insights into service availability, demographic characteristics, and the spatial distribution of the served population. Since rural communities often have varying levels of ICT access and are sparsely populated, mobilising and conveying the community's voice to demand improved service delivery can be challenging for ICTs. As a result, service providers might not be compelled to address service delivery issues promptly. The studied context exhibited reluctance towards adopting new technologies, limitations in ICT skill utilisation, and resistance towards the accountability provided by ICT systems. To achieve their maximum impact, ICTs must extend access and utilisation throughout the population they aim to benefit. This necessitates national policies that enhance education and alleviate poverty levels. The findings suggest a proposition regarding the significance of ICT proliferation in low- and middle-income contexts, highlighting the importance of preexisting socioeconomic status. The proposition is as follows:

> ***Proposition 2:*** *When ICT proliferation occurs in rural contexts of low -and middle-income countries with pre-existing advanced socioeconomic status, they can enhance service provision by improving the effectiveness and efficiency of service delivery through the implementation of monitoring and management systems, e-Government systems that enhance communication and information dissemination, and by offering substitute or complementary modes of service delivery.*

9.2.3 Cultural Value

Mass media and social media platforms showcase a plethora of cultural practices across expansive geographical regions. Social media, as well as national or regional radio and television programmes, highlight and promote various traditions, cultures, religions, and trends. These platforms also serve as repositories of knowledge for rural inhabitants and learners. In the context of the cultural value of ICTs, this thesis presents insights into the impact of ICTs and e-service provision on cultural norms and practices, along with strategies for enhancing the acceptance of ICT-enabled services. This exposure fosters growth in commercial activities, employment opportunities, knowledge dissemination, and information exchange. The proposed implications of ICT proliferation on culture can be summarised as follows:

Cultural Assimilation:

Exposure to external cultures and the assimilation of knowledge from ICTs may potentially lead to the transformation of cultural practices. This transformation occurs through the integration of new knowledge facilitated by e-learning and exposure to practices conveyed via technological mediums. It is noteworthy that certain traditional norms may be challenged by these technologies as practices predominantly portrayed on ICT platforms gain prominence and acceptance. Valuable information is obtained through accessible websites that rural learners access, covering various topics, including health matters, employment opportunities, and national affairs.

One significant cultural challenge arising from the opportunities presented by ICT-enabled service delivery pertains to the tradition of rural inhabitants communicating community grievances to their traditional leaders. This includes matters related to services. The relationship between rural communities and their traditional leaders influences various aspects of rural residents' lives. As a result, there might be reluctance among rural inhabitants to communicate directly with municipal officials, preferring to follow the guidance of their traditional leaders. Consequently, the communication channels established between service providers and consumers could potentially undermine the authority of traditional hierarchies and structures.

Within the study, some respondents expressed a preference for reporting service-related issues through their traditional leaders rather than utilising e-services that directly link community members with service providers. Conversely, traditional leaders hold greater authority in reporting service issues to municipal officials and may have a better ability to cover the operational costs of ICTs. While the exposure facilitated by ICTs might disrupt traditional hierarchies, these technologies simultaneously streamline the tasks of traditional leaders. As a solution, service providers might initially encourage the adoption of ICT channels among traditional leaders before promoting their use among the broader community, in alignment with the authority of these traditional figures.

An even more convenient approach involves maintaining existing norms while encouraging traditional authorities to embrace available technologies for communication with municipalities and to receive communication from community members. Overall, the implementation of technologies should consistently consider the cultural dynamics of the communities they aim to serve, seeking ways in which ICTs can enhance service delivery processes. This approach ensures that technological solutions align with established traditional

practices and structures. This way, rural communities can determine how ICT solutions can enhance their well-being without causing conflicts.

Information, Knowledge, and Commercial Activities:

Enhanced communication and information dissemination may contribute to increased commercial activities such as farming.

ICT channels need to consider the cultural context in which they are meant to benefit. Regarding Moore's public value account (Figure 3.1), the study proposes that public value losses can be expressed by measures that reflect conflict with cultural practices. The findings on the cultural importance of ICT proliferation in low- and middle-income contexts give rise to the following proposition, which particularly underscores the appropriateness of ICTs for the context based on their character and the predominant nature of communication they provide:

> ***Proposition 3:*** *When ICT proliferation takes place in low- and middle-income contexts with a primarily top-down character of information dissemination, they can enable rural communities to access diverse cultures, new knowledge, and education, potentially leading to cultural assimilation and a shift towards practices facilitated by cost-effective and easy to use technologies.*

9.2.4 Social Value

Communication by mobile phone services and mass media enables information dissemination and communication in areas that are inaccessible by road infrastructure. The social impact of these technologies is summarised as follows:

Communication and Networking to Create Social Empathy:

Studies have emphasised the need to understand how ICTs impact the relationship between and behaviours over extended periods. Underdeveloped areas are usually not easily accessible (poor road networks, insecure locations, and informal settlements). The new connections provide direct links to service providers and amongst service providers. Mass media incorporates programming across a vast geographic divide, which fosters an understanding of social contexts across a large geographical area. Since rural economies and livelihoods have become increasingly linked to urban areas, the high penetration of mobile phone services is vital for maintaining links between migrant workers and their rural communities. These ICTs also facilitate easy financial transactions between migrants and their households.

Facilitate Civic Engagement in Service Delivery:

Despite the widespread reach of mass media and mobile phones, their predominant role in underdeveloped rural areas tends to be centred around information dissemination and communication. However, e-services play a crucial role in kickstarting co-production by equipping citizens with information that triggers discussions and active participation in

matters related to development. In comparatively more developed communities, the extensive adoption of ICTs contributes to enhanced user satisfaction. This is achieved through the consistent exchange of feedback and service-related grievances via these communication channels. Consequently, these technologies primarily augment the service provider's understanding of service satisfaction levels and establish mechanisms for sharing service-related experiences among users.

Drawbacks of ICT initiatives arise from their susceptibility to compatibility issues with local community factors and technological preferences. The effectiveness of ICT-driven systems can be hampered by variations in preferences and access levels influenced by financial capabilities and the degree of trust in technology, particularly in regions spanning a wide geographical expanse. For example, there are differences between communication and technology preferences across age groups. As a result, contemporary ICT solutions may struggle to maintain national unity or cultivate an understanding of the challenges faced by developing countries, particularly in rural settings. Findings regarding the social value of ICT proliferation in low -and middle-income contexts give rise to the following proposition:

Proposition 4: *When ICT proliferation takes place in low- and middle-income, remote, or previously excluded contexts, it can establish communication and network connections that have the potential to promote social empathy.*

9.3 Conclusion

Regarding the public value of ICTs within low- and middle-income country contexts, the study put forth propositions encompassing economic value (reducing transport expenses for service provision and access), enhanced service provision efficiency and effectiveness, the cultural value associated with these technologies, and social value (fostering social empathy).

The implementation of e-service delivery in developing country contexts hinges on conducive national strategies, particularly in establishing conditions favourable for providing e-services. Within these contexts, the suitability of ICTs in terms of affordability, the technological skills of rural residents, and national policies of openness are critical facets shaping the correlation between ICTs and rural areas. Consequently, in low- and middle-income country contexts, service providers hold a stronger position compared to consumers in terms of leveraging the informational equilibrium arising from favourable ICT proficiency and accessibility. Consequently, readily accessible mobile phone services and mass media serve predominantly as channels for information dissemination, repositories of knowledge, and platforms for communication through which rural ICTs users receive information.

10 CONCLUSION

The study's research question was, '*What is the relationship between rurality and ICT proliferation in the service-dominant approach to public service delivery in low- and middle-income contexts?*' Chapter 2 delved into a comprehensive literature review concerning South African rurality. Chapter 3 focused on scrutinising the study's theoretical framework, while Chapters 4 and 5 presented the research design and the data. Chapters 6 and 7 unveiled the analysis of literature and interview data. Chapter 8 outlined the formulation of spatial indexes specific to the context under study, and Chapter 9 summarised the study's findings. The current chapter begins by evaluating how the study effectively addressed the research question and fulfilled its objectives.

10.1 Coverage of Research Objectives

Three research objectives were set at the commencement of the study, that is:

i. *To elucidate the underpinnings of the current state of access to improved public service delivery (including infrastructure, household amenities, and public services) within the South African rural context.*

ii. *To expound upon the impact of ICT proliferation on public service delivery in the South African rural context.*

iii. *To elucidate the concept of rurality in the digital era by updating the country's rurality measures in accordance with the prevailing context of ICT proliferation.*

Coverage of the objectives is discussed in Sections 10.1.1, 10.1.2, and 10.1.3, respectively.

10.1.1 Review of Public Service Delivery in the South African Rural Areas

The term 'service delivery' pertains to the South African government's responsibility to provide its citizens with essential public infrastructure and services such as schools, roads, hospitals, and police, as well as household amenities that include water, sanitation, and electricity (Reddy, 2016). The rapid transition in local government administration post-1994 overlooked the necessary governance structure required to address the needs of the most underserved areas (Parnell, 2002; Powell, 2012). As a result, inadequate service delivery standards and socioeconomic development disparities continued to characterise rural regions in South Africa.

Official area classifications, such as those utilised by CoGTA, categorised South African areas based on indicators like agriculture, historical homeland status, population distribution, reliance on social grants, housing conditions, and deficits in public amenities. These classifications lacked consideration for variations in municipality sizes and other pertinent factors (Schmidt & du Plessis, 2011). Investigating the interplay between post-1994 development initiatives, advancements in digital technologies, former homeland statuses, and other area characteristics was essential to comprehensively characterise an updated state of rurality (Section 7.3.2). The distinctive context of South Africa, boasting one of one of the leading e-service platforms among low- and middle-income countries, presented an invaluable opportunity to generate insights into consumer-focused e-service delivery within marginalised contexts (Verkijika & de Wet, 2018;

Twizeyimana & Anderson, 2019). As South Africa transitioned to post-1994 governance, service-dormant models emerged, shaped largely by prevailing global trends (Cameron & McLaverty, 2008; Chipkin & Lipietz, 2012).

10.1.2 ICT proliferation and South African rurality

As expected in low- and middle-income contexts, mobile phones and mass media were the focal forms of technology amongst rural stakeholders. Mobile phones provided voice and messaging services, Internet, money transfer utilities, and other services. Mass media (radio services) had broader coverage, ease of use, and affordability.

The main findings concerning mobile phones (voice and messaging) were as follows:

i. Monitoring the health of patients in remote rural communities, especially the elderly in remote, B4, rural communities.
ii. Messaging services were used in B3 municipalities by service providers to disseminate information by consumers to communicate water and electricity service complaints.
iii. Payment and purchases for public services such as electricity and water via mobile phone banking systems.
iv. Money remittances by urban labour migrants to their rural households
v. Community and family communication: Mobile phones were vital for communicating with family members who lived or worked in urban areas.

The Internet (accessed via all devices) was used for the following purposes:

i. Accessing educational content by learners in remote rural areas (B4)
ii. Accessing information on jobs and health
iii. For service payments or purchases
iv. Money remittances by urban labour migrants to their rural households

Radio stations and television served the following purposes:

i. Receiving, sharing, and discussing community issues (B3 areas).
ii. Communicating obituaries, traffic news, and transmitting community development discussions
iii. Receiving community, national and international news (mainly acknowledged in B4 areas)
iv. Transmitting educational content (B3 areas)

The character of communication provided by e-services mainly provided rural dwellers with information from service providers (Table 6.2). The advantages exhibited were improvements in the efficient management of service provision processes and information dissemination by the service

providers. Hence, there were limitations regarding the extent of co-production activities between service providers and consumers. As would be expected, in remote rural areas, sparse population distribution and inaccessible geographical terrain were barriers to the availability and connectivity of mobile phone services and other communication signals.

10.1.3 Rurality in the Context of ICT Proliferation

An exploratory mixed-methods design explored the relationship between rurality and the digital divide. Qualitative analysis determined the development of rurality indexes. The study yielded the following findings:

i. Based on the ICT indexes in Section 9.1.3.6, households accessed various ICTs even at low levels of access to basic amenities (water, sanitation, and electricity), possibly due to the widespread accessibility and ease of use provided by mobile phones.
ii. Evidence from the quantitative and qualitative analyses unveiled that e-service delivery was more likely to positively impacted healthcare and education services.
iii. While the ICT component of the indexes had a minimal influence on the overall computed rurality measures (Section 8.1.4), access to the Internet and computers each emerged as the most critical elements within the ICT access indexes (Section 8.1.1.5).

Regarding the proliferation of ICTs and its impact on the information economy in low- and middle-income contexts, the study revealed the following key findings:

i. Imbalances in the relationships between consumers and service providers primarily stem from differences in ICT-based, C4D capabilities and ownership of the C4D platforms. These disparities lead to varying benefits derived from the information economy, even among different population groups or settlements.

ii. Despite the impact of the digital divide, in low- and middle-income country contexts, mobile phone banking provides timely financial insights, facilitates service delivery transactions, and improves financial inclusion.

iii. The availability of health information and improved communication between healthcare service providers and users were positive outcomes resulting from ICT proliferation. This contributes to the enhancement of health services, potentially leading to better healthcare outcomes.

iv. The study highlighted that e-government services have played a crucial role in improving accountability and transparency. These digital services have the potential to enhance local government accountability and make administrative processes more transparent, even though this may not be a result of information advantages directly accruing to service users

since they may not be able access or use the information. Central government or other entities may enforce the advantages provided by the publicly available information.

Regarding the public value of ICTs within the studied contexts, the investigation highlighted the following propositions (Section 9.2):

> ***Proposition 1****: When ICT proliferation and the emergence of e-service provision take place in rural contexts of low -and middle-income countries, they can contribute economic value by alleviating the primary service delivery challenge of distance between service centres and remote or rural dwellers, reducing operational costs for service providers, and fostering economic activities, although their effectiveness hinges on individual and national strategies aimed at addressing digital exclusion.*
>
> ***Proposition 2:*** *When ICT proliferation occurs in rural contexts of low -and middle-income countries with pre-existing advanced socioeconomic status, they can enhance service provision by improving the effectiveness and efficiency of service delivery through the implementation of monitoring and management systems, e-Government systems that enhance communication and information dissemination, and by offering substitute or complementary modes of service delivery.*
>
> ***Proposition 3:*** *When ICT proliferation takes place in low- and middle-income contexts with a primarily top-down character of information dissemination, they can enable rural communities to access diverse cultures, new knowledge, and education, potentially leading to cultural assimilation and a shift towards practices facilitated by cost-effective and straightforward technologies.*
>
> ***Proposition 4:*** *When ICT proliferation takes place in low- and middle-income, remote, or previously excluded contexts, it can establish communication and network connections that have the potential to promote social empathy.*

Section 10.2 presents the contributions in greater detail.

10.2 Study Contributions

The current section summarises the theoretical contributions in the context of service-centric e-service provision in low- and middle-income country settings, as illustrated by the propositions in Section 10.1.3, which stem from the findings summarised in Table 9.2. According to Presthus & Munkvold (2016), theoretical contributions are described in three forms: confirmation (an indication that a chosen theory is still valid or that it works in a different setting), extensions (adds to an existing theory), contradiction (contradicts the whole or parts of the theory, for example, providing evidence of more interplay between constructs), and elimination (indicates that part of a theory is obsolete in the chosen setting) of theory components. Based on Whetten (1989), a theoretical contribution has three features: logical explanations of the social or individual phenomena of interest, a description of the constructs or factors that constitute the related theory, and justifications for the psychological, economic, and social factors justifying the selection of the factors and the proposed casual relationships.

10.2.1 Explaining Social Phenomena and Theory Constructs in the Context of Rurality in the Digital Age

The theories and models discussed in this study are grounded in the service-dominant models of NPM, which are further elucidated through the lenses of information asymmetry theory, digital divide theory, and public value theory. Communication within this context is analysed using the C4D framework, which draws from participatory and modernisation theories. Opu (2019) extensively elucidated the C4D framework, encompassing its core components, including capabilities, spaces, and power. Opu's research underscored the necessity for additional exploration of capabilities, the creation of C4D spaces, their influence on development negotiations, the dynamics of development trajectories, and the significance and function of communication within this process.

Rural regions in low- and middle-income countries encounter distinct development challenges (Section 6.1.1). In accordance with the information asymmetry theory, and as presented in Table 10.1, public service providers amass power by virtue of their greater accessibility to information facilitated by ICTs, leveraging their relative capability advantages and their influence on ICT based C4D spaces. The service provider's power is established through the utilisation of material and technological advantages and further legitimised by standards and decisions (Matheson, 1987; Pashapa, 2008). Traditional norms and practices exert influence over the participation of rural communities within C4D spaces. Traditional beliefs exert invisible power which originates from the sacredness of beliefs and customs, and the deep respect bestowed upon authority figures and their roles (Matheson, 1987; Pashapa, 2008). These findings augment our understanding of how power levels exert influence over C4D processes as a follow-up to a study by Opu (2019) and, subsequently, how these dynamics impact rurality.

Table 10.1 C4D in Low- and Middle-Income Contexts in Terms of Capabilities, Spaces, and Power Dynamics

	Power	Spaces	Capabilities
Service Provider	**What kind of power?** Dissuasive, Invisible **How does it arise?** Knowledge gains	**What spaces?** Creation and ownership of Invited spaces **How do they arise?** Discussions of radio, Internet	**What capabilities?** Material & Resources **How do they arise?** Access to state resources
Consumer	**What power?** Hidden power **How it arises?** Culture **How does it affect asymmetry?** Power arising from greater participation, creation, and ownership of spaces.	**What spaces?** Organic **How do they arise?** Interaction on social media, Internet **How do they affect asymmetry?** Creation and ownership of C4D spaces; Lack of participation by senior decision-makers	**What capabilities?** Variable but generally limited access to material and resources **How do they arise?** **E**xclusion, economic disadvantages **How do they affect Asymmetry?** Limited participation in digital spaces; Limited gains from the information economy

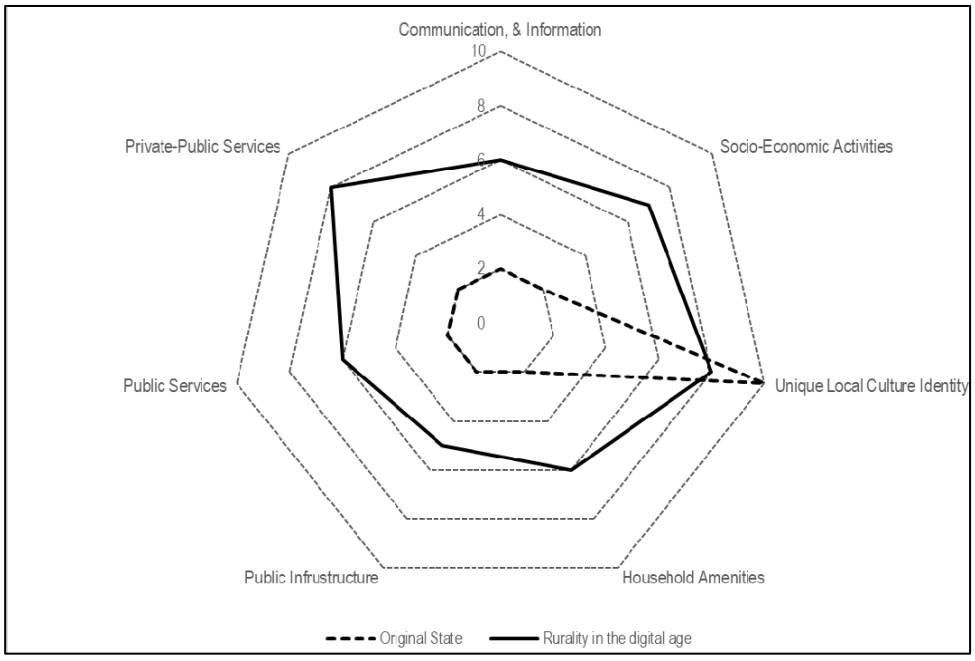
In the examined scenario, the benefits of the digital age for service consumers are prominently observed through online service accessibility, which decreases the necessity for service delivery related migration. Owing to the digital divide, the role of ICTs in these contexts is still evolving, transitioning from basic functions

such as communication facilitation and information dissemination to marginalised groups to getting active participation from them.

For consumers of public services, the primary impact of ICT proliferation is that e-services empower rural inhabitants to access information about various services without needing to travel to service centres physically. In South Africa, accessible communication channels and mobile phone-based remittance services facilitated connections between urban labour migrants and the local population. Mobile phone communication and mass media served to sustain these connections. Moreover, alterations in migration regulations and enhancements in transportation systems facilitated frequent return migration for labour migrants.

The exposure facilitated by improved communication and information services results in the adoption of practices disseminated to rural communities through these technological means. While this exposure introduced by modern communication avenues enhances communication, education services, and information dissemination, it also holds the potential to supplant existing practices, setups, and structures, thereby leading to potential conflicts. These conflicts have an impact on the role of ICTs in development communication. It is essential to integrate the cultural context into the design of technologies intended for context-specific development purposes. Figure 10.1 depicts improved service quality, reduced migration to service centres, rural economic activities, and dissolved distinct practices and cultures in rural settings in low- and middle-income contexts in the digital age.

Figure 10.1 Idealised Pictorial Comparison of Rurality Factors Before and After the Digital Age in Low- and Middle-Income Contexts



10.2.2 Theoretical Implications of the Relationship Between ICT Proliferation in the Service-Dormant Approach to the NPM in Developing Country Contexts.

Service-dominant approaches to public service delivery have positioned the utilisation of knowledge and skills as central components for enhancing the service experience (Osborne et al., 2013). In addition, Cordella & Paletti (2018) highlighted the significance of comprehending the mode of service production and the characteristics of services rendered in the digital age, encompassing factors like openness or closure and varying degrees of control. Equally important is a grasp of the effective implementation of co-production practices facilitated by ICTs and the potential structural shifts within public administration (Paletti, 2016; Cordella & Paletti, 2018). Previous research also underscored the significance of recognising the public value of ICTs in low- and middle-income countries, particularly within the service-dominant approach to public service delivery (Twizeyimana & Anderson, 2019). Within the current study, the investigation into value addition revolved around theories of information asymmetry, public value, and theories supporting C4D (as discussed in Chapter 3).

10.2.2.1 Rurality, ICT Proliferation, and Information Asymmetry in Low- and Middle-Income Contexts

Based on the information asymmetry theory, when a service provider possesses more information regarding a particular commodity, they tend to inflate the commodity's price by concealing crucial information. This practice ultimately results in a less efficient market (Akerlof, 1970, 2002). In that regard, in regions with low to middle-income levels, individuals with elevated socioeconomic statuses typically exhibit greater proficiency in ICTs and enjoy higher levels of access to such resources. Consequently, they wield a significant advantage in terms of information, especially when compared to disadvantaged consumers. Additionally, service providers themselves benefit from information advantages, given their access to technology and relevant information. Consequently, they maintain a comprehensive understanding of the entire service delivery process compared to service users.

Socioeconomic Disparities and Information Asymmetry:

Disparities in socioeconomic status are evident among communities belonging to different economic strata, resulting in varying levels of digital access. Enhanced economic well-being widens the scope for utilising ICTs for accessing or disseminating information. A higher economic status brings forth advantages and opportunities for participating in development communication, owing to increased access and the ability to employ a diverse range of technologies. Conversely, individuals with lower socioeconomic status encounter limitations when engaging in development communication. In such instances, their participation is primarily restricted to receiving information from service providers, and, in general, they face obstacles in actively participating in development communication.

Concerning the relationship between public service providers and service consumers, providers typically possess access to consumer data, technical skills, and technologies, affording them a

more comprehensive understanding of the service delivery process compared to marginalised service consumers. As marginalised communities embrace digitalisation, their use of available digital platforms initially starts with early adopters. At this stage, service providers have the capability to establish ICT-based C4D spaces, granting them the authority to regulate the information disseminated within such spaces. In this scenario, the advantages stemming from information asymmetry predominantly favour the service providers, as they possess a broader perspective on service delivery processes.

While service providers reap substantial benefits from the information economy, personnel in local government roles in developing or underdeveloped regions often lack proficiency in ICT use. Consequently, they may not fully harness the utmost advantages of the information economy. Nonetheless, service providers generally wield greater influence within the information economy in low- and middle-income contexts due to their capabilities and ownership of C4D spaces. Overall, socioeconomic status yields advantages in the information economy, encompassing financial inclusion, enhanced access to service delivery information, and improved accountability in service delivery processes as discussed further.

Mobile phone and Internet banking, Information Asymmetry, and Financial Inclusion:

The growing adoption of mobile banking and Internet banking services in low- and middle-income regions, particularly in remote areas, has ushered in real-time access to transaction details, service costs, account information and, consequently, increased engagement in financial activities related to service delivery. This trend serves to mitigate information asymmetry through the transparency it brings to banking transactions. Even in the most secluded areas, residents are increasingly willing to undertake transactions using mobile money services that may not be deemed 'trusted' in traditional banking contexts. They do so due to the convenience, cost-effectiveness, and time savings that such services offer. Remote communities are often willing to accept the risks associated with potentially 'less secure' online banking services, especially when they face the need for impromptu transactions. Consequently, in addition to early adopters, a segment of 'forced adaptors' also participates in online banking transactions despite their information gap.

It is worth noting that low levels of digital and financial literacy and limited trust in technology can pose challenges in rural contexts. However, mobile phones have achieved the highest penetration rates and serve as the primary medium for conducting transactions, even in underdeveloped areas. This significantly contributes to elevated levels of financial inclusion, as highlighted by Ahmad, Green, & Jiang (2020). The successes of mobile phone banking are attributable to the widespread access, acceptance, user-friendly interfaces, and lower operational costs associated with mobile phone technology.

Telehealth and the Information Economy:

The ready availability of health information online empowers individuals to access a wealth of health-related knowledge, enabling them to self-assess their health and validate any information provided by healthcare practitioners. This shift toward greater information accessibility empowers both patients and healthcare providers to make informed decisions about health.

Patients, particularly those residing in remote communities, would enjoy easier access to healthcare practitioners, thanks to the seamless communication and readily available information about medical consultation schedules and mobile health service visits. Practitioners can conduct assessments, consultations, and patient management online, eliminating the need to wait for the patient's next physical visit. Moreover, practitioners benefit from automated services, which provide them with access to patient data. The remote monitoring of patients further accelerates the flow of information, offering swift insights into patients' conditions and closing crucial information gaps. Telehealth services deliver additional details on mobile health services and immunisation programs. Telehealth emerges as a vital enabler of information dissemination and health inclusion, particularly for elderly individuals in remote rural communities. Ultimately, the primary beneficiaries of these advancements are the users of public healthcare services, as the collective increase in information accessibility benefits both service providers and users alike. These improvements manifest in various ways, including easier access to information about healthcare services and a reduced need for extensive travel to access services, resulting in time and cost savings.

ICTs in E-Government and Public Service Delivery:

Digital platforms, including websites and social media, primarily serve as information dissemination tools for residents of low- and middle-income regions. However, a significant concern arises from limitations in the accessibility of these platforms by rural inhabitants and the specific demographics that tend to use them. Those who access online platforms are typically from the younger generation, and their influence in community decision-making may be limited. Residents in low- and middle-income contexts often find their participation on these platforms restricted to information consumption.

Despite valuable information on online platforms, such as websites, a substantial portion of this information remains unused by rural communities. Furthermore, these platforms do not facilitate meaningful engagement or follow- up discussions by rural dwellers. This limitation stems from the fact that service providers are primarily responsible for establishing the platforms on which discussions occur. While online platforms undeniably promote transparency and accountability, their initial establishment is often for alignment with regulatory or policy requirements. The importance of fostering transparency and accountability

is recognised, with monitoring of these aspects taking place both within the government and by external parties. It is worth noting that these external parties are often not the end consumers due to their limited access and utilisation of the available information.

Additional benefits are evident within the information economy in the elevated status of those involved in economic activities such as farming. This elevation primarily hinges on access to critical information, such as weather updates, market trends, and insights into security issues, all of which contribute to the enhancement of management systems. In a broader context, the endeavour to cultivate partnerships and collaborations through ICTs encounters formidable challenges posed by the digital divide. These challenges are most pronounced in terms of restricted technology access, limited digital skills, and resistance to adopting emerging technologies, especially among rural residents. The deficiency of technology access not only constrains the range of services available to low- and middle-income rural inhabitants but also significantly influences the type of content disseminated through ICT channels, as it is mainly determined by those with unlimited access to the platforms on which information is transmitted.

Furthermore, remote, underdeveloped, and sparsely populated agricultural regions grapple with obstacles arising from inadequate investments in ICT infrastructure. This underscores the critical importance of e-services, underpinned by initiatives aimed at bridging the digital divide. Neglecting such initiatives would render partnerships and collaborations between service providers and community members largely ineffective. The information benefits derived from ICTs result in the economic, social, cultural, and service management benefits that are explained in the next section.

10.2.2.2 The Public Value of ICTs in Low- And Middle-Income Contexts

The ensuing public value of ICTs in low- and middle-income contexts is presented in terms of economic value, social value, cultural value, and the effectiveness and efficiency of service delivery as discussed in Section 9.2.

Economic Value:

The economic value of ICTs for residents of underdeveloped rural areas primarily stems from a decreased migration frequency between service providers and consumers. Consequently, ICTs have a notable impact on intangible service aspects in healthcare, education, police, emergency services, as well as commercial services like banking services, due to the reduction in service-related migration. Public services like police, education, and healthcare are more amenable to the proliferation of ICTs compared to public infrastructure and amenities such as water, sanitation, housing, and electricity. The economic advantages encompass diminished travel costs and time savings for both consumers and service providers, along with heightened investment, business prospects, and employment opportunities (Table 9.2).

Social Value:

The social value of ICTs encompasses a wide array of attributes, including factors related to social stability and overall quality of life (Li, 2019). Television and radio stations still serve as broadcasting programming channels that address various issues spanning vast and diverse geographical distances. Religious or cultural programming is significant for rural residents, particularly the elderly demographic. The dissemination of information and communication through accessible, user-friendly, and reliable technologies like mass media and mobile phone communication played a pivotal role in nurturing social understanding, particularly in a nation like South Africa. Mobile phone technologies form the foundation for delivering e-services in underdeveloped contexts. This approach facilitates the attainment of social value through ICT technologies that are well-suited to the specific conditions of the regions. However, it is important to note that modern forms of ICTs might not effortlessly maintain national unity across extensive geographic areas, as rural inhabitants may not be confined to a single type of technology or ICT service. There are also variations in the rates of technology assimilation and demographic composition which is related to technology preferences (for example, in the study, one respondent cited that the elderly did not participate in community social media groups (NW_RAT_B4_01).

Cultural Value:

The cultural value of ICTs signifies the extent of cultural alignment, educational impact, and societal frameworks (Li, 2019). ICTs play a role in fostering cultural understanding and serve as repositories of knowledge, education, and information. Nevertheless, the introduction of ICTs can potentially disrupt local social systems and clash with traditional norms and practices.

The Effectiveness and Efficiency of Service Delivery:

The effectiveness and efficiency of service delivery encompass the management and response to the expectations of consumers (Osborne et al., 2013). The service-dominant approach underscores the significance of both consumers and service providers in the service delivery journey. ICTs function as conduits for consumer feedback and offer vital data for service creation despite the influence of the digital divide. Consequently, ICTs elevate user contentment by facilitating ongoing communication and networking, thus guaranteeing the consistent fulfilment of rural consumer needs.

10.2.2.3 Rurality and the Characteristics of Public Service Delivery in the Digital Age

The characteristics of public service delivery in low- and middle-income contexts in the digital era are described in terms of the mode of service production and character of the new services (Cordella & Paletti, 2018).

Mode of Service Production in Low- and Middle-Income Contexts:

While ICTs are commonly associated with open-source modes of service production (Cordella & Paletti, 2018) and a reduced level of control in the service output, the scenario differs for low- and middle-income settings. In these settings, there is limited evidence of reduced control exercised by service providers due to the digital divide. Within such contexts, service consumers are constrained by digital exclusion. As a result, they are more inclined to contribute to the service production process by providing data related to the services and service delivery processes. Digital platforms offer alternative modes for delivering and producing various services, including education, healthcare, and other intangible service offerings. Mobile money transactions are critical in transactions from migrant workers to their rural households. However, it is important to acknowledge certain constraints. Digital platforms do not provide alternatives to the direct provision of amenities such as water, sanitation, and electricity, but instead, they support service provision processes.

Characteristics of New Services in Low- and Middle-Income Contexts:

Service provision in the digital age primarily revolves around delivering services that are predominantly intangible, aiming to enhance service management. Within the examined context, these advancements have led to reductions in the costs associated with accessing services. Consequently, new public services can be described based on factors such as quality, quantity or frequency, and the expenses incurred to access service offerings. These are explained as follows:

Cost of Accessing and Providing Services: Electronic services have made certain public services available partially or entirely online. ICTs play a role in diminishing transportation expenses to service centres and cutting down the time and cost involved in accessing services. ICTs also reduce physical interactions between service providers and consumers, thereby decreasing human resource requirements in face-to-face service provision. Conversely, certain drawbacks arise, such as inhabitants of rural areas often being exempted or receiving subsidies for service payments, which subsequently increases the costs associated with providing services. Households with economic capabilities living in these regions might resist the transparency these systems introduce (as observed in LD_WC_TWK_B3_01 in Table 6.3).

Quantity of Service Units Accessed/Frequency of Accessing Service: Given that intangible services are accessible online, these services can be easily accessed and frequently utilised by distant consumers who have the means to access online services. The ease of availability leads to a higher frequency of accessing services due to the reduced expenditure of both costs and time associated with service access.

Quality of Service: Online services facilitate feedback mechanisms, service monitoring, and communication, contributing to the enhancement of service reliability, maintenance, and quality. For instance, prompt feedback and reporting related to water and electricity interruptions enable quicker repairs, ensuring uninterrupted availability and delivery of services. Moreover, e-health services allow individuals living far from healthcare centres to access vital information and connect with healthcare personnel. ICTs also serve as sources of information and knowledge. Quality enhancement is also achieved through increased consumer participation via feedback and advanced product monitoring mechanisms in the service delivery process.

10.2.3 Practical Contributions

The study contributes to the comprehension of rurality in the digital age within low- and middle-income countries through the following means:

i. Previous classifications of South African rurality categorised rural areas as either formal rural (B3) or urban-rural (B4) without offering finer distinctions between these areas (DNT, 2012). To mitigate biases arising from differences in underlying population and municipal areas, standardisation of municipality sizes was employed. Index measures were also utilised to quantify the extent of spatial changes over time. The study also noted wider variation between B3 municipalities by province, for example those defined for the WC provinces and those for other areas. In that regard, spatial plans for such municipalities should cater for such an inherent difference. In addition, the findings and analysis in the study lay the foundation for future comparisons of spatial patterns related to rurality and service delivery, utilising spatial autocorrelation methods, including data sources centred around the 2021 census data.

ii. The study formulated service delivery indexes for essential facets, including water, sanitation, formal housing, ICTs, electricity, and healthcare. Access to public health services was notably greater in underdeveloped areas (B4), potentially due to the heightened public health requirements of disadvantaged rural communities, warranting an increased number of health centres in these regions. The Indexes for healthcare are particularly important since the previously used categorisations were discontinued (Schmidt & du Plessis, 2011). In terms of electricity, despite the extension of electricity grid lines to reach most rural communities, significant challenges persisted due to deficiencies in household access to energy-efficient housing and lower household income levels among rural dwellers.

iii. The study encompassed ICT connectivity alongside other pivotal elements, including service proximity, variable weighting that defines South African rurality, the proximity of services in

alternate municipalities, and the adoption of the JRC-EC's index development procedure.

iv. This study established a foundation for crafting indexes on access to fundamental education and police services within the studied context. Variables such as access to Internet services could potentially be incorporated into education indexes, pending data availability. Police and justice services could similarly encompass indicators like the number of magistrate courts per municipality and the range of services provided per police station (for instance, units focused on addressing cattle rustling and child-victim support). These indexes can be regularly updated as current data becomes accessible.

v. Google Distance APIs can be used in conjunction with other online data to obtain real-time measurements of distances to services and access to services.

10.3 Recommendations

E-Service delivery is associated with intangible aspects of services whose subtleties are difficult to measure. There is a need to develop methods to monitor the quality and standards of services, such as online health and education services. Such measures would go beyond determining whether households access e-services but use standard measurements to determine the quality of e-services accessed. Since ICTs have become a critical part of life, in addition to capturing data on household access to amenities (water, sanitation, electricity), services (education, healthcare, and policing services), and connection to ICTs, census data may also collect information on e-services. In that regard, unlike conventional household amenities available in STATS SA's data, the digital divide is additionally concerned with how ICTs are used. Such data would be important to explain the extent to which services are accessed electronically and how improvements can be made to service provision processes. In this way, the NPM principle of accountability returns its importance.

Before upgrading to higher-end applications and technologies, e-service provision needs to take full advantage of the existing advantages of low connection costs and broader reach of mass media and existing mobile phone services. South Africa's rural context revealed that the broad reach of mass media was based on the airing of programming in indigenous languages, ease of use, and affordability. Additionally, mobile phones provide a wide range of more affordable Internet-based services. In the case studied, mobile phone services and mass media directly impacted the provision of healthcare, education, and police and emergency services. Upgrading of technology must consider that rural stakeholders may already be unable to connect to existing services owing to geographical exclusion (LD_WC_TWK_B3_01) or a lack of technology use skills. Hence, upgrade in such cases leads to wider exclusion from services regardless of the socioeconomic capacity of the intended beneficiaries.

Prior studies have recommended the need to consult and provide integrated service centres such that existing government departments, parastatals, and other sectors would use whatever means possible to provide services to disadvantaged South African communities (DPSA, 2009). The basis of such a solution is to minimise the efforts and costs of setting up and maintaining centres. Rural communities often use school addresses as postal addresses. The interviews proved that rural community members used ICT services (telephones, computers, and the Internet) at school premises to communicate emergencies and convey formal communication. In addition, rural school premises tend to host various community activities. Investments can be directed to computerising rural schools or setting up public access points near schools since they are located within rural communities. Investing in the computerisation of schools has the advantage of building on existing infrastructure such as Internet connections and electricity lines. Hence, improvements in rural places must be cognisant that amenities are interrelated. For example, investment in healthcare, schools, and police services would be redundant without setting up roads, water, and sanitation services. There is also a need for e-service initiatives to remain mindful of the needs of disabled people and the multilingual composition of rural communities.

The rural government officials interviewed indicated concerns about the ICT skills deficit amongst some municipal officials that slowed the uptake of new technologies. As a solution, socioeconomic development, particularly investment in education and digital literacy, should precede sustaining the rollout of ICTs, particularly in the least developed areas (Ngwenyama, Andoh-Baidoo, Bollou, & Olga, 2006). In addition, the commencement of digitalisation of service delivery requires compelling rural stakeholders, especially consumers, to use existing platforms such as municipality websites.

10.4 Generalisations, Transferability, and Data Limitations

10.4.1 Generalisability

A significant concern in this study lies in the limitation imposed by the relatively small number of interviews conducted for qualitative analysis relative to the country's rural population. This could potentially impact the ability to draw general conclusions based on qualitative findings. Generalising from qualitative studies is often deemed inappropriate because the outcomes can vary when different researchers replicate an investigation. However, the results from the reviewed literature and the quantitative findings derived from data encompassing the entire South African population provide corroborating evidence. For instance, it is evident that healthcare and education services are better suited for e-service provision than household services and that mobile phones, radio, and television have the highest penetration in the rural population. Qualitative findings pertaining to rural development practices and the utilisation of ICT predominantly underscore the significance of water and sanitation services and the prevalence of mobile phone-related technology services in most interviews. As a result, additional interviews were not anticipated to yield new findings. Moreover, the qualitative component of this study aimed to delve deeply into the subject matter to complement the quantitative aspect of the exploratory mixed methods

study design. This is typically achievable with a relatively small sample size (Creswell & Creswell, 2014). Consequently, the combined findings from both the qualitative and quantitative components can be applied to the entire South African population and to similar contexts. In addition, qualitative studies are often assessed for their transferability instead of generalisability.

10.4.2 Transferability

In terms of transferability, the context of this study can be evaluated by considering the extent to which the South African rural context resembles rural contexts in other African and developing countries, particularly those characterised by profound socioeconomic disadvantage among marginalised communities. Additionally, the context encompasses extensive commercial rural farming areas, which can be compared to developed rural regions in countries that generally have access to basic amenities. Furthermore, rural areas worldwide consistently encounter challenges in delivering public services to sparsely populated populations under diverse socioeconomic conditions, as represented by commercial (B3) and communal rural areas (B4) in the current study, along with varying cultural factors but similar geographical factors (mountainous terrain and sparse population).

10.4.3 Limitations

The study was primarily anchored on the 2011 South African census data and other datasets corresponding to the year 2011. As new data becomes accessible, updated measurements can be computed to reflect current circumstances. Moreover, enhancements can be introduced by including comprehensive information on schools, police services, and social grants. To refine the schools' data, additional variables can be incorporated, encompassing details about computer laboratories, Internet connectivity, school security measures, teacher qualifications, and sports facilities (Section 2.1.3.2). For police services data, an encompassing view can be constructed by incorporating information about the spectrum of services offered at each station and the staffing numbers per station (SAPS, 2018). Regarding social grants, indicators can provide insights into the proportion of households reliant on financial assistance (CoGTA, 2009b; Pauw & Mncube, 2011; DNT, 2012) even though financial capacity was included in the Electricity Indexes developed in the study (Section 8.1.1.4).

10.5 Final Note

Advancements in communication and information services have significantly exposed rural areas to interactions with other communities. The digital age has dismantled geographical barriers, reducing the impact of rural distance on service accessibility, and decreasing the necessity for travel to access services. Simultaneously, the frequency of accessing services available online has increased. However, it is of utmost importance to be cautious, as the swift progress of e-service systems can surpass the capabilities of underdeveloped or geographically isolated regions, potentially exacerbating existing disparities in an exponential manner. Furthermore, it is important to recognise that in contexts where ICT systems are

primarily employed for information access by service consumers and dissemination by service providers, information systems tend to amplify the benefits derived from top-down communication. This can result in information asymmetry that disadvantages service consumers. The study emphasises that effective e-service provision in remote and underdeveloped areas demands elevated levels of socioeconomic development and support to bridge gaps and achieve meaningful progress. Potential solutions could circumvent cost and skill barriers by maximising the use of established and affordable technologies like mass media and mobile phone communication systems. Amidst the accelerated pace of technological advancement, addressing existing disparities in the digital divide and formulating tailored e-services for rural areas remain imperative.

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12 APPENDICES

12.1 APPENDIX A: Household Questionnaire

12.1.1 Household Questionnaire

Household Questionnaire:

The effect of ICTs on rurality and service delivery in South Africa 2016

Aim of study

The study aims to investigate how ICT diffusion affects South African rurality. Thus, the study will investigate how improved access to public amenities is attributable to the widespread use of various forms of ICTs in rural South African places.

Participants' consent

This research has been approved by the Commerce Faculty Ethics in Research Committee at University of Cape Town. Your participation in this research is voluntary. You can choose to withdraw from the research at any time and you can chose not to answer any question which you are not comfortable answering. Your participation in the research will take approximately 20 minutes to complete. Due to the nature of the study you will need to provide the researchers with some form of identifiable information. However, all responses will be confidential and used for the purposes of this research only. Should you have any questions regarding the research please feel free to contact the researchers at the addresses given below.

The questionnaire is to be completed by the researcher and the responses will also be recorded by an audio recorder. The questionnaire is to be administered on household heads or acting heads of households. Interpreters will also be used to administer questionnaires in indigenous languages. The sample aims to be representative of rural South African households.

Participant approves participation in interview: ☐ Yes ☐ No

Interview completed: ☐ Yes ☐ No

Reason for none completion:

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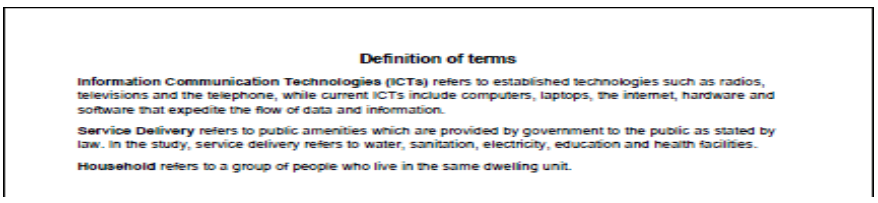


Definition of terms

Information Communication Technologies (ICTs) refers to established technologies such as radios, televisions and the telephone, while current ICTs include computers, laptops, the internet, hardware and software that expedite the flow of data and information.

Service Delivery refers to public amenities which are provided by government to the public as stated by law. In the study, service delivery refers to water, sanitation, electricity, education and health facilities.

Household refers to a group of people who live in the same dwelling unit.

Household ID: ☐

Household location:

Province: ☐ Local municipality/Code: ☐

Main Place: ☐ Sub Place: ☐

Household Characteristics

1. **Characteristics of household** (Respondent may choose not to answer any question)
   - ☐ Race group of household head (1.African 2.White 3.Indian 4.Colored)
   - ☐ Gender of household head (1.Male 2.Female 3.Other ...)
   - ☐ Marital Status of household head (1.Single 2.Married 3.Divorced 4.Widowed)
   - ☐ Age of household head
   - ☐ Employment status (1.Employed 2.Not Employed 3.Self-employed 4. Student 5. Retired)
   - Source of income/livelihood:
     ☐ Farming (commercial/small scale) ☐ Farm Work ☐ Businessperson ☐ Other formal Work ☐ Grant ☐ Other.....
   - ☐ Education level of head (1.No Schooling 2.Grade 0 3.At least 1 yr primary 4.At least 1 yr high school 5. Tertiary school/other)
   - ☐ Total number of people in household

Access to Household Services

2. **How far is your household from piped water?**
   ☐ Piped water inside household ☐ Piped water inside yard ☐ Community tap within 200m of household ☐ None

3. **If any, what other water source does your household use?**
   ☐ Borehole ☐ Spring ☐ Rain water tank ☐ Dam/pool/Stagnant water ☐ River water
   ☐ Water vendor ☐ Water tanker ☐ Other.....

4. **What type of toilet is used by your household?**
   ☐ Flush toilet (connected to sewage system) ☐ Flush toilet (with septic tank) ☐ Chemical toilet ☐ Pit with ventilation (VIP)
   ☐ Pit toilet without ventilation ☐ Bucket toilet ☐ Other/None

5. **What is the main power source used for heating/cooking in your household?**
   ☐ Electricity ☐ Gas ☐ Solar ☐ Paraffin ☐ Wood ☐ Coal
   ☐ Candles ☐ Animal dung ☐ Other ☐ None

6. **What is the main power source used for other electric appliances in your household?**
   ☐ Electricity ☐ Solar ☐ Battery ☐ No other

Access to ICTs, e-Skills and e-Services

7. **HOUSEHOLD ACCESS TO ICTs** *(Tick Applicable)*

Where does your household access the ICT? 1.Home 2.Neighbour 3.School 4.Library 5.Community center 6.No access		*What is the main reason for not having the ICT in your household if applicable?*	*Type of power source used? 1.Electricity 2.Solar 3.Battery 4.Other*
Computer/laptop	☐	.....	☐
Television	☐	.....	☐
Satellite TV (DSTv)	☐	.....	☐
Radio	☐	.....	☐
Landline Phone	☐	.....	
Cellphone	☐	.....	☐

8. **CELLPHONES** *(Tick Applicable)*

i. **How important to you is your cellphone in terms of the following uses?**

Use of ICT	*Level of importance (Very important, Slightly and not important, None use)*			
	Very important	*Slightly important*	*Not important*	*None/Does not use*
Making calls	☐	☐	☐	☐
Receiving calls	☐	☐	☐	☐
Sending text	☐	☐	☐	☐
Receiving text	☐	☐	☐	☐
Emergency calls	☐	☐	☐	☐
Access and reading emails	☐	☐	☐	☐
Community/Government/Current news	☐	☐	☐	☐
Entertainment/Sports news	☐	☐	☐	☐

ii. **What is the greatest limitation from effectively using cellphones?** (i.e. coverage, using phone functions, using device, screen view, battery life, screen)

.....

.....

9. **INTERNET & e-SKILLS** *(Tick Applicable)*

i. **When did you learn to use a computer?**

☐ 3 years ago
☐ More than 3 years ago
☐ Cannot use a computer

ii. **How did you acquire your computer skills?**

☐ Formal education (school, college, university)
☐ Training courses in adult education center
☐ Vocational training courses (while of training for specific skills like nursing, engineering, blacksmith etc.)
☐ Self-study
☐ Informal assistance
☐ Other (mention).....

iii. **Which devices do you use to connect to the internet in your household?**

☐ Desktop computer/Laptop
☐ Cellphone
☐ Other device E.g. tablet
☐ None

iv. **For which of the following activities did you use the internet in the last 3 months?**

Communication

☐ Discussions and communication on social networks with friends & family
Which social network do you use? ☐ WhatsApp ☐ Facebook ☐ Twitter ☐ Other.....

Access to information

☐ Seeking health related information (e.g. injury, disease etc.)
☐ Looking for information about education, training or course offers
☐ Finding information about ward/municipality/government services

Political participation

☐ Reading and posting opinions on municipal or political issues via websites
☐ Taking part in on-line consultations or voting to define municipal or political issues

Learning

☐ Studying an online course
☐ Consulting the internet to obtain information about any subject

Other uses

☐ Bill payment, online/mobile banking, telephone banking, traffic fine payment etc.
☐ Other online purchases

v. **Did you interact with ward/municipality/government authorities over the internet in the last 12 months for the following activities?**

☐ Obtaining information from authorities' web sites
☐ Downloading official forms from websites
☐ Sending filled in forms by email
☐ Sending service complains

e-Service delivery

10. **Does your town/district/area have a local TV/Radio station?** Do you listen to/watch the station? What kind of community development information is transmitted via the stations? Which informative programs do you know/listen/watch on the station?

.....
.....

11. **How effective is the transmission of community news via the TV and Radio stations?** To what extent do people in your community know/benefit from them?

.....
.....

12. **Does the local government send announcements or news via, cellphones i.e. sms, voice messages or calls?** To what extent is the communication effective/frequent?

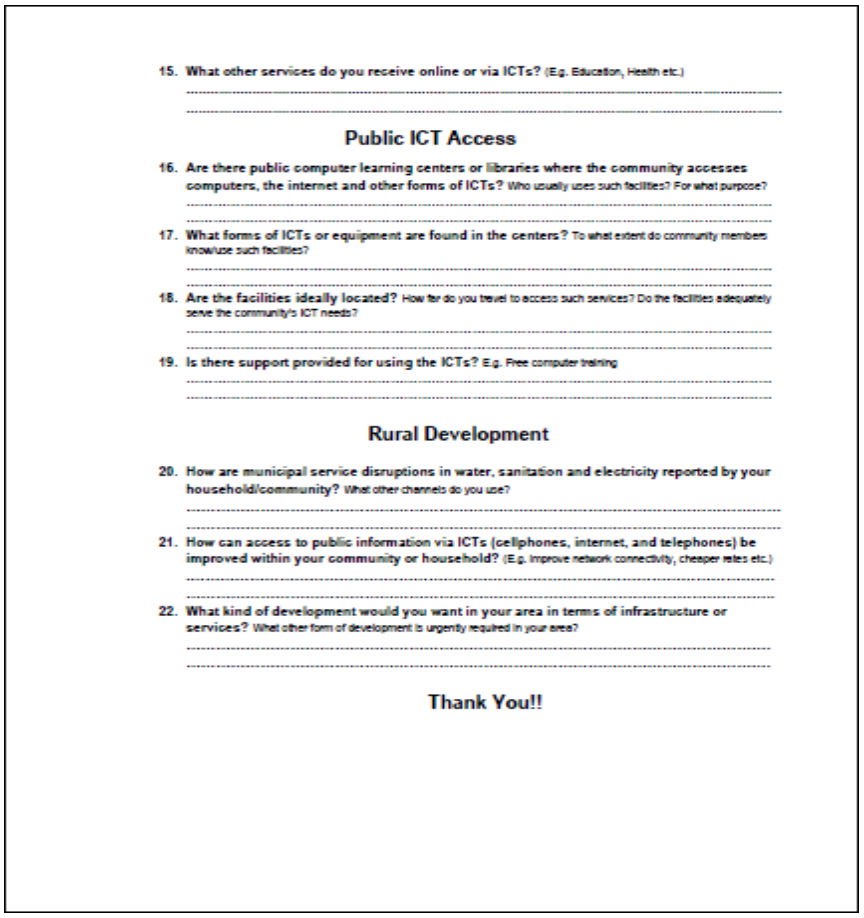
.....
.....

13. **Does your household send local government news through email and social media** (Facebook, WhatsApp, Twitter etc.)? What type of information do you receive? How effective is the mode of communication?

.....
.....

14. **Have you ever used mobile/internet banking to buy/pay for services such as water, electricity, traffic fines or other services?** How often do you use such facilities? If 'No', explain why?

.....
.....



15. **What other services do you receive online or via ICTs?** (Eg. Education, Health etc.)

Public ICT Access

16. **Are there public computer learning centers or libraries where the community accesses computers, the internet and other forms of ICTs?** Who usually uses such facilities? For what purpose?
17. **What forms of ICTs or equipment are found in the centers?** To what extent do community members know/use such facilities?
18. **Are the facilities ideally located?** How far do you travel to access such services? Do the facilities adequately serve the community's ICT needs?
19. **Is there support provided for using the ICTs?** E.g. Free computer training

Rural Development

20. **How are municipal service disruptions in water, sanitation and electricity reported by your household/community?** What other channels do you use?
21. **How can access to public information via ICTs (cellphones, internet, and telephones) be improved within your community or household?** (E.g. Improve network connectivity, cheaper rates etc.)
22. **What kind of development would you want in your area in terms of infrastructure or services?** What other form of development is urgently required in your area?

Thank You!!

12.1.2 Data Collection Record per Province

12.1.2.1 WC

Theewaterskloof (B3)

The municipality is situated approximately 80 kilometres away from Cape Town. During the fieldwork, the municipality provided the valuable support of a community development worker to guide the research process. In this municipality, a total of ten households were visited, and interviews were conducted with two community development workers. To ensure effective communication, a research assistant was also present to assist with Afrikaans translations as needed. The interviews encompassed a diverse range of locations within the municipality, including:

i. *Melrose Settlement and Naledi Settlement:* Interviews were conducted with two respondents and one community development worker.

ii. *Grabouw Low-Density Settlement:* Three respondents were interviewed in this location.

iii. *Algin Valley Vinelands:* One household respondent was interviewed.

iv. *Genadendal Small Plots:* Interviews were conducted with two households and one community development worker.

v. *Greyton Farmlands:* One household interview took place in this area.

vi. *Grabouw Farmlands:* An additional household interview was conducted in this location.

vii. *Councillor's Response:* One councillor provided her responses via email.

12.1.2.2 EC

Intsika Yethu (B4) (30 June 2016 to 2 July 2016)

Permission to conduct interviews in Engcobo was granted during a prearranged visit to the Intsika Yethu municipality. Since the two municipalities are situated adjacent to each other, the fieldwork for the Engcobo municipality was organised and carried out concurrently, resulting in interviews with six households. The researcher travelled to Port Elizabeth, which is approximately 743 kilometres away from his base in Cape Town, he met with a research assistant who served as a Xhosa translator. From Port Elizabeth, they drove to Queenstown, covering approximately 351 kilometres, where they were based for the research activities. Queenstown is located approximately 100 kilometres from the Engcobo municipality. During the fieldwork in Intsika Yethu (B4) from June 30, 2016, to July 2, 2016, a total of nine households and two municipality officials were interviewed. These interviews took place at various locations within the municipality, including:

i. *Municipality Office at Cofimvaba:* Interviews were conducted with one community development worker and one community liaison officer.

ii. *Otheni Village:* Three participants were interviewed in this location.

iii. *Kwagwabevu:* Interviews were conducted with two participants.

iv. *Phindelani Village:* Two participants were interviewed in this village.

Engcobo (B4), (30 June 2016 to 2 July 2016)

In the Engcobo municipality, a total of six households and two municipal officials were interviewed during the research process. These interviews were conducted at the following locations:

i. *Engcobo Municipality Office:* Interviews took place with a councillor and a community development worker at the municipality office.

ii. *Various Locations:* Six households were interviewed in different areas, including Madwaleni, Villages Around All Saints, and households around Engcobo town.

12.1.2.3 LIM

In the municipality of Greater Tzaneen, a total of eight households were interviewed during the fieldwork. The researcher was based in Tzaneen for this phase of the study. Greater Tzaneen and Phalaborwa are areas where Sepedi, Tsonga, and Venda languages are spoken.

Greater Tzaneen (B4), (9-11 November 2016)

The interviews in the Greater Tzaneen municipality were conducted at various locations, including:

i. *Dan Village, De Beare, Gravelotte, Nomafara Village*: Interviews were conducted with four households in these areas.

ii. *Maake, Bokgakga, Mogapeng Village:* Interviews took place with four households in these locations.

Phalaborwa, (B3), (11-12 November 2016)

The majority of the municipality's inhabitants were concentrated around Phalaborwa town, while the remaining areas of the province primarily consisted of wildlife sanctuaries. The municipality is situated along South Africa's border with Mozambique. A total of six households were interviewed. These interviews were conducted at various locations, including:

i. *Kurhula*: Interviews were conducted with two households in this area.
ii. *Lulekani*: Two households were interviewed in Lulekani.

iii. *Nomakgale:* Interviews took place with two households in Nomakgale.

12.1.2.4 MP and NW

Following the completion of data collection in Thaba Chweu, the researcher embarked on another round of interviews in Ratlou municipality, located in the NW province. During the data collection phase in Thaba Chweu, the researchers were based in Sabie. For the subsequent data collection in Ratlou, he was based in Mahikeng.

Thaba Chweu Municipality (B3 in MP provice), (25-26 November 2016)

In the Thaba Chweu municipality, a total of eight households and one municipal official were interviewed. These interviews were conducted at various locations within the municipality, including:

i. *Anderson Extension:* One respondent was interviewed in this location.
ii. *Graskop:* Interviews took place with two households in Graskop.

iii. *Pilgrim's Rest:* A municipal official interview was conducted in Pilgrim's Rest.

iv. *Simile:* Two households were interviewed in Simile.

v. *Mashishing:* Interviews were conducted with three households in Mashishing.

Ratlou Municipality (B4 in NW province), (28-29 November)

In the municipality, a total of nine households were interviewed during the research process. These interviews were conducted at various locations within the municipality, including:

i. *Disaneng*: Interviews took place with three households in Disaneng.

ii. *Modibogo:* Two households were interviewed in Modibogo.

iii. *Setlagole:* Two households were interviewed in Setlagole.

iv. *Kraaipan:* Two households were interviewed in Kraaipan.

12.1.2.5 KZN

The two researchers were based in uMzimkhulu town during the research period. Simultaneously, interviews were conducted in the Ubuhlebezwe local municipality. Both uMzimkhulu and Ubuhlebezwe predominantly consisted of Zulu-speaking households, with a smaller number of Xhosa-speaking households.

uMzimkhulu Municipality (B4)

In the municipality, a total of thirteen households were interviewed during the research process. These interviews were conducted at various locations within the municipality, including:

i. *Cancele:* Interviews took place with three households in Cancele.

ii. *Diepkloof:* One household was interviewed in Diepkloof.

iii. *Gceni, Cecatho, Mastela, Matsitsi, Moyeni, Mshayazafe, Ngudwini, Nkadudu, Ntsikeni:*

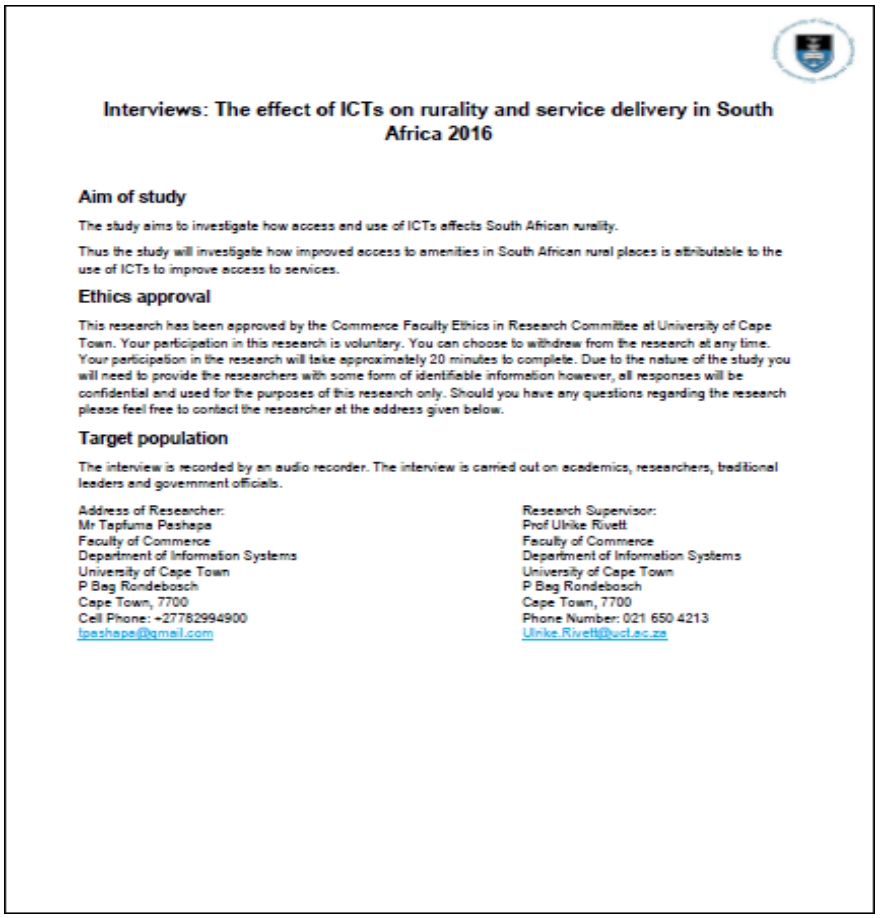
Interviews were conducted with nine households in these different areas.

Ubuhlebenzwe Municipality (B4)

In the municipality, a total of sixteen households were interviewed during the research process. These interviews were conducted at various locations within the municipality, including:

Chibini, Sofafa, Plainhill, Emazabekwani, Hlokozi, Hlokozi Ghudlucingo, Morning Side, Mariathal, Nxakubana, Nxakubana Qhumane, Splanz, and Makholweni (16 households).

12.2 APPENDIX B: Community Leader's Questionnaire



Interviews: The effect of ICTs on rurality and service delivery in South Africa 2016

Aim of study

The study aims to investigate how access and use of ICTs effects South African rurality.

Thus the study will investigate how improved access to amenities in South African rural places is attributable to the use of ICTs to improve access to services.

Ethics approval

This research has been approved by the Commerce Faculty Ethics in Research Committee at University of Cape Town. Your participation in this research is voluntary. You can choose to withdrew from the research at any time. Your participation in the research will take approximately 20 minutes to complete. Due to the nature of the study you will need to provide the researchers with some form of identifiable information however, all responses will be confidential and used for the purposes of this research only. Should you have any questions regarding the research please feel free to contact the researcher at the address given below.

Target population

The interview is recorded by an audio recorder. The interview is carried out on academics, researchers, traditional leaders and government officials.

Address of Researcher:
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Research Supervisor:
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Faculty of Commerce
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P Bag Rondebosch
Cape Town, 7700
Phone Number: 021 650 4213
Ulrike.Rivett@uct.ac.za

Background of Respondent

Organization.....Position.....

Province.....Local Municipality.....

Main Place.....Sub Place.....

Physical Address

.....

.....

Interview questioning structure

Official interviewed	Key questions	Notes
Community leaders (Traditional leaders/Councillors)	• How has the widespread use of ICTs improved your interaction with members of your community? • How have ICTs improved their participation in community projects? • In your area, what role do ICTs play in terms of improving access to services? • In your opinion, what characteristics define your community to be rural? • What kind of development is required in your area?	.....
Academics/Researchers (Anthropologists/Settlement Studies/Population Studies/Rural-urban Planning/Statistics South Africa)	• To what extent are the various forms of ICTs accessible and used by rural dwellers in South Africa? • How have ICTs improved communication in rural areas? • How do ICTs contribute to development especially in terms of access to improved public services? • What defines a community to be rural in South Africa? • To what extent do households in the rural areas have access to various forms of ICTs? What determines the difference? • How are South African rural and urban places defined in your field of study? • To what extent are the definitions ideal? What can be improved?	.....
Municipality/Government Officials (Water and Sanitation/Education/Health/Electricity)	• How are rural areas defined in your sector? • Why is the definition of urban and rural places important in your sector? • How are ICTs used to monitor or even provide services especially in rural places? • To what extent have these initiatives been successful in rural places? How successful are the ICTs based on the variable nature of the rural landscape?	.....

12.3 APPENDIX C: Application of JRC-EC Index Formulation Procedure

The current section explains the application of JRC-EC's index formulation procedure to the study (JRC-EC, 2008).

12.3.1 Specification of the Theoretical Framework

The specification of the theoretical framework phase refers to the statement of a model for selecting and combining variables into the composite index. Appraising the literature provided a base for choosing an appropriate model (Chapter 2 and Chapter 7). The SRI by Mountrakis et al. (2005) was used in the study. The qualitative phase of the study was also used to guide the development of the index (Chapter 6).

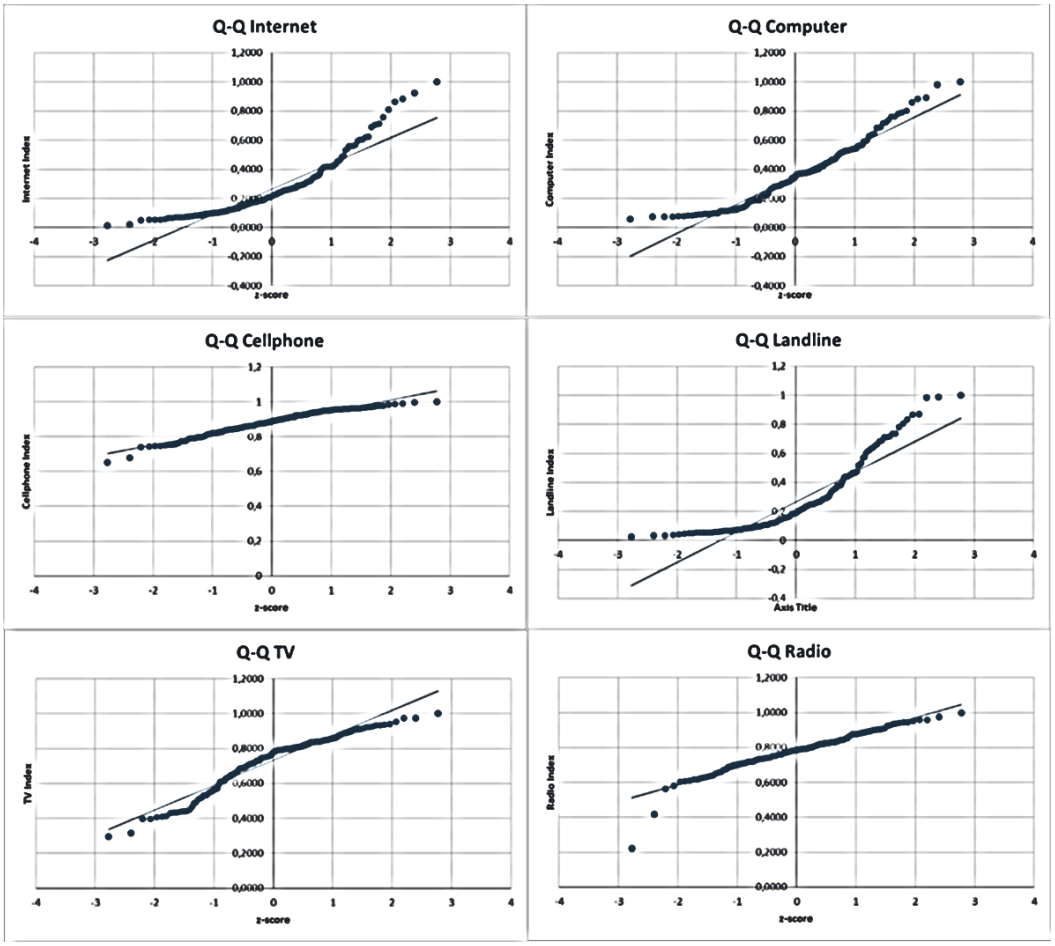
12.3.2 Selection of Variables

The SRI consists of connectivity and access to service variables (Chapter 7, Section 7.3.4). Variable selection is part of the theoretical framework stage (JRC-EC, 2008). The SRI method defined connectivity variables as connectivity to a network of services such as piped water, sanitation, electricity, housing, and communication services (ICTs). Access to service variables were defined as the degree of access and quality of services (education, hospitals, and police services). Additional and crucial aspects of the selected variables, obtained from the responses of rural dwellers, included the distance to water points, housing type, and proximity to urban services via public roads. Place classifications in the document review of CoGTA publications also referred to traditional housing as one of the major characteristics of communal rural areas. The inclusion of variables in the index was also determined by data availability at municipality level. The primary data set used for the study was the 2011 Census data (Section 5.4).

12.3.3 Statistical Analysis

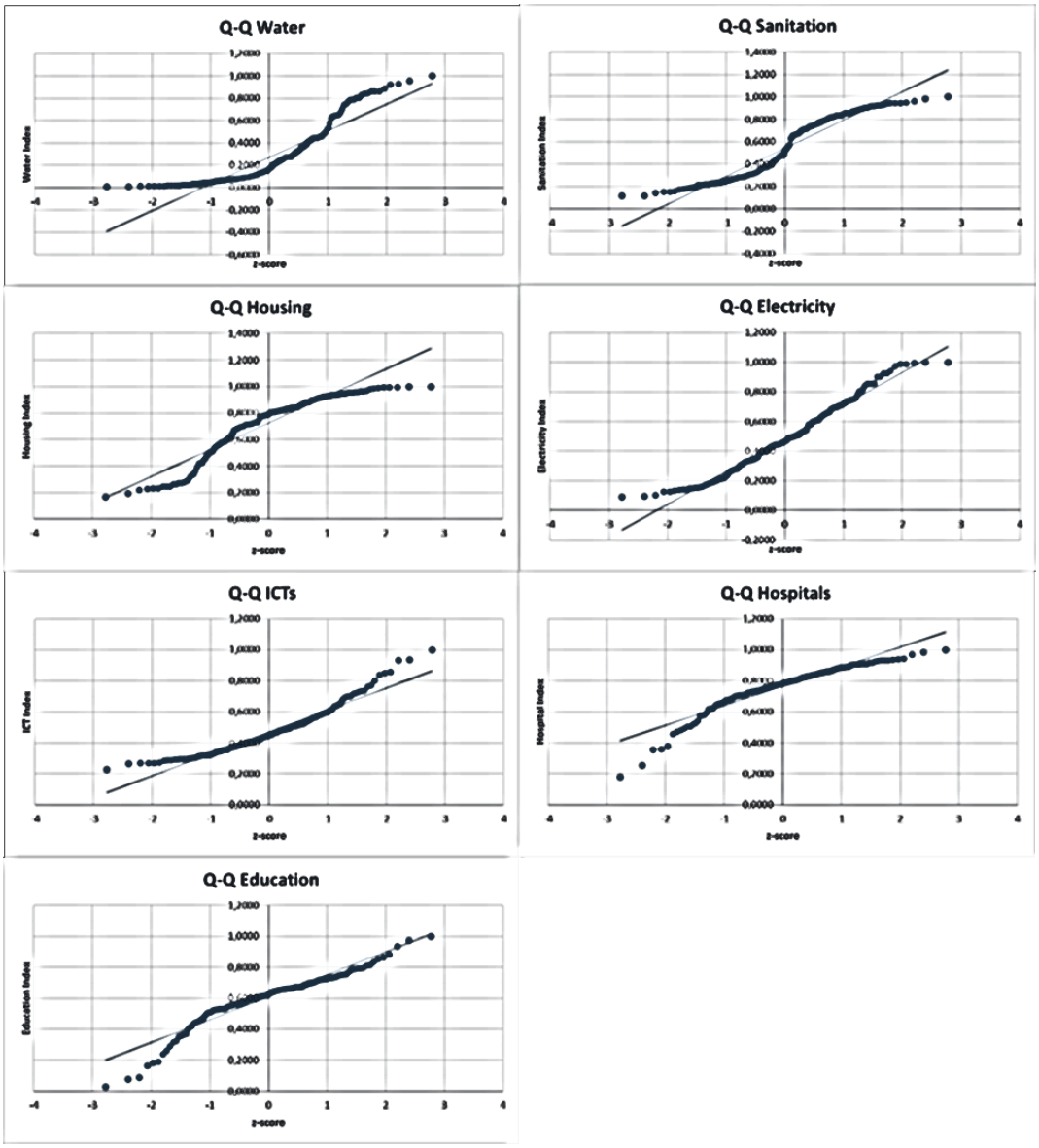
Measures of central tendency such as the mean, median, and interquartile range were used to study individual variables. The median is not affected by outlying data. The interquartile range and the box and whisker plots were essential for identifying outlying values. Graphical illustrations and tests such as the Cronbach Alpha, Q-Q and Shapiro-Wilk tests for normality, KMO, and Bartlett's test were used to test the data for consistency and normality, amongst other tests. Cronbach Alpha test was used to test the commonalities of items in the presence of multidimensionality (Katsuragi, Okamura, Kokubo, Ikeda, & Miyamoto, 2017). Sensitivity Analysis was also used to study the impact of variables and their interaction effects on the overall Indexes. Spatial Autocorrelation Analysis was also employed to understand the spatial distribution of indexes (Appendix P).

Figure 12.1 Q-Q Plots and Shapiro-Wilk Tests for Normality for ICT Variables



Note: Shapiro-Wilk Test *p*-values < .01 for all the variables.

Figure 12.2 Q-Q Plots and Shapiro-Wilk Tests of Normality for Index Variables of the Overall Index



Note: Shapiro-Wilk Test *p*-value < . 01 for all the variables

12.3.4 Data Normalisation

The normalisation of variables is important before aggregating variables to remove the differences in the undelaying measures used to generate each variable (JRC-EC, 2008). Normalisation enables comparison between different variables. The choice of a normalisation method tends to be a hard problem because a single method cannot tackle all data issues and one subset of features can be best normalised by one method, while the other subset of features by some other methods (Singh & Singh, 2020). The study considered two forms of normalisation: min-max and standardisation methods.

i. Normalisation was done by scaling the variables' values from 0 to 1. The procedure was done by dividing the difference between each variable's value and the minimum recorded value of

the variable by the difference between the maximum and minimum recorded values of the variable. That is, for a given variable *X,*

$$X_{si} = \frac{X_i - X_{min}}{X_{max} - X_{min}}$$

Where,

X_i was the original value of a variable *X,* which was to be normalised.

X_{si} was the normalised value of an original value.

X_{min} and X_{max} are the minima and maxima values, respectively.

ii. Normalisation was also done by transforming each variable's values to the standard normal distribution.

The choice of method for normalising data influences the overall index. These differences were analysed by sensitivity and uncertainty analysis (Section 8.1.4).

12.3.5 Weighting and Aggregation

The BA method and the generation of weights by the factor analysis method (JRC-EC, 2008) were used to generate weights. Due to the subjective nature of the selection of weighting and aggregation methods, uncertainty and sensitivity analysis were carried out to assess variability arising from the utilised methods (Section 8.1.4).

12.3.5.1 BA Method (weighting by type or level of service offered, quality of services, and distance to service)

Distance to the nearest service was incorporated into the calculation of weights in the BA weighting system for the cases when a service was not found within a municipality's boundary. In addition to the availability of a service, a measure of weighted service quality was included. The weighting used government service standards, information from the literature review, and information obtained from interviews. The distance travelled for service was included to consider differences in the distances travelled to a service. The distance travelled was measured from the source municipality's centroid to the service municipality's centroid. The quality of service, distance to service, and type or level of service offered were assumed to be independent. The following steps were followed in generating the BA weights.

Step I: Identification of the Categories, Types, or Levels of Service Offered

Identification of service category, service type, or level of service was based on a review of official documentation. For example, health facilities were identified as one of five: clinics, district hospitals, regional hospitals, tertiary hospitals, and central hospitals.

Step II: Generation Of the Weights for Each Category of Service Based on the Service Offered For health facilities, clinics were the entry-level service centre for receiving healthcare. Central Hospitals were the highest referral centres for health complications because they had highly specialised services and medical personnel. Weights were proportionally allocated according to differences in the level of services provided, given that clinics and central hospitals provided the entry-level and highest level of services respectively. Other considerations for developing the weights were differences in the services provided by each facility type. That is, if a clinic offered health services without patient admission, while in comparison, a district hospital offered health services with 24-hour patient admission, weighting scores were generated to reflect the differences in service provision.

Step III: Normalisation of Weights

Data normalisation (Section 12.3.4) was done to standardise weight measurement across sub-components. The following formula was applied:

$$W_i = \frac{Score_i}{Maximum\ Score}$$

Where i was the ith category of service provided

$Score_i$ was the score for category i services.

W_i was the resultant weight.

Step IV: Incorporation of the Quality of Service

Quality of service was obtained as the average service rating for a municipality's services category. The service users provided the quality-of-service ratings. Quality ratings were converted to a decimal number between 0 and 1. Thus the combined weight became,

$$Qweight_i = W_i \times Q_{im}$$

Where,

Q_{im} was the average quality of service rating for municipal m given for service category i

W_i was the weight obtained in *Step III*

$Qweight_i$ was the resultant weight for the i th category of a variable

Step V: Distance to the Nearest Service Factor

For municipalities which did not have access to a service, the distance to the nearest municipality that contained the service was incorporated into the weight by assuming that consumers used the

nearest service point. This distance was measured as the distance between the centroids of the municipalities. For calculating the distance weight (D_i), the distance from a sending municipality to the municipality with a service was divided by the maximum distance (the longest distance travelled by any rural dweller outside their municipality to obtain service). Distances to the nearest service points were obtained using the Google Distance Matrix API (Appendix E) and normalised for each service category.

$$D_i = \frac{M_{im}}{Maximum\ (M_i)}$$

Where,

Mi was the distance from the source municipality to the municipality with service category *i*

Maximum (M_i) represents the maximum distance travelled to the nearest municipality for the *i* th category of the service throughout the country.

To calculate the weights to incorporate the distance factor ($QDweight_i$) for the *i* th category of weights, the complement of D_i was multiplied by W_i and Q_i. That is,

$$QDweight_i = W_i \times Q_i \times (1 - D_i)$$

Where

Wi and *Qi* were defined

in *Steps III and IV*

Di was the distance factor to the municipality with a service.

(Obtained by normalising using *Maximum (M_i)* as a maximum distance)

Table 12.1 illustrates an example of the formulation of weights for two types of health facilities (clinic and district hospital).

Table 12.1 Example on the Generation of Weights for Health Centres

Stage	Description	Health Facilities	
Step 1	Category of services	Clinic	District Hospital
Step 2	Allocation of points according to importance of service offered	Primary Health Care (1)	24-hour Service (1)
		30 patient beds average (1)	300 beds average (10)
			Train health personal (1)
		Total Score (2)	Total Score (12)
Step 3	Normalisation of weights	2/12 = .167	12/12 = 1.000
Step 4	Quality of service	Assume the quality of service is 80% (.800)	Assume the quality of service is 78% (0.78)
	Population of area served by the facility (Assume the population for municipality and district are 2500 and 50000 respectively).	Assume the clinic serves 1000 people. Population weight factor will be given by (1-1000/2500) = .600	Assume population in district is 35000. Population weight factor becomes (1-35000/50000) = .700
Stage 5	Incorporation of distance to service for areas that do not have the service. Assume the longest distance travelled to a district hospital is 350km (for municipalities that do not have a district hospital).		If the distance to the nearest district hospital is 177km. Then the distance factor is (1-177/350) = .494

Note: Service scores are given in brackets. For example, 'Primary Healthcare (1), '30 patient beds average (1).'

12.3.5.2 Calculating Weights for the Composite Indexes by Using Factor Analysis

Factor Analysis is primarily a variable reduction method. Factor analysis is a data compressing technique that finds k-rank, $k = 1, 2, \ldots p$, projection matrix $\boldsymbol{P}_k$ such that the variance of the projected data $\boldsymbol{X}$ by $\boldsymbol{P}_k$ is maximised (Jolliffe, 2011). It is used to reduce the number of explanatory variables to a smaller number which can explain the character of the elements under investigation in the best way. Factor analysis was used to find the coefficients that were used to aggregate the variables for obtaining the index for each municipality.

Method 1: Factor Analysis Using Multiple Principal Components.

JRC-EC (2008) describe the application of factor analysis in the generation of weights. The method uses weights to account for overlapping information between a composite index's components (variables). JRC-EC describe the steps taken in the extraction of the weights as follows.

Step I: Prerequisite Tests.

Correlation analysis was carried out as an initial step. In addition, the suitability of the data for conducting the factor analysis was determined by the KMO test (Kaiser, 1970; Kaiser & Rice, 1974). A KMO test statistic value of at least .70 was deemed acceptable for applying the method. Bartlett's test of sphericity was also done as set out by Bartlett (1950). Cronbach's alpha test was also done to determine the data's consistency (Katsuragi et al., 2017).

Step II: Identification of Factors (the number of factors is usually fewer than the Factor Loadings. Each factor depends on the correlation with factor loadings. Various rules were used to identify the loadings with the largest variance. They were selected based on the following criteria:

i. Associated eigenvalues are greater than one.
ii. Contribute individually to explaining the variance by more than ten percent.
iii. Contribute cumulatively to explaining the variance by a factor of 60 percent.

Step III: Rotation of Factors

The third step was the rotation of factors to minimise the number of indicators that had a high loading on the same factor. Rotation makes the differences between factor loadings more evident by recalculating them.

Step IV: Calculation of Weights

Finally, the weights were constructed from the matrix of factor loadings after rotation. The square of the factor loadings represented the proportion of the total unit of the variance of the indicator explained by a factor.

Method 2: Factor Analysis Using One Component.

The factor analysis method has been used extensively in the generation of indexes in various studies (Li, Zhang, Yuan, Liu, & Fan, 2012; Balestrieri, 2014). The method consists of running a factor analysis while assuming one principal component (Jolliffe, 2011). That is, all the variables in the study represent one component. Loadings and weights obtained from the factor analysis are normalised, and the weights for each variable are extracted.

12.3.6 Aggregation

Linear aggregation (LIN) was the main method used for data aggregation. For example, the index for '*Municipality 1*' is calculated as

$$INDEX_{Municipality\ X} = \sum_{i=1}^{n} W_i P_i$$

Where

$INDEX_{Municipality\ X}$ is the index of rurality for *Municipality X*

W_i is the weight of the i th category of sub-component.

P_i is the total number of households in Municipality X with access to the i th category of a variable.

The index obtained for each municipality can be multiplied by another factor to get an improved indicator. Another aggregation method is the geometric mean (GA). For example,

$$INDEX_{municipality\ 1} = \prod_{i=1}^{n} P_i\ X\ w_i$$

$INDEX_{municipality\ 1}$ is the Index of rurality for municipality *1*.

W_i is the weight of the i th category of sub-component.

P_i is the total number of households with access to a variable category.

The choice of aggregation method also influences the overall index. The influence was also evaluated by sensitivity and uncertainty analysis (Section 8.1.4).

12.3.7 Uncertainty and Sensitivity Analysis

Uncertainty and sensitivity analysis are both seen as methods of model validation (Saisana Saltelli & Tarantola, 2005).

Uncertainty Indexes (Saltelli, Ratto, Andres, Campolongo, Cariboni, Gatelli, & Tarantola, 2008)

Uncertainties in a model arise from subjective decisions making on factors such as the method of aggregation, the inclusion of variables, and variable weighting. The uncertainties are presented in Table 8.13. In that regard, uncertainty analysis was carried out using Monte Carlo simulations to estimate Sobol's sensitivity indexes.

Given the model, $Y = f\ (X_1, X_2, X_3, \ldots X_k)$,

Sobol's first-order sensitivity are such that,

$$\boldsymbol{S_i} = \frac{\frac{1}{N}\sum y_A^{(j)} y_{C_i}^{(j)} - \frac{1}{N^2}\sum y_A^{(j)} \sum y_B^{(j)}}{\frac{1}{N}\sum (y_A^{(j)})^2 - \boldsymbol{f_0^2}} \quad \text{where } \boldsymbol{f_0^2} = (\frac{1}{N}\sum_{j=1}^{N} \boldsymbol{y_A^{(j)}})^2 \quad \textbf{Equation 12.1.}$$

$$A = \begin{pmatrix} x_1^{(1)} & x_2^{(1)} & \dots & x_i^{(1)} & \dots & x_k^{(1)} \\ x_1^{(2)} & x_2^{(2)} & \dots & x_i^{(2)} & \dots & x_k^{(2)} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_1^{(N-1)} & x_2^{(N-1)} & \dots & x_i^{(N-1)} & \dots & x_k^{(N-1)} \\ x_1^{(N)} & x_2^{(N)} & \dots & x_i^{(N)} & \dots & x_k^{(N)} \end{pmatrix},$$

$$B = \begin{pmatrix} x_{k+1}^{(1)} & x_{k+2}^{(1)} & \dots & x_{k+i}^{(1)} & \dots & x_{2k}^{(1)} \\ x_{k+1}^{(2)} & x_{k+2}^{(2)} & \dots & x_{k+i}^{(2)} & \dots & x_{2k}^{(2)} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{k+1}^{(N-1)} & x_{k+2}^{(N-1)} & \dots & x_{k+i}^{(N-1)} & \dots & x_{2k}^{(N-1)} \\ x_{k+1}^{(N)} & x_{k+2}^{(N)} & \dots & x_{k+i}^{(N)} & \dots & x_{2k}^{(N)} \end{pmatrix}, \text{ and}$$

$$C_i = \begin{pmatrix} x_{k+1}^{(1)} & x_{k+2}^{(1)} & \dots & x_i^{(1)} & \dots & x_{2k}^{(1)} \\ x_{k+1}^{(2)} & x_{k+2}^{(2)} & \dots & x_i^{(2)} & \dots & x_{2k}^{(2)} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{k+1}^{(N-1)} & x_{k+2}^{(N-1)} & \dots & x_i^{(N-1)} & \dots & x_{2k}^{(N-1)} \\ x_{k+1}^{(N)} & x_{k+2}^{(N)} & \dots & x_i^{(N)} & \dots & x_{2k}^{(N)} \end{pmatrix}.$$

$\boldsymbol{C_i}$ is a matrix of all columns of matrix $\boldsymbol{B}$ except the $\boldsymbol{i}$th column, which is taken from matrix $\boldsymbol{A}$ (N *by k matrix*). k represents the number of factors in the model. The matrices are obtained by generating an N by $2k$ matrix of k random inputs. $\boldsymbol{A}$ and $\boldsymbol{B}$ each contain half of the sample. $\boldsymbol{N}$ can be as large as several thousands. $x^{(i)}$ represents a random realisation of the kth factor given the choices of computing the factor—for example, the choice between using imputed and unimputed data to determine the kth factor value. The following formula gives the second-order sensitivity.

$$\boldsymbol{S_{T^i}} = \boldsymbol{1} - \frac{\frac{1}{N}\sum y_B^{(j)} y_{C_i}^{(j)} - \boldsymbol{f_0^2}}{\frac{1}{N}\sum (y_A^{(j)})^2 - \boldsymbol{f_0^2}} \quad \textbf{Equation 12.2}$$

According to Saltelli et al. (2008), when $S_T{}^i$ is greater than .15, the uncertainty indicator reflects that the uncertainty factor (i) has a very important effect on the measured index. $.100 < S_T{}^i \leq .150$ indicates that the factor is quite important, $.050 < S_T{}^i \leq .100$ reflects that the factor is rather important. A value of less than or equal to .050 reflects that the factor is insignificant at the significant level of testing.

Sensitivity Indexes for the Impact of Each Variable on the Calculated Index Measure

Developing a composite index involves subjective decision-making. For example, the choice of the weighting scheme, the selection of the individual indicators, data imputing, data normalisation, and other decisions (Saisana, Saltelli, & Tarantola, 2005; JRC-EC, 2008). Uncertainty analysis focuses on how certain input factors propagate through the composite indicator's structure and affect the index's values (Saisana et al., 2005). Sensitivity analysis can be defined as the study of how uncertainty in the output of a model (numerical or otherwise) can be apportioned to different sources of uncertainty in the model (Saltelli, Tarantola, Campolongo, & Ratto, 2004). Herman & Usher (2017) say three sources of uncertainty exist. These are:

i. First-order, measure the contribution of the output variance by a single model input.
ii. Second-order, measure the contribution to the variance caused by the interaction of two inputs.
iii. Total indexes measure the contribution of the output variance by a model input, including its first-order effects and all higher-order interactions.

The study used SALib (Herman & Usher, 2017), an open-source Python software library, to conduct sensitivity analysis. SALib generates model inputs and computes sensitivity indexes of the outputs. Indexes were calculated in the following steps:

i. Determination of model inputs and their sample range.
ii. Running the sample function to generate the model inputs.
iii. Evaluation of the model using the generated inputs.
iv. Analyses of the output to compute the sensitivity indexes.

Sensitivity analysis was conducted using the Sobol Variance-based analysis.

Figure 12.3 Python Software Code and the Output for the Sensitivity Analysis of the ICT Indexes using the Sobol method of the SALib Library

```
from SALib.sample import saltelli
from SALib.analyze import sobol

def ET(X):

   return((0.2457*X[:,0])+(0.2473*X[:,1])+(0.1686*X[:,2])+(0.1963*X[:,3])+(0.0667*X[:,4])+(0.0754*X[:,5]))

problem = {'num_vars': 6,
           'names': ['Internet','Computers','MobilePhones','Landlines','TV','Radio'],
           'bounds': [[0.0141, 1],
                [0.05707, 1],
                [0.65249, 1],
                [0.02606, 1],
                [0.29733,1],
                [0.22146, 1]]
                }
# Generate samples
param_values = saltelli.sample(problem, 1024, calc_second_order=True)

# Run model (example)
Y = ET(param_values)

# Perform analysis
Si = sobol.analyze(problem, Y, calc_second_order=2, print_to_console=True)
```

```
                     ST   ST_conf
Internet       0.369748  0.029470
Computers      0.342623  0.029649
MobilePhones   0.021626  0.002016
Landlines      0.230323  0.019499
TV             0.013842  0.001258
Radio          0.021718  0.002098
                     S1   S1_conf
Internet       0.369402  0.044317
Computers      0.342646  0.046466
MobilePhones   0.021679  0.012091
Landlines      0.230422  0.044216
TV             0.013839  0.010526
Radio          0.021651  0.012796
                                      S2   S2_conf
(Internet, Computers)       3.709926e-04  0.070857
(Internet, MobilePhones)    4.385417e-04  0.063921
(Internet, Landlines)       5.713726e-04  0.072368
(Internet, TV)              3.693551e-04  0.062735
(Internet, Radio)           4.263654e-04  0.062986
(Computers, MobilePhones)   2.871138e-05  0.063850
(Computers, Landlines)     -2.915700e-05  0.075004
(Computers, TV)             4.289758e-05  0.062426
(Computers, Radio)         -9.021279e-07  0.062350
(MobilePhones, Landlines) -1.720687e-04  0.018976
(MobilePhones, TV)         -1.201574e-04  0.016686
(MobilePhones, Radio)      -1.193153e-04  0.016906
(Landlines, TV)            -2.603049e-04  0.063361
(Landlines, Radio)         -2.789385e-04  0.060874
(TV, Radio)                 2.522932e-06  0.015152
```

Figure 12.4 Python Software Code and the Output for the Sensitivity Analysis of the Overall Rurality Indexes using the Sobol method of the SALib Library

```
from SALib.sample import saltelli
from SALib.analyze import sobol

def ET(X):
      return((0.0092*X[:,0])+(0.0465*X[:,1])+(0.2083*X[:,2])+(0.6342*X[:,3])+(0.0087*X[:,4])+(0.0081*X[:,5])+(0.0850*X[:,6]))

problem = {'num_vars': 6,
           'names': ['Water','Sanitation','Housing','Electricity','ICTs','HealthCare','Education'],
           'bounds': [[0.0075, 1],
                [0.1142, 1],
                [0.1702, 1],
                [0.0925, 1],
                [0.2270, 1],
                [0.18,1],
                [0.0284, 1]]
                }
# Generate samples
param_values = saltelli.sample(problem, 1024, calc_second_order=True)

# Run model (example)
Y = ET(param_values)

# Perform analysis
Si = sobol.analyze(problem, Y, calc_second_order=2, print_to_console=True)
```

```
                ST   ST_conf
Water         0.000225  0.000021
Sanitation    0.004587  0.000419
Housing       0.080786  0.006519
Electricity   0.895698  0.066547
ICTs          0.000122  0.000009
HealthCare    0.000119  0.000010
Education     0.018443  0.001534
                S1   S1_conf
Water         0.000223  0.001411
Sanitation    0.004594  0.005538
Housing       0.080805  0.024793
Electricity   0.895733  0.074106
ICTs          0.000122  0.000967
HealthCare    0.000117  0.000948
Education     0.018409  0.011778
                                    S2   S2_conf
(Water, Sanitation)         1.937752e-06  0.001930
(Water, Housing)            5.286312e-06  0.002031
(Water, Electricity)        1.379096e-06  0.002658
(Water, ICTs)               1.409500e-06  0.001936
(Water, HealthCare)         1.379096e-06  0.001934
(Water, Education)         -1.143903e-07  0.001968
(Sanitation, Housing)      -9.282988e-06  0.010076
(Sanitation, Electricity) -1.044534e-05  0.010375
(Sanitation, ICTs)          1.172214e-06  0.009227
(Sanitation, HealthCare)    1.173696e-06  0.009237
(Sanitation, Education)     8.239832e-06  0.009234
(Housing, Electricity)     -6.043562e-05  0.049495
(Housing, ICTs)            -2.045176e-05  0.033149
(Housing, HealthCare)      -1.988288e-05  0.033136
(Housing, Education)        8.297236e-06  0.032605
(Electricity, ICTs)        -2.603632e-05  0.082761
(Electricity, HealthCare) -2.339682e-05  0.082582
(Electricity, Education)  -1.568756e-05  0.081322
(ICTs, HealthCare)          3.826218e-06  0.001531
(ICTs, Education)           2.872818e-06  0.001522
(HealthCare, Education)     4.084822e-06  0.001355
```

12.3.8 Other Considerations for the Generation of Indexes

Data visualisation tools in the form of graphs and maps were used. In that regard, Spatial Autocorrelation Analysis in the form of Moran's Indexes and LISA were used (Appendix P).

12.4 APPENDIX D: Electricity Index

Electricity accessibility was determined by household income and the thermal efficiency of household dwellings. In that regard, census data were used to identify households connected to the electricity grid, household income level, and the main type of household dwelling. Based on those factors, the index measures were determined as follows (the procedure was followed in the sheet named **Electricity2011** of the Excel File **SouthAfrica_RI.xlsx)**.

Step I

Connection to the electricity grid, household income, and the type of dwelling were major factors contributing to access to electricity in rural households (DoE, 2013; Jamal, 2015). The 2011 census dataset provided data on households connected to the electricity grid, household income, and household dwelling type.

Step II

According to DoE (2013), a household is considered energy-poor if it has less than 60% of South Africa's median per capita monthly income and meets at least one of the following conditions:

i. The household reports that it is dissatisfied or very dissatisfied with its accommodation.

ii. The state of repair of the household's accommodation is described as 'poor.'

iii. One or more of the following problems are reported with the accommodation: lack of adequate heating, a leaky roof, damp walls, floor, or foundations, or damaged or broken windows or doors.

iv. The health of a household member has deteriorated due to the housing conditions.

Based on these conditions, three indicators were derived from the census data. That is, connection to electricity (household access to electricity was determined by household electricity use for cooking, heating, or lighting). Second, the household dwelling's thermal efficiency. The structure of the main household dwelling was identified. All informal and traditional dwelling structures were assumed to be inefficient. Any form of formal housing was assumed to be energy efficient based on the assumption that they were built following solar heat gain building standards (SABS, 2011). The third indicator was the household's annual income.

Step III

Households that resided in informal housing structures were assumed to be dissatisfied with their accommodation. The 60-percentile household income amount was used to determine the rural household's financial ability to sustain electricity purchases throughout the year.

i. The amount of R35368 per annum (Cell **K14** in the sheet named **ElectricityAnalysis**) was determined to be the 60-percentile household income from the data (R38400 was used as the approximate value because the income variable was categorical). An income level weighting for households with less than the 60 percent threshold was developed, with higher incomes represented by a weight of one and lower-income categories (less than the 60 percentile) by proportionally smaller weights. Additionally, a weighting system for household size was factored into household income to adjust the income capacity since larger households use more electricity.

ii. Four households were identified based on their income and ability to sustain household electricity needs. That is, i) households with access to electricity who lived in thermally efficient housing (**CS** Excel sheet), ii) households with access to electricity who lived in energy inefficient dwellings (**CSno** Excel sheet), iii) households that were not connected to electricity but lived in thermally efficient housing (**CnoS** Excel sheet), and iv) households not connected to electricity and lived in inefficient housing (**CnoSno** Excel sheet).

Step IV

In summary, the electricity connectivity index per municipality was based on the following:

i. The proportion of households connected to electricity,

ii. Household level of income and household ability to sustain household electricity needs (based on the household size), and

iii. Thermal efficiency of the household's dwelling (all informal dwellings and traditional structures were assumed to be energy inefficient). The conditions were based on the specifications of the DoE (2013).

> Note: *The electricity accessibility measure assumed uniformity in solar heat gain across the South African landscape. Future studies could consider the effect of different climatic regions of location and the different building materials used to build the dwellings on the structure's thermal efficiency.*

12.5 APPENDIX E: Google Distance Matrix API

Google Distance Matrix API is a service which provides travel distance and time for a matrix of origins and destinations based on start and destination points (Google Incorporated, 2018). The Distance Matrix API was obtained through the HTTP interface using URL requests with the origins and the destinations in the form of the municipalities' names. The centroid of municipalities was used as the reference for respective municipalities. The following code is a URL request for the distance from Theewaterskloof Municipality to Thaba Chweu Municipality.

Figure 12.5 Google Distance Matrix API code

```
https://maps.googleapis.com/maps/api/distancematrix/json?units=imperial&origins=
Theewaterskloof+Municipality&destinations= Thaba+Chweu+Municpality
&key=YOUR_API_KEY
```

(Source: https://developers.google.com/maps/documentation/distance-matrix/start)

The API requires registration with Google API services, and it was executed based on an API key specified in place of the text '*YOUR API KEY'* in Figure 12.5. Microsoft Power BI software was used to connect a database of source and destination pairs to the web, where the URL searches and relays back distance and time data to Power BI. The URL was coded in Power BI by indexing origins and destinations to make the variable for the 27378 searches requested from Power BI. The 27378 searches took approximately four hours to be completed. The distance matrix is presented in the Excel file **SouthAfrica_RI.xlsx** (sheet **Distance_imp** in the cells **H247:IH481**).

12.6 APPENDIX F: Spatial Interaction Factors

Spatial interaction factors were incorporated into the municipality indexes by considering the attractiveness of facilities in other regions (Lee & Hoshino, 2017). Lee & Hoshino describe the formula for calculating the factor by using the following formula.

$$I_{ij} = G_{ij}\frac{m_i.m_j}{d'^2_{ij}} = \left(H'_i - H'_j\right).\frac{p'_i.p'_j}{d'^2_{ij}}$$

I_{ij} is the interaction between the origin (i) and the destination (j).

G_{ij} is a constant determined by the attraction forces between the two locations (i) and (j)

H'_i and H'_j are weighted entropy of the locations or the attraction factor (the difference can be positive or negative).

m_i and m_j are population functions of the two locations.

p'_i and p'_j are population sizes of the two locations.

d'_{ij} is the distance between the two locations. The attraction factor is assumed to be linear.

The overall interaction effect for each municipality is obtained as the summation of interactions with all possible municipality destination.

The distance matrix of interact factors is presented in the Excel file **SouthAfrica_RI.xlsx** (sheet **Distance_imp** in the cells **E9:IH242**).

12.7 APPENDIX G: Health Services Indexes

This Section explains the procedures used to determine rurality indexes for health services. Rurality was defined in terms of the extent to which rural dwellers had access to public health facilities. Distance to the services and the quality of the services were the most important factors (Section 2.1.3.2). Various forms of weighting were used based on the weighting systems described in Section 12.3.5. The weights were based on the level of public health facilities accessible to an area, the services available at the facilities, the quality of services available, and the distance to the nearest and available health centre (incorporation of the distance to the nearest service was done when facilities were not available in municipality boundaries), and the population of the service area.

Assumptions:

- All rural dwellers depend on public health services.
- Rural households access health services at the nearest health centre.
- Rural dwellers were referred to the immediate higher-level medical centres that were within their district or province of location.
- Distance to the service centre, quality of service, the population of the municipality, and the level of service at the health centre determined rurality.

The following steps were followed in determining the health services index. The steps were followed in the Excel sheet **HealthIndex** in the file **SouthAfrica_RI.xlsx.**

Step I: Determination of Rurality Characteristics in Terms of the Provision of Health Services.

The determination of variables that defined rurality in the health sector was based on a literature review, DoH standards, and qualitative data analysis. The South African census data set provided population data at the municipality (B3 and B4 categories), district (C category), and provincial levels. South Africa Hospital Survey data of 2011 provided information on health facilities, the quality, and the type of services offered (Code for South Africa, 2018b). SAHS data contained data on the health centres available per municipality and the quality of service rendered. The quality of service per facility (cells **S15:W251**) was provided as an aggregate percentage that was based on the following considerations:

i. Availability of a service facility, quality of health facility, and the availability of infrastructure, medication, and other additional facilities.
ii. Management and corporate business practices
iii. Availability of health personnel, their level of skill, and experience

The other data used for developing the measure were the distance to higher-level services (Derived from Google distance matrix API services in Appendix E) and the population sizes receiving the services per facility (Based on the 2011 census data).

Step II

Five health facilities were identified based on their hierarchy of importance: primary health centres (clinics), district hospitals, regional, tertiary, and central hospitals (DoH, 2012). Community health centres (CHCs), community day care centres (CDC), health posts, satellite clinics, and specialised clinics were classified as clinics. Subjective weights (BA weights) were developed to differentiate the facility level (shown on the **FacilityWeights** Excel sheet in the cells **FH8** to **HL41**). Differences were based on facility specifications stated by the DoH (2012) as follows:

i. *Bedding Capacity:* Clinics were used as the reference category with a maximum possible number of 30 beds and hence given a weighted score of 15 beds (the average for the range of 1 to 30 beds). Similarly, district, regional, tertiary, and central hospital bedding weights were allotted scores of 325, 500, 600, and 1000 respectively.

ii. *Service Offered:* All the services provided at clinics were given a score of 1 (entry-level service). Weights for services provided at subsequent higher-level health facilities were apportioned scores double that of prior levels. A score was allotted for services not offered at a lower service level by assuming that the service was provided at levels below it. For example, in-patient, ambulance, and emergency services, which were unavailable at clinics, were assigned a score of 2 for district hospitals.

iii. *Support From Higher-Level Facilities:* If a facility received support from a higher-level facility to offer a service, 25 percent of the original service score (from i) was added to the score. For example, to find the score for 'paediatric services' at a regional hospital, one was added to the original score of 4 to give 5 (shown in the Excel sheet **FacilityWeights** in cell **FW17**).

iv. The weight for each type of health centre was derived by normalising the total scores for respective facility levels (**F2: GV32**).

Table 12.2 presents the weights derived by following the explained procedure. Weight derivation was subjective and based on the descriptions provided (DoH, 2012). There were differences in terms of the distances travelled to access the facilities (especially the higher-level facilities such as provincial hospitals) and the quality of service offered by facilities of the same service level. These differences are accounted for in *Step III*.

Table 12.2 Development of Weights for the Health Accessibility Index

		Score	**Weight**
Clinics/Satellite/Community Clinics			
Maximum 30 beds/ for 48 hours		15	
24 Emergency services		1	
Primary healthcare (PHC)		1	
	Total	17	**.014**
District/Specialist			
Beds: small (50-150), medium (150-300), large (300-600)		325	
Time open: 24-hour		2	
General & clinical nurse primary health services		2	
In-patient, ambulance, and emergency services		2	
Provides training to health service provinces		2	
Receives support from specialists from regional hospitals			
i)Paediatric		2.5	
ii)Obstetrics		2.5	
ii)Internal medicine		2.5	
iii)General surgery		2.5	
iv)Family physician		2.5	
	Total	345.5	**.282**
Regional Hospital			
Size: 200-800beds		500	
Time open: 24 hours		4	
General & clinical nurse primary health services		4	
In-patient, ambulance and emergency services		4	
Provide training to health service provinces		4	
Receives support from a specialist of a tertiary hospitals			
i)Paediatric		5	
ii)Obstetrics		5	
iii)Internal medicine		5	
iv)General surgery		5	
v)Family physician		5	
vi)Additional specialist service (orthopaedic, psychiatry, anaesthetics, radiology)		4	
	Total	545	**.445**
Tertiary Hospitals			
Size 400-800		600	
Open 24 hours		8	
General & clinical nurse primary health services		8	
In-patient, ambulance, and emergency services		8	
Provide training to health service provinces		8	
Receives support from the specialist of tertiary hospitals			
i)Paediatric		10	
ii)Obstetrics		10	
iii)Internal medicine		10	
iv)General surgery		10	
v)Family physician		10	
vi)Additional specialist service (orthopaedic, psychiatry, anaesthetics, radiology)		10	
vii)Intensive care services under the supervision of a specialist		8	
viii)Attached to a medical school		8	
	Total	708	**.578**
Central Hospitals			
1200 maximum beds		1000	
Open 24 hours		16	
General & clinical nurse primary health services		16	
In-patient, ambulance, and emergency services		16	
Provide training to health service provinces		16	
Receives support from specialists from tertiary hospitals			
i)Paediatric		16	
ii)Obstetrics		16	
iii)Internal medicine		16	
iv)General surgery		16	
v)Family physician		16	
vi)Additional specialist service (orthopaedic, psychiatry, anaesthetics, radiology)		16	
vii)Intensive care services under the supervision of a specialist intensivist		16	
viii)Attached to a medical school		16	
ix)Must Conduct Academic Research		16	
x) Extremely specialised intensive and expensive services (heart, lung transplant, bone marrow transplant, live, cochlear implants)		16	
	Total	1224	**1.000**

Step III: Adjustments for the distance to services, differences in the number of service centres per municipality, and other quality of service differences.

The following procedure was used to account for differences in the number of service centres per municipality, the distances to the nearest service, and other quality of service characteristics. The procedure was followed in column **A** to column **PB** of the Excel sheet **Facility Weights**.

- Population size and the number of facilities at each level were obtained from the 2011 South African census and the 2011 SAHS data sets. The served population for each clinic was derived by dividing the population size of the municipality of location by the number of clinics in the municipality. The served population of a district hospital was the population of the municipalities in the district of location. The served population for regional, central, and tertiary hospitals was the total population of all the municipalities in the respective province of location. For example, Umzimvubu municipality, located in Alfred Nzo district in the EC province, was recorded to have 38 clinics, 3 district hospitals located in Alfred Nzo District municipality, 3 regional hospitals within its province of location, 1 central hospital in its provincial location, and 2 tertiary hospitals in its provincial location (**FacilityWeights** sheet in row number **7**). The municipality had a population size of 191 562 people. The study assumed that providing healthcare to international migrants did not pose significant effects on the level of services rendered.

- Calculation of the average service percentage scores for facilities of the same level within each service area: Umzimvubu municipality, which had 38 clinics, was allotted a service quality score of the average scores of the 38 clinics (clinics with missing data were excluded from the average score calculation) to obtain an average of 41 percent (**HealthIndex** Excel sheet in cell **S21**). The same principles were applied to obtain the district, regional, central, and tertiary level average percentages.

  Note: Facility scores were obtained from a comprehensive appraisal of facilities by the South African DoH to cover facility performances in terms of a range of indicators of the quality of facilities, human resources, and consumer service scores (Chapter 5).

- Service level scores were multiplied by the quality-of-service score to adjust the weight for the quality of service rendered at each facility. For service centres located outside municipality boundaries, the distance factors (**FacilityWeights** sheet in columns **AL: FB**) were used to adjust the facility weights for the distance travelled for services. The adjustment factor was based on the normalised distances travelled to other municipalities for services. Longer distances travelled resulted in a larger reduction of the initial facility weight.

Step IV

The population size and the number of health centres per municipality were adjusted by standardising to the area of rural municipalities (cells **H18: H251** in the **HealthIndex** sheet). Standardisation was done to ensure that observed differences did not result from area differences.

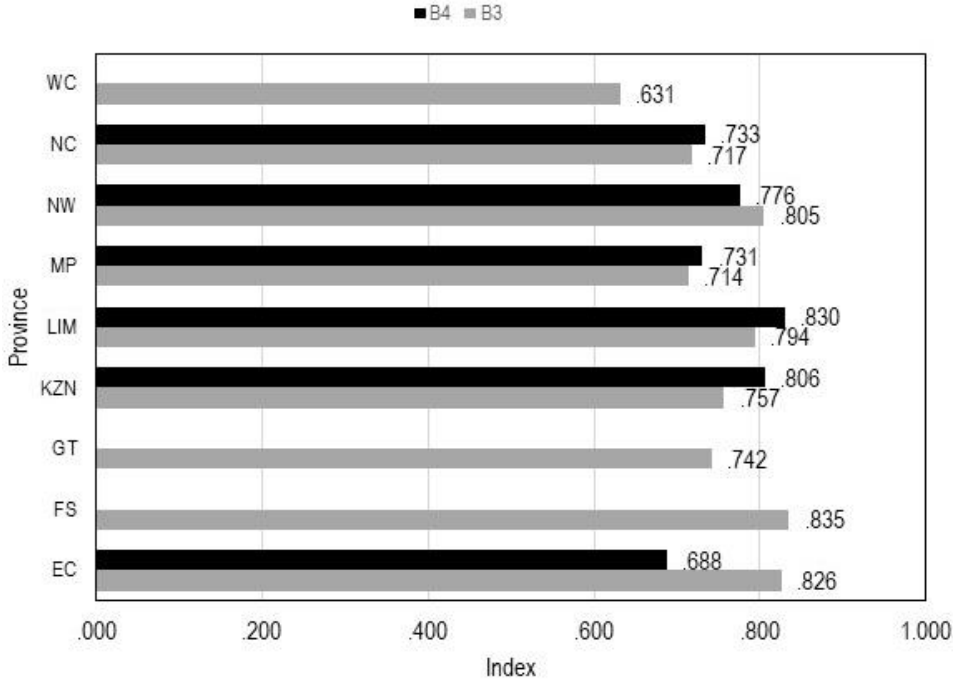
Step V

The population sizes obtained from *IV*) were divided by the number of centres obtained from *IV*) to get the population served per health centre (**HealthIndex** sheet in range **AM: AQ251**).

Step VI

The arithmetic mean was calculated from the populations served per centre (*V*) and the weights iii) to obtain a raw index. The raw index values were then normalised to obtain the final accessibility measure for each municipality.

Figure 12.6 Average Rural Healthcare Accessibility Index per Province



Data Sources: Code for South Africa (2018b) and STATS SA (2011)

Figure 12.7 Spatial Distribution of the Health Services Indexes

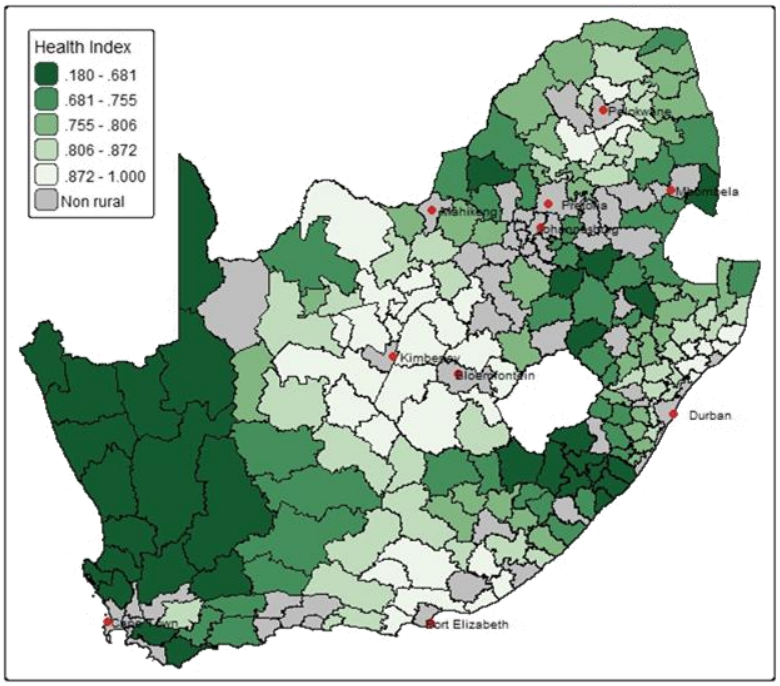
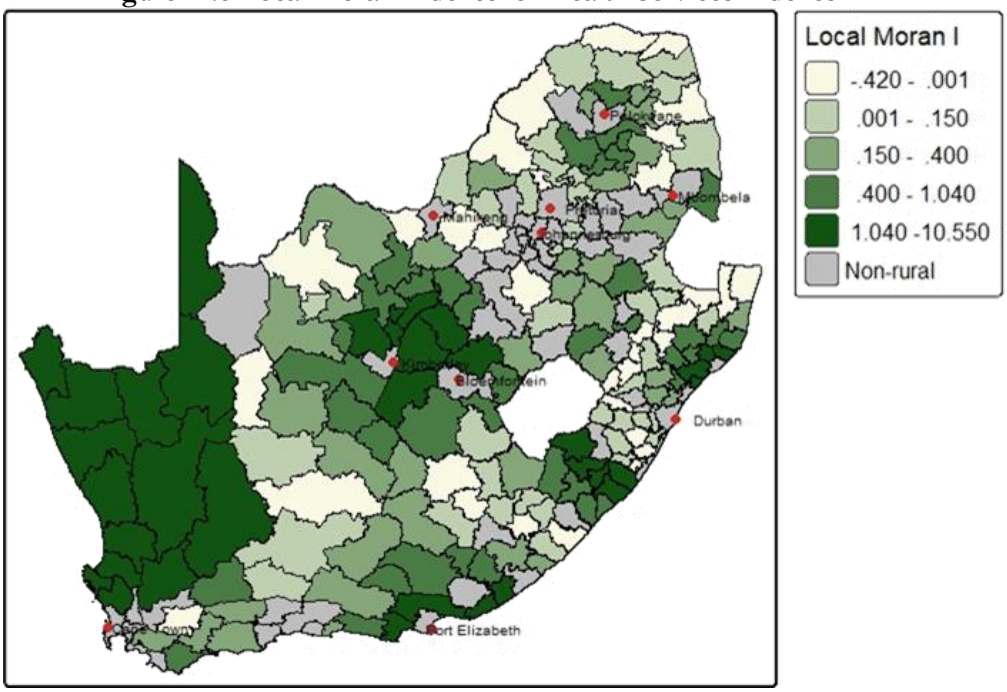


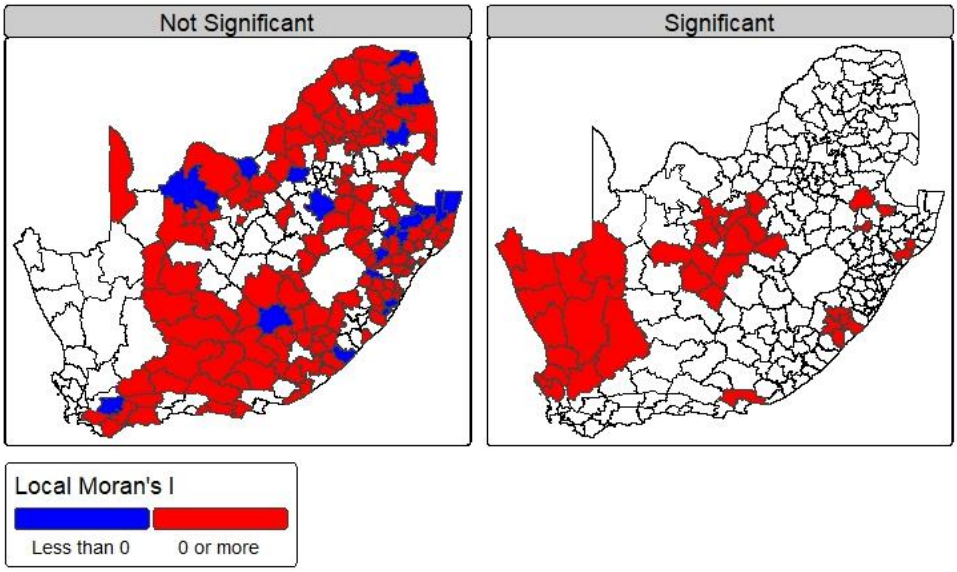
Figure 12.8 Local Moran Indexes for Health Services Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 13.973, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.728290649      -0.005524862       0.002757934
```




```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       146        0.300          0.171      0.417      -0.452        2.50       0.414
2 Significant            36        2.47           1.48       2.55        0.0229       11.8        1.98
```

Figure 12.9 Autocorrelation Scatter Plot of Moran Indexes for Health Services Indexes

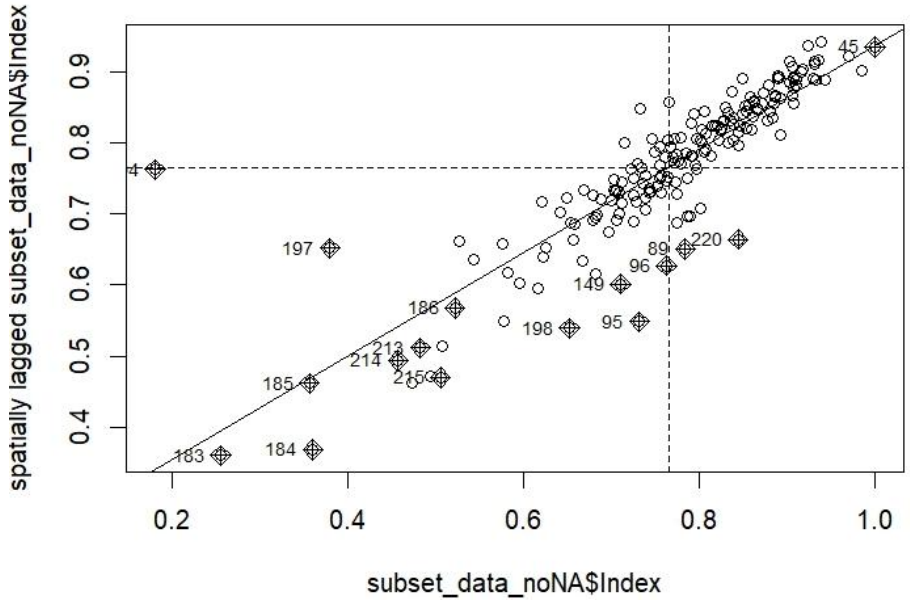
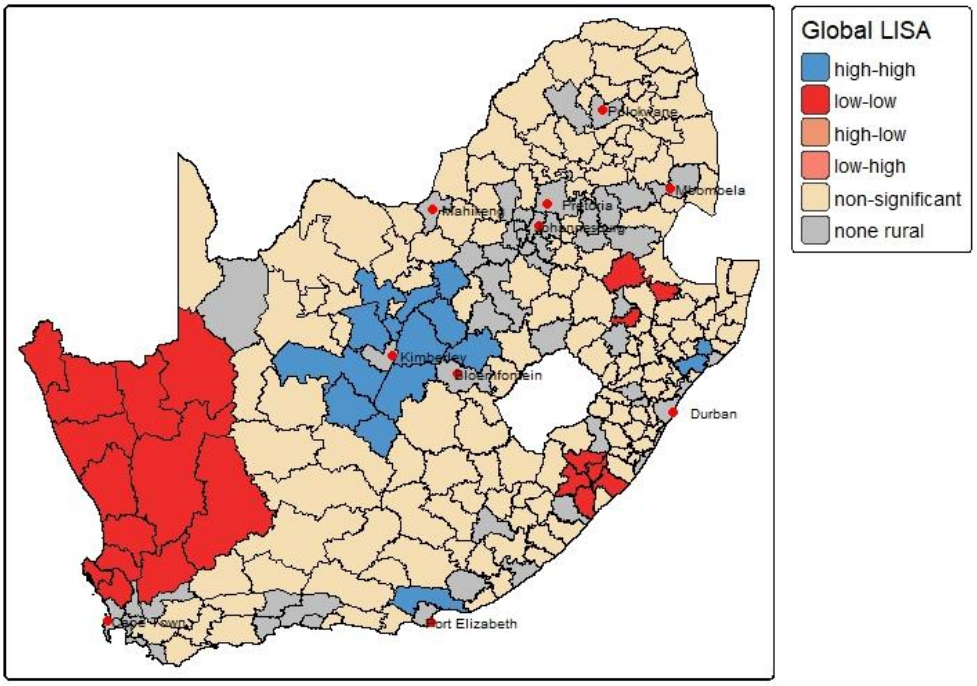


Figure 12.10 LISA Clusters for Health Services Indexes




```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.72829, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.8 APPENDIX H: Basic Education Services Indexes

Data for Education indexes were obtained from the South African DoE's EMIS website (https://www.education.gov.za/Programmes/EMIS/EMISDownloads.aspx). The information utilised from the data were on the number of teachers and learners at each learning centre per municipality. Four main categories of schools were present in the data (primary, intermediate, combined, and high schools). Intermediate schools were treated as combined schools. The following components were found to be ideal for representing rurality in the schools' index (Section 2.1.3.2):

i. The ratio of qualified teachers in relation to the learners.
ii. Average distances travelled for schooling by learners.
iii. Access to services at the schools (water, sanitation, electricity).
iv. School security in the form of school perimeter fencing and other security devices.
v. Science and technology education in the form of science laboratories, computer laboratories, and human resources.
vi. Access to sports and recreation facilities.
vii. Access to communication networks as represented by access to the Internet.
viii. Availability of vocational training services and the adoption of context-specific curricula.
ix. Age-focused learning (i.e., exclusive focus on one of primary or secondary schooling).

The following steps were taken in producing the measures (**Education_2011** sheet in the **SouthAfrica_RI** Excel file):

Step I: Data and Imputation.

The available data could only cater for calculating student-to-teacher ratios. District and provincial-level data were used to impute data for municipalities with missing data.

Step II: Allocation of Weighting.

Subjective weights were allocated for primary, combined, and secondary schools. Combined schools were assigned weight values of .750 to account for the fact that primary and secondary schools had age-focused curricula and low learner numbers, and thus more easily manageable. Primary and secondary schools were each allotted a weight of 1.000.

Step III: Overall Teacher-to-Student Ratios

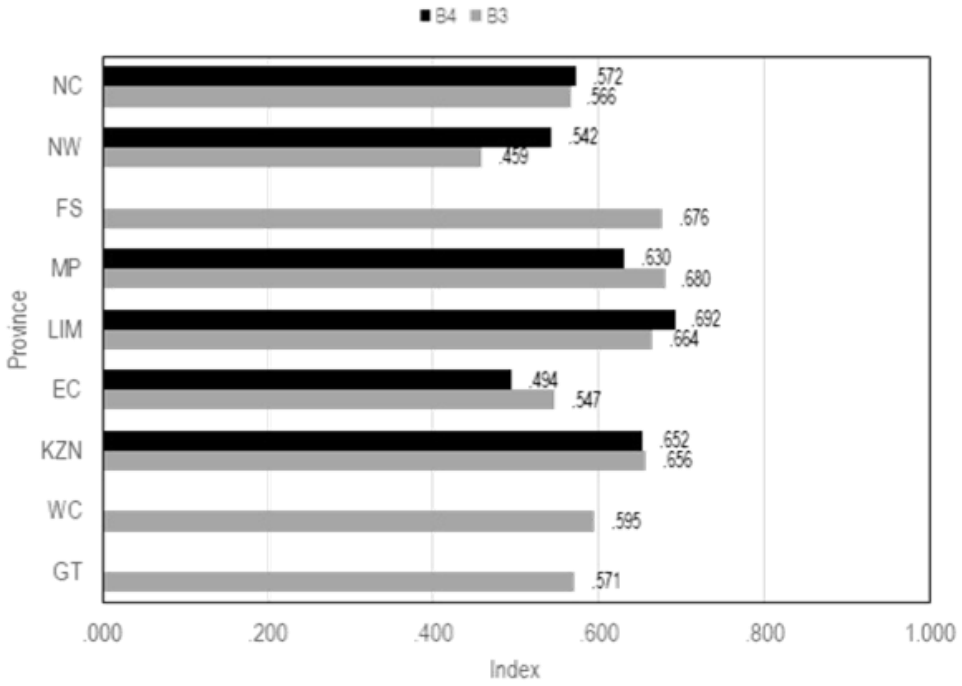
The overall teacher-to-student ratios were calculated as weighted means by using the weights found in *Step II*.

Step IV: Final Index

The values from *III* were normalised to obtain the final index measure values for the municipalities.

Note: To achieve greater accuracy and given the availability of data, the missing variables numbered i) to ix) can be included by normalising (Section 12.3.4) the scores of each variable per municipality and by calculating the weights (Section 12.3.5) for each variable before aggregation.

Figure 12.11 Average Basic Education Indexes Per Province



Data Source: DBE (2018) and STATS SA (2011)

Figure 12.12 Spatial Distribution of Basic Education Services Indexes

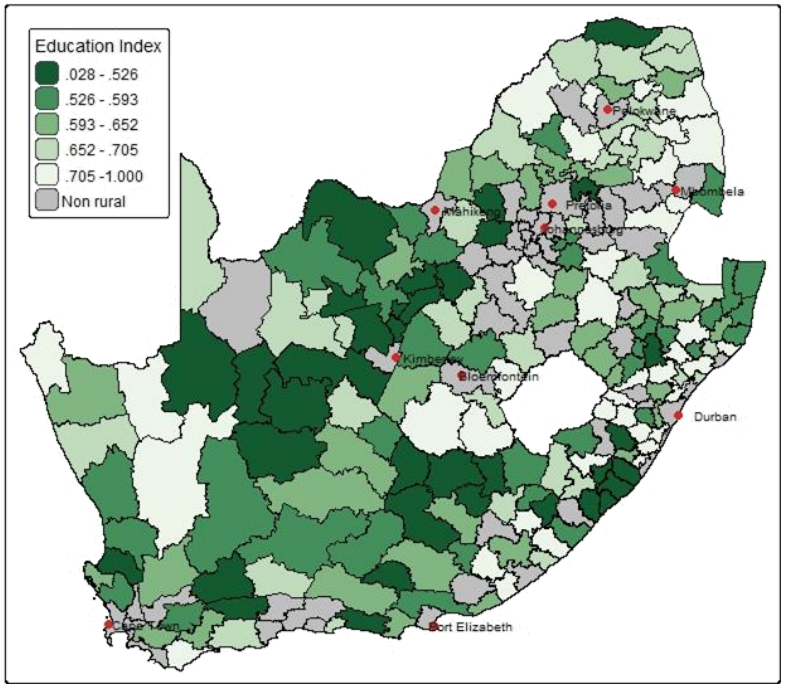
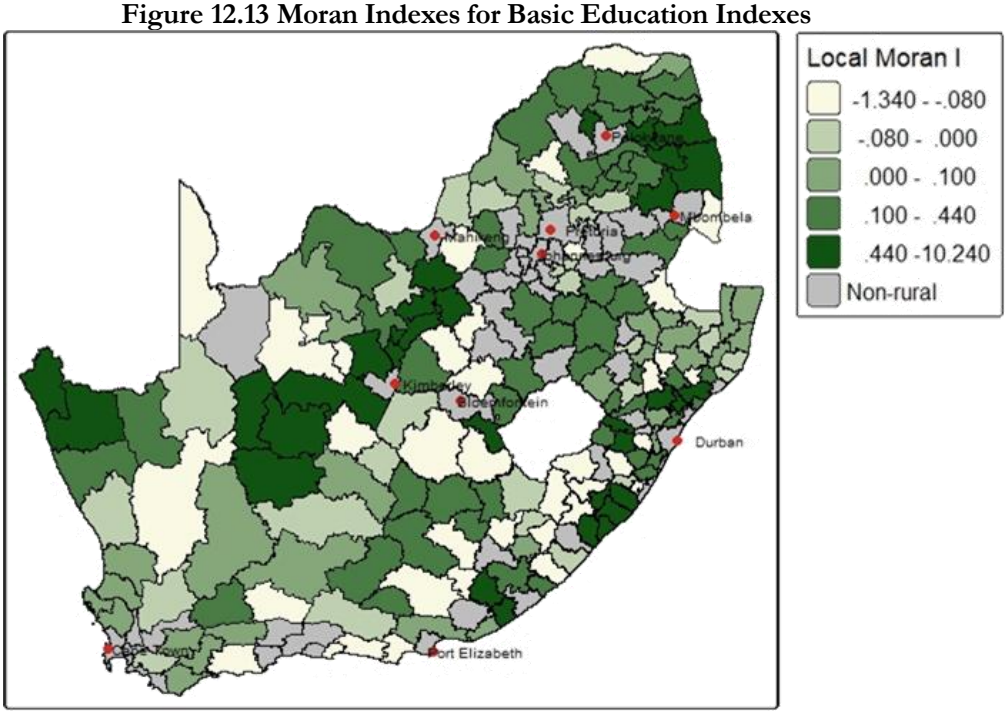


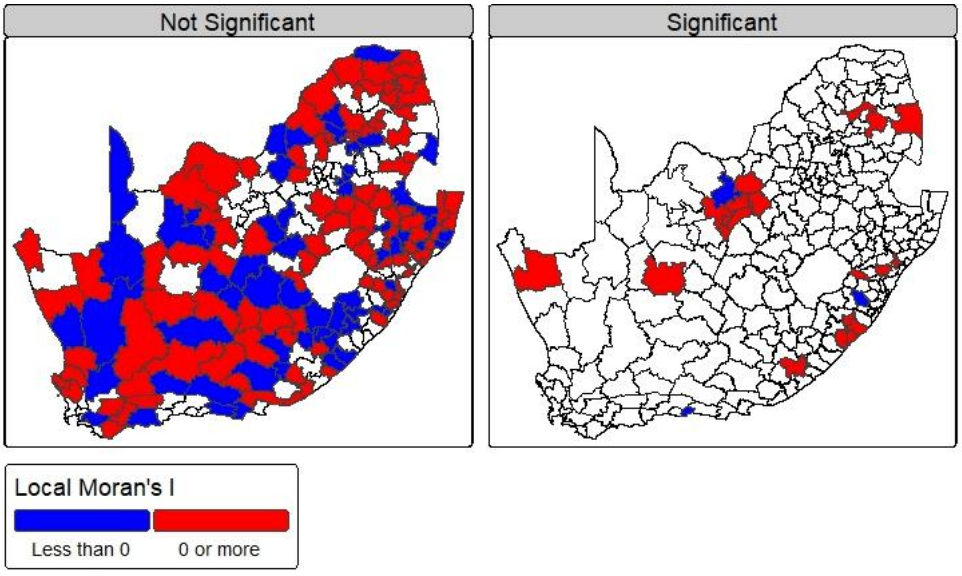
Figure 12.13 Moran Indexes for Basic Education Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 6.5587, p-value = 2.713e-11
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.339601272      -0.005524862       0.002768943
```

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Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>      <dbl>      <dbl>       <dbl>
1 Not Significant       159        0.118         0.0405      0.357     -0.792       2.07       0.290
2 Significant            23        1.87          0.724       3.04      -1.30       10.7        1.88
```

Figure 12.14 Autocorrelation Scatter Plot of Moran Indexes for Basic Education Indexes

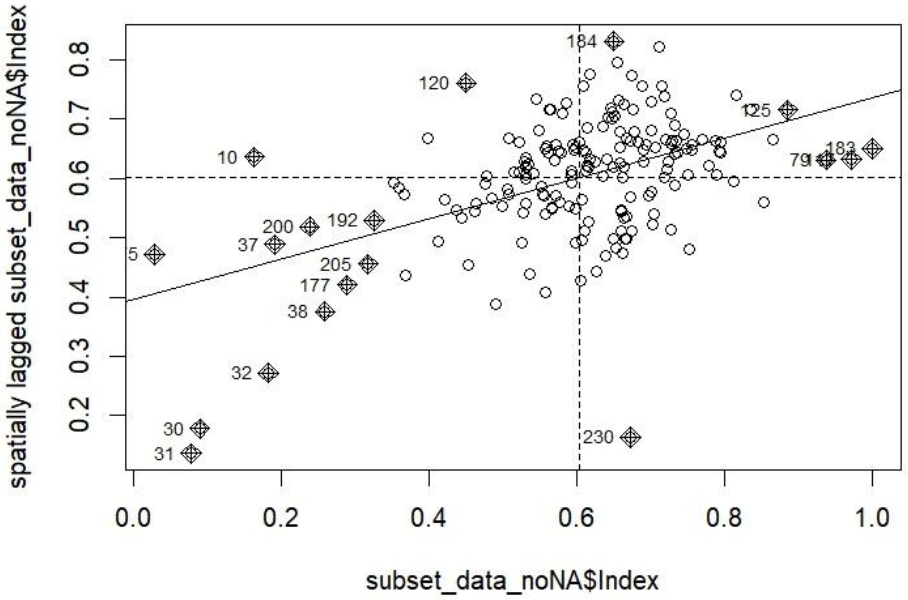
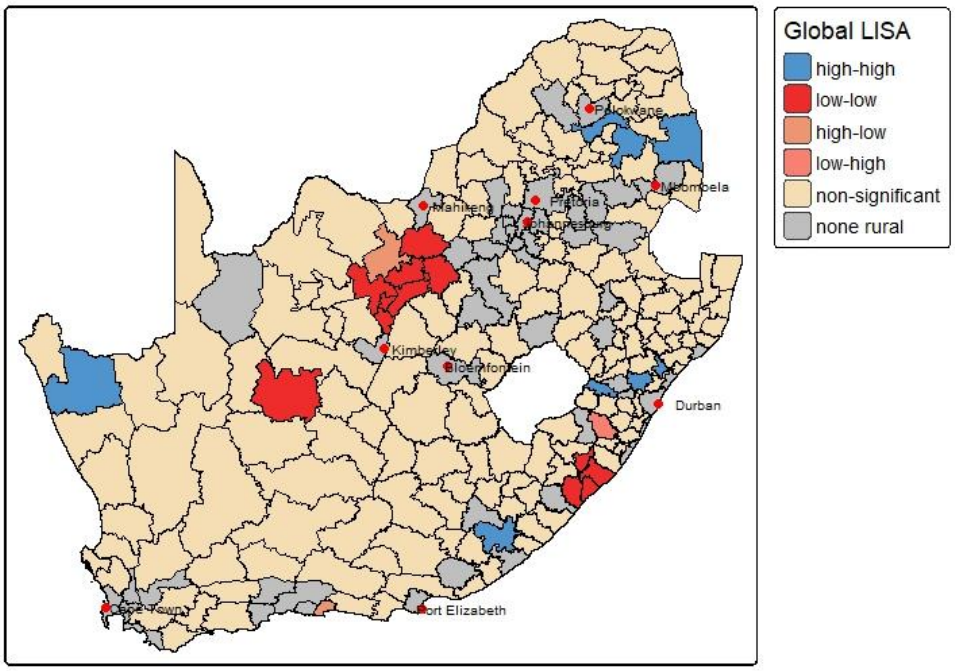


Figure 12.15 LISA Clusters for Basic Education Indexes



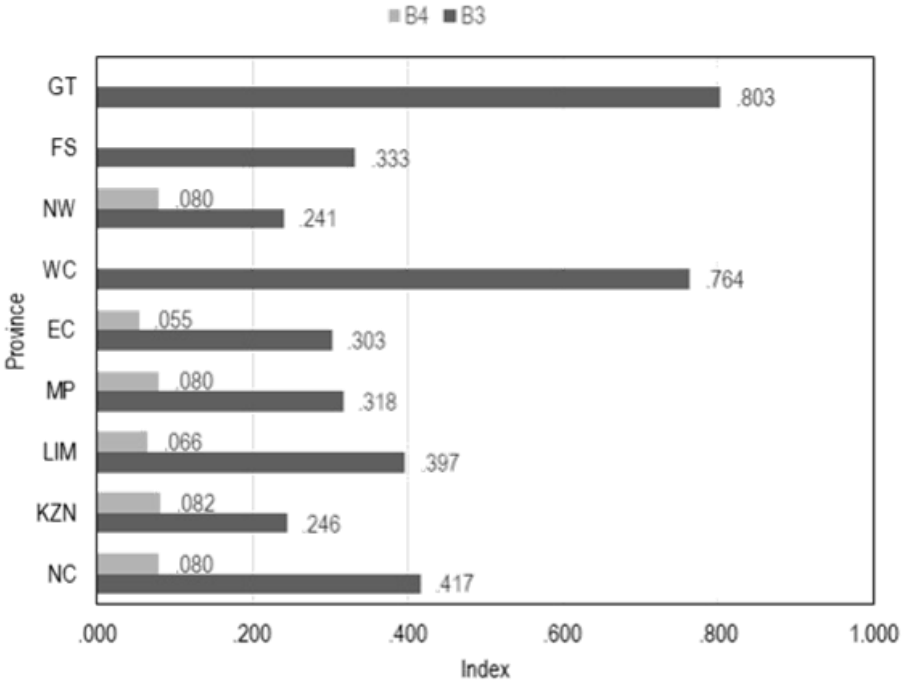

```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.3396, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.9 APPENDIX I: Water Indexes

Figure 12.16 Average Piped Water Accessibility Indexes per Province



Data Source: STATS SA (2011)

Note: The data were standardised to disregard municipality population size differences. WC, GT, and FS provinces did not have B4 areas.

Figure 12.17 Spatial Distribution of Water Access Indexes

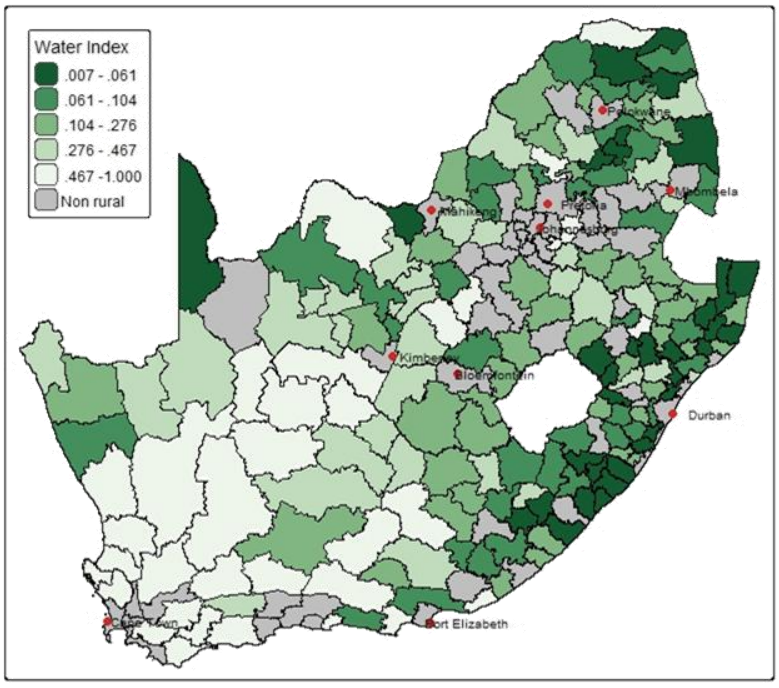
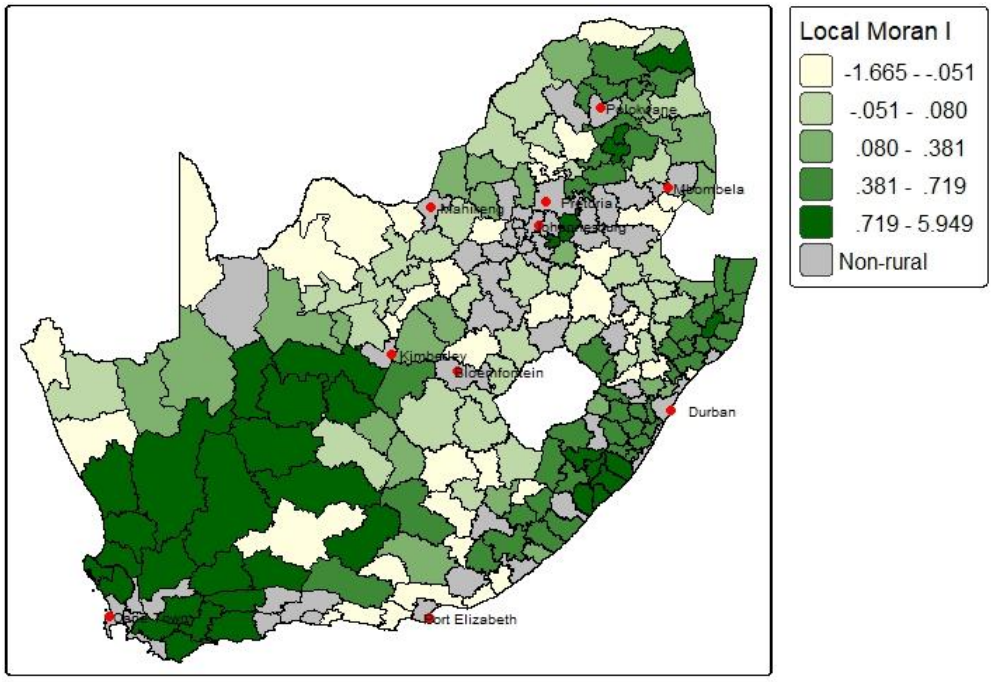


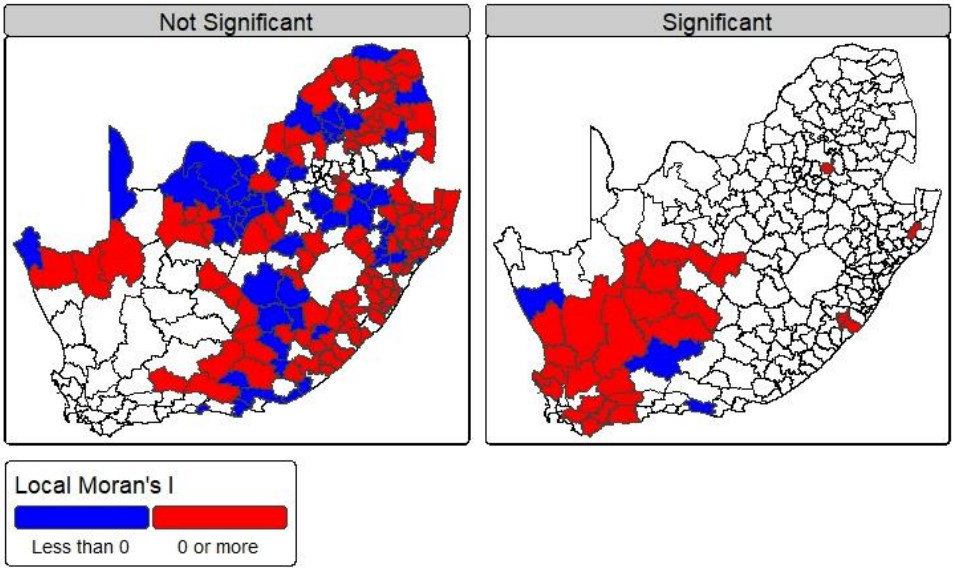
Figure 12.18 Moran Indexes for Water Access Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 10.036, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.525917917      -0.005524862       0.002804083
```

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Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>       <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       153        0.192          0.133       0.436       -1.75        1.72       0.506
2 Significant            29        2.29           1.77        2.08        -1.30        6.53       3.41
```
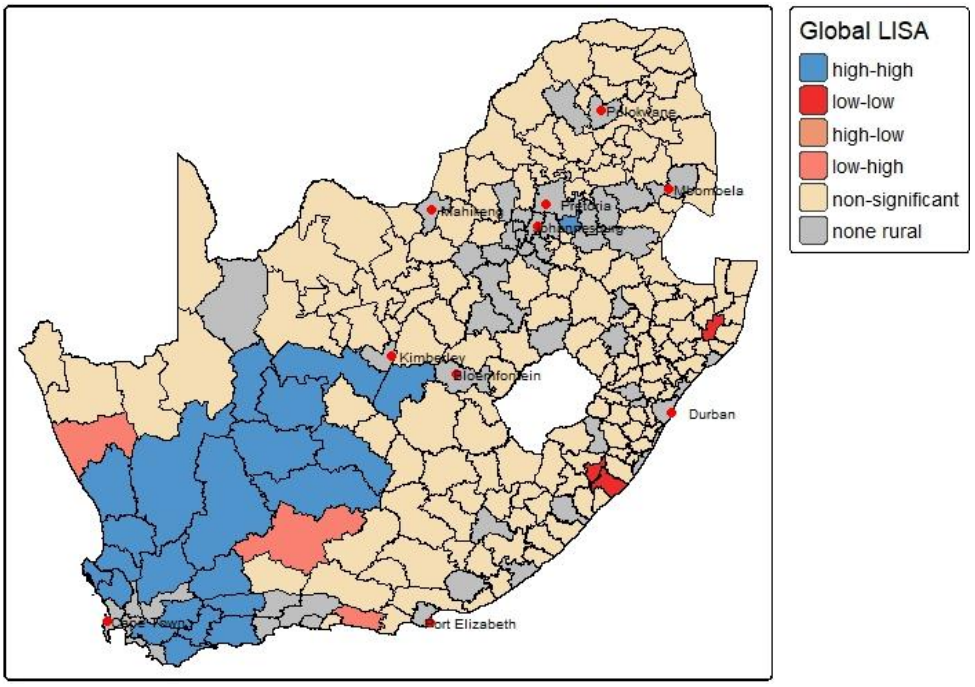
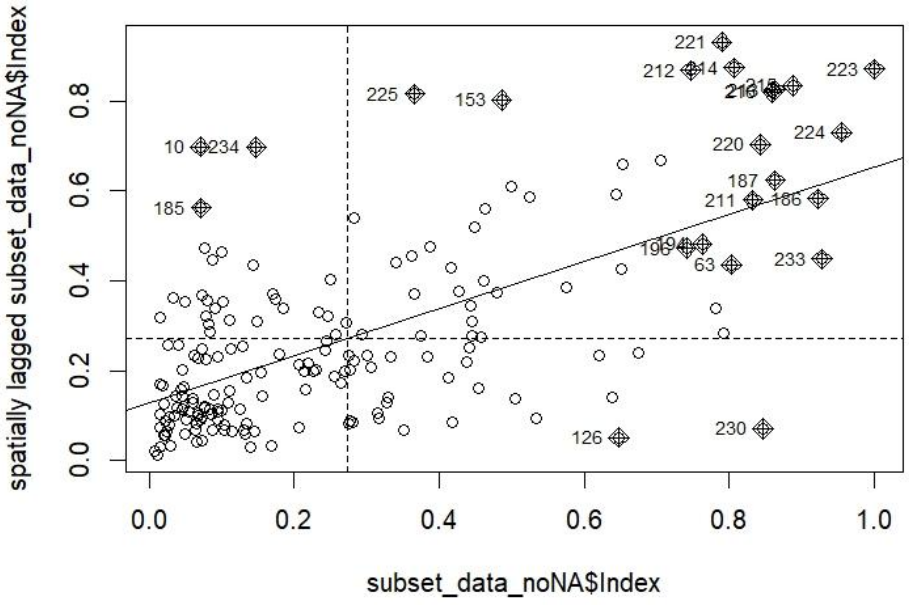

Figure 12.19 LISA Clusters for Water Indexes



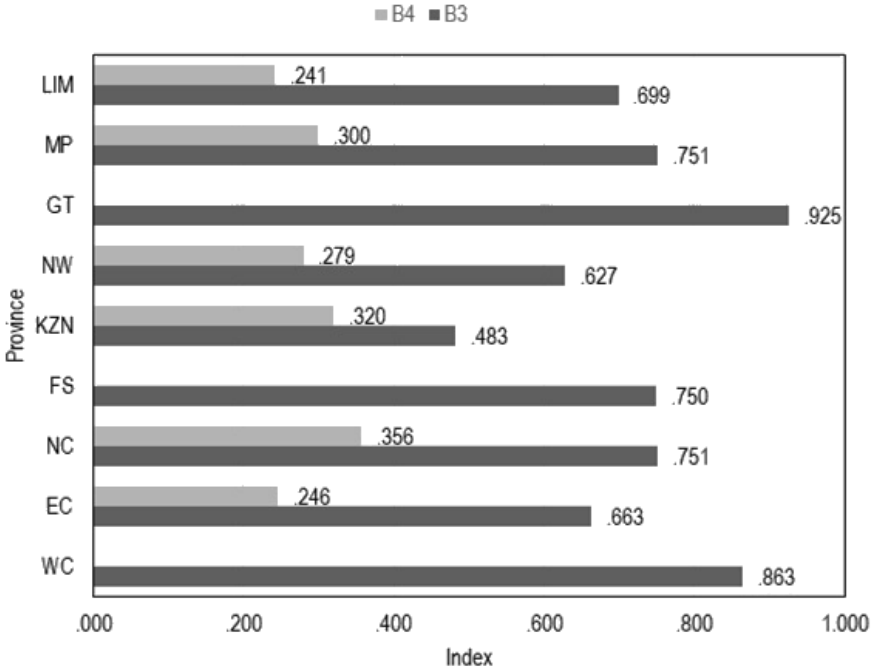

```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.52592, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

Figure 12.20 Autocorrelation Scatter Plot of Water Accessibility Indexes



12.10 APPENDIX J: Sanitation Indexes

Figure 12.21 Average Sanitation Accessibility Index per Province



Data Source: STATS SA (2011)

Note: The data were standardised to disregard the population size differences of municipalities

Figure 12.22 Spatial Distribution of Sanitation Indexes

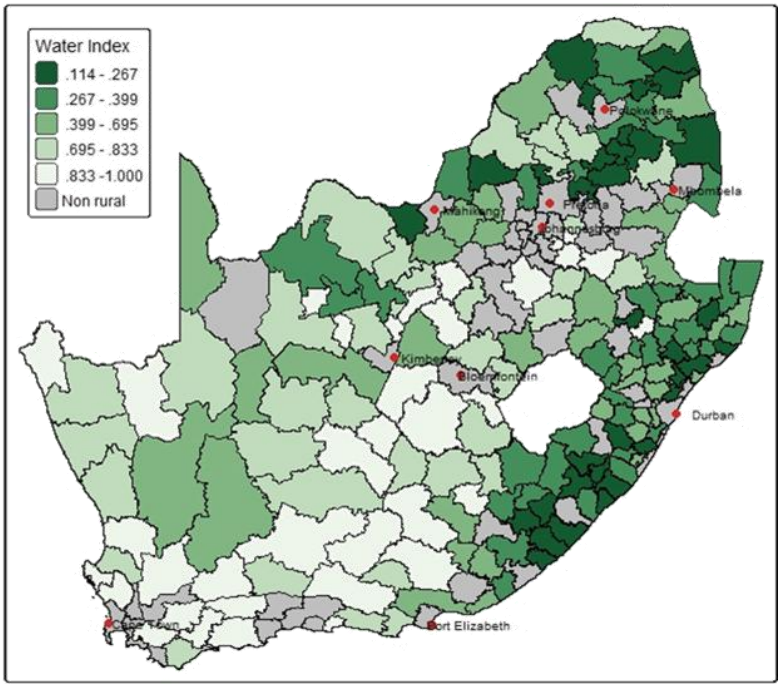
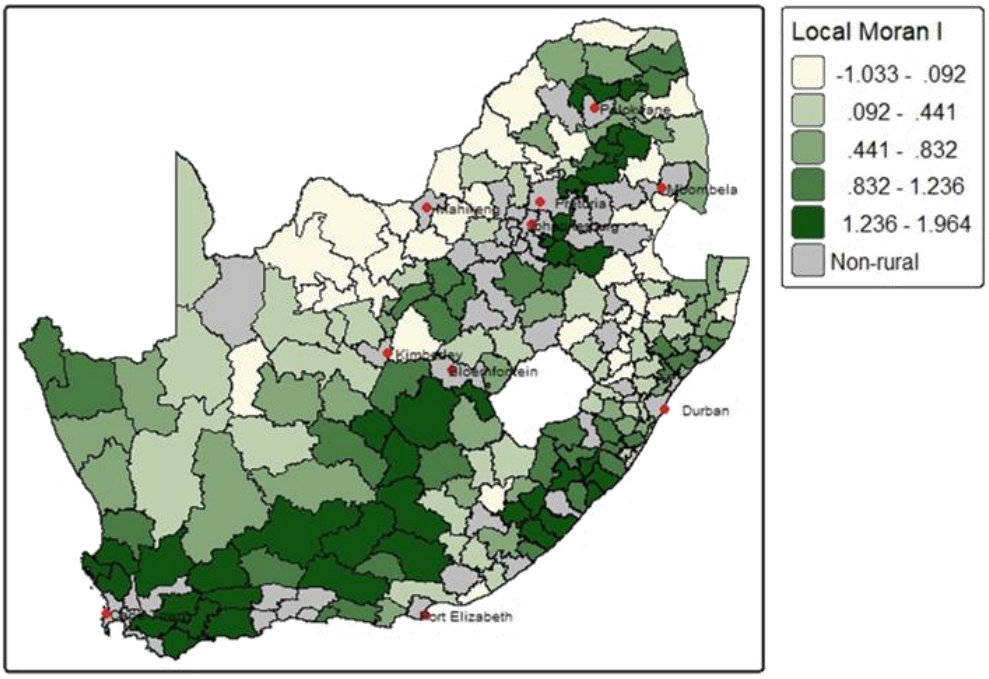
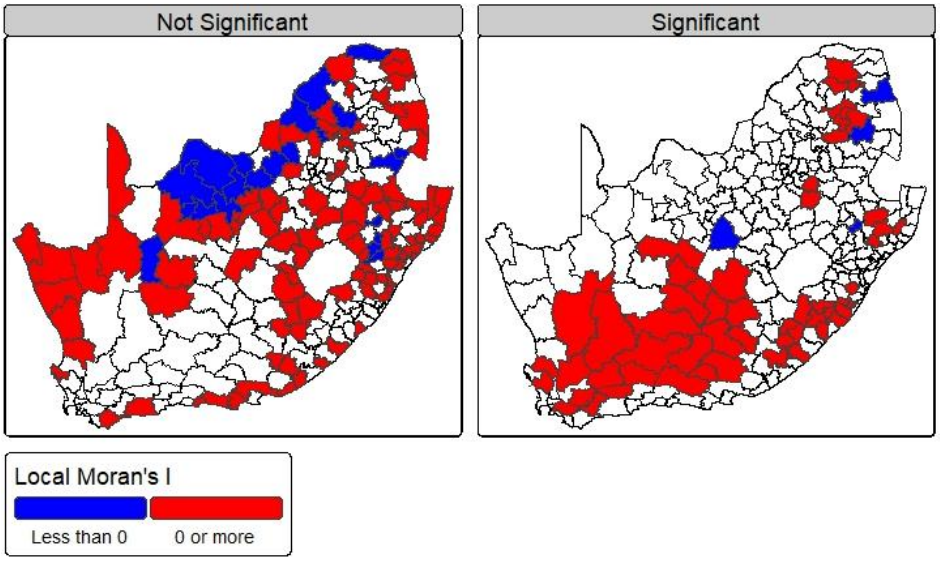


Figure 12.23 Moran Indexes for Sanitation Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 12.284, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.648038301      -0.005524862       0.002830765
```




```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       123        0.477          0.402      0.552      -0.705        2.03       0.758
2 Significant            59        1.00           1.23       0.636      -1.04         2.11       0.626
```

Figure 12.24 Autocorrelation Scatter Plot for Sanitation Indexes

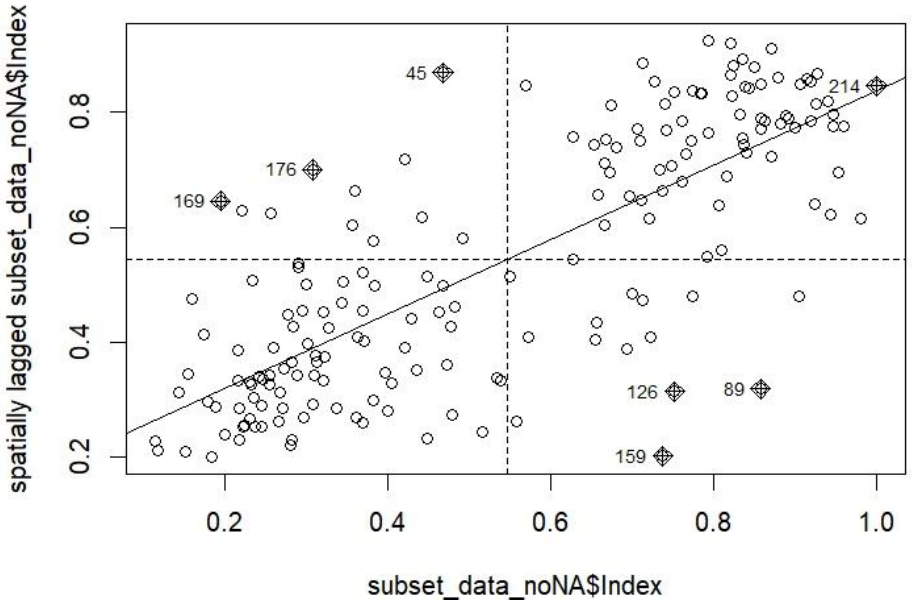
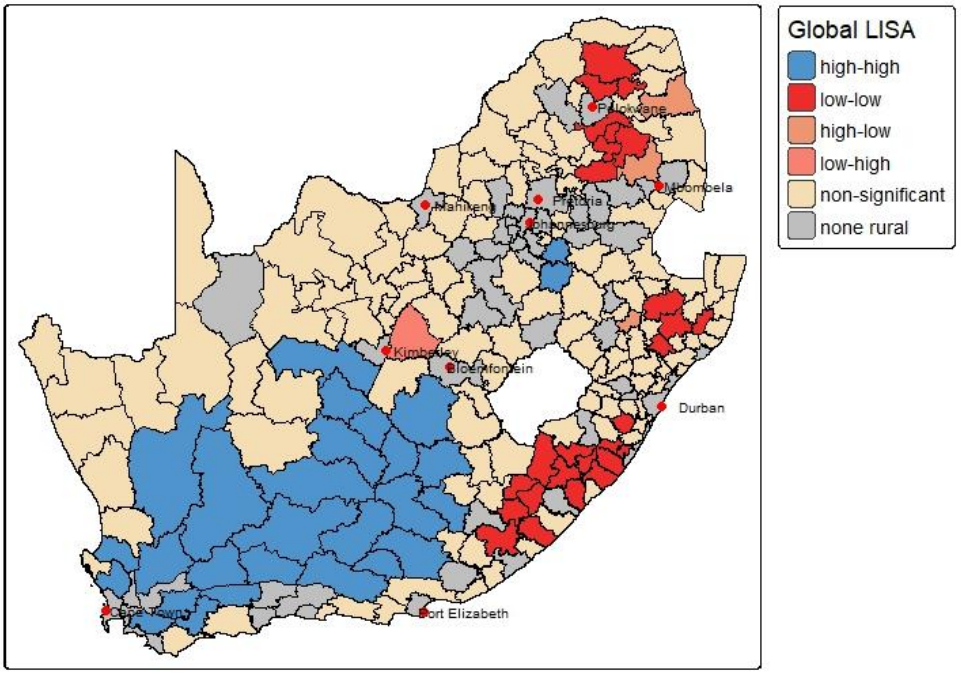


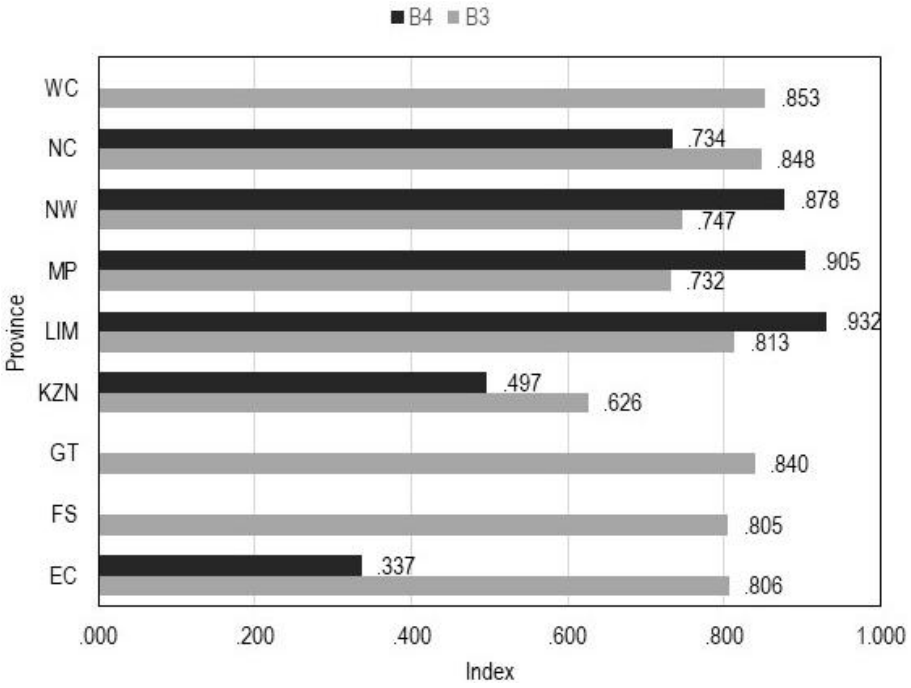
Figure 12.25 LISA Clusters for Sanitation Indexes




```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.64804, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.11 APPENDIX K: Formal Housing Indexes

Figure 12.26 Average Formal Housing Indexes per Province



Data Source: STATS SA (2011)

Note: The data were standardised to disregard the population size differences of municipalities

Figure 12.27 Spatial Distribution of Formal Housing Indexes

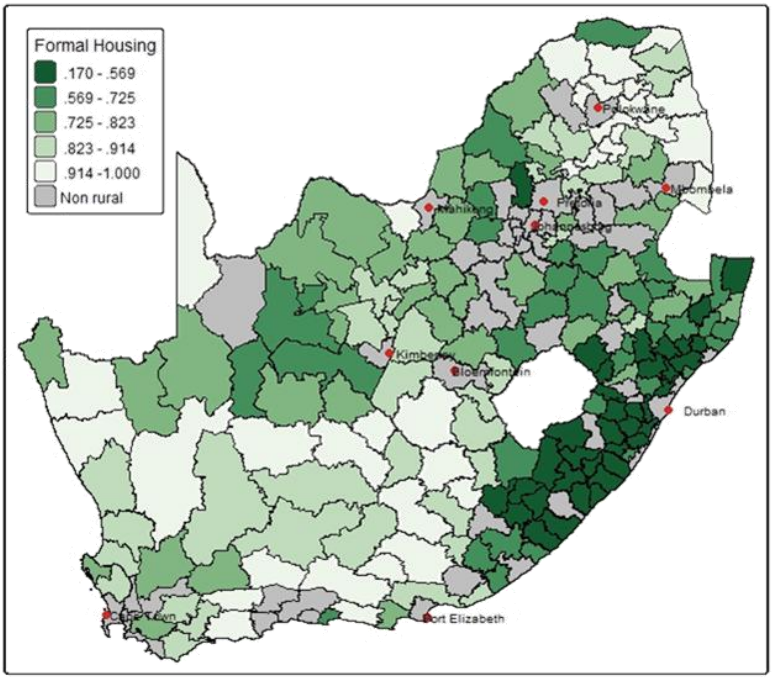
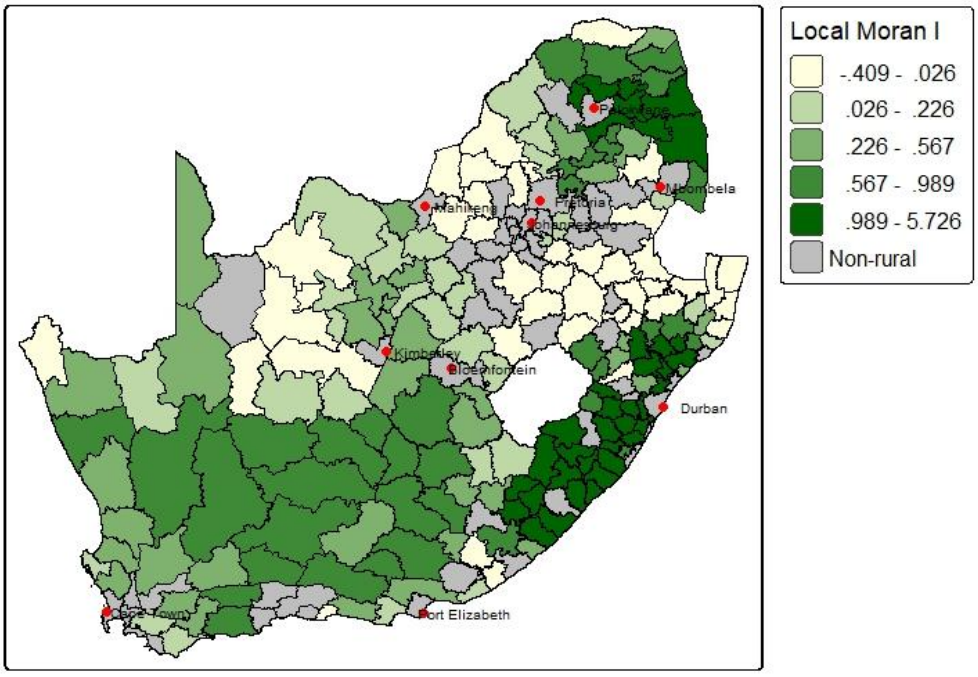
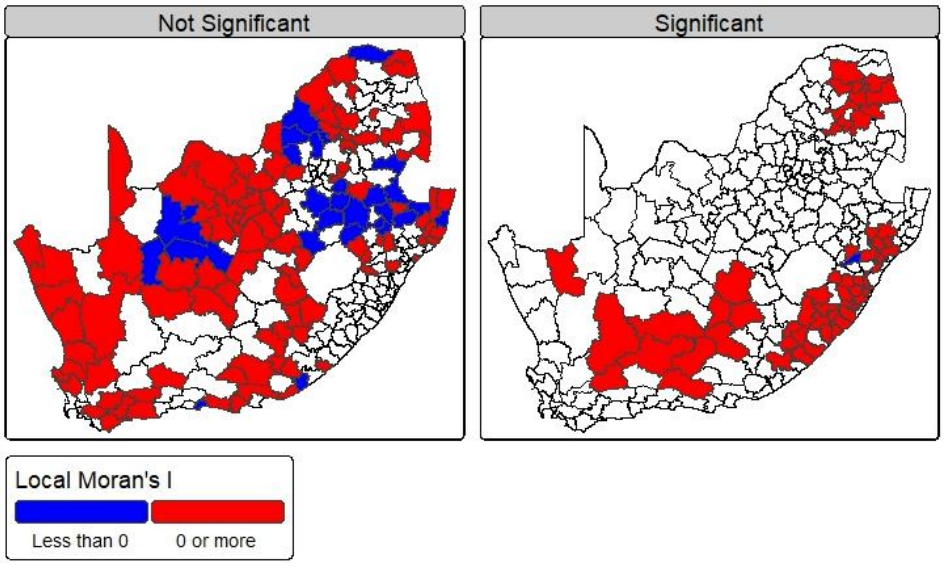


Figure 12.28 Moran Indexes for Formal Housing Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 15.363, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.808206471      -0.005524862       0.002805654
```




```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       125        0.286          0.200      0.347      -0.414        1.36       0.500
2 Significant            57        1.95           1.16       1.58       -0.119        5.74       2.41
```

Figure 12.29 Spatial Autocorrelation Scatter Plot for Formal Housing Indexes

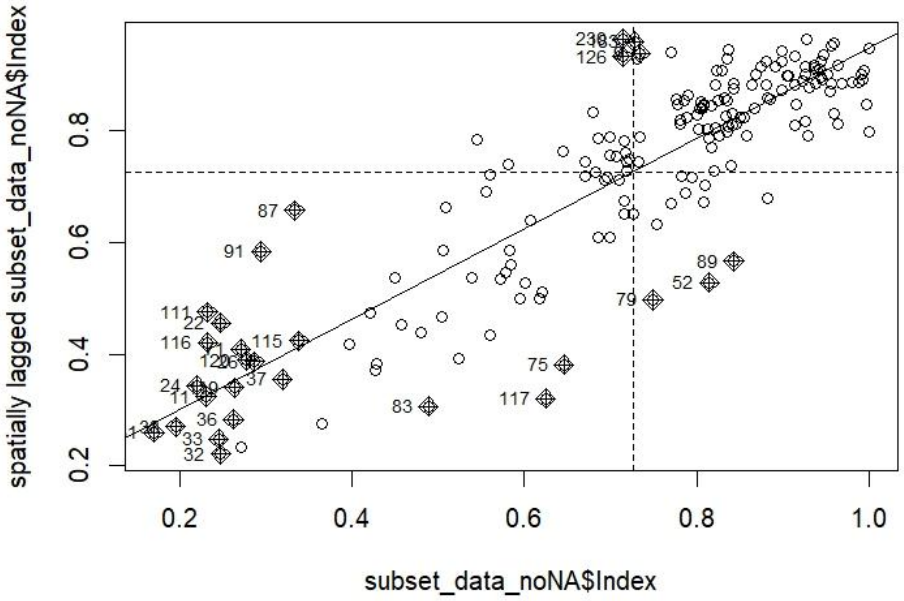
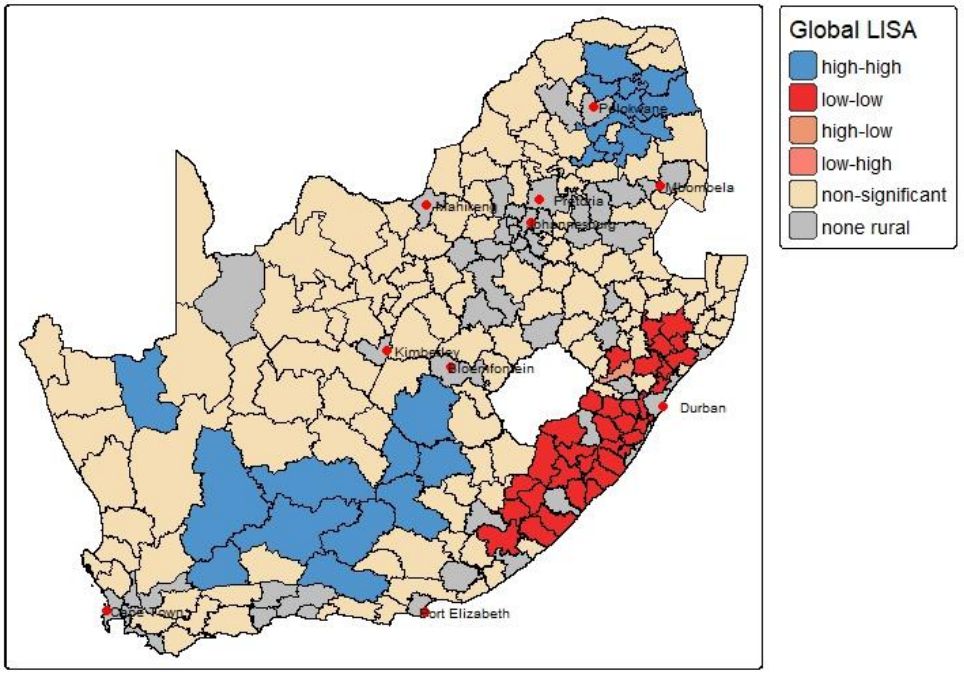


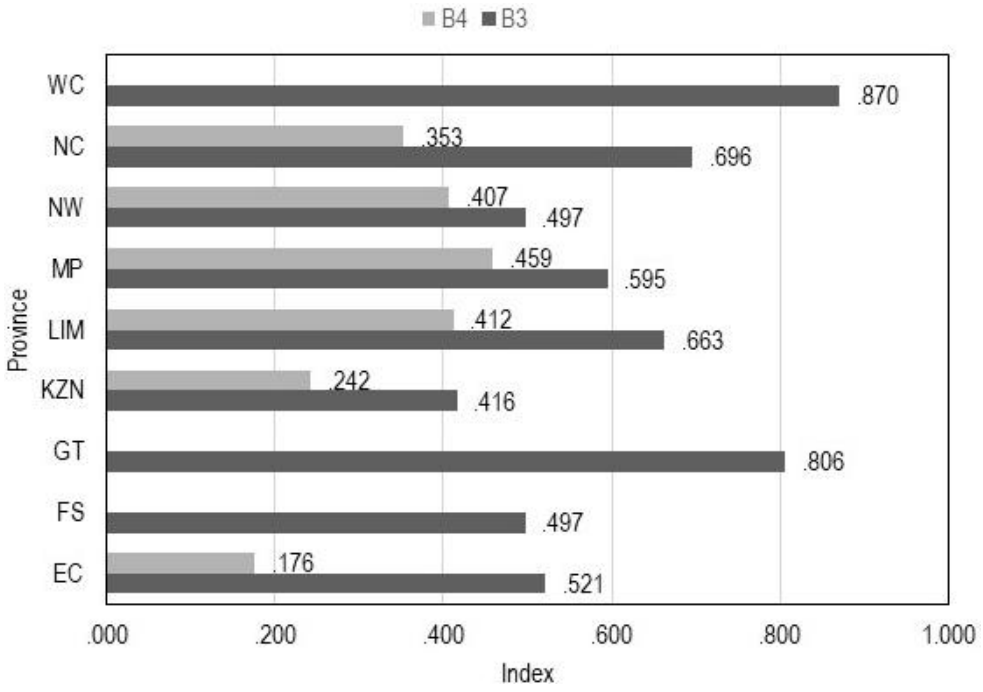
Figure 12.30 LISA Clusters for Formal Housing Indexes




```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.80821, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.12 APPENDIX L: Electricity Indexes

Figure 12.31 Average Electricity Accessibility Indexes per Province



Data Source: STATS SA (2011)

Figure 12.32 Spatial Distribution of Electricity Accessibility Indexes

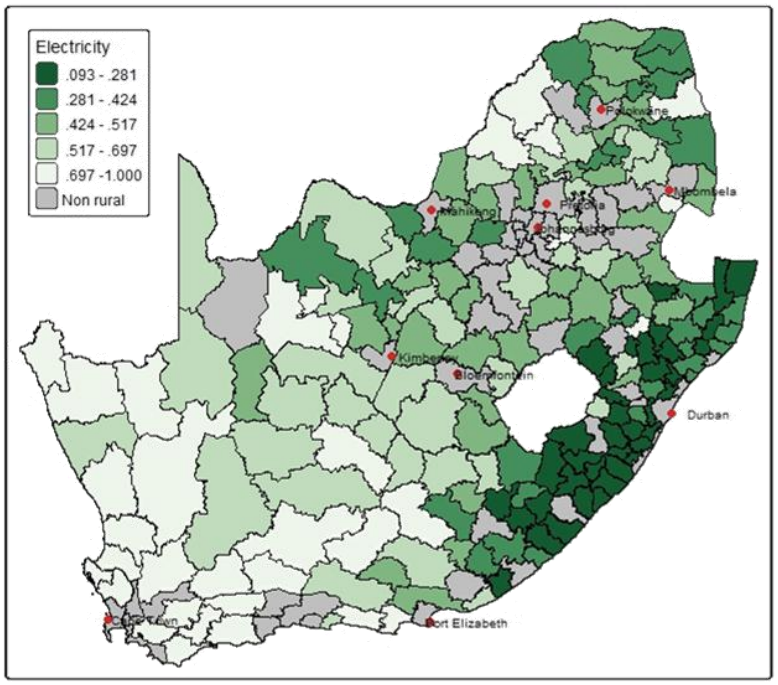
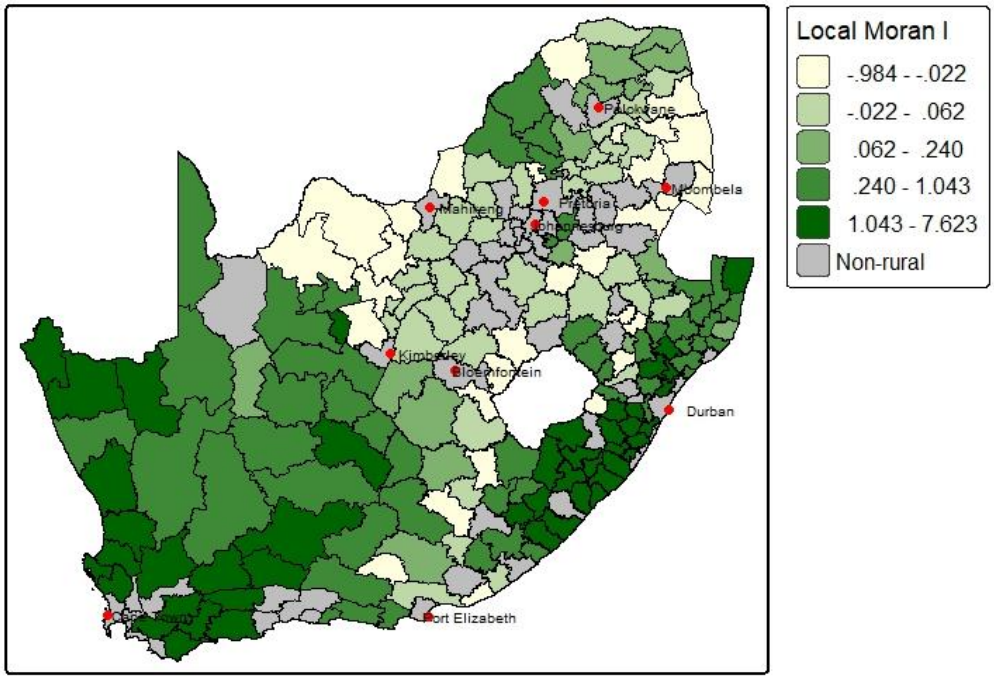
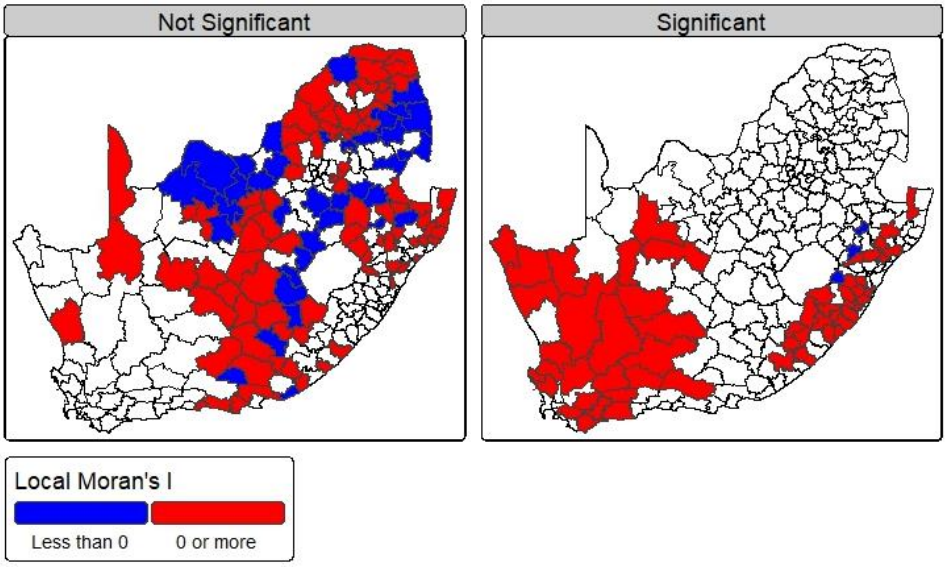


Figure 12.33 Moran Indexes for Electricity Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 13.605, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.716446711      -0.005524862       0.002815942
```




```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       124        0.266         0.0568       0.440      -0.454        2.03       0.551
2 Significant            58        1.68          1.57         1.24       -1.06         5.00       1.33
```

Figure 12.34 Autocorrelation Scatter Plots for Electricity Indexes

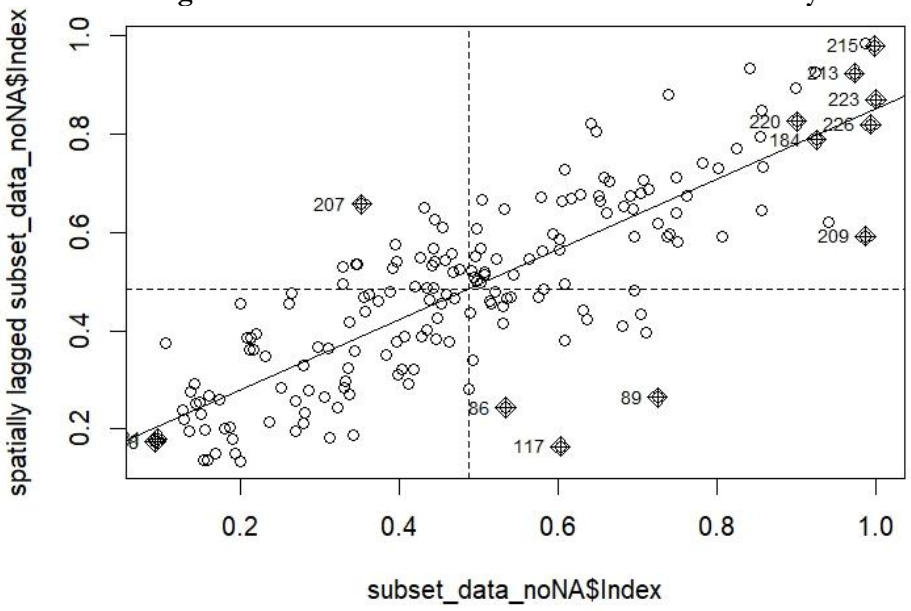
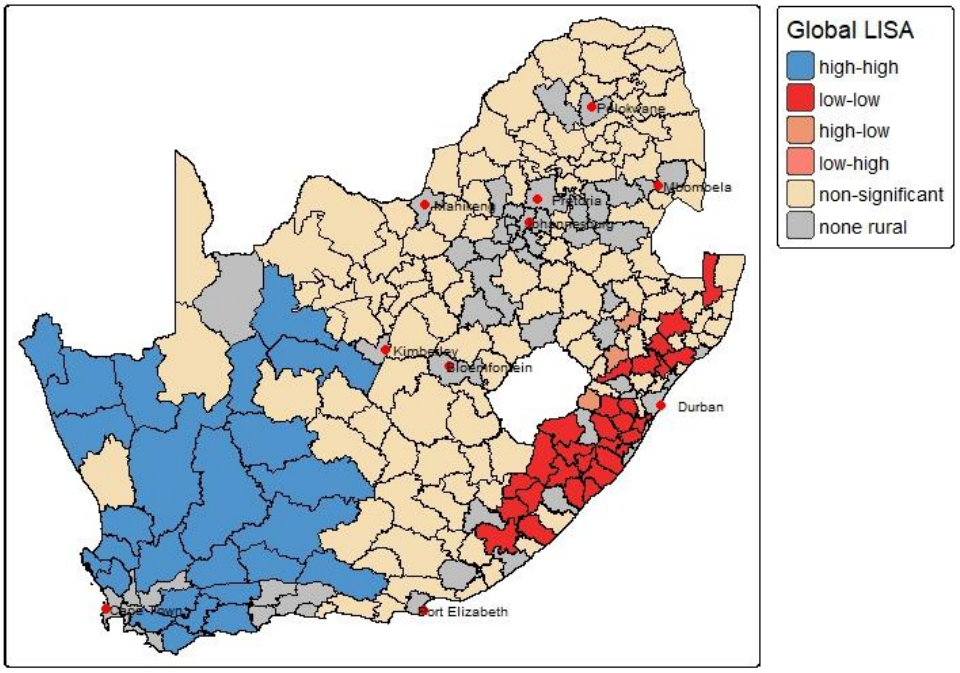


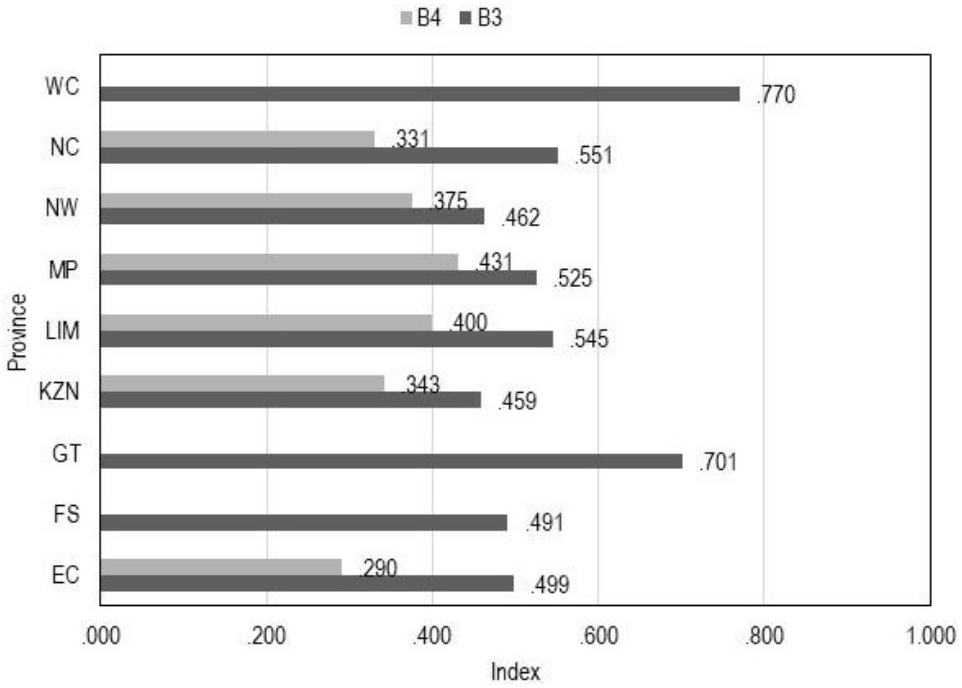
Figure 12.35 LISA Clusters for Electricity Accessibility Indexes




```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.71645, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.13 APPENDIX M: ICT Indexes

Figure 12.36 Average ICT Accessibility Index per Province



Data Source: STATS SA (2011)

Figure 12.37 Spatial Distribution of ICT Indexes

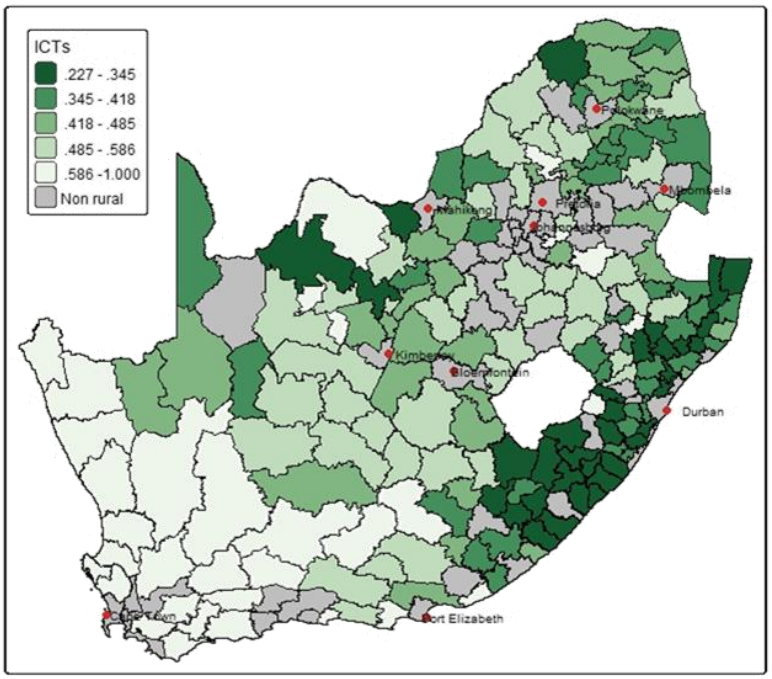
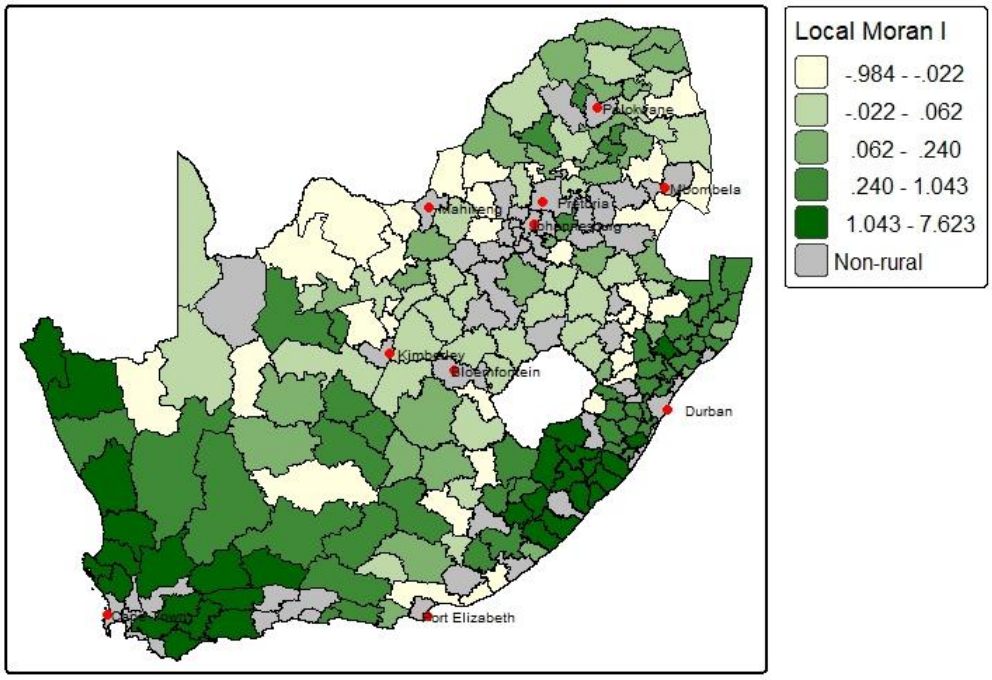
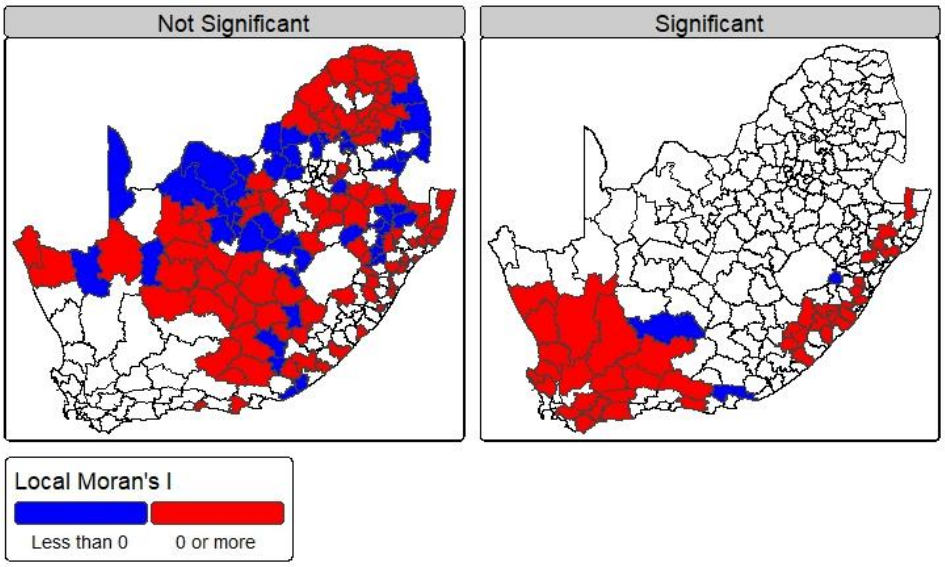


Figure 12.38 Moran Indexes for ICT Indexes




```
        Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 11.559, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.605130333      -0.005524862       0.002790982
```




```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>       <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       139        0.186         0.0689       0.464      -0.842        2.88       0.297
2 Significant            43        1.96          1.35         2.11       -1.08         8.20       1.32
```

Figure 12.39 Autocorrelation Scatter Plots for ICT Indexes

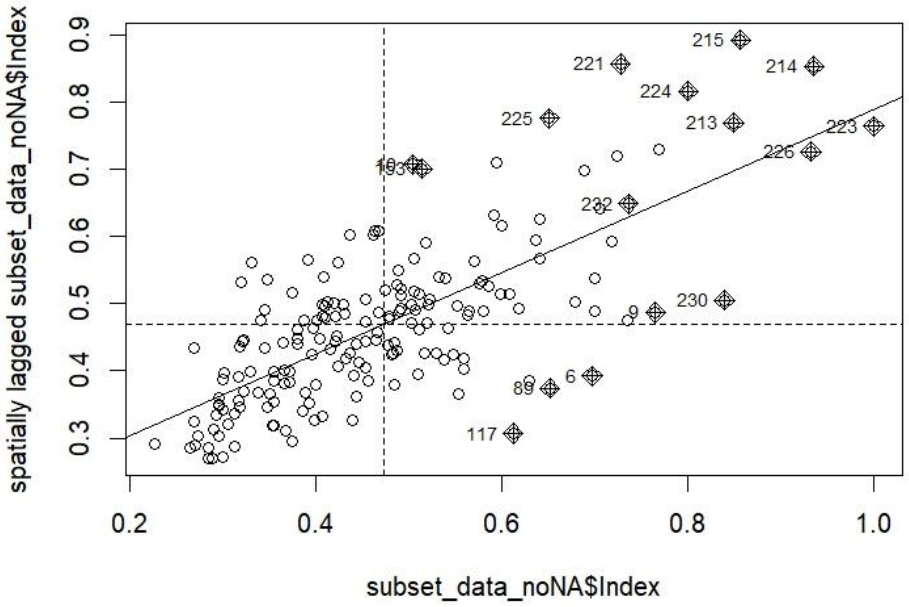
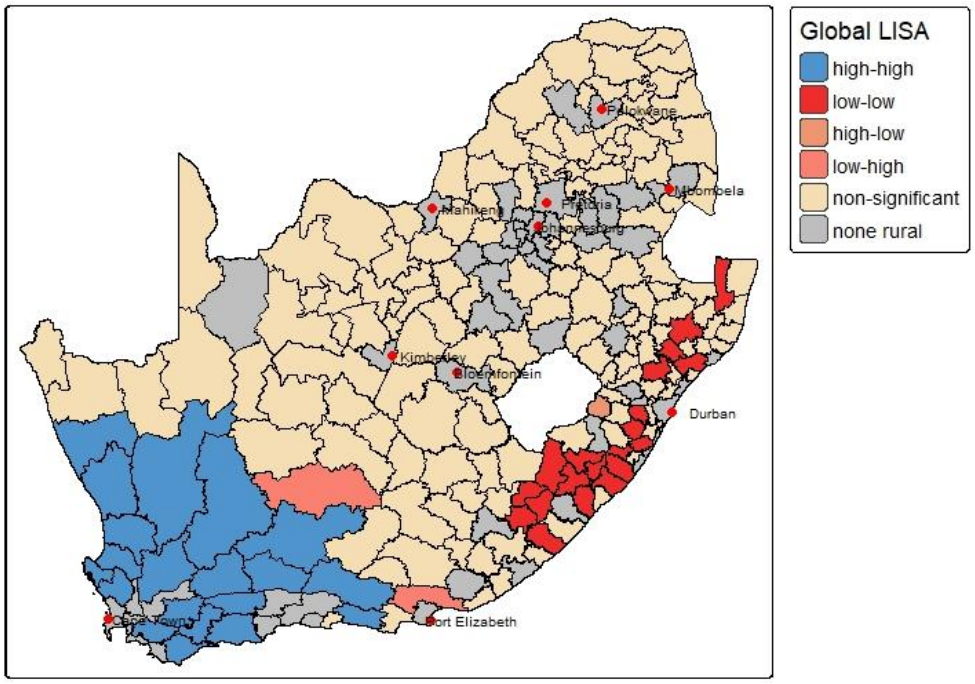


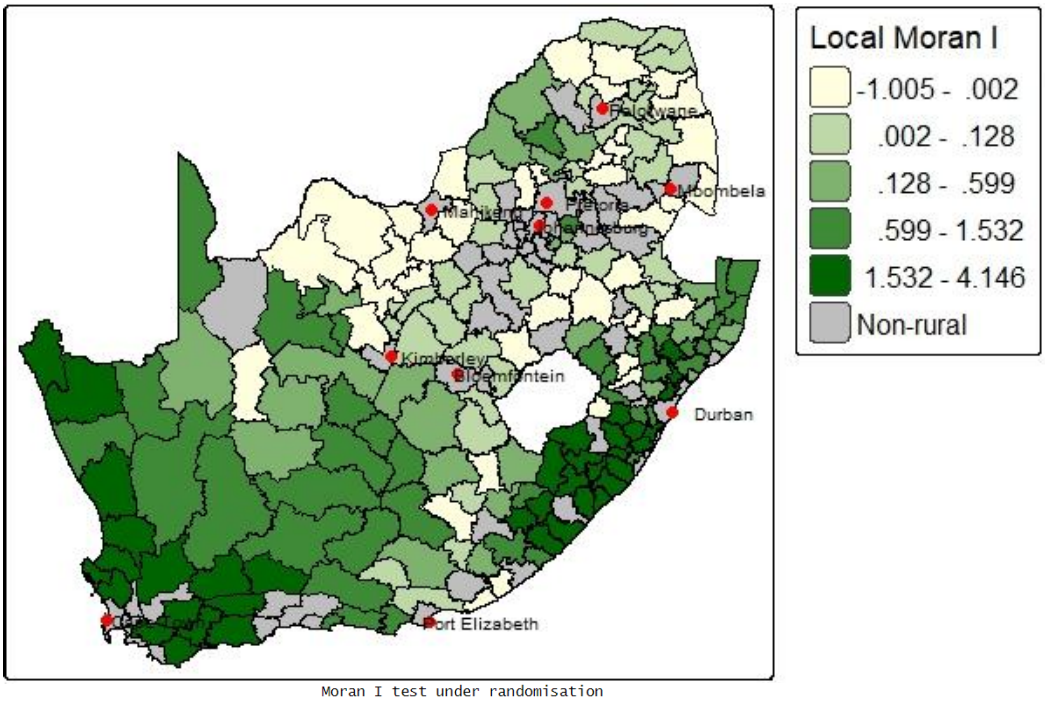
Figure 12.40 LISA Clusters for ICT Indexes



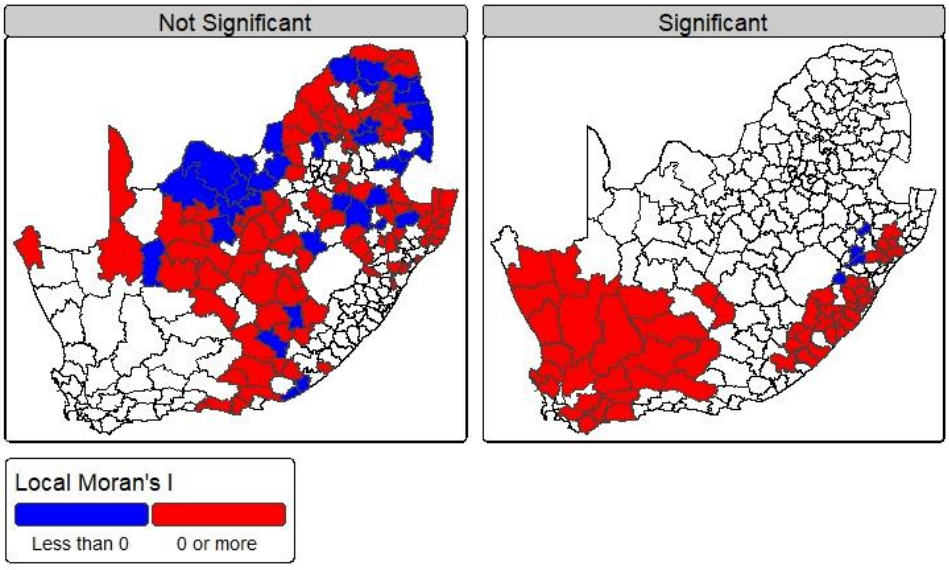

```
        Monte-Carlo simulation of Moran I

data:  subset_data_noNA$Index
weights: dnb.listw_noNA
number of simulations + 1: 1000

statistic = 0.60513, observed rank = 1000, p-value = 0.001
alternative hypothesis: greater
```

12.14 APPENDIX N: Overall Indexes

Figure 12.41 Moran Indexes for the Overall Indexes

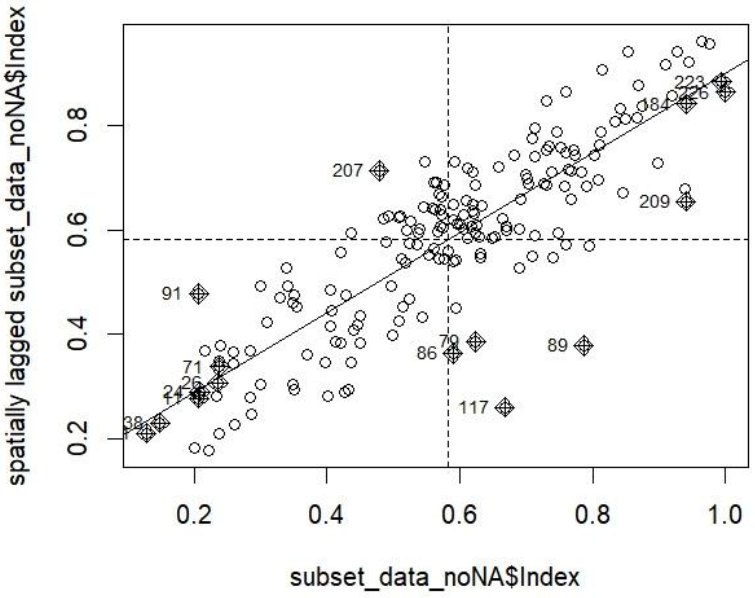



```
Moran I test under randomisation

data:  subset_data_noNA$Index
weights: dnb.listw_noNA

Moran I statistic standard deviate = 14.456, p-value < 2.2e-16
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
      0.761593583      -0.005524862       0.002815832
```



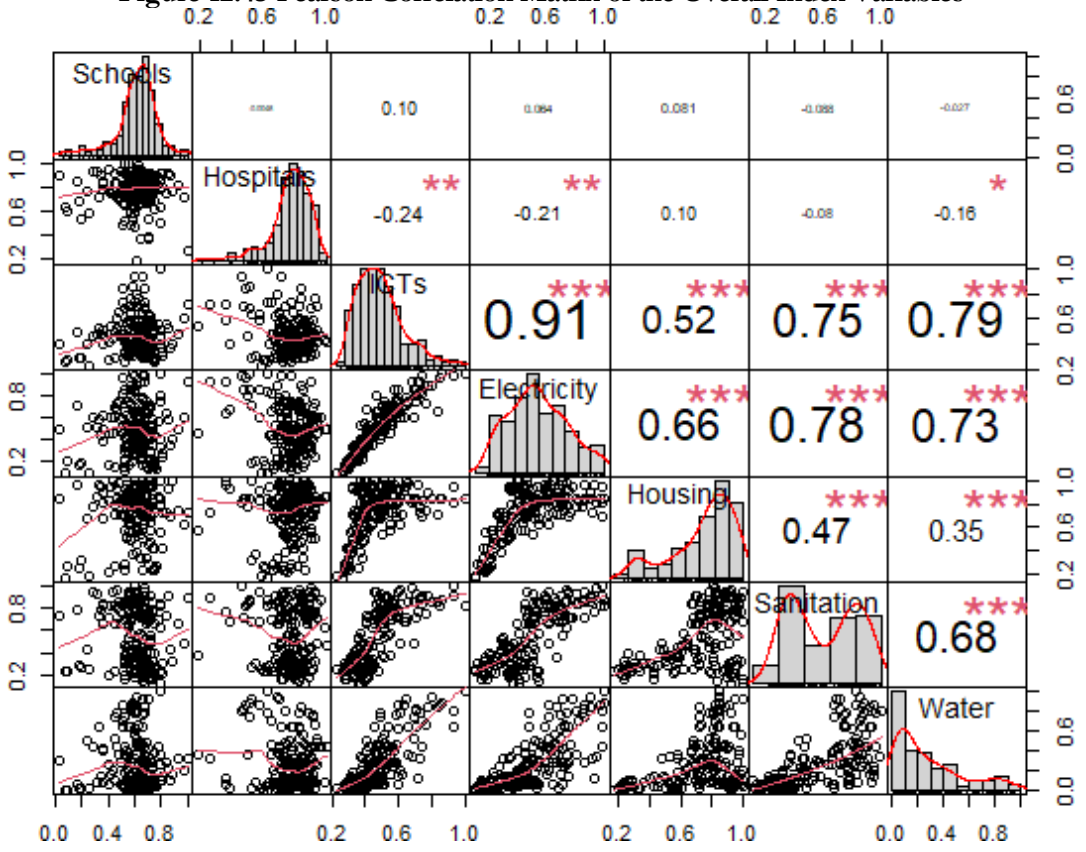

```
Simple feature collection with 2 features and 8 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 16.45189 ymin: -34.83417 xmax: 32.94498 ymax: -22.12503
Geodetic CRS:  WGS 84
# A tibble: 2 × 9
  significant_cluster Count Mean_Moran_I Median_Moran_I SD_Moran_I Min_Moran_I Max_Moran_I IQR_Moran_I
  <chr>               <int>        <dbl>          <dbl>      <dbl>       <dbl>       <dbl>       <dbl>
1 Not Significant       123        0.258         0.0494      0.438      -0.343        3.12       0.516
2 Significant            59        1.81          1.77        1.16       -1.05         4.27       1.61
```

Figure 12.42 Autocorrelation Scatter Plot for Overall Index



12.15 APPENDIX O: Pearson Correlation Matrix

Figure 12.43 Pearson Correlation Matrix of the Overall Index Variables



Note: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

12.16 APPENDIX P: Moran Indexes and LISA

According to Anselin (1995), the purpose of LISA indicators is twofold: to provide a global measure of the presence of hotspots in the space distribution of data and to assess the individual contributions of specific locations to the overall measures. Moran's Index lies in the interval from -1.000 to 1.000. Values close to 1.000 are for sub-areas with the same score clustered together, while -1.000 indicates a random spatial distribution of scores across space. The primary statistic used is the Global Moran's Index which tests the following hypothesis:

H_0: Spatial Randomness of Data

H_1: Clustering of Data (Spatial Autocorrelation)

Dubé & Legros (2014) explain that the Moran Index is given by the formula.

$$I = \frac{N}{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}} \cdot \frac{\sum_{i=1}^{N}\sum_{j=1}^{N} w_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{N}(y_i - \bar{y})^2}$$

Where N is the total number of observations.

$\bar{y}$ is the mean of the observed variables of y.

w_{ij} is an element of the spatial weights matrix linking observation i to observation j.

$$\bar{y} = \frac{\sum_{i=1}^{N} y_i}{N}$$

I follows a standard normal distribution and therefore a t-test is carried out to test the null hypothesis of spatial randomness.

An alternative method for conducting the test is to carry out Monte Carlo simulations to come up with hundreds of samples by randomly changing the values of y over each point. According to Dubé & Legros (2014), the decision rule is based on rejecting the null hypothesis of the absence of spatial autocorrelation when the permutational distribution's p-value of a t-test is smaller or equal to the nominal level α priori retained for the test.

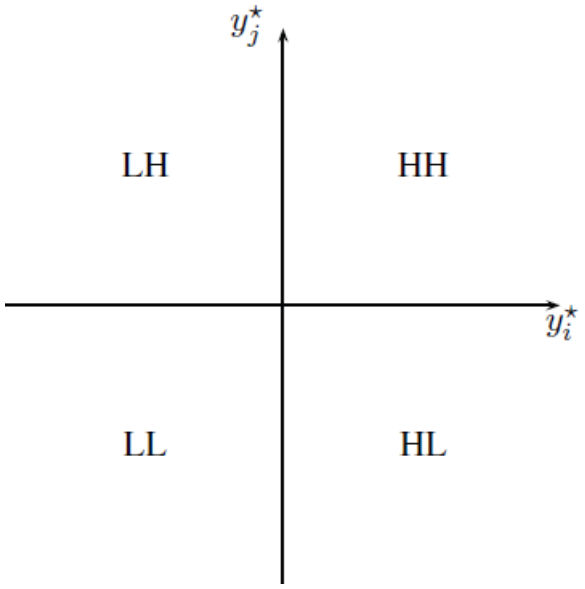
Local spatial autocorrelation is meant to verify whether for a given observation i there exists similar values. Calculation of local Moran's Index values is based on determining the contribution of each pair of observations to the Global Moran's Index value. Local Moran's Indexes are calculated by the following formulae:

$$I_i = (y_i - \bar{y}) \sum_{j=1}^{N} w_{ij}(y_j - \bar{y})$$

Where i is not equal to j.

Moran's Index scatter plot is used to analyse local and global spatial associations by correlating lagged values with observed values. The scatter plot is divided into four quadrants as shown in Figure 12.44.

Figure 12.44 Moran Index Scatter Plot Quadrants.



High-High (HH) represents high levels of observations clustered together.
Low-low (LL) represents low levels of observations clustered together.
High-low (HL) represents high levels of observations mixed with low levels of observations.
Low-high (LH) represents low levels of observations surrounded by high scores of observations.

When the majority of areas are located in the HL and LH regions, the scores would be randomly distributed across the space under study.