A proposed risk assessment framework for public health responses: A case study of Melusi, an informal settlement in Gauteng, South Africa

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Declaration

I, Nhlanhla Pheletso Suzan Sempe, declare that the dissertation titled “Assessing Risk to Communicable Disease at the Informal Settlement Scale in Melusi, Gauteng South Africa”, which I hereby submit for the degree MSc Environmental Management at the University of Pretoria is my own work and has not previously been submitted by me for a degree at another university.

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Abstract

Global statistics suggest that approximately one billion people worldwide live in slums and under other conditions of informality (SDG, 2021), where they are particularly vulnerable to the outbreak of communicable diseases and poor service delivery. Without planned interventions, a significant proportion of the world's population will remain vulnerable, ill-prepared and not resilient to health crises and disease outbreaks. Global efforts and commitments to reducing the instances of informality, and by extension poverty and similar inequalities, have been hampered by the COVID-19 pandemic. Furthermore, the pandemic has raised concerns over the ability to manage the outbreak of communicable diseases in the context of informal settlements.

Current risk assessment frameworks for communicable diseases either do not assess risk at the informal settlement scale or the studies that have focused on disease outbreaks in informal settlements have only acknowledged a limited number of influential factors. Therefore, this study was executed with the aim of developing a risk assessment framework for health responses in informal settlements using COVID-19 as a case study to understand associated risks to informal settlement dwellers. Through this risk assessment framework, improved insights into a community's level of risk were revealed. To make the framework more granular, COVID-19 risk was defined in terms of the community's vulnerability, preparedness and resilience. In this way, by achieving the research objectives, this framework will provide researchers and decision-makers with a set of baseline factors that should be acknowledged when developing and enforcing intervention strategies in informal settlements – namely those areas that house socially and economically vulnerable pockets of the population.

This study focused on Melusi, an informal settlement in Pretoria, as the area of study. The COVID-19 risk assessment framework in this study was developed from existing risk assessment frameworks which were reviewed in the context of COVID-19. Based on this evaluation the study proposes a COVID-19 risk assessment framework that was applied in the context of Melusi.

This framework informed the type of data that was collected, which was done through a mixed method approach involving qualitative and quantitative methodologies. Primary data (qualitative) was collected from focus group discussions held with 21 community health workers stationed in the settlement during the month of August 2021. The responses from these focus group discussions were collated and allocated scores based on the indicator's categorisation. Secondary data (quantitative) was retrieved from the University of Pretoria Community Oriented Primary Care (UP COPC) unit's household data that was collected in

2018 by the Ward Based Outreach Teams, which were made up of the community health workers, for 1667 households. The secondary data was analysed based on the volume of occurrences per indicator across the number of households in the community.

Through the adoption of the mixed method approach, it was found that, in the context of COVID-19 in Melusi, the greatest exacerbators of the community's vulnerability were the physical structure of the dwellings (which compromise the ability to self-isolate and practice social distancing); household size; access to water and handwashing facilities; and the cleanliness of the communal bucket (portable) toilets. The community's attitude towards masks, sanitizers and social distancing compromised the settlement's overall preparedness. Lastly, the community's resilience scores were lowered by the overall reliance on public transport for the majority of community members and the nature of employment as the majority of community members held part-time or temporary employment positions.

These findings provide an indication of the need for more risk assessments at the informal settlement scale, which would facilitate in streamlining health responses in informal settlements. As vacuums of informality, the implementation of a multi-faceted risk assessment framework may serve to adequately recognise the factors for which makes dwellers in informal settlements more vulnerable, less prepared and less resilient to the outbreak of communicable diseases, compared to those who reside in more formal settings.

Keywords: informal settlements, COVID-19, risk assessment

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1 INTRODUCTION

1.1 Background

A South African informal settlement is an unplanned settlement on land that has not been proclaimed as residential and consists mainly of informal dwellings – makeshift structures not approved by a local authority and not intended as permanent dwellings (Stats SA, 2003; HDA, 2013). As of 2019, approximately 13% of households lived in informal dwellings in South Africa (Stats SA, 2019). Informal settlements are also continually plagued by service delivery challenges and frequently precarious living conditions.

Informal settlements around the world experience a range of challenges, including the spread of communicable diseases. Informal settlements have underlying characteristics for which they are typically defined, these include but are not limited to; poor or inadequate access to services such as water, housing, and health, lack of resources and high levels of unemployment (WPI, 2014; Williams *et al*, 2019; GOES,1997; Muzondi, 2014; Wilkinson, *et al*, 2020). Most informal settlements in South Africa rely on communal taps (HDA, 2013). The density of dwelling structures in informal settlements tend to vary with lower densities recorded for settlements in peri-urban areas compared to overcrowded inner-city settlements (Wilkinson, *et al*, 2020; Gibson & Rush, 2020). Additionally, informal settlements are often regarded as illegal and unplanned, thus making effective planning and policy implementation within these areas difficult. Due to aspects related to the illegality and unprecedented rate of expansion of these settlements, up-to-date and reliable data about informal settlements in South Africa are often limited (de Albuquerque et al, 2019; Wilkinson *et al*, 2020; Gibson & Rush, 2020). The lack of current and reliable data about conditions within these areas frequently results in fragmented policy responses with a limited understanding of the true extent of the level of vulnerability and resilience of informal dwellers, especially in the context of coordinating effective health-related responses.

The conditions prevalent in informal settlements, including overcrowding, inadequate access to clean water and healthcare, and poor sanitation, creates an environment that increases the likelihood of residents contracting communicable diseases like COVID-19, and also exposes them to a greater risk of suffering from the socio-economic related impacts of these diseases compared to their counterparts in formal settlements. Concerns have been raised about the difficulty to manage the spread of communicable diseases in informal settlements due to the lack of clean water, inadequate sanitation, and overcrowded dwellings (Zerbo *et al*, 2020). The burden of communicable and non-communicable diseases,

undernourishment, and injuries within informal settlements in Sub-Saharan Africa is high, and everyday health risks in urban informal settlements should be assessed for a better understanding of the full spectrum of urban health risks (Zerbo *et al,* 2020). Therefore, in order to prevent and minimize the spread of communicable diseases in informal settlements, one has to assess the risk, and this needs to be done at the informal settlement scale.

The level of risk for residents of informal settlements became an area of focus with the outbreak of the COVID-19 virus (DHS, 2020). As a result of the lockdown measures implemented by the government (South Africa, 2020), residents of informal settlements in South Africa were faced with multifaceted challenges during the COVID-19 pandemic. One such challenge was the initial ban on informal food vending or the operation of spaza shops (Battersby, 2020). Additionally, preventative practices such as handwashing, sanitising and social distancing were inherently difficult to implement in overcrowded and poorly constructed and ventilated dwellings (SERI, 2018).

The incidence of communicable diseases in informal settlements often reflects the inequalities between different types of settlements. A comparative study done by Gibbs *et al* (2020) on the prevalence of HIV across different settlement types in South Africa demonstrated the spatial patterning of HIV across the country. The authors assessed HIV prevalence between urban informal, urban formal, rural informal, and rural formal settlements in terms of age and gender. Results from the study indicate that HIV prevalence is highest in urban informal settlements. The association between HIV rates and informal settlements has been linked to the high levels of poverty in these settlements (Gibbs *et al*, 2020). Poverty and household instability are hypothesised to drive HIV-risk behaviour (Gibbs *et al,* 2020). Additionally, factors such as a lack of education and high unemployment (which was common among the survey participants in urban informal settlements) contribute to the burden of a higher HIV incidence rate in informal settlements (Gibbs *et al*, 2020).

Preventing and minimizing the spread of communicable diseases in informal settlements presents relevant authorities with distinct challenges. Such was the case for the coronavirus. In 2019, the new coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was detected in China. This SARS-CoV-2 causes the coronavirus disease (hereafter referred to as COVID-19), an infectious disease. The eventual COVID-19 outbreak was declared a pandemic in 2020 and by January 2021, there had been 2.5 million COVID-19-related deaths (MayoClinic, 2022).

The COVID-19 virus is spread through droplets of saliva or discharge from the nose when an infected individual coughs or sneezes (WHO, 2021). This manner of transmissibility is what makes the virus highly infectious. In response to mitigating the spread of the virus, one of the World Health Organisation's recommendations to the public was for all individuals to practice social distancing by maintaining a distance of at least 1 meter between one another, frequent hand sanitizing with an alcohol-based substance or handwashing with soap and water, and keeping rooms well-ventilated (WHO 2021). Therefore, aspects including, but not limited to, health, dwelling structures, and water access play a key role in the ability of communities to mitigate the contraction or transmission of the COVID-19 virus.

In the context of disease outbreaks, a range of attempts have been made to understand specific disease transmission risks in informal settlements. An improved understanding of disease-related risks will better inform interventions, management and responses to disease outbreaks (Kienberger and Hagenlocher, 2014; Oppenheim *et al*, 2018).

The risk of communities to disease outbreaks can be measured in different ways, depending on the theme of research and on how the researchers choose to define the term 'risk'. Kienberger and Hagenlocher (2014) contextualise the risk of Malaria (mosquito-borne infectious disease) in terms of vulnerability. From the same study, the term 'vulnerability' is defined as the lack of capacity to anticipate and the lack of capacity to cope. The definition of vulnerability, therefore, can be further extended to refer to how sensitive an informal settlement might be to the impacts of COVID-19 (DPCD 2008, cited in van Huyssteen *et al*, 2013), in consideration of the definition ascribed by Kienberger and Hagenlocher (2014). Risk to disease outbreaks can be measured in terms of preparedness Oppenheim *et al* (2018), in the context of epidemics, define preparedness as the reflection of institutions such as public health authorities to detect, report, and respond to outbreaks. In this way, preparedness may refer to strategies put in place to deal with COVID-19-associated impacts before they present themselves to a community. Disease outbreak risk can be defined in terms of resilience such that it (resilience) is defined as the capacity of societies, communities, and populations groups to respond and absorb the negative impacts from diseases (Kienberger and Hagenlocher, 2014).

In developing indicator frameworks and conducting risk assessments, a better understanding of the spatial variation of disease prevalence and social risk factors (Kienberger and Hagenlocher, 2014), links between the disease and human health (Dickin *et al*, 2013), and the localised risk indicators that may contribute to disease outbreaks (de Kadt *et al*, 2020)

is presented. The factors/indicators influence the ability of societies, population groups and communities to react, minimise and respond to the impacts of communicable diseases.

Studies have been conducted to measure the levels of risk, vulnerability, preparedness and/or resilience to communicable diseases, epidemics or pandemics. Dickin *et al* (2013) developed a water-associated disease index tool to asses vulnerability to water-borne diseases through a mapping methodology. Kienberger and Hagenlocher (2014) developed an indicator framework to assess social vulnerability to Malaria in parts of East Africa. An Epidemic Preparedness Index was created by Oppenheim *et al* (2018) to measure a country's capacity to detect and respond to infectious disease events. De Kadt *et al* (2020) created a COVID-19 risk assessment framework in response to the coronavirus pandemic to understand factors that might exacerbate the health and socio-economic impacts on communities in Gauteng.

Risk, as measured in terms of vulnerability, preparedness, and resilience, is assessed according to the disease in question, as specific conditions (or indicators, as often referred to in the literature) are conducive to the spread of one disease whereas they do not necessarily significantly facilitate the spread of another. Risk models for diseases, including COVID-19, have been developed (Dickin et al., 2013; Keinberger & Hagenlocher, 2014; De Kadt et al, 2020). Therefore, current assessment frameworks or risk models assess the risk for a group of suburbs or settlements, or even a larger area, and do not focus on COVID-19 at the informal settlement scale.

1.2 Problem Statement

Wilkinson *et al* (2020) note that one of the greatest challenges facing informal settlements is the lack of data about the number of people in a given settlement, their location, and their health. Studies conducted in response to the COVID-19 pandemic have explored various factors that could exacerbate undesirable conditions in informal settlements. Gibson and Rush (2021) for example considered the role of dwelling structures and the spread of diseases in informal settlements and a study conducted by Matamanda et al (2021) focused on the impact of COVID-19 on existing health inequalities in informal settlements.

Research has been undertaken to assess risk or vulnerability in South Africa. Le Roux *et al* (2019) developed an indicator framework to assess the vulnerability of South African settlements to climate change at the municipality scale. The Gauteng City-Region Observatory (de Kadt *et al*, 2020) developed a COVID-19 risk indicator framework to determine the factors

that would contribute to the spread of COVID-19 at the ward scale. To aid South Africa's National Disaster Management Centre (NDMC) in responding to and managing the COVID-19 pandemic, the Council for Scientific and Industrial Research (CSIR) developed a COVID-19 vulnerability dashboard scaled from the provincial level down to the ward level (CSIR, 2020). From the studies that have been conducted, there exists a gap whereby limited work has been undertaken to assess the risk of communicable diseases at the scale of a single informal settlement. Furthermore, there is also a somewhat limited availability of robust multifaceted risk assessment frameworks or tools to assess vulnerability to communicable diseases in informal settlements.

The assessment of risk, vulnerability, preparedness and/or resilience for communicable diseases has been regarded as an important part of reducing the burden of disease because the knowledge of factors that may contribute to disease risk can better inform intervention strategies (Keinberger & Hagenlocher, 2014). As such, assessing multiple factors, both qualitative and quantitative, more acutely acknowledges the dynamics within an informal settlement and recognises the intricacies within these settlements which are characterised for high poverty levels and lack of access to basic services and city infrastructure (UN Habitat, 2015).

1.3 Aim and objectives of the research

This research aims to develop a risk assessment framework for health responses using COVID-19 and its associated social impacts as a case study to understand the risks to which the people in an informal settlement in South Africa are exposed. The level of risk is assessed based on vulnerability (susceptibility), preparedness (capacity to anticipate), and resilience (capacity to cope). Melusi, an informal settlement in the City of Tshwane, Gauteng (South Africa), is used as a case study. To meet the stated aim, the following objectives have been formulated:

1. To review available risk assessment tools and responses to public health crises or pandemics in the context of informal settlements in South Africa.
2. To design and implement a risk assessment framework based on indicators relating to vulnerability, preparedness, and resilience using the outbreak of the COVID-19 pandemic in Melusi as a case study.
3. To evaluate the proposed risk assessment framework in this study for future replication in the context of outbreaks or pandemics in South African informal settlements.

1.4 Study area

1.4.1 Gauteng province

Gauteng is one of the nine provinces of South Africa. It is a landlocked province situated in the North-eastern region of the country. South Africa's executive capital, Pretoria, is located in this province. The province is home to approximately 15 million (26%) of the country's total population, making it the most populated province in South Africa (Stats SA, 2019).

Gauteng contributes approximately 35% to South Africa's gross domestic product and dominates the majority of the economic sectors in the country, apart from agriculture and mining (Alexander, 2021). As a result, job prospects and economic opportunities are disproportionately located in this province.

Earmarked as the economic hub of the country, people migrate to Gauteng with the belief that they stand a better chance of getting some form of employment in this region (Stats SA, 2018). Between the period of 2016 and 2021, Gauteng received 1.02 million in-migrants, the highest number of all the provinces in the country (Stats SA, 2018). The majority of the migrants who do find their way into South Africa end up forming informal settlements or adding to the existing inhabitants of an informal settlement, in response to the country's failure to meet the increased housing demand (Marutlulle, 2021).

1.4.2 City of Tshwane metropolitan municipality

Gauteng is divided into 3 metropolitan municipalities and 2 district municipalities. The City of Tshwane (CoT) municipality is one of the three said metropolitan municipalities. Based on the most recent municipal data available, the City of Tshwane is home to approximately 25% of Gauteng's populace (COGTA, 2020; Stats SA, 2017). Additionally, an estimated 16.4% of the residents in the City of Tshwane are living in informal dwellings (GHS, 2019, cited in SAHRC, 2021).

1.4.3 Melusi informal settlement

Melusi informal settlement is located West of Pretoria's city centre in Ward 55. The spatial layout of Melusi can be seen in Figure 1.1. Melusi has a population density of

approximately 10,286 people/square kilometres, with the population generally consisting mostly of working-age individuals. As is the case with most informal settlements in South Africa, it cannot be said with certainty as to when the settlement had first been established. However, with the assistance of satellite imagery, evidence suggests that the settlement first began to emerge in 2009. Figure 1.2 and Figure 1.3 illustrates the growth in the settlement between 2009 and 2022.

Figure 1.1: Melusi informal settlement

Figure 1.2: Establishment and growth of Melusi - 2009

Figure 1.3: Establishment and growth of Melusi - 2022

The bulk of the community members resides in one-room shacks (that is, dwelling structures made of corrugated iron as depicted in Figure 1.4) Residents retrieve water from communal tanks or taps that are located around the settlement. With regards to toilet facilities, most households in the settlement have pit toilets in their yards, and for those that do not, there are communal portable toilets. The majority of the community members rely on getting food from nearby wholesale grocers or informal vendors within the settlement. However, households identified as being in need would be provisioned with food donations from various organisations.

The aforementioned information about Melusi was sourced from conversations with facilitators and coordinators from the Department of Family Medicine at the University of Pretoria (UP). At the time this study had been conducted, there was no indication of existing census information about Melusi, apart from the household data collected by the university's family medicine department through the Community Oriented Primary Care (COPC) unit.

Figure 1.4: Dwelling structure in Melusi

1.5 Significance of research

The common characteristics of South African informal settlements, such as inadequate dwelling structures and limited access to services such as running water, clean toilets, and electricity serves as barriers to managing the transmission of and dealing with the effects of the COVID-19 pandemic. Limited data on informal settlements (Wilkinson *et al*, 2020; Satterthwaite *et al*, 2019) affects the number of risk assessments that can be done in these areas.

The context of this is therefore relevant to the existing work that has been done on informal settlements as the dynamic nature of these settlements often makes them difficult to study. Therefore, this study will apply a mixed method approach to collect data, which offers the opportunity to collect first-hand accounts from community members, while also utilising the available quantitative data to further substantiate community feedback and gain a more holistic understanding of the informal settlement of the study. This will therefore help to support a more rigorous approach to the management of communicable diseases in the context of informal settlements.

Additionally, through focus group discussions, residents of informal settlements are empowered with the ability to dispense knowledge on the determinants of risk to COVID-19 (and other communicable diseases), specific to their community. Scaling risk assessments at the ward or town level are of no assistance to gauging risk for individual informal settlements.

Therefore, the final output and findings of this research help to inform policy-making decisions at the informal settlement scale. Furthermore, the relevant variables and indicators identified in this study may be further explored and assessed against the current condition of the informal settlement in question, while considering the communicable disease that the risk assessment is based on.

1.6 Chapter overview

Chapter 2 explains aspects/characteristics of informal settlements, COVID-19, and risk assessments, based on the review of existing literature. Objective 1 is addressed as existing risk assessment tools and frameworks for communicable diseases are reviewed.

Chapter 3 describes how the risk assessment framework of the study was designed, and subsequently implemented by conducting focus groups, and analysing secondary data about Melusi, which was data collected by community health workers as part of their work routine. This chapter addresses Objective 2 as the steps of designing and implementing the risk assessment framework in practice is incorporated into the research process.

Chapter 4 presents the proposed framework and the results of the implementation of the framework using Melusi as the case study. This chapter meets Objective 2 as it presents the results of implementing the framework.

Chapter 5 discusses and contextualises the results of the study by reflecting on the efficacy of the COVID-19 risk assessment framework in determining the level vulnerability, preparedness and resilience in a South African informal settlement. Objective 3 is addressed

as the framework's implementation is assessed against the dynamics within the informal settlement.

Chapter 6 as the final chapter provides a summary of findings and recommendations and gives the conclusion and suggestions for further research pertaining to health risk assessment frameworks for informal settlements. Objective 3 is met as the chapter reflects on the replicability of the proposed COVID-19 risk assessment framework for other informal settlements in South Africa.

2 LITERATURE REVIEW

2.1 Chapter overview

In this chapter, informal settlements in the global and South African context are reviewed, focusing on the extent of informality and varying terms and definitions of informality. Response measures for COVID-19 that have been put in place for informal settlements worldwide are described, while also reviewing studies done on COVID-19 impact and management in South African informal settlements.

The definition of risk across different disciplines is reviewed, along with the definitions of vulnerability, preparedness, and resilience. The chapter goes on to explore the risk assessment studies undertaken for communicable diseases, including COVID-19.

Finally, in this chapter, the global prevalence and impact of the COVID-19 pandemic are described. In addition, the variables that are thought to contribute to overall COVID-19 are explored.

2.2 Informal settlements

2.2.1 Informal settlements at a global scale

Informal settlements are a global phenomenon that can exist in different forms, typologies, and geographical locations. Furthermore, apart from informal settlements, there exists other forms of informality, including but not limited to slums, shanty towns, and favelas (UN-Habitat, 2015). Informal settlements have been defined as areas where the inhabitants of the land do not have the security of tenure for the dwellings they live in, they lack access to basic services and city infrastructure, and the housing in which they reside may not comply with regulations and could be situated in hazardous areas (UN-Habitat, 2015). Slums are defined as the more impoverished forms of informal settlements, often characterised by extreme poverty and larger agglomeration of dilapidated housing, often in hazardous areas (UN-Habitat, 2015). Slum dwellers also lack access to basic services and infrastructure, and are often subject to evictions, violence, and disease (UN-Habitat, 2015). Shanty towns (or squatter camps) are illegal or unauthorised settlements characterised by housing structures made up of materials such as corrugated iron (Tanyanyiwa, & Kanyepi, 2020).

Very often, the distinction between these various forms of informality can become unclear, leading to the interchangeable use of the terms. In other instances, the use of the terms can depend on the context, for instance, the geographical location. For example, in

Brazil, slums are referred to as *Favelas*, and these areas are often subject to high levels of violence and are characterised by poverty and a lack of water and sanitation systems (McCarthy, 2022). Furthermore, *Favelas* are the result of historical circumstances unique to the lived experiences of Brazilian citizens.

The United Nations reported that in 2018 the absolute number of people living in slums or informal settlements amounted to approximately one billion (SDG, 2021) whereby sub-Saharan Africa has the second largest proportion of this population at almost 238 million people. The greatest proportion of slum or informal settlement dwellers, an estimated 370 million people, reside in Eastern and South-Eastern Asia (SDG, 2021).

Although some of the aforementioned terms may be used interchangeably, this study will refer to the study area as an informal settlement. Uses of the other terms that refer to living in informality will be maintained as per the referenced sources.

2.2.2 Informal settlements at a global scale – COVID-19 impact and responses

The emergence of informal settlements has been driven by a number of interrelated factors, these include but are not limited to population growth, migration to urban areas, economic vulnerability, and displacement (UN-Habitat, 2015). In reviewing the everyday risks in informal settlements in Sub-Saharan Africa, Zerbo *et al* (2020) assessed the challenges in managing communicable diseases in these settlements. Their study concluded that the lack of access to water and sanitation cultivates an environment for infectious diseases to thrive due to poor hygiene and sanitation. Their study further confirmed that overcrowding in these settlements allows for greater transmission of infectious diseases (Zerbo *et al*, 2020). Finally, their study also concludes that the lack of financial resources in the community, particularly among young women, has led to the adoption of risky sexual activities which has increased the exposure to and prevalence of HIV in poorer urban areas (Zerbo *et al*, 2020).

One of the world's largest slums, and Asia's largest and most densely populated slum, is Dharavi which is located in the city of Mumbai (Golechha, 2020). One of the main drivers of the continued growth of Dharavi has been due to poor rural inhabitants migrating to urban Mumbai, India's financial and entertainment capital, with the aspirations of seeking employment opportunities. Additionally, rent in Dharavi is significantly lower compared to other parts of Mumbai, thereby offering affordable housing for those who migrate to Mumbai (Business Standard, 2022). Dhavari is characterised by being overcrowded with derelict buildings and open sewage (Golechha, 2020). Therefore, there was great concern that

Dharavi could be a potential COVID-19 hotspot (Golechha, 2020). However, during the early stages of the pandemic, the viral spread of COVID-19 was successfully contained by the local municipality's implementation of their 'chasing the virus' strategy – which entailed actively tracing, tracking, testing and treating inhabitants in the slum (Golechha, 2020). Despite this success, Dharavi soon became a COVID-19 hotspot (Mumbai Live, 2022).

Similar to Dharavi, Kibera in Nairobi, Kenya, Africa's largest informal settlement, is characterized by overcrowding, and lack of access to adequate basic infrastructure and services such as water, sanitation, housing, and healthcare (UN-HABITAT, 2007). Population statistics of the Kibera slum that is available vary across sources, with the final values often depending on the sections of the slums that are included in the calculations. UN-HABITAT (2007) estimated the population in the Kibera slum to range between 600,000 and 1,000,000 people, whereas Bloxham (2020) provides an approximation of 250,000. During the pandemic, Kibera informal settlement never became a COVID-19 hotspot, despite the apparent concerns around informal settlements due to the living conditions around these areas, which would otherwise facilitate the spread of the virus (Solymári *et al*, 2022). It is believed that Kibera was safeguarded against becoming a COVID-19 hotspot due to a number of reasons, including the following (Solymári *et al*, 2022):

- increased monitoring by the Ministry of Health during the early phases of the pandemic, particularly in the Kibera slum,
- Rapid mass testing targeting the informal settlement, and
- Residents of the informal settlements being used to managing other infectious diseases, including HIV and tuberculosis.

Similarly, response plans were put in place for informal settlements in South Africa in an attempt to mitigate the spread of the COVID-19 virus and to assist residents in these areas to cope. During the roll out of these strategies, the contextual challenges of mitigation strategies in the context of informality became particularly evident which also illustrates the need for a better understanding of health-related programmes in these contexts.

Therefore, it is important to acknowledge the intricacies that underpin the ability to manage infectious diseases in informal settlements. Ali *et al* (2023) recognise the importance of understanding the dynamics that determine the vulnerability of informal settlement communities to communicable diseases whereby the study focused on the 2014-2016 Ebola virus disease (EVD) outbreak in Sierra Leone. The data collected for this research was obtained through a qualitative research approach that involved interviewing key informant and

community member interviews and focus group discussions in two informal settlements in western Sierra Leone. Through this approach, it was found that the greatest determinants of the level of vulnerability of informal settlement communities to EVD was bucketed under the following two categories: 'community beliefs and practices' and 'structural poverty and low socio-economic status'. This research revealed how imperative it is to understand the context and challenges faced within an informal settlement as these could inform the strategies that should be put in place to manage the spread of disease within an informal settlement.

A study done by Gichuki and Mategula (2021) examined TB mortality in two informal settlements in Nairobi Kenya. The authors used the Nairobi Urban Health Demographic Surveillance System (NUHDSS) to assess the TB-related deaths in informal settlements, examining these cases alongside the socio-economic background of those who reside in the informal settlements. In this paper, it was acknowledged that people living in informal settlements are more prone to TB deaths compared to the rest of population. Gichuki and Mategula (2021) reported that between the two informal settlements, a decline in TB deaths was observed between 2005 and 2016.This decrease has been attributed to the roll-out and implementation of various intervention strategies across the years, including active defaulter tracing mechanisms (2005), the utilisation of community health volunteers for home-based care and community-based healthcare provision (2007) and the introduction of support groups for HIV/TB co-infected patients (Gichuki and Mategula, 2021). It was concluded that the effective management of TB in informal settlements will arise through raising community awareness, strengthening TB surveillance, and improving access to TB diagnosis and treatments within informal settlements (Gichuki and Mategula, 2021).

2.2.3 South African informal settlements

An estimated 13% of households in South Africa live in informal dwellings – makeshift structures, such as shacks, that are not erected according to approved architectural plans (Stats SA, 2019). Like informal settlements in other countries, informal settlements in South Africa are characterised by a lack of access to basic services and infrastructure such as water, sanitation, and electricity (SERI, 2018).

Colonialism and Apartheid played a significant role in the emergence of informal settlements in South Africa. Between 1652 and 1948 Dutch and British settlers expropriated land from the native populations of South Africa, seizing control of the land and displacing the native black populations (Mgushelo, 2018). Evidently, colonialism laid the foundations for

Apartheid. In a takeover of control from the British, a Dutch/Boer unification led to the end of colonialism and brought in the era of the Apartheid regime from 1948 (Mgushelo, 2018)

In 1913, the Native Land Act was passed. Under this law, black people in South Africa were restricted from buying or occupying land, except when working as employees of white employers (Government of South Africa, 2013). This skewed access to quality housing for the majority of the black South African population and was further perpetuated by the Apartheid government when it implemented mass relocations of black people to poor, marginalised land and townships (Government of South Africa, 2013; SERI, 2018). During the regime, the failure to invest in the infrastructure in the country's townships [1]– which are residential areas occupied by black people, and formerly (under Apartheid legislation) set aside for black occupation – led to the eventual establishment of informal settlements as the areas began to experience overcrowding and housing shortages (SERI, 2018).

South Africa's post-apartheid government has also perpetuated housing challenges in the country because it has persistently failed to address the housing inequalities caused by apartheid city planning (SERI, 2018). Despite the provision of subsidised housing by the post-apartheid government since 1994; the housing shortage in the country is still estimated to be approximately 3.7 million (CAHF, 2021). A World Bank report in 2022 has identified South Africa as the country with the greatest level of inequality in the world, which may be attributed to, in part, its high unemployment rate of 33.9% (Stats SA, 2022) and poverty rate. The inequality that exists within the country, therefore, cultivates the continued establishment and growth of informal settlements.

The studies that have been conducted on South African informal settlements in the context of COVID-19 focus on the impact of the pandemic relative to one or more of the defining characteristics of informal settlements. Matamanda *et al* (2021) considers the impact on health in the community by focusing on the access, or lack therefore, to basic services and healthcare services, and the disruption in mobility as most residents rely on public transportation. Gibson and Rush (2020) acknowledge that dwellings in informal settlements are often built close together with very few gaps and narrow pathways. They use this knowledge to assess the feasibility of social distancing in this context. Additionally, the strategies that have been proposed and implemented, such as the interventions initiated by the Department of Human Settlements, were meant to cater to the people residing in informal settlements.

[1] Definition derived from the Southern African Oxford Secondary School Dictionary

2.2.4 South African informal settlements – COVID-19 studies and responses

Matamanda *et al* (2021) recognised the dimension of inequality that exists in South Africa by examining the impact of the COVID-19 pandemic on communities that reside in informal settlements. In this study, the lived experiences of people living in Dinaweng, an informal settlement located in Bloemfontein, were collected to gather insights into the impact on living conditions and livelihoods due to the national lockdown measures that were imposed in the country. It was found that there were no testing centres located within the settlement. This limited the ability of residents to get tested for COVID-19 as the majority could not afford the costs of travelling to the nearest centre (Matamanda *et al*, 2021). Access to basic services was another critical issue of concern as community members would have to obtain water from communal taps, making social distancing nearly impossible (Matamanda *et al*, 2021). Another major challenge was the restrictions put in place on public transport (South Africa, 2020) and how this compromised the daily movements of a number of community members as they often rely on this mode of transportation (Matamanda *et al*, 2021). Due to the overall disconnectedness, lack of addresses, and suitable roads, Dinaweng often struggles with getting suitable access to an ambulance and other emergency healthcare services (Matamanda *et al*, 2021). The community's response and attitude towards the virus varied, with some households opting to protect themselves by adhering to the instruction to stay indoors and self-medicate, while others continued to live in contravention of the recommendations and regulations (Matamanda *et al*, 2021). During the early stages of the lockdown, it was noted that there was an overall lack of government support in Dinaweng. Many residents experienced significant disruptions in their access to food due to the lockdown regulations and higher food prices. Matamanda *et al* (2021) therefore explain that informal settlements have been highlighted as spaces of high risk due to the inequalities experienced in these areas.

In the early stages of the pandemic, there was concern that due to the conditions of informal settlements in South Africa, social distancing and self-isolation would not be feasible, and may create breeding grounds for viral spread (Gibson & Rush, 2020; Van Belle *et al*, 2020). Gibson and Rush (2020) lamented the challenge of effectively putting social distancing into practice in Cape Town informal settlements by focusing on the feasibility of implementing the social distancing measures that aim to reduce the opportunity for COVID-19 transmission (WHO, 2021, South Africa, 2020). It is recognised that due to the competition for space in the more densely populated settlements, particularly in locations closer to the city where there are more economic opportunities, dwellings in informal settlements can be built close together

with very narrow pathways or gaps in between. For these reasons, Gibson and Rush (2020) sought to assess the feasibility of social distancing in a Cape Town informal settlement. The approach involved using GIS software to measure the distance between neighboring dwellings, using two Cape Town informal settlements as case study areas. Using the 2-meter measurement, the results of the study lead to the conclusion that social distancing would be difficult to achieve in these informal settlements as the majority of the dwellings had a distance of less than 2 meters between each other. To maintain social distancing, residents would have to remain in their dwellings, something that is impossible in the context of informal settlements, because toilets and water access points are outside of the dwelling structures (Gibson and Rush, 2020).

Informal settlements have been identified as areas of high density that may lead to overcrowded private/shared living spaces. The Department of Human Settlements (DHS) therefore proposed to de-densify[2] informal settlements to contain the spread of COVID-19 (DHS, 2020). This was met with widespread discontent as this manner of relocation can be problematic as it may disrupt people's access to work, schools, and services. Additionally, de-densification is a pedantic process that requires several technical and resource considerations if it is to be successful and not to the detriment of the households that would be subject to this endeavour (Planact, 2020). However, whether it is due to the pushback by organisations and particular settlements, or the lack of resources, the execution of this initiative was stalled.

Collaborative efforts between the DHS and other departments and organisations facilitated the continued efforts in catering to the residents of informal settlements during the COVID-19 pandemic. The Asivikelane initiative collected data on informal settlements which was subsequently used by the DHS to better interact with municipalities for informal settlement interventions (Asivikelane, 2021). Collaborations such as these, and other initiatives, have facilitated emergency responses that have been to the benefit of informal settlements in South Africa through the installation of taps and toilets (Asivikelane, 2021), and the provision of food parcels (SASDI, 2020).

Co-ordinated efforts between the Department of Human Settlements and other organisations formed a big part of the COVID-19 response efforts. The COVID-19 vulnerability index created by the Council for Scientific and Industrial Research (CSIR) was used by the

[2] De-densification is the process of making densely occupied settlements less dense by means of relocation.

DHS to coordinate its efforts in high-priority areas, including informal settlements (CSIR, 2020). This tool is further elaborated on in subsection 2.3.3.

2.3 Risk assessments

2.3.1 Defining risk, vulnerability, preparedness, and resilience to communicable diseases

The term ‘risk’ often varies in definition and use and depends on the sector, discipline and/or context. The Oxford Dictionary defines risk as the (exposure to) possibility of loss, injury, or other adverse or unwelcome circumstances.

Risk in the context of business refers to the exposure an organisation or company has to factors that will lower its profits – anything that may threaten a company’s ability to achieve its financial goals (Kenton, 2022). The epidemiological definition of risk is based on the premise of chance or probability whereby it is defined as the proportion of initially disease-free individuals who develop the disease over a defined period (Wilkinson, 2009). In occupational health and safety, risk is described as the probability that a person will be harmed or experience an adverse health effect if exposed to a hazard (any source of potential damage, harm, or adverse health effects) (CCOHS, 2020). These variations demonstrate that there is no singular universal definition that can be ascribed to the term risk.

In a study that focused on creating a conceptualised framework to assess social vulnerability to Malaria, Kienberger and Hagenlocher (2014) first defined risk as the potential occurrence of harmful consequences resulting from the interaction between vector-borne diseases and vulnerable conditions of different population groups. Additionally, Kienberger and Hagenlocher (2014) take the term vulnerability and consider it as an element of risk. In the framework proposed by Kienberger and Hagenlocher (2014), vulnerability is defined in terms of susceptibility and lack of resilience, whereby susceptibility is the predisposition of societies or humans to be negatively affected by a vector-borne disease, and lack of resilience refers to the lack of a population or society’s ability to respond to and absorb negative impacts as a result of their own lacking in the capacity to anticipate, respond to and recover from diseases. The capacity to anticipate revolves around the strategies, programs, and social capital available before the disease hazard arises, and further deals with the reduction of exposure, in the context of Malaria, this includes the use of bed nets (Kienberger and Hagenlocher, 2014). The capacity to cope, as defined by Kienberger and Hagenlocher (2014),

refers to the ability to manage those adverse conditions that may arise as a result of an epidemic disease, through the collaboration of resources and available skills.

Dickin *et* al (2013) developed an index that would be used to identify and visualise vulnerability to water-associated disease with the study focusing specifically on Dengue. Dicken *et al* (2013) defines vulnerability as the propensity to be adversely affected, whereby this definition encompasses exposure to stresses and the susceptibility to those stresses. Therefore, vulnerability is defined in terms of susceptibility and exposure, whereby susceptibility represents the existing conditions that may make a society or humans sensitive to the impacts of disease, and exposure is the conditions that can facilitate the transmission of water-associated pathogens in the environment (Dicken *et al*, 2013).

Oppenheim *et al* (2018), developed an Epidemic Preparedness Index to be able to assess preparedness at the national scale. In the study, epidemic preparedness is described as the capacity of institutions such as public health and emergency response bodies to detect, report and respond to outbreaks (Oppenheim *et al*, 2018). Global preparedness is an important element to assess as it provides insights into a country's capability to respond to threats to public health (Oppenheim *et al*, 2018).

By reflecting on the different definitions of the terms 'risk' 'vulnerability', 'preparedness', and 'resilience' across literature, it is shown that these terms often vary and depend on the context they are being discussed and utilised. Furthermore, there may be several factors that influence and/or determine the level of risk, vulnerability, preparedness, and resilience individually. Therefore, in the development of a risk assessment tool, the manner in which risk is defined will inform the nature of the indicators adopted for such an assessment framework.

2.3.2 Defining risk assessment

A risk assessment is defined as a three-part process that consists of identification, analysis, and evaluation (DEFF, 2006 & ASSP, 2019). Firstly, in a typical assessment process, the potential hazards and risks relevant to the project are identified. Secondly, the circumstances, causes, and consequences of the risks and hazards are analysed, sometimes against existing risk criteria. Thirdly, aspects around the risk elements identified are evaluated for the action that needs to be taken to moderate the impact and effects of these risks.

The analysis of risk is invaluable as this process helps to better understand the potential dangers of communicable diseases (and non-communicable diseases) and confirm

the actions that are required to mitigate and/or manage the potential risks (Ellis, 2021). For COVID-19, such risks include transmission due to face-to-face interactions or potential vulnerabilities relating to income. Therefore, the potential dangers (or hazards) are to be evaluated, or removed (CCOHS, 2017). Alternatively, the risk that these potential dangers/hazards could add needs to be mitigated by means of introducing control measures where necessary (CCOHS, 2017). In the context of COVID-19, the policies and injunctions that are put in place to minimise the spread of the virus may be facilitated by how well risk is assessed (Ellis, 2021).

Risk assessments have been done across several disciplines, including but not limited to, environmental management, health and safety, manufacturing, and engineering (DEFF, 2006). In this same way, risk assessments have been and should continue to be done for communicable diseases.

2.3.3 Risk assessments of communicable diseases

In the study on social vulnerability to Malaria, Kienberger and Hagenlocher (2014) developed a conceptual framework based on social factors that would influence the level of risk and vulnerability in East Africa. As part of the methodological process, a vulnerability indicator framework was created in line with their definition of vulnerability, which is defined in terms of susceptibility and lack of resilience. The resultant output from Kienberger and Hagenlocher's (2014) study were visualisations generated using the data collected and GIS software, based on the conceptual framework. The final images illustrate the variation in social vulnerability to Malaria across certain parts of East Africa, at a regional scale. The results showed that vulnerability can vary across space, with the research presenting relevant information for policy-makers to identify place-specific interventions which will help decrease people's susceptibility and strengthen their resilience (Kienberger and Hagenlocher, 2014).

Dickin *et al* (2013) focused on implementing a vulnerability mapping methodology to assess vulnerability to water-borne diseases. In the study, the methodology included the implementation of the Water-associated Disease Index (WADI) which first required the development of a conceptual framework that would describe the linkages between humans, the environment, and the dengue mosquito and virus (Dickin *et al*, 2013). From this conceptual framework, the WADI for Dengue fever (WADI-Dengue) was constructed based on quantitative datasets. The resultant output included vulnerability maps derived from the WADI-Dengue. The purpose of this study was to develop this water-associated disease index tool as a viable approach to mapping vulnerability. Dickin *et al* (2013) therefore surmise that WADI-

Dengue is a holistic tool that can be used in identifying priority areas to streamline interventions such as vector control resources and education programs in areas of high vulnerability.

Risk-based assessment tools were also developed in response to the COVID-19 pandemic. South Africa's National Disaster Management Centre (NMDC) collaborated with the Council for Scientific Research (CSIR) to develop a COVID-19 vulnerability index (CSIR, 2020). The purpose of the index was for the NMDC to be able to support local municipalities in their response to the COVID-19 pandemic. This tool would be used to identify key areas that should be prioritized for urgent interventions. The final product from this collaboration was a GIS web-based spatial dashboard, as illustrated in Figure 2.*1*, that showed the level of vulnerability across South African regions and communities. This tool would also be used by the Department of Human Settlements (as previously indicated in subsection 2.2.4).

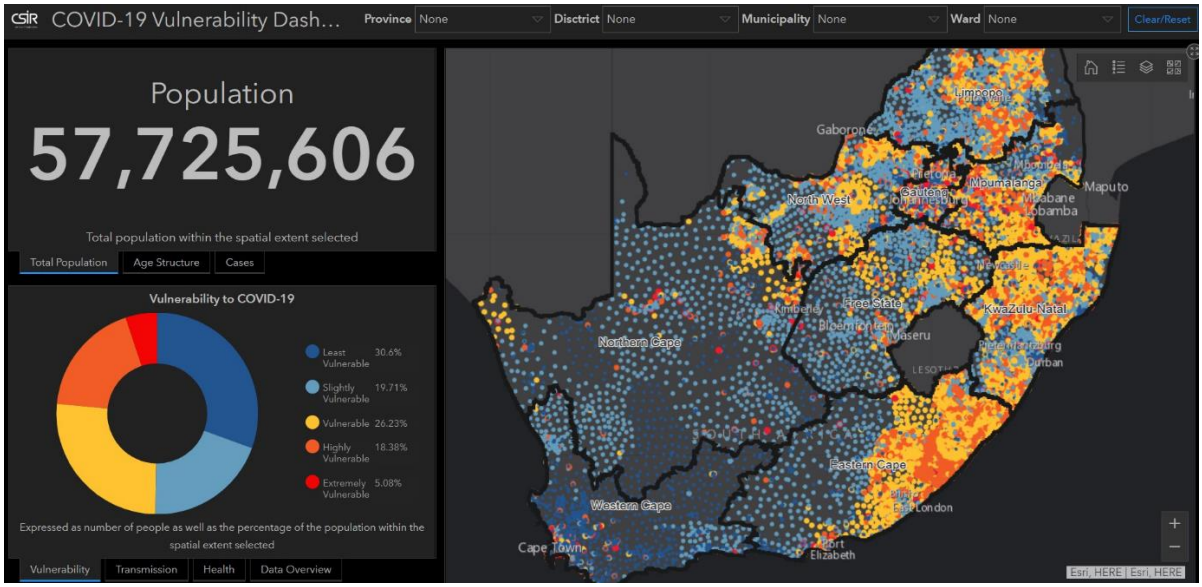

Figure 2.1: CSIR COVID-19 vulnerability dashboard

To better understand the potential localised risk factors that may contribute to the spread of COVID-19 and heighten socio-economic and health impacts on Gauteng communities, the Gauteng City-Region Observatory (GCRO) developed thematic maps at the scale of wards in the province (De Kadt *et al*, 2020). The result was two maps, whereby one map explored risk factors for maintaining basic preventative hygiene, and the second map explored risk factors that could potentially increase a ward's health and socio-economic vulnerability (De Kadt *et al*, 2020). To create these maps, the GCRO team used the survey data in their database from the year 2017/18 and derived six risk factors that could be impediments towards maintaining basic hygiene and six factors that could augment health and

socio-economic vulnerability (De Kadt et al, 2020). Although an entire ward may be shaded to represent a high level of risk, it is important that any interventions introduced do not neglect communities at a more granular level, so that the appropriate context-specific measures are dutifully put in place (De Kadt et al, 2020).

2.4 COVID-19

2.4.1 COVID-19 in the Global context

In late 2019, media reports began to circulate regarding cases of “viral pneumonia” in Wuhan, in the People’s Republic of China (MayoClinic. 2022). It was later verified that China was the ground-zero for a new coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (MayoClinic. 2022). The SARS-CoV-2 virus causes coronavirus disease (COVID-19) – an infectious disease where the virus can be spread from an infected person’s mouth or nose via small liquid particles when they breathe, cough, or sneeze (MayoClinic. 2022, WHO, 2020a). The symptoms of COVID-19 can vary between individuals, with the most common symptoms being a dry cough, fever, and/or fatigue (WHO, 2021). Other symptoms may include nausea or vomiting, muscle pain, headache, and/or a sore throat (WHO, 2021). In the more severe cases, infected individuals could experience shortness of breath, persistent chest pain or pressure, extremely high body temperature (above 38ºC), or loss of appetite (WHO, 2021).

Between January and March 2020, COVID-19 cases were detected across a number of countries, rapidly spreading within the populace of various countries. In response to this spread of the virus, on March 11th, 2020, the WHO declared the COVID-19 outbreak as a pandemic when cases were rapidly being detected across territories and countries around the world (Ducharme, 2020).

As of November 3rd, 2022, there has been a cumulative of 628,346,704 confirmed COVID-19 cases globally, with approximately 6,573,968 reported COVID-19 related deaths (WHO, 2022b). Africa has recorded 9,363,488 cumulative COVID-19 cases, making it the continent with the lowest contribution to worldwide statistics (WHO, 2022b). Since the beginning of the pandemic, Africa continued to record one of the lowest numbers of confirmed COVID-19 cases compared to other regions. This occurrence has been credited to a number of factors, including, but not limited to, the early response by African governments, Africa’s population demographics, airports and international travel restrictions, and testing capacity in Africa (Soy, 2020; Bamgboye *et al*, 2021) Most African governments implemented preventative measures and policies at the early stages of the pandemic (Soy, 2020,

Bamgboye *et al*, 2021). Bamgboye *et al* (2021) note that many African countries that are experienced in managing other epidemics of infectious diseases such as Ebola closed their airports to international flights, limiting contact with other continents and several African countries. Compared to other countries, such as Europe, Africa has a relatively young population, which is important in the context of COVID-19 as people older than 60 years were identified as being at high risk of severe infection (Bamgboye *et al*, 2021; WHO, 2022a). Another reason for the low number of cases in Africa may have been due to the lower number of COVID-19 tests done compared to other countries, which has been linked to limitations such as the cost of the tests as well as a lack of relevant equipment and trained personnel (Bamgboye *et al*, 2021).

2.4.2 COVID-19 in the South African context

As of 2nd November 2022, South Africa recorded 4,028,198 confirmed COVID-19 cases (DoH, 2022).

In response to the declaration of the COVID-19 outbreak as a pandemic, countries all over the world declared states of emergency and nationwide lockdowns. On March 26th, 2020, South Africa's presidency instituted a nationwide lockdown along with specific regulations aimed at containing and minimising the spread of the COVID-19 disease (South Africa, 2020). At the onset of the lockdown, the restrictions thereafter included the restriction on the movement of persons and goods, prohibition of public transport (unless for essential work), and cessation of "non-essential" business operations and services (South Africa, 2020). The immediacy of an economic shutdown of this magnitude left many South Africans without jobs or with reduced salaries (World Bank, 2021). Subsequently, the recovery of jobs was low in the months to come, with only 40% employment loss recovery being recorded at the end of 2020 (World Bank, 2021).

Governments around the world announced more than 1600 new social protection measures, collectively, with a lot of new collaborations formed in order to address the challenges being faced by the world's population (SDG, 2021). Similarly, the Department of Human Settlements in South Africa created COVID-19 Policy, Regulatory and Technical Input groups to craft policies and initiatives to address the challenges created by COVID-19 (DHS, 2020). The department's approaches were focused on identifying key areas of vulnerability, de-densification and relocation, and accelerating efforts for the delivery of services and other essentials, including healthcare and food (DHS, 2020).

2.4.3 COVID-19 and the Sustainable Development Goals

In 2015, United Nation Member States adopted a set of 17 goals known as the Sustainable Development Goals (SDGs). These goals are a worldwide call to end poverty and improve the livelihoods of individuals, while also protecting the planet from the adverse effects associated with climate change, ensuring the preservation of lives for the next generation by 2030 (SDG 2021). The COVID-19 pandemic abruptly disrupted the implementation of many of these SDGs.

Target 1.5 of goal 1 aims to “build the resilience of the poor and those in vulnerable situations” and to reduce their exposure and vulnerability to “other economic, social and environmental shocks and disasters”. Previous projections were indicative of the world not being on track to reach this Goal by 2030 as the rate of poverty reduction had slowed between 2015 and 2017 to less than half a percentage point annually (SDG 2021). However, in 2020, when the pandemic was declared, there was an increase in the global poor of between 119 million and 124 million, the first rise in the poverty rate since 1998 (SDG 2021). With poverty levels still projected to rise, any good results that were being made under the global initiative may have been compromised for years to come, leaving populations in states of deprivation, with some being worse off than before the pandemic.

Target 3.d of goal 3 is to “strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks”, thus making a call to promote better preparedness. The pandemic has negatively affected progress in matters pertaining to health by disrupting access to medical care for those with comorbidities, compromising the health of those with comorbidities, and further perpetuating existing health inequalities such as access to public health care or poor living conditions (SDG, 2021). What has been demonstrated by the pandemic, therefore, is the importance of designing effective policy interventions, which can only be effectively done where there is a more extensive database of demographic and epidemiological data (SDG,2021).

Goal 11.1 of goal 11 aims to ensure access for all to adequate, safe, affordable basic services and slum upgrade by 2030. COVID-19 exposed the vulnerabilities of urban areas which stem from the lack of adequate access to services such as water, sanitation, public transport, public health systems, and affordable housing (SDG, 2021). Moreover, the pandemic resulted in an increase in the number of slum and informal settlement dwellers, and therefore also highlighted the need to improve services rendered to cities, including the improvement of access to public transport and management of public spaces (SDG, 2021).

Focusing on the influence that certain factors may have on the ability of communities to sustain their livelihoods during a pandemic, the following section explores the variables that may influence the spread of the COVID-19 virus or exacerbate challenges linked to people's livelihoods as a result of the COVID-19 pandemic.

2.5 COVID-19 risk variables

Gillies *et al* (2022) inform that the severity of COVID-19 varies significantly between individuals, as such, it is imperative to fully understand risk factors so that individuals or segments of society most at risk from the disease can be identified. In the study done by Keinberger and Hagenlocher (2014), indicators such as 'distance to roads', 'distance to closest hospital', and 'immunity' were selected to assess social vulnerability in East Africa to Malaria. Similarly, De Kadt *et al* (2020) identified a total of 12 localised risk factors that could be of significance to the spread of the COVID-19 virus and its socio-economic impacts. For the remainder of this chapter, 10 key variables/indicators of relevance in the context of COVID-19 were identified and the following part of this chapter provides a short overview of key considerations in relation to each of these indicators.

2.5.1 Household dynamics

Household dynamics in reference to household size and age range is regarded as an important indicator of COVID-19 infection risk. Household size and COVID-19 infection rates have an association as individuals in a larger household may be at greater risk of contracting the disease due to increased mixing within the household (Gillies *et al*, 2022).

Research on the association between household size and COVID-19 has been conducted, however, household size has been analysed in different ways (Gillies *et al*, 2022). In a study conducted in the United Kingdom (UK) on household size and its association with COVID-19, Gillies *et al* (2022) found that households with three or more individuals were at higher risk to exhibit the "non-severe" (i.e., people who tested positive but did not require hospitalisation) symptoms of the COVID-19 virus.

Federgruen and Naha (2021) conducted a study to assess the incidence rates of COVID-19 and average household size in New York City. The study concluded that average household size is the single most important variable associated with infection rates, dismissing population density as an important variable of consideration. When the study was conducted,

New York City accounted for 12.8% of the United States of America's (USA) reported COVID-19 cases (Federgruen and Naha, 2021). This was an illustration of the importance of household size as an exploratory variable in investigating COVID-19 infection rates.

Research has further demonstrated that household size is just one type of household characteristic that could potentially be assessed in the context of COVID-19 risk. The overall composition of the household can also influence the level of vulnerability to contracting COVID-19 (Parker and de Kadt, 2020). In a Gauteng study that assessed the relationship between a number of household characteristics, including multi-generational households, and exposure factors that may impact vulnerability to COVID-19, it was found that the overall COVID-19 risks vary between different household structures and living conditions (Parker and de Kadt, 2020). Key findings from the study were as follows: Firstly, households living in informal dwellings faced the greatest level of risk in relation to the ability to exercise preventative measures such as social distancing. Secondly, households with five or more children are at greater risk in relation to risk factors that would likely increase health and socio-economic vulnerability. Thirdly, further risk analysis revealed that households living in informal swellings are more likely to have inadequate or shared access to sanitation services and households with five more children are more likely to rely on public healthcare services. A UK study found that multi-generational household is associated with an increased risk of COVID-19 infection and death (Nafilyan *et al*, 2021).

People over the age of 60 years old and who have comorbidities such as diabetes, lung diseases, or other compromising health conditions are considered to be most at risk of adverse effects that may come from COVID-19 infection (WHO,2022a). A publication from the statistics modelling platform, Statista, demonstrated that as of July 2020, out of a total of 2,657 COVID-19 related casualties, the majority of the deaths (a total of 717) fell within the 60 to 69 years age group (Galal, 2021). Therefore, age is an important aspect to consider when assessing COVID-19 risk.

Different household characteristics, therefore, impacts an individuals' COVID-19 risk, whether it is as independent variables or as a collective. This means that the average age of the household can have the ultimate influence on COVID-19 vulnerability. Alternatively, the combination of age and, for example, the employment status of household members together may contribute to overall COVID-19 risk.

2.5.2 Housing structures

Housing type is an important variable to consider in assessing the risk to COVID-19 as the dwelling size and type of construction material could inform the overall capacity to practice COVID-19 protocols such as social-distancing and isolation, where required.

South Africa's National State of Disaster guidelines on social distancing state that any persons in public spaces should maintain a distance of at least one-metre from each other (South Africa, 2021). Guidelines such as these are based on the universal recommendations of the World Health Organisation, therefore the feasibility of this is dependent on the way the dwelling structures are arranged.

Gibson and Rush's (2020) examination of the feasibility of social distancing in selected South African informal settlements demonstrated the impracticality of maintaining a safe separation distance between households, due to the proximity between dwellings. This suggests that any lockdown measures considered for implementation should be scaled to be more context-specific.

WHO (2021) advises persons to open windows to increase the amount of ventilation indoors. However, such a guideline may not be easily applicable to dwellings in informal settlements, as many informal settlements in South Africa are made up of shacks that are often poorly ventilated (Manderson & Levine, 2020, cited in Van Wyk & Reddy, 2022). Informal dwellings in South Africa are typically built-up of corrugated iron or tin shacks which can get so hot that without adequate ventilation such as windows, it can make it hard for the dwelling-occupants to breathe (Koitsioe, 2020).

2.5.3 Water

Water is regarded as an important preventative measure against COVID-19 because an important preventative measure in limiting the spread of COVID-19 is frequent and correct hand hygiene (Who, 2020b). Most informal settlements have precarious access to water and community members often do not have their own water supply, for example, piped water within their dwelling (Muzondi, 2014; Wilkinson *et al*, 2020). This makes it difficult to practice frequent handwashing.

Access to water is also imperative for the general livelihoods of individuals. The reliance on non-piped water in areas such as informal settlements may also increase the risk

of getting sick from other water-borne diseases, possibly increasing the need to receive medical attention (de Kadt *et al*, 2020).

In most cases, water in informal settlements, including those in South Africa, is accessed via communal taps or water tanks (Muzondi, 2014; de Kadt *et al*, 2020; Wilkinson *et al*, 2020). Therefore, the directive to stay home (South Africa, 2020) is not feasible in the context of informal settlements as community members need to go out and walk to collect water for their daily use. Isolation also becomes impossible due to the need to leave the house to collect water (Wilkinson *et al*, 2020).

The heavy reliance on shared water sources limits the ability to effectively practice social distancing as households are forced to interact in this regard, inadvertently increasing the risk of COVID-19 transmission (de Kadt *et al*, 2020; Wilkinson *et al*, 2020).

2.5.4 Sanitation

Informal settlements are often characterised by having toilets outside of dwellings and are more so often shared between community members. Therefore, there is a COVID-19 risk with the interactions that take place at these points and the general state of toilet facilities.

In several informal settlements across South Africa, the number of toilets is disproportionate to the population number. National statistical data has demonstrated that a number of households living in informal settlements have been forced to share toilet facilities (Stats SA, 2016 cited in SERI, 2018). Sharing toilet facilities means that there is forced interaction between households, therefore making the ability to practice the guidelines around social distancing and strict isolation nearly impossible (de Kadt *et al*, 2020, Wilkinson *et al*, 2020).

Maintaining hygiene in shared toilet facilities can become very difficult, especially in cases whereby it is many households that share a set of toilet facilities (de Kadt *et al*, 2020). Moreover, there is added risk if shared ablutions are not properly maintained, and thus may present other health risks such as Urinary Tract Infections (UTIs) (de Kadt *et al*, 2020, Wilkinson *et al*, 2020).

2.5.5 Mobility and transportation

In the context of COVID-19, mobility and transportation may be regarded as COVID-19 risk variables because, when these elements are not properly regulated, managing the spread and transmission of the virus becomes more challenging. This was proven when COVID-19 spread from China, the country of origin, to Italy and other countries, eventually finding its way to South Africa (NICD, 2020a). This indiscriminate spread of the virus occurred during the period when few restrictions were put in-place on international travel. Therefore, greater mobility demonstrates an increased risk of COVID-19 spread.

Informal settlements often consist of immigrants (local and international) who come to cities seeking jobs and access to other sections of the economy, to improve their current standard of living. As such, Wilkinson *et al* (2020) highlight mobility as a key consideration that may determine the transmission of COVID-19. This is because, as community members in informal settlements travel back to their regions of origin, the risk of spreading COVID-19 increases.

The 2019 general household survey (Stats SA, 2019) highlighted that approximately 26.3% of South Africa's population uses taxis to get to work, with a further 5.6% using the bus or train. Therefore, with public transportation, the risk of COVID-19 transmission is greater due to the high passenger turnover, limited ventilation, and inability to practice social distancing due to seating (de Kadt *et al*, 2020).

2.5.6 Electricity, energy, and other essentials

Access to electricity services and other essentials speaks to the livelihood of informal settlement residents. In this way, assessing COVID-19 risk in terms of a community's access to goods and services provides a holistic view on the conflict between implementing COVID-19 interventions and the standards of living pre-pandemic.

Informal settlements are characterised by lacking access to basic services, including electricity (SERI, 2018). As South African informal settlement households also often lack electricity mains in their dwellings, they usually resort to using more dangerous and risk-prone alternatives for lighting and cooking (Musango, 2014), and this diminishes the overall quality of life in informal settlements.

Access to alternative energy sources such as paraffin and gas, as well as food and other essential items were influenced during the pandemic, particularly in the earliest stages of the national lockdown. Informal traders and spaza shops were initially not considered 'essential workers' under the COVID-19 regulations (Van Wyk & Reddy, 2022), which severely compromised access to affordable essentials for informal settlement residents. Regulations were later amended to include spaza stores and informal traders (South Africa, 2020). Under these regulations (South Africa, 2020), both formal and informal shops were expected to adhere to the same rules, however, most informal traders and establishments may not have the space required to enforce effective social distancing. Additionally, the resources to afford sanitizers could also have been a challenge

2.5.7 Community behaviour and attitude

For some states, successful efforts to curb the spread of the COVID-19 virus have come from a concerted effort from the state's implementation of the World Health Organization's recommendations (WHO, 2021) and the compliance of the public to these recommendations. Legalising these recommendations, namely, the implementation of preventative hygiene, masks, and social distancing has formed a big part of countries' pandemic response.

A report compiled by a Brazilian Senate Committee reveals the lack of duty of care from the Bolsonaro administration to protect the general public during the pandemic, which resulted in more deaths that could have been prevented (Canineu & Muñoz, 2021). Dismissing recommendations by the World Health Organisation - by vetoing making masks mandatory by law in churches and prisons, and deliberately not providing oxygen tanks to the health authorities - demonstrates how a disregard for exercising health protocols could impact a population in the context of COVID-19 (Canineu & Muñoz, 2021).

As the COVID-19 virus is spread via respiratory droplets produced when an infected person coughs or sneezes, masks are regarded as an important preventative COVID-19 control measure (NICD, 2020b; DoH 2020; WHO, 2021), which is why they form part of the WHO recommendations. By reducing the number of close-contact scenarios between individuals, there is a lower risk of viral transmission. As such, social distancing has been included in the WHO recommendations (WHO, 2021). Another means of protection against COVID-19 is practicing good hand hygiene by ensuring that hands are frequently kept clean by using soap and water or, in the absence of water, an alcohol-based sanitizer (DoH, 2020; WHO, 2021). In this way, any germs or viruses on the hands can be eliminated.

In considering the preventative hygiene and transmission mitigation measures recommended by the WHO, it is important to acknowledge that public willingness to adhere to these recommendations was inconsistent across regions. In the United States of America (USA), mask-wearing policies were put in-place relative to the countries respective individual states (Fischer *et al*, 2021). Despite the incorporation of COVID-19 protocols into state policies, instances of dissent were observed. It has been recognised that instances of dissent complying with COVID-19 preventative measures (legal or recommended) is informed by people's beliefs, attitudes and socio-economic characteristics (Kim *et al*, 2023).From a survey conducted by Kim *et al* (2023), a representative sample of 2,000 respondents, were classified into the following four groups: Group A – support government mandates to wear face masks ad themselves wear face masks; Group B – people who themselves wear face masks even though they oppose mandatory mask-wearing; Group C – people who are non-compliant supporters as they support regulation, but do not wear masks; and Group D – those who oppose face mask regulation and do not wear masks themselves. A more granular assessment on the socio-economic and political characteristics of the respondent groups provides a potential indication on what has informed the stance adopted by individuals, including religious beliefs, political ideologies and age. (Kim *et al*, 2023). Evidently, people's individual attitudes and inherent belief systems can determine the overall level of adherence and compliance to mandated COVID-19 policies and regulation (Fischer *et al*, 2021, Kim *et al*, 2023).

Therefore, the attitudes that a population has towards COVID-19 is of vital importance in attempts to mitigate and control the spread of the virus. South Africa's response to these recommendations was to put them into legal effect by mandating that masks be worn in public settings and/or at mass gatherings and instituting social distancing measures where applicable (South Africa, 2020). Once these regulations were eased as the country moved from lockdown level 5 down to 3, there was an exponential increase in COVID-19 cases which Moonasar *et al* (2021) linked to the poor adherence to the guidelines as more freedom of movement was provided.

2.5.8 Food security

Prior to the global crisis, approximately 650 million people were suffering from hunger worldwide as of 2019 (SDG, 2021). Food security has been further threatened by the pandemic, whereby in 2020, according to estimations by the United Nations, the number of people suffering from hunger worldwide has increased to between 720 million and 811 million people, an increase of almost 160 million people (SDG, 2022).

Food insecurity in South Africa was further exacerbated by the reduction of, or the loss of household income due to the economic shutdown associated with the pandemic (Van Wyk & Reddy, 2022). Additionally, food access was also compromised during the earliest stages of the lockdown as informal food vendors – which are major sources of food for many living in poorer settlements – were forced not to operate as they were initially not regarded as "essential" (Battersby, 2020, cited by Van Wyk & Reddy, 2022).

Van der Berg *et al* (2021), however, describe the support provided by the South African government in the response to the pandemic. These responses included the provision of a special social grant and food parcels distributed to those identified as the most vulnerable. They go on to lament the fact that without the establishment of these forms of support, poorer households could have experienced even more severe hunger (Van der Berg *et al*, 2021). An inability to meet basic nutritional needs could mean greater chances of severe infection or COVID-19 effects (De Kadt *et al*, 2020). Despite the commendable nature of these efforts, there were still noted discrepancies in the distribution of food parcels, with several households stating that they did not benefit from these COVID-19 initiatives (Van der Berg *et al*, 2021).

2.5.9 Healthcare

People with underlying medical conditions, including but not limited to heart disease (including high blood pressure), chronic respiratory diseases, and diabetes, were marked as those most at risk of COVID-19 in terms of infection (NICD, 2022a). Before the onset of the pandemic, the South African health system was already battling with the heavy burden of tuberculosis (TB) and HIV/Aids cases (Van Wyk, & Reddy, 2022). A major concern was therefore that a predicted influx of COVID-19 cases would increase the burden on already constrained public health facilities thus compromising their ability to provide basic health care and chronic disease related services (de Kadt *et al*, 2020).

Community members of informal settlements face a number of health risks. The threat of exposure to indoor air pollution is greater due to the reliance on cooking and energy alternatives such as wood, paraffin, and gas, and may lead to respiratory disease (Musango, 2014; Wilkinson *et al*, 2020). The inability to meet nutritional needs makes individuals more at risk of severe infection (de Kadt *et al*, 2020). A nationwide lockdown creates barriers to food access, particularly for those in informal settlements, who sometimes rely on street food and informal vendors (Van Wyk, & Reddy, 2022). The closing of schools also affects the provision of school meals for children, which further creates a burden on poorer-income households that

are already struggling to ensure that the household is fed (de Kadt *et al*, 2020; Van der Berg *et al*, 2021). Therefore, poor health status attributed to pre-existing health conditions will likely increase the risk of COVID-19 infection and associated illness (de Kadt *et al*, 2020).

In the health context, stigmatisation is the negative association of a specific disease with a group of people who share a certain characteristic (UNICEF, 2020). Well-documented information regarding COVID-19 specific stigmatisation cases or explorations is currently limited.

Vaccines are designed to protect children and adults from disease-causing germs by training the immune system to combat viruses/bacteria (NICD, 2022b). As of July 2022, 12 billion COVID-19 vaccine doses (this includes first and second doses, as well as boosters) had been administered worldwide, with approximately 62% of the global population being fully vaccinated (Our World in Data, 2022). As of July 2022, roughly 37 million vaccines had been administered in South Africa since the vaccination campaign began in April 2022, with the highest cumulative number, 10.3 million, being in Gauteng (Figure 2.*2*).

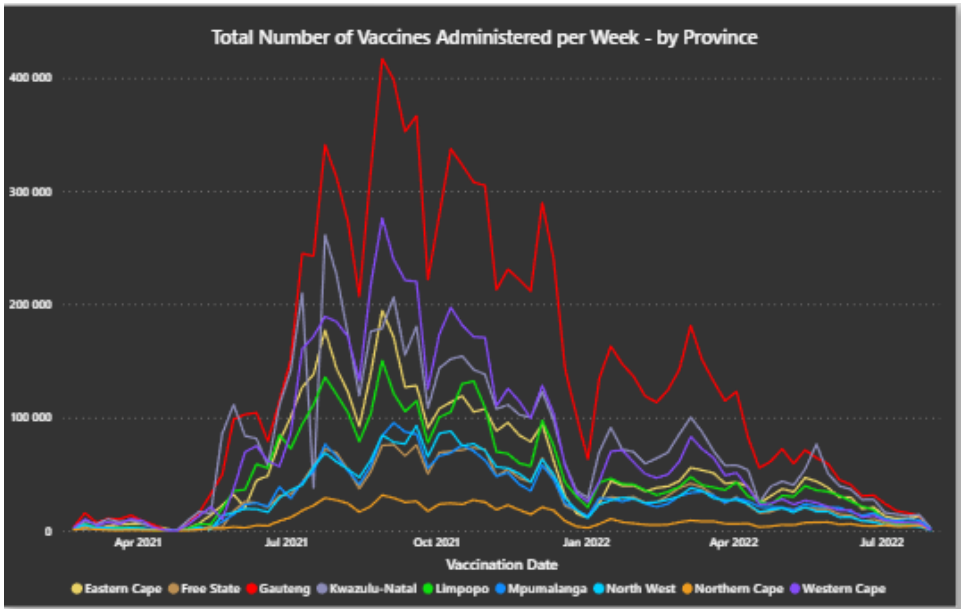

Figure 2.2: Dashboard displaying the total number of vaccines administered in South Africa - by province (Sourced from the Department of Health of South Africa COVID-19 online portal, 2022)

The challenges linked to the distribution of vaccines in South Africa were around the financial considerations and logistics associated with obtaining the vaccine for everyday citizens (Gonzalez, 2021), as opposed to an imbalance between supply and demand. By the end of 2021, approximately twelve million people had applied for the R350 emergency COVID-19 grant (Gonzalez, 2021). By considering this and the fact that the average costs of a taxi fare is R20-R30, there is significant trade-off between obtaining vaccination and the overall standards of living.

It is recognised that informal settlements consist of the proportion of the population often working insecure, under-paying jobs (UN-Habitat, 2015). Furthermore, healthcare services are often absent from informal settlements, meaning most settlers rely on clinics and hospitals that are outside of the informal settlement whereby the distance to these facilities can vary. As seen from the residents of Dinaweng, (Matamanda, 2021), travelling to medical facilities was forfeited due to the cost of travelling and the time spent at these facilities.

2.5.10 Employment

In the context of COVID-19, employment type or the manner in which people get their daily income is regarded as a variable that would influence the ability of households to cope with a pandemic.

The declaration of COVID-19 as a pandemic by the World Health Organisation led to governments worldwide instituting national lockdowns in an effort to limit the spread of the virus among the populace *i.e*. to “flatten the curve” of COVID-19 infections. However, the result of economic shutdowns directly affects employment through job losses, salary cuts, and limited work opportunities. The International Labour Organization estimated that the working hours lost in 2020 were equivalent to 255 million full-time jobs (Richter, 2021). In South Africa, it was estimated that approximately two million jobs were lost between 2019 and 2021 due to the COVID-19 pandemic (BusinessTech, 2022)

Between 2019 and 2020, the global unemployment rate increased by 1.1% to a value of 6.5% (SDG, 2021). South Africa demonstrated a similar trend between 2019 and 2022. The country’s unemployment rate increased from 29% in 2019 to 35.3% at the beginning of 2022 (Trading Economics, 2022). Albeit COVID-19 had a negative effect on employment, South Africa’s battle with catering to its continuously growing unemployed population far preceded the pandemic (Mail & Guardian, 2019). Therefore, the pandemic further perpetuated a pre-existing socio-economic issue in the country.

Furthermore, working from home or staying indoors is not feasible for people living in informality because informal settlements are characterised by inadequate dwelling structures and lack of access to basic infrastructure, particularly, in this case, electricity for connectivity (UN-Habitat, 2015). Simultaneously, informal dwellers are more likely to be employed in the informal job market where their absence from work would translate into a “no work no pay” type of outcome which heightens their level of vulnerability and the number of job losses in

these communities compared to individuals employed in the more formal job market. The South African government's COVID-19 policies put in place, as lamented by Van Wyk & Reddy (2022), failed to appropriately acknowledge the dynamics around informal settlements and how residents maintain their livelihoods.

2.6 Chapter conclusion

The literature review reveals the high level of vulnerability of settlers in informal settlements on a day-to-day basis. These existing vulnerabilities further exacerbate the dweller's risk to the outbreak of communicable diseases, as exhibited by the outbreak of COVID-19. Furthermore, the risks associated with residing in informal settlements has found expression in both the international and South African context.

It was further observed that a challenging factor in coordinating appropriate responses to the COVID-19 pandemic in informal settlements was the nature of the settlements. As areas that are dynamic and consist of the marginalized population, the disparity in the levels of destitution across informal settlements creates a challenge towards informed intervention strategies. Furthermore, as a result of these conditions, there is a lack of suitable risk assessment frameworks in the context of informality.

Moreover, the literature review has revealed the importance of considering context-specific indicators/variables within informal settlements in planning responses as these indicators/variables act as determinants of risks in informal settlements.

In the chapter to follow, the methodology employed in the study is described, particularly the development of the COVID-19 risk assessment framework and how it was used to assess risk in Melusi, an informal settlement in South Africa.

3 METHODOLOGY

3.1 Chapter overview

The study was conducted in Melusi informal settlement, Pretoria West (Chapter 1.4.3). This chapter provides an overview of the methodological approach adopted for this inquiry. Creswell (2009) asserts that the methodological approach adopted in a study should align with the stated intent of the research, the result of which is demonstrated by the framework generated. The chapter goes on to illustrate the risk assessment framework developed and describes the data collection process and data analysis methods employed.

3.2 Research design

For this study, the methodology was informed by the mixed method approach. One part of the approach involved the corroboration of quantitative data for Melusi, which was obtained from the household survey data provided by the UP Community Oriented Primary Care (COPC) unit from the Department of Family Medicine. The qualitative data was collected through focus group discussions with the community health workers stationed in Melusi. Additionally, discussions with some of the coordinators of the COPC (regarded as the key informants of this study) were held to gather informed insights from those who operate at the managerial capacity. The literature review conducted guided the researcher on the data to be collected for the study which included the quantitative data from the secondary sources (i.e., the household surveys conducted by the local community health workers) as well as the qualitative data collected during the focus groups. The data collection focused on three inter-connected themes: informal settlements, risk assessments for communicable diseases and COVID-19. The methodological process is summarised in Figure 3.1.

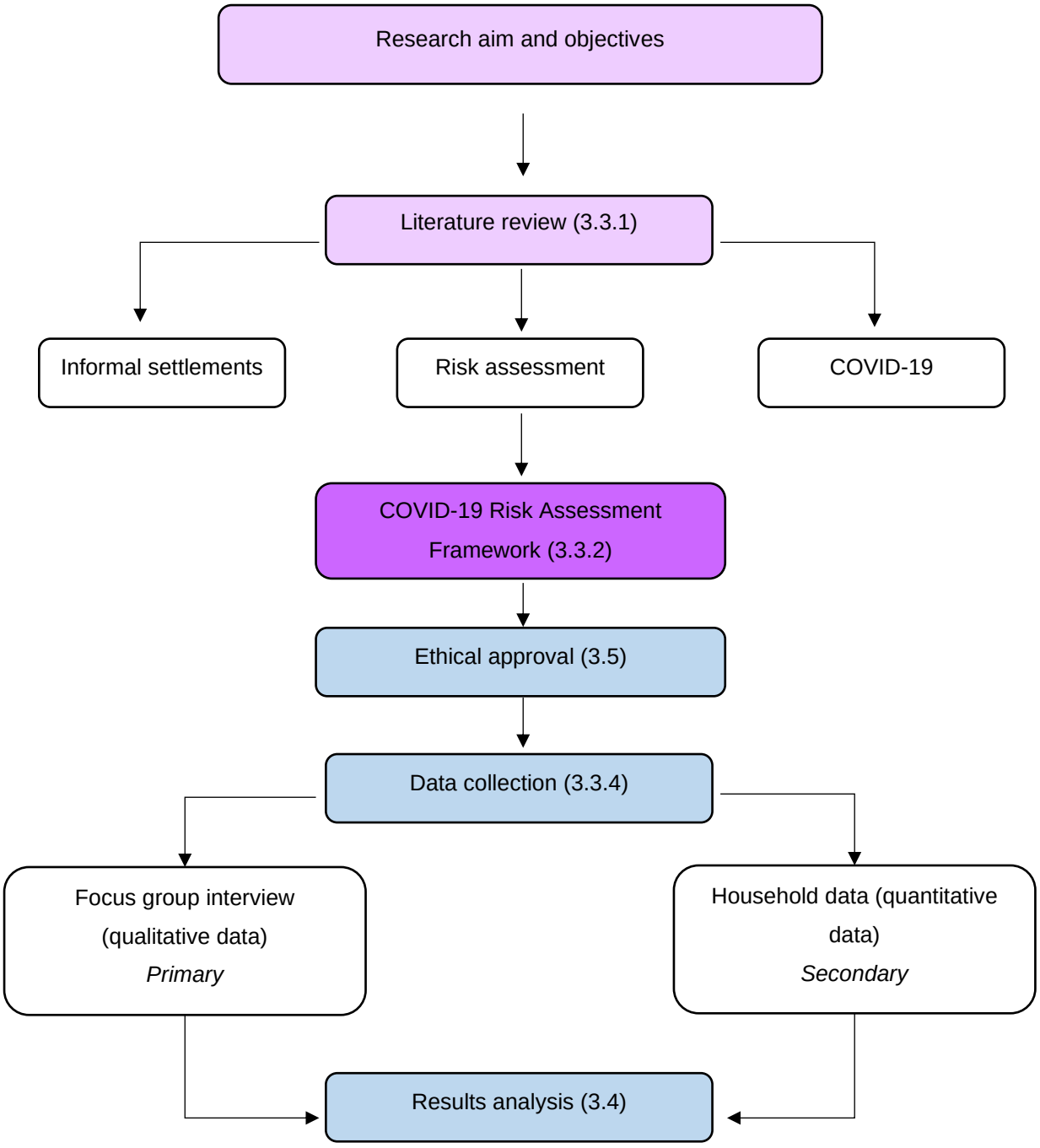

Figure 3.1: Methodology carried out in this study and the corresponding methods chapter.

The research design of this study was formulated to understand the lack of COVID-19 risk assessments at the informal settlement scale. A mixed method approach was deemed the most appropriate method to implement in this study. The mixed method design integrates techniques from qualitative and quantitative data collection approaches which, by combining these two traditional approaches, can best tackle research questions (Pinto *et al*, 2012). By adopting this approach, a more holistic narrative can be presented around the level of risk of COVID-19 in an informal settlement.

In this study, risk was ultimately defined according to three domains - vulnerability (susceptibility), preparedness (capacity to anticipate), and resilience (capacity to cope) - which were derived from Kienberger and Hagenlocher (2014). Subsequently, through the review of literature, a total of eleven variables were selected to model COVID-19 risk according to the three domains of risk. These eleven variables are presented in the COVID-19 risk assessment framework developed for this study (Chapter 3.3.2).

During visits to the study site, it was established that the Daspoort Clinic in Pretoria West, which is the site for the COPC unit, works in conjunction with the University of Pretoria's Department of Family Medicine. Furthermore, it is through the COPC that the community health workers stationed in Melusi are trained and given licence to operate within the community. Visits to the site enabled the researcher to conduct key informant interviews and to observe and form an understanding of the physical attributes of the study area.

For this study, community health workers stationed in Melusi were identified as the most suitable participants for the focus group discussions. Community health workers are members of a community who trained to offer basic healthcare services to the community (Smit & Hugo, 2021). As part of their work, community health workers conduct home visits, deliver medication, and make referrals to the clinic or other healthcare professionals (Smit & Hugo, 2021). The community health workers also do work in the clinic, where they form Ward Based Outreach Teams (WBOT[3]) and are supervised by professional nurses (Smit & Hugo, 2021). As members of the community, community health workers are well-acquainted with other households in the community, making them a point of reference to obtain information regarding community dynamics within the settlement.

In preparation for the focus groups with community health workers, a pilot session was conducted with students from the Department of Geography, Geoinformatics and Meteorology at the University of Pretoria. Participants of the pilot study provided feedback regarding the way the focus group was moderated. Additional suggestions about conducting a focus group were provided. The feedback received was to be used by the moderator of the focus group discussions in Melusi. The purpose of the pilot study was to receive confirmation that the questions to be presented were ethical and did not intrude on participant comfort or privacy.

[3] The City of Tshwane partnered with UP Family Medicine to roll out WBOTs in the Tshwane district. UP Family Medicine is responsible for managing data and technology and coordinating the WBOTs with the aim of providing community oriented primary care services.

Based on the feedback from the pilot study participants, no amendments to the questions asked were required.

Hennink (2014) states that the purpose of focus groups is to gain an understanding of the issues on a research topic from the perspective of the participants, and to highlight the range of perspectives. Therefore, focus groups would assist in getting the views of the participants about the variables of risk in Melusi in a time-effective manner. In non-threatening group environments, participants feel comfortable sharing their views, hearing the views of others, interacting with others in the groups, and subsequently raising additional issues or sharing similar experiences (Hennink, 2014). Therefore, it is through these interactions that more data can be obtained, as opposed to if individual interviews were done. A weakness of the focus group method, however, is that focus groups may become dominated by one or two participants, leaving the less outspoken participants intimidated into not sharing their insights, resulting in skewed data toward one viewpoint.

The qualitative data was collected during three focus groups, observation visits to the site, and the meetings with the COPC facilitators. The design of the interview template for the focus groups (Appendix A) was derived from the COVID-19 risk assessment framework developed in this study. Therefore, the main themes presented in the focus groups were based on the eleven variables selected to assess COVID-19 risk in Melusi. To analyse the qualitative data, the framework method (Gale *et al*, 2013) was used. This method is described as a 7-stage process that consists of the following steps: transcription, familiarisation with the interview, coding, developing an analytical framework, applying the analytical framework, charting data into a framework matrix, and interpreting the data. This will be expanded upon in subsection 3.4.1.

The quantitative data used was secondary data provided by the COPC. As part of the WBOTs, which fall under the COPC research unit, the community health workers based in Melusi collected information by conducting survey data from the households situated in the area for research purposes under the COPC. To analyse the quantitative data, a scoring method that focused on the survey tallies was done, as described in subsection 3.4.2.

The remainder of this chapter will describe the methodology employed according to the objectives of the study as shown in Table 3.1.

Table 3.1: Linking the study objectives to the methodology.

Objective Number	Objective Statement	Methodology
Objective 1	To review available risk assessment tools and responses to health crises or pandemics in the context of informal settlements in South Africa.	• Literature review of informal settlements, risk assessments, and COVID-19
Objective 2	To design and implement a risk assessment framework based on indicators relating to vulnerability, preparedness and resilience using the outbreak of the COVID-19 pandemic in Melusi as a case study.	*Design* • Perusal of risk assessment studies on communicable diseases • Selection and allocation of risk variables, indicators and descriptors *Implement* • Focus group (qualitative data) • Secondary household survey data (quantitative data) • Pilot study
Objective 3	To evaluate the proposed risk assessment framework in this study for future replication in the context of outbreaks or pandemics in South African informal settlements.	• Analysis of focus group transcripts • Analysis of secondary household survey data • Scoring matrix development

3.3 Document review (objectives 1 and 2)

3.3.1 Document review (objective 1) - informal settlements, risk assessment, and COVID-19

The first part of this study, the literature review, was done to reach objective 1 of the study which was to review available risk assessment tools and responses to health crises or pandemics in the context of informal settlements in South Africa.

Studies on informal settlements at the global and national scale were explored. This included researching informal settlements in the context of COVID-19. Previous work on developing risk assessment frameworks and tools for communicable diseases was consulted. COVID-19 was reviewed in terms of the general overview of the pandemic. Followed by an in-depth review of factors that could potentially facilitate the spread of the COVID-19 virus or could create a negative socio-economic impact as a result of the pandemic.

3.3.2 COVID-19 risk assessment framework (objective 2)

The literature review conducted informed the development of the risk assessment framework, to meet objective 2 of the study, which was to design and implement a risk assessment framework based on indicators relating to vulnerability, preparedness, and resilience using the outbreak of the COVID-19 pandemic in Melusi as a case study.

The selection of the domains – vulnerability, preparedness, and resilience – to measure risk was derived from the study done by Kienberger and Hagenlocher (2014), who created a risk and vulnerability framework for malaria. Furthermore, to identify the variables and indicators that would be ascribed to one of the three domains, the studies done by De Kadt *et al* (2020), Kienberger and Hagenlocher (2014) and WHO guidelines on COVID-19 were used as the main sources. The variables were chosen based on how relevant they were for assessing COVID-19 risk, according to existing research. A total of 11 variables were identified and categorised in the process of creating the COVID-19 risk assessment framework. In this study, of the variables identified, household dynamics, dwelling structures, water, and sanitation were categorised under the vulnerability domain. COVID-19 preventative measures (I.e., use of masks, sanitizer, and social distancing), food availability, and community healthcare were placed under the preparedness domain. The following variables were categorised under resilience: mobility and transportation, access to essentials and energy, community attitude, and income structure.

The variables selected were then prescribed a set of indicators that would be used to assess risk in terms of vulnerability, preparedness, or resilience. Recognising that data for informal settlements are not always readily available or sufficient, quantitative and qualitative indicators were assigned to assess the relevant variables. This way, the risk assessment framework is not limited to assessing risk in terms of one type of data.

Therefore, the output from the categorisations was a six-table risk assessment framework that looks at vulnerability, preparedness, and resilience to COVID-19 and its associated impacts, split according to the quantitative and qualitative indicators for each variable, as can be seen in Appendix D.

For the risk assessment framework in this study, susceptibility represents the existing conditions (economic, social and/or cultural) that render a population sensitive to the negative impacts of a virus (as described by Dicken *et al*, 2013 and Kienberger & Hagenlocher, 2014).

Thus, relevant variables and indicators of susceptibility were used to assess why and in which ways the community of Melusi is vulnerable in the COVID-19 context. (Table 8.5, Table 8.6)

Capacity to anticipate (Table 8.7, Table 8.8) looks at an informal settlement's level of preparedness. In this context, the capacity to anticipate may be defined as the set of adequately stipulated strategies or programs that are made available before the virus hazard arises (Kienberger & Hagenlocher, 2014). Variables and indicators of preparedness are used to assess whether the Melusi community is prepared to deal with COVID-19 related impacts. Some indicators under this domain may be linked to the injunctions put in place to mitigate the spread of the virus (South Africa, 2020; South Africa, 2021).

Capacity to cope (Table 8.9, Table 8.10) refers to the ability of communities to utilise available resources to deal with the adverse conditions that may arise as a result of a pandemic (Kienberger & Hagenlocher, 2014). Therefore, variables and indicators under this domain were used to determine whether the Melusi community was resilient and can bounce back after a lockdown period and/or the pandemic.

3.3.3 Site visits and orientation

The site visit started at the Daspoort Clinic, located in Pretoria West – approximately 3 km north of the mobile clinic situated in Melusi, the study area. The senior staff members onsite (i.e., the key informants of this study) welcomed the research team. These key informants were facilitators and supervisors who are part of the Community Oriented Primary Care (COPC) research team. A roundtable discussion took place whereby a breakdown was provided of Daspoort clinic's functions in relation to providing healthcare services to the community members of Melusi. Furthermore, the key informants provided insights about the housing situation, water access and sanitation, feeding schemes, employment levels, governance, and, energy access in Melusi were provided. Additionally, visual observations such as the number of people observed in the area, water tanks, and the structure of the buildings were also noted.

In addition to the visits to site, regular communication was kept with the key informants through the data collection and analysis process. Through these meetings, more information was provided regarding the COPC operations within Melusi and the community dynamics. The key informants for the study consisted of two of the coordinators stationed at Daspoort Clinic. These coordinators' main role was to manage the community health workers and facilitate the research process on behalf of the COPC. Other key informants included one of the nurses

stationed at Daspoort Clinic and one of the main researchers of UP COPC who oversaw all matters pertaining to the provision of primary healthcare across informal settlements in the City of Tshwane. Approximately five interviews were conducted with the key informants across during the study period.

The mobile clinic within Melusi, which serves as the base for the community health workers and nurse(s), was visited. As part of the COPC initiative, the mobile clinic operates to offer free primary care services, covering basic healthcare and nutritional needs and empowering the community by providing them with access to education and technology for both the youths and adults (Meyer, 2021).

Visits to the study area were beneficial as they allowed the researcher to familiarise herself with Melusi, the mobile clinic, and Daspoort Clinic, which functions as a referral clinic for Melusi residents.

3.3.4 Data collection

i. Focus groups

The qualitative data required to assess risk was collected through, predominantly, focus groups. During the focus group discussions undertaken for this study, participants discussed household dynamics, the internal layout of dwellings, access to water, sharing of sanitation, mobility and transportation, access to essentials, community social distancing, mask-wearing and sanitising, food availability, community healthcare, community attitude, and income structure.

The participants for the focus groups were selected using convenience sampling, which can be defined as the selection of a sample of participants based on how easily accessible and readily available they are (Salkind, 2012). As the study area was identified through communication with the Department of Family Medicine Community Oriented Primary Care (COPC) division from the University of Pretoria, all 21 community health workers employed in this research unit were identified as suitable participants for the focus groups. This was because a key concern for community health workers is health-related issues within the community they live in. In performing their duties, they also collect health-related data for each homestead. It was therefore felt that interviewing community health workers would give the researcher valuable and more representative insights about health-related issues and general conditions within the community.

The community health workers for all these sessions were responsible for rendering community health functions across the entire Melusi. Although some participants indicated that they were field workers, they readily acknowledged that both community health workers and field workers still do the same work, therefore the distinction had no significant bearing on the responses given.

From the discussions, it was established that Melusi was divided into three sections, as depicted in Figure 3.2, and each community health worker was assigned to a specific zone. Each focus group consisted of a mixture of participants who were assigned to either Melusi 1, 2 or 3. This diversity within the focus groups allowed for detailed conversations about conditions in each of the respective zones in Melusi, thus helping the researcher to gain a more holistic understanding of conditions in each zone.

To notify and assemble the community health workers, a liaison was organised with one of the coordinators and one of the nurses based at the Daspoort clinic located in Pretoria West (affiliated with the Department of Family Medicine). The period of these discussions was for August 2021, with one session per day taking place on Friday 13th, 20th, and 27th of August. Focus group 1 consisted of nine community health workers (seven females and two males). Focus group 2 was conducted with eight community health workers (six females and two males) and focus group 3 consisted of four community health workers (three females and one male). The average duration for the focus group sessions was two hours. Within these two hours, a 15-minute break was initiated between the first and second hour of the session. During these breaks, the participants were provided with light snacks and refreshments. At the close of these focus group discussions, the participants were provisioned with takeaway lunch packs as an incentive for the time taken by the participants to sit in on these sessions.

The focus groups sessions were conducted using the questionnaire developed for this study, which can be found in Appendix A. Although the questionnaire was compiled in English, in order to accommodate the participants as far as possible, participants were told that they were welcome to speak in the local languages of Setswana and Sepedi, and the moderator would respond in kind. During the focus groups, the questions would be asked by the researcher, with plenty of time allocated for participants to reflect on their answers. Every attempt was made to ensure that the group discussions were not dominated by one or more individuals by gently prompting each one of the focus group members to respond to the questions.

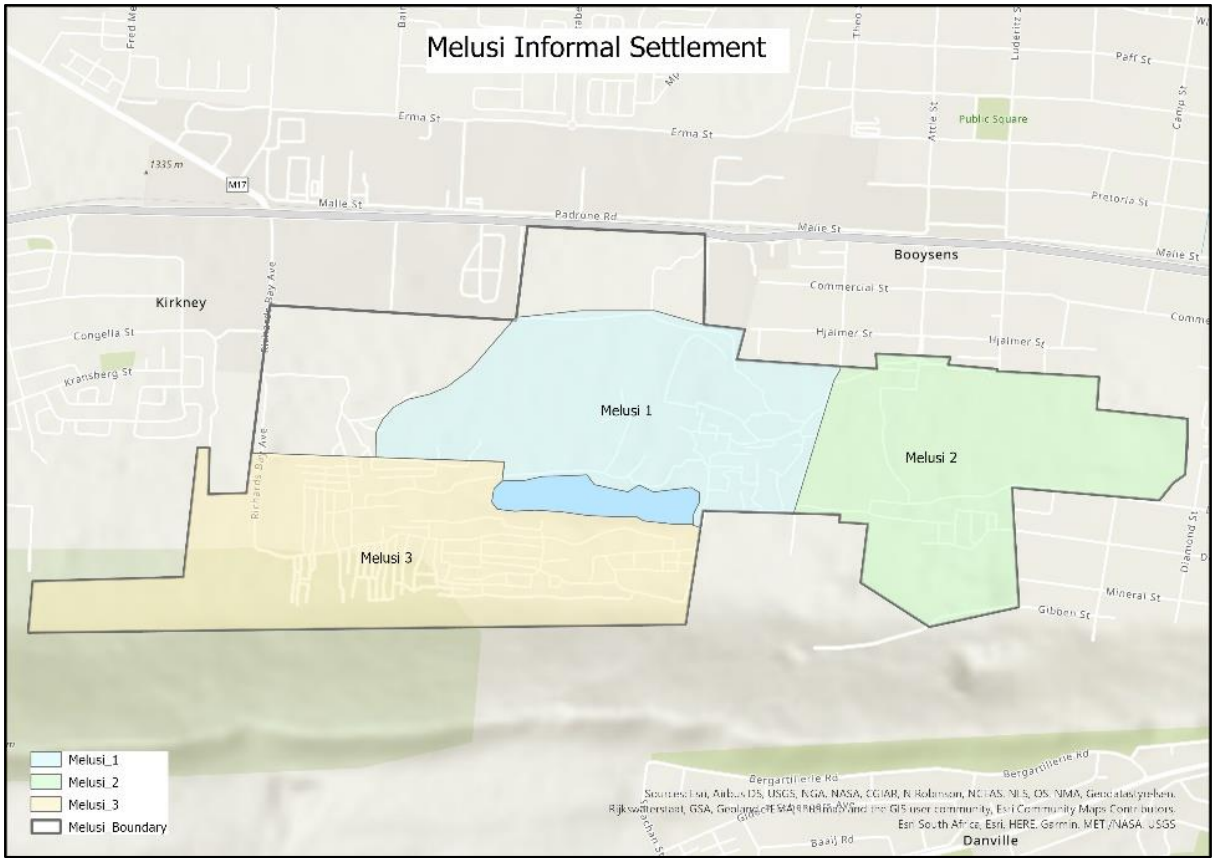

Figure 3.2: Layout of Melusi and demarcations (Source from: UP COPC)

ii. Household survey data

The quantitative data obtained for the study was the household-level data obtained from the UP COPC. In 2018, Melusi's WBOTs were deployed across the community to collect information that would be used by the COPC for research purposes and for informed decision making. Data was collected for a total of 1667 households and the topics covered included the following household information: registration, members, individual health statuses, and characteristics, including the size of the household and dwelling, type of sanitation facilities, water access type, source of energy, status of food access, and household employment status.

The purpose of the collection of the household data in Melusi was focused around four considerations that would inform the operations of the WBOTs within the communities (Kinkel *et al*, 2015). Firstly, to obtain information that would allow WBOTs to provide community-oriented primary care services. Secondly, to support WBOTs in their service offering. Thirdly, for monitoring and evaluation. Finally, to generate new knowledge about the health of the communities.

3.4 Data analysis (objective 3)

The analysis of the data collected, in reference to the COVID-19 risk assessment framework developed in this study, was done to meet objective three of this study, which is to evaluate the proposed risk assessment framework in this study for future replication in the context of outbreaks or pandemics in South African informal settlements.

3.4.1 Qualitative data analysis (the Framework Method)

To analyse the qualitative data collected from the focus group discussions, the seven-stage Framework Method described by Gale *et al* (2013) was used (as illustrated in Figure 3.3).

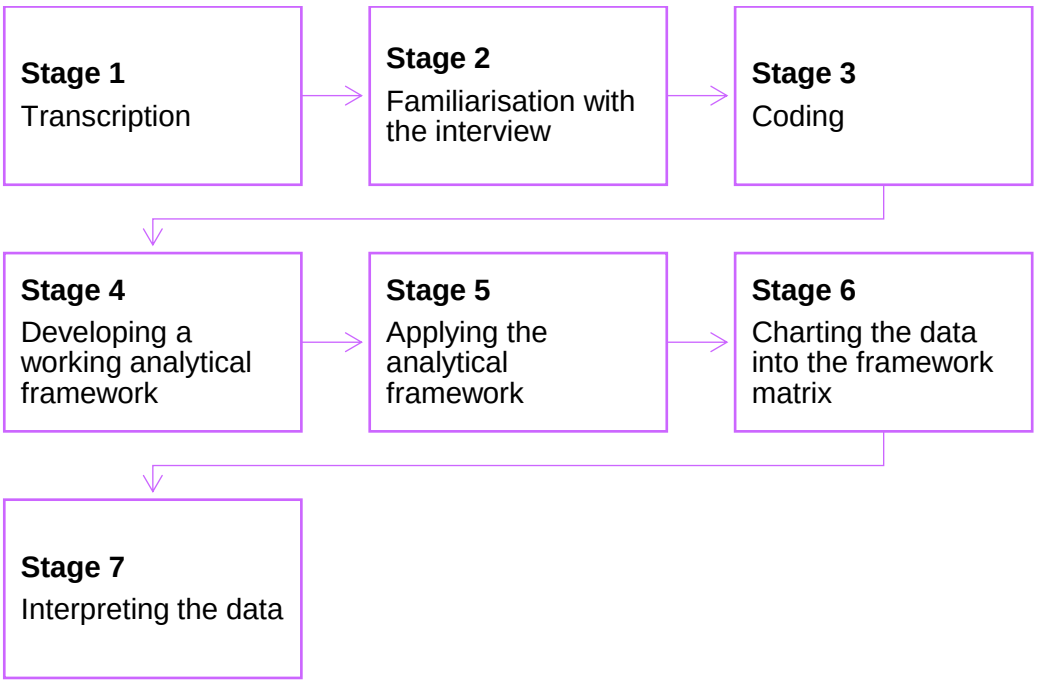

Figure 3.3: The Seven-Stage Framework Method adopted from Gale et al (2013) and implemented in this study.

i. Stages 1, 2, and 3 (transcription, familiarisation with the interview, and coding)

Following the conclusion of the focus groups, the recorded sessions were manually translated from Setswana/Sepedi to English. The English translations were then transcribed. The transcripts were then read alongside the recorded sessions as a form of re-listening (familiarising) to identify broad themes. The final transcripts were imported into the software tool, Atlas.ti. for analysing qualitative data. On this software, 'codes' were applied to the participants' responses and comments. The codes were then categorised according to the

sub-themes addressed in the questionnaire, and then these codes were further grouped under one or more of the eleven pre-determined variables of COVID-19 risk. The qualitative data was collated and assessed against the relevant indicators in the COVID-19 risk assessment framework (Appendix D)

ii. Stages 4, 5, 6, and 7 (developing and applying the analysis framework, charting data into a matrix, and interpreting the data)

The COVID-19 risk assessment framework was developed based on the literature reviewed, as explained in subsection 3.3.2. The framework was further refined following the focus group discussions, feedback from the COPC facilitators, and visits to the site.

To assess risk using qualitative data, a decision matrix risk assessment (DMRA) technique (Pascarella *et al,* 2021) was used. This technique is an approach in risk assessment that is used to determine and rank the level of risk, and also works on the idea that risk depends on two variables, i.e., impact and likelihood (Pascarella *et al,* 2021). Impact is defined as the anticipated outcome, or effect, of the risk if it were to occur, and likelihood refers to the probability or the chance of an event or incident occurring (Pascarella *et al,* 2021).

When using the DMRA technique for qualitative data, the value of the likelihood and impact of specific indicators is presented by using a rating scale (Pascarella *et al,* 2021). In the matrix to categorise the level of risk, likelihood was expressed according to a three-tier scale, whereby an indicator is either ‘highly unlikely’, ‘likely’ or ‘very likely’ to contribute to either the spread of COVID-19 or adversely affect the livelihoods of the community in Melusi. Similarly, impact was also assigned a three-tier scale in the matrix, with an indicator being categorised as either having a ‘negative’, ‘neutral’ or ‘positive’ impact on the livelihoods of people in the community and the ability of the community to contain the spread of the virus was also considered in this regard. Once the indicator is scaled according to its likelihood and impact, the result is that the level of vulnerability, preparedness, or resilience is either ‘low’, ‘moderate, or ‘high’. These categories are assigned score numbers, with 0 indicating ‘low’, 1 indicating ‘moderate’, and ‘2’ indicating ‘high’. The final scoring matrix can be seen in Appendix C.

In assigning the score, the consideration is that the higher the score in the context of vulnerability, the greater the risk for the community. On the other hand, in the context of preparedness and resilience, a lower score indicates an increased level of risk for the community.

3.4.2 Quantitative data analysis

On the other hand, the quantitative data from the COPC household survey data were analysed to provide an indication of the conditions in the informal settlement, based on the COVID-19 risk variables and indicators selected for this research.

The quantitative data that was available for this study was analysed according to the indicator's numerical value. Therefore, depending on the indicator's numerical value, the level of vulnerability, preparedness, or resilience will be either 'low', 'moderate', or 'high'. As scoring goes, anything less than 33% would be regarded as 'low' (score of '1'), an indicator with a value between 0.33 and 0.67 would be 'moderate' and anything with a value above 0.67 is considered as 'high' (as can be seen in Appendix C). A similar scoring methodology was adopted by the United States based non-profit organisation, Surgo Ventures (Surgo Ventures, 2020b), using the Africa COVID-19 Community Vulnerability Index (Africa CCVI) developed by the organisation (Surgo Ventures, 2020a). The Africa CCVI is made up of seven themes which each consisting of factors that contribute to community vulnerability. In the final visualisations of the Africa CCVI, vulnerability is classified in quintiles of very low (<20%), low (20-40%), moderate (40-60%), high (60-80%), and very high vulnerability (>80%) (Surgo Ventures, 2020a).Based on the Africa CCVI scoring system, Surgo Ventures assessed COVID-19 vulnerability in South Africa by grouping the nine provinces of South Africa into three categories of vulnerability: high (a score of 0.67–1.0 on the CCVI, where 1.0 is the highest possible score), medium (0.33–0.67), and low (0–0.33) (Surgo Ventures, 2020b).

The same considerations apply as with the qualitative data scoring methodology in that the higher the score in the context of vulnerability, the greater the risk for the community. On the other hand, in the context of preparedness and resilience, a lower score indicates an increased level of risk for the community.

3.5 Ethical considerations

During the focus groups, the moderator informed the participants about the research study. Participants were then informed that the session was recorded strictly for transcription purposes related to this study. The participants were asked to sign a consent form that stipulated the following: that the participants had willingly volunteered to be in the focus group discussions; and that the identities and responses of the participants would remain confidential.

The letter of ethical approval from the Faculty of Natural and Agricultural Sciences Ethics Committee was received on 16 July 2021 and is attached as Appendix B.

3.6 Chapter conclusion

The methodology employed (Table 3.1, Figure 3) was informed by the objectives of this study. To achieve objective one, a thorough review of literature on informal settlements, risk assessments, and COVID-19 had to be undertaken. To achieve objective two, a COVID-19 risk assessment framework was developed. To achieve objective three, the data collected needed to be analysed based on the framework developed to evaluate its effectiveness in assessing risk.

The study employed the mixed method approach to assess risk of COVID-19 at the informal settlement scale. To collect data for this study, focus group interviews were undertaken to collect qualitative data. The quantitative data on the other hand was corroborated from the secondary household data that was provided by the COPC. The qualitative data was analysed using the 7-stage Framework Method (Gale *et* al, 2013), whereas the quantitative data was analysed based on the number of responses for each indicator in the household data. Subsequently, the qualitative and quantitative data were scored in the risk matrix developed, assessing the level of vulnerability, preparedness, and resilience.

4 RESULTS

4.1 Chapter overview

This chapter presents the results following the analysis of the qualitative and quantitative data collected, using the COVID-19 risk assessment framework (Appendix D) that had been developed for this study.

As a part of the analysis process, the qualitative data was given a score of either 0 (‘low’), 1 (‘moderate), or 2 (‘high) (as can be seen in Table 8.1, Table 8.2, Table 8.3) This score was based on the likelihood of an indicator occurring and the impact this had on the community. The quantitative data was also be given a score of either low, moderate, or high. Unlike the qualitative data that was based on likelihood and impact, the analysis for quantitative data was based on the numerical value of a specific indicator, whereby anything with a percentage lower than 33% was considered low, between 33% and 67% was moderate, and anything greater than 67% was high (as can be seen in Table 8.4).

In this chapter, the data analysis results and final COVID-19 risk scores are presented for the following variables: household dynamics; dwelling structures; access to water; sanitation; use of masks, sanitizers, and social distancing; food availability; community healthcare; mobility and transportation, access to essentials; community attitude; and income structure (Figure 4.1).

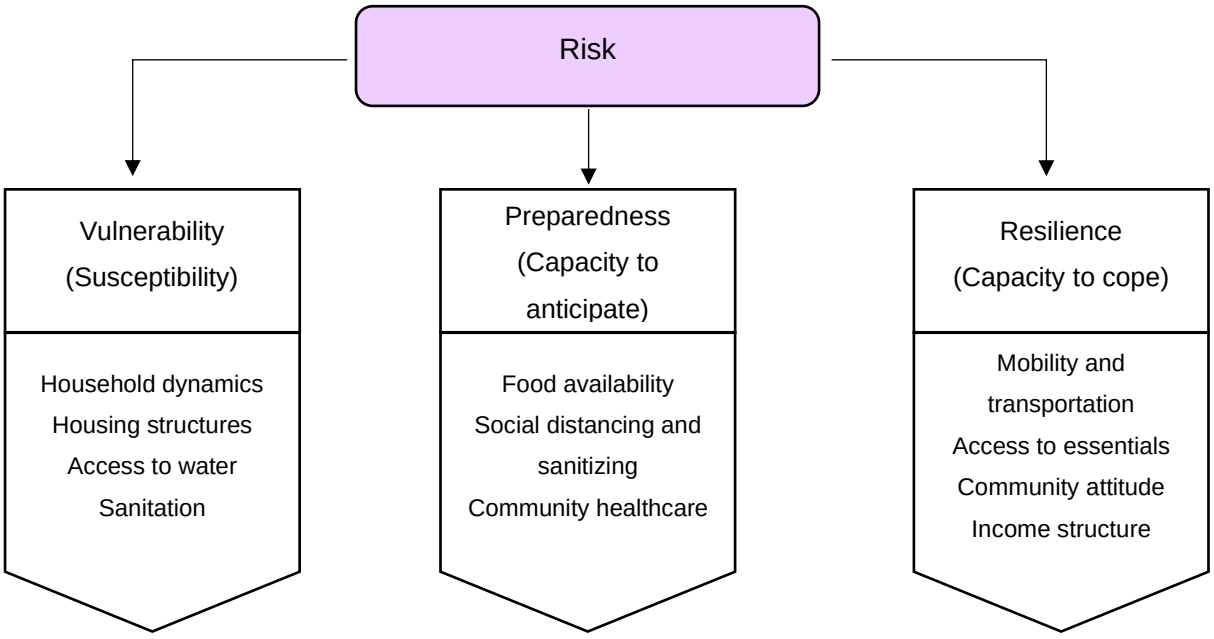

Figure 4.1: Domains and variables of COVID-19 risk.

4.2 Vulnerability (susceptibility) to Covid-19

4.2.1 Household dynamics

According to available data, the Melusi community is characterised by a predominantly young population, with a high proportion belonging to the working-age group (Table 4.1). The comments made by the participants were similar to those made by the key informants at the site visits conducted, whereby it was indicated that people of working age found space in Melusi, in efforts to find employment in Pretoria, and other parts of Gauteng. This result suggests that the likelihood of the majority of the population being over age 60 is 'highly unlikely', which could lead to a positive impact on the community, in the context of COVID-19. As such, the 'Age demographic' indicator was scored a 0, which means low vulnerability. Participants informed the researcher that it is far more common for different households to share a yard, rather than sharing a single housing structure. Therefore, the 'Dwelling sharing' is scored a '0' for low vulnerability (Table 4.1, Figure 4.2). Furthermore, instances of dwelling sharing are mostly observed in Melusi 2, where most people rent rooms because they want access to electricity (a service available exclusively in Melusi 2).

Table 4.1: Vulnerability score for the qualitative indicators that fall under the household dynamic variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
			Participants believe/comment/think that:				
Susceptibility (Vulnerability)	Household dynamics	Dwelling sharing	Majority of households share a dwelling or a yard with other households (de Kadt et al, 2020)	Likely	Positive	Low vulnerability	0
		Age demographic	Majority of the community population is above the age of 60 years old	Highly unlikely	Positive	Low vulnerability	0

Figure 4.2: Multiple household dwellings in one yard, an example of yard sharing.

Yard sharing was highlighted as a COVID-19 concern, as it is commonplace to interact with yard-mates without masks, whether it is voluntarily or not, one of the participants during the focus groups captured this perspective with the following statement:

"*There's the thing that if you wear a mask, then those you share a yard with might say things like, "Why are you wearing a mask around us? Are you trying to say that we have COVID?" Some people sometimes take it like you are insulting them or saying something about their health or hygiene"*.

Another COVID-19 concern was that the directives to stay at home (South Africa, 2020) were not feasible in the context of Melusi as many community members had jobs that required them to get out of the house. Additionally, most things like food and water can only be accessed by walking outside of the dwellings.

Households with children were also viewed as areas of COVID-19 concerns because it is admittedly difficult to have children wear masks consistently, and this makes them prone to potentially bringing home illness due to the interactions with other children.

In all three focus groups, participants provided consistent responses when asked to describe the typical make-up of households in Melusi. The consensus was that Melusi is predominantly characterised by young families belonging to the working age group. It was

further expressed that, based on what has been observed, the size of households in Melusi was relatively small, with between 3-5 people residing in a given dwelling. Data from the UP COPC household survey supported this observation indicating that the average number of people per dwelling was 1.98. Furthermore, out of the 1667 households interviewed for the COPC survey, 50% of the dwellings in Melusi consisted of one occupant (Table 4.2). As this value is between 33% and 67%, the 'Household population' indicator is scored a 1, which indicates moderate vulnerability (Table 4.2).

Table 4.2: Vulnerability score for the quantitative indicators that fall under the household dynamic variable, based on the household survey data.

Domain	Variable	Quantitative Indicators	Indicator Description	Value	Level	Score
Susceptibility (Vulnerability)	Household dynamics	Household population	Percentage of dwellings with one occupant	50%	Moderate vulnerability	1

Overall, during the conversation on household dynamics, there were no substantial polarising viewpoints expressed.

4.2.2 Dwelling structures

The majority of the dwelling structures in Melusi were described as small shacks made up of corrugated iron or some other kind of metal sheets. How these structures are built made participants believe that any attempts at self-isolation were highly unfeasible, demonstrating high vulnerability (i.e., score of '2') for the 'Self-isolation feasibility' indicator because the majority of the dwellings are made of corrugated iron ('highly likely') and this would cause some level of difficulty in containing the spread of the COVID-19 virus (neutral impact) (Table 4.3). One of the focus group participants explained this by saying,

"My concern is, because the rooms are too close and we find that in shacks with walls of corrugated iron, the walls are not entirely sealed."

Rooms inside the shacks were described as divided using either corrugated iron or alternative materials such as cardboard, curtains, or even furniture and/or kitchen appliances – anything that is non-brick/non-cement/non-clay (Table 4.3). Therefore the 'Material used to separate rooms in a dwelling' indicator was given a score of '1', indicting moderate

vulnerability. The dwellings were further described as structures with very minimal windows, “a window for the room and a window for the kitchen”.

Table 4.3: Vulnerability score for the qualitative indicators that fall under the dwelling structures variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
			Participants believe/comment/think that:				
Susceptibility (Vulnerability)	Dwelling structures	Material used to separate rooms in a dwelling	Majority of dwelling rooms are divided using non-brick material	Highly likely	Neutral	Moderate vulnerability	1
		Self-isolation feasibility	Majority of community members can self-isolate in their current dwellings	Highly unlikely	Negative	High vulnerability	2

The household survey indicated that 98% of the households in Melusi lived in shacks. As the majority of households in the community live in this type of dwelling structure, the ‘Dwelling type’ indicator scores a 2 for high vulnerability (Table 4.4, Figure 4.3). The percentage of those dwellings that do not have windows for every single room was 54%, meaning moderate community vulnerability (i.e., score of ‘1’) for the ‘Dwelling ventilation’ indicator (Table 4.4, Figure 4.3). Furthermore, 52% of the dwellings in Melusi have less than 2 rooms, indicating moderate vulnerability for the ‘Dwelling space’ indicator (Table 4.4, Figure 4.3).

Table 4.4: Vulnerability score for the quantitative indicators that fall under the dwelling structures variable, based on the household survey data.

Domain	Variable	Quantitative Indicators	Indicator Description	Value	Level	Score
Susceptibility	Dwelling structures	Dwelling type	Percentage of households living in a shack	98%	High vulnerability	2

	Dwelling ventilation	Percentage of dwellings where every room does not have a window	54%	Moderate vulnerability	1
	Dwelling space	Community with dwellings that have on, average, less than 2 rooms.	52%	Moderate vulnerability	1

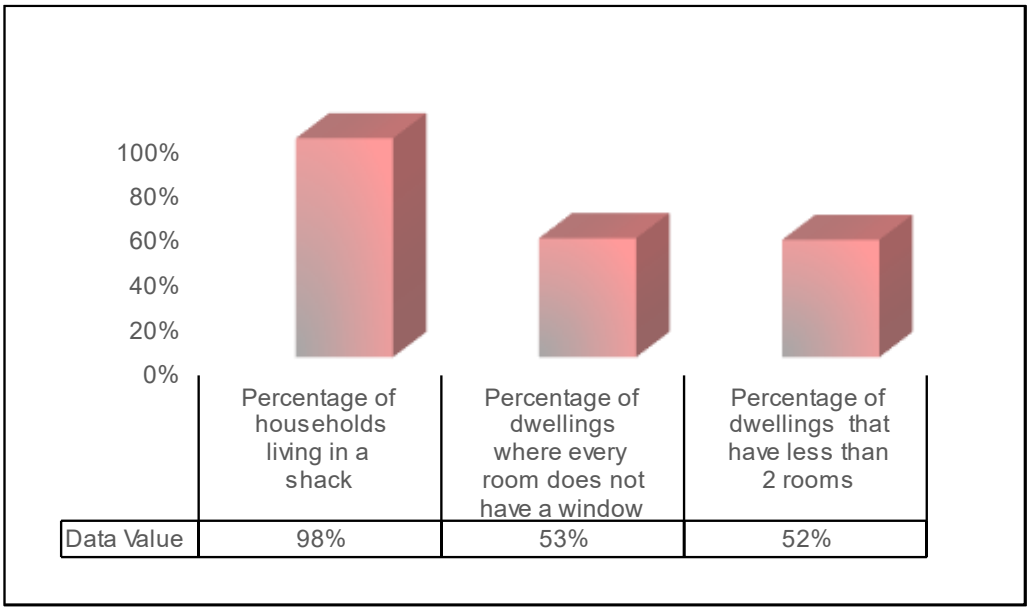

Figure 4.3: Dwelling structure indicators that determine vulnerability level, based on percentage values.

Not included in the framework was the topic of renting and ownership. Participants of the focus group discussions highlighted that the renting of rooms was most common in Melusi 2, the only section of Melusi which also happens to have access to electricity.

4.2.3 Access to water

Key informants during site visits, as well as participants in the three focus groups, described access to water in Melusi as follows: Melusi 2 has water tanks, Melusi 1 has taps situated in the yards and on the street, and Melusi 3 residents have access to both taps and water tanks.

With regards to the 'Crowding at water points indicator', Melusi scored a 0 for low vulnerability as participants across the three focus groups agreed that community members

can obtain water from water access points, without excessive queuing throughout the week (Table 4.5), with the weekends being possible exceptions due to more people being home to do household chores.

Focus group participants explained that contractors who are meant to supply water to Melusi may stop services for two days, compromising the community's access to water. Participants in the focus groups expressed frustration about this service delivery concern when the issue was raised. However, it was never observed that the participants were directly agitated at how they accessed water on a daily basis.

Responses during the focus groups indicated that the community members, from general experience, are very complacent in ignoring the preventative hygiene recommendations such as handwashing (indicator 'Handwashing attitude') – resulting in moderate vulnerability, i.e., a score of '1' (Table 4.5). At this topic, participants laughed in exasperation at the fact because as community health workers, they are often forced into interactions with people who adopt this attitude (ranging from lack of access to taps, to generally not caring). The household data indicates that 77% of households do not have toilet handwashing facilities. This means the indicator 'Handwashing facilities' scored a '2' for high vulnerability (Table 4.6).

Table 4.5: Vulnerability score for the qualitative indicators that fall under the water variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
			Participants believe/comment/think that:				
Susceptibility (Vulnerability)	Water	Crowding at water points	Water access points such as taps and tanks are always crowded	Highly unlikely	Neutral	Moderate vulnerability	1
		Handwashing attitude	Majority of residents are very strict about handwashing.	Likely	Neutral	Moderate vulnerability	1

Household data demonstrated that 84% of the 1667 households in Melusi do not have taps in their yards, indicative of high vulnerability, i.e. a score of '2', for the 'Water access – taps' indicator (Table 4.6, Figure 4.4). The percentage of households that state they rely on

the use of communal water tanks is 86%, therefore the 'Water access - water tanks' indicator is scored a '2' for high vulnerability (Table 4.6, Figure 4.4).

Table 4.6: Vulnerability score for the quantitative indicators that fall under the water variable, based on the overall response from the focus group participants.

Domain	Variable	Quantitative Indicators	Indicator Description	Value	Level	Score
Susceptibility	Water	Water access – taps	Percentage of households with no taps in the yard	84%	High vulnerability	2
		Water access - water tanks	Percentage of households who use communal water tanks	86%	High vulnerability	2
		Handwashing facilities	Percentage of dwellings without toilet handwashing facilities	77%	High vulnerability	2

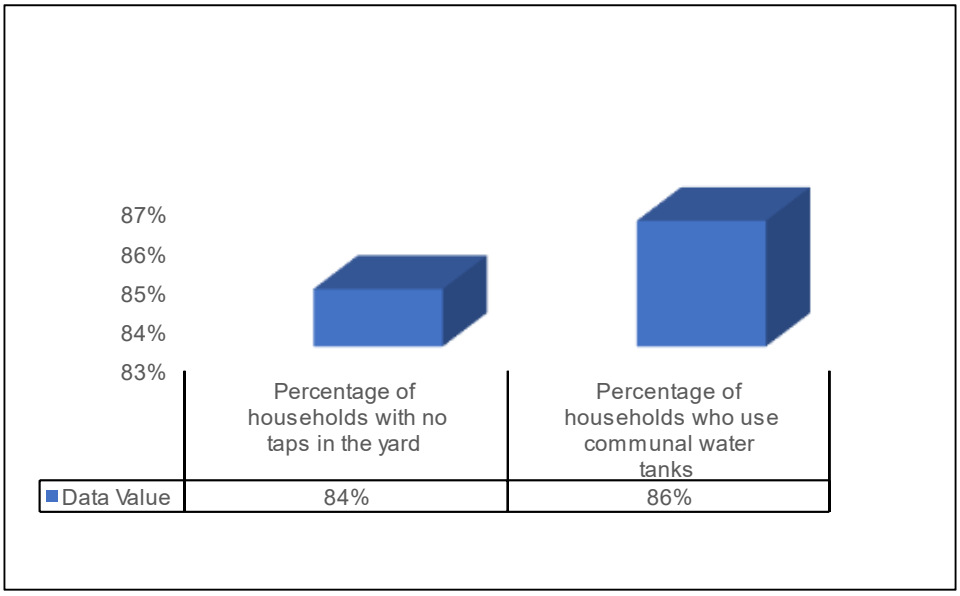

Figure 4.4: Distribution of households who do not have taps in their yard, and those who use communal water tanks as a source.

4.2.4 Sanitation

Across the three focus group discussions, the following was concluded: Melusi 1 and 3 have pit latrines that are found in people's yards, whereas Melusi 2 consists of communal portable bucket toilets. Throughout the discussion around toilets, the participants from all three

focus groups demonstrated visible anger at the state of the toilets, particularly those in Melusi 2 which are communal. Driving through the settlement, the research team observed the state of the area around the toilets in Melusi 2 (Figure 4.5).

Figure 4.5: Toilets in Melusi 2

'Pit toilet cleanliness' scored 0 for low vulnerability, as these types of toilets were regarded as being well-maintained by the participants (Table 4.7). In contrast, the bucket (portable) toilets in the settlement were lamented for their abhorrent conditions, resulting in a score of '2' for high vulnerability for the 'Bucket toilet cleanliness' indicator (Table 4.7).

Table 4.7: Vulnerability score for the qualitative indicators that fall under the sanitation variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
			Participants believe/comment/think that:				
Susceptibility (Vulnerability)	Sanitation	Pit toilet cleanliness	Hygiene of the majority of the pit toilets is well-maintained	Highly likely	Positive	Low vulnerability	0

		Bucket toilet cleanliness	Hygiene of the majority of the bucket toilets is well-maintained	Highly unlikely	Negative	High vulnerability	2

Household survey data indicates that 51% of households in Melusi have pit latrines in their yards, which results in a score of '1', meaning moderate vulnerability, for the 'Toilet type - pit latrines' indicator (Table 4.8, Figure 4.6). The percentage of households who indicated that they use the bucket toilet or the chemical toilet [4]is 32%, also resulting in a score of '0' for the indicator 'Toilet type - bucket toilet or system or chemical toilet (communal)' (Table 4.8, Figure 4.6). This result from the household survey does not support the feedback from the focus groups where it was indicated that there were a few communal toilets that would be used by a large section of the community, compared to the pit latrines where the use was often limited to the those who dwell in a yard were the latrine is located. The 'Toilet sharing' indicator scored a '1' because 41% of households in the informal settlement say that they share toilets with other households (Table 4.8).

Table 4.8: Vulnerability score for the quantitative indicators that fall under the sanitation variable, based on the household survey data.

Domain	Variable	Quantitative Indicators	Indicator Description	Data Value	Level	Score
Susceptibility	Sanitation	Toilet type - pit latrines	Percentage of households with pit toilets in the yard	51%	Moderate vulnerability	1
		Toilet type - Bucket toilet or chemical toilet (communal)	Percentage of households that use bucket toilet system	32%	Low vulnerability	0
		Toilet sharing	Percentage of households that share toilets with other households	41%	Moderate vulnerability	1

[4] Bucket and chemical toilet are combined as, based on conversations with the participants, there was an overlap between the use of bucket toilets and the communal chemical toilets.

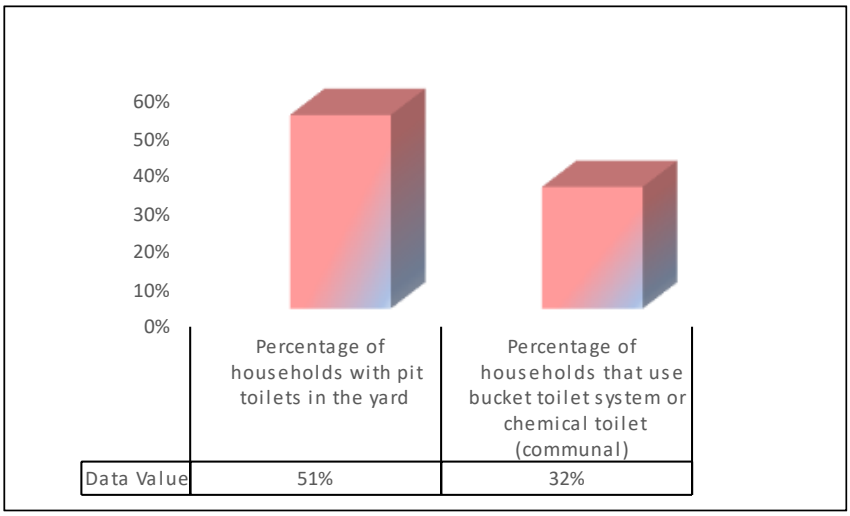

Figure 4.6: Households who use pit latrines versus households who use bucket toilets (note: these are not mutually exclusive. One person can use both of these in a given day).

4.3 Preparedness (capacity to anticipate) for Covid-19

4.3.1 Use of masks and sanitizers, and social distancing

According to the focus group participants the majority of the community demonstrated an obvious contempt towards wearing masks, thus the 'Attitude towards masks' indicator scored a '0', which means low preparedness (Table 4.9), as it is 'highly unlikely' that the community members willingly wear masks and this could generally create an overall 'negative impact' within the community. The most receptive population group to wearing masks was noted as the elderly. Participants explained that just because the community was not ready to wholly embrace masks, it did not mean that the community did not have access to masks. The community would be given masks via the workshops hosted by the COPC or can purchase them at retail stores. Therefore, in terms of the indicator 'Access to masks', the community is given a score of '1' indicating moderate preparedness as the means to access masks is present (Table 4.9).

The comments made on sanitizer-use amongst community members were similar to those on mask use. Due to the presence of sanitizer being at the behest of either the dwelling occupants or shop owners, often, sanitizers would not be present. As such, the 'Attitude towards sanitizer' indicator received a score of '0', meaning low preparedness (Table 4.9). When participants were asked whether the community struggles with access to sanitizers, a number of the participants responded with exasperation as they emphasised that community members and local business owners did have access to sanitizer, they were just not inclined

to use them. As such, the 'Access to sanitizer' indicator scored a '1' for moderate preparedness (Table 4.9).

The participants observed that the community members would not readily practice social distancing in areas where it was possible to do so unless they were forced to do so. This observation meant that the 'Attitude towards social distancing' indicator scored a '0' for low preparedness (Table 4.9). The participants admitted that they could not fault community members for not social distancing all the time, and further revealed that they have, at times, conformed to similar behaviours,

> *"You can't just go to the tank without a mask. Then you're the only one there with a mask on. People are going to look at you some type of way."*
>
> *"We are just living our lives, to be honest. We are at home, so we do not feel pressed at times to wear masks."*

Table 4.9: Preparedness score for the qualitative indicators that fall under the mask, sanitizer, and social distancing variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
			Participants believe/comment/think that:				
Preparedness (Capacity to anticipate)	Use of masks and sanitizers, and social distancing	Attitude towards masks	Majority of community members readily adhere to mask-wearing regulations and recommendations	Highly unlikely	Negative	Low preparedness	0
		Access to masks	Majority of community members struggle with getting access to masks	Highly unlikely	Neutral	Moderate preparedness	1
		Attitude towards sanitizer	Majority of community members readily use sanitizers	Highly unlikely	Negative	Low preparedness	0
		Access to sanitizer	Majority of community members have access to sanitizer in public spaces within	Likely	Neutral	Moderate preparedness	1

		the community, and their homes				
	Attitude toward social distancing	Majority of community members readily adhere to social distancing regulations and recommendations	Highly unlikely	Negative	Low preparedness	0

The household survey data was collected before the COVID-19 pandemic. As such, there is no quantitative data about masks, sanitizers, and other COVID-19-specific information.

4.3.2 Food availability

Participants expressed that there was no real concern regarding the diet of community members as they stuck to the basic foods such as maize meal, chicken, tin fish, spinach, and other basic foods. Therefore the 'Common food in households' indicator scored a '2' for high preparedness (Table 4.10).

Food access in Melusi was not flagged as an issue, therefore the 'Community food access' indicator scored a '1' for moderate preparedness (Table 4.10). Participants expressed that during routine home visits, several community members would be confused at the question of whether they have sufficient access to food with one participant in the focus group saying,

> *"Even when we would ask during the heavy stages of lockdown, they would laugh a little, "Is it possible for someone to go without eating?". Like there is still access to food."*

Discussions with the key informants revealed that in response to the pandemic, food vouchers were distributed amongst those identified as most in-need. Participants of the focus groups furthered this notion by highlighting that food programs were only initiated in response to the pandemic and did not exist prior. Furthermore, these food programmes started to wind-down with the easing of restrictions. This would have resulted in a score of 'low' were it not for the one participant out of all three focus groups who mentioned a programme specifically for child development. This programme incorporates food provision and is implemented on a

general basis and is not a response to the pandemic. This demonstrates that there are instances of food-providing assistance,

> "*There is a centre that helps take care of children. It assists in ensuring that children get to school, helps them with their school work, and provides the children with meals. The parents do need to make a small payment of about R20 to R30 a month. They have sponsors."*

As such, the 'Community food programmes' indicator was given a score of '1' for moderate preparedness (Table 4.10).

Food sharing between households in the community is not common in Melusi, according to the group participants' lived experiences. Therefore, the 'Food sharing between households' indicator was assigned a score of '1' for moderate preparedness (Table 4.10). Any linkages to food sharing may potentially be in the sharing of cooking appliances, particularly in scenarios where households share a dwelling.

Table 4.10: Preparedness score for the qualitative indicators that fall under the food availability variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Preparedness (Capacity to anticipate)	Food Availability	Common food in households	Majority of community members have food that would be considered a stable diet	Highly likely	Positive	High preparedness	2
		Community food access	Majority of community members have adequate access to food	Likely	Neutral	Moderate preparedness	1
		Community food programmes	Normally, food program initiatives are running in the community.	Likely	Neutral	Moderate preparedness	1

		Food sharing between households	Majority of households in the community share meals and food expenditures with other households	Highly unlikely	Neutral	Moderate preparedness	1

The secondary data available showed that households were asked a number of questions about food access, however, a number of these questions were left unanswered. This suggests that there is a sensitivity around the willingness to disclose information about food access, and questions relating to this may be otherwise considered too invasive. As such, participants were never asked directly about their particular access to food but rather were asked to discuss food security in a broader context – this made the participants more receptive to providing feedback.

4.3.3 Community healthcare

The presence of the mobile clinic in Melusi allows for immediate access to primary healthcare. As such, participants believed that the majority of community members have access to basic healthcare, even during the most restrictive stages of the national lockdown. Therefore the ‘Access to healthcare’ indicator scored a '2’ for high preparedness (Table 4.11). If the community health workers suspected a community member to have contracted COVID-19, the general procedure was to refer them to the Daspoort clinic, which in turn would refer patients to Kalofong or Pretoria West hospital.

The indicator ‘Community comorbidity management’ scored ‘2’ for high preparedness (Table 4.11). This is because the focus group participants explained that even during the strictest stages of the lockdown, they worked to ensure that community members receive their necessary medical treatments. However, there were cases of defaulters, with reasons ranging from the perceived inability to access medications to an individual’s negligence.

Table 4.11: Preparedness score for the qualitative indicators that fall under the community healthcare variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Preparedness (Capacity	Community Healthcare	Access to healthcare	Majority of community members have access to healthcare services	Highly likely	Positive	High preparedness	2

to anticipate)		Community comorbidity management	Majority of community members get their required medical treatments.	Likely	Positive	High preparedness	2

Healthcare data available in the survey illustrates that 96% of households in Melusi have no members with tuberculosis (TB). Therefore the 'Tuberculosis cases' indicator scored a '2' for high preparedness (Table 4.12).

Table 4.12: Preparedness score for the quantitative indicators that fall under the community healthcare variable, based on the household survey data.

Domain	Variable	Quantitative Indicators	Indicator Description	Data Value	Level	Score
Preparedness (Capacity to anticipate)	Community Healthcare	Tuberculosis cases	Percentage of community with zero TB cases	96%	High preparedness	2
		HIV/Aids cases	Percentage of households with zero members with HIV	No data available	Not Applicable	N/A
		Hypertension cases	Percentage of households with zero hypertension cases	No data available	Not Applicable	N/A
		Diabetes cases	Percentage of community members with diabetes	No data available	Not Applicable	N/A

4.4 Resilience (capacity to cope) with Covid-19

4.4.1 Mobility and transportation

Participants provided descriptions of the community's use of public transportation. Due to the reliance on public transportation for community members, the 'Modes of transportation' indicator was scored '0', which means low resilience (Table 4.13) as community members are "highly likely" to use public transportation, and this could create a "negative" impact as many people in a closed space like that could facilitate COVID-19 transmission. One of the participants described the issue of transportation and children,

> "*My concern is the school transport. Especially the private ones. On the buses, they do put their masks on but in these private ones, you will see the kids with their heads out the window. And then you will see those small cars that have packed too many kids in the car, and none of them would be wearing masks. The school bus makes sure the kids wear masks.*"

Other than the concerns raised regarding the children's transportation, the sentiment provided by the participants was that access to transportation was not severely hindered as a result of the pandemic, as one participant explains:

> *"We do not struggle with transport because the taxis are all over. I think if anyone might struggle to get transport, it would be those who live deep in Melusi 2 because the taxis do not go into Melusi 2. So, the people who live in the inner parts have to walk down to where the taxis are."*

A score of '1' for moderate resilience was given to the 'Frequency of inter-provincial travel' indicator (Table 4.13). The participants across the three focus groups explained that Melusi consisted of many people who are originally from outside of Gauteng. Therefore, frequent inter-provincial travel is to be expected. Furthermore, the migrant population is predominantly foreign nationals, who mostly reside in Melusi 2, according to the participants.

Table 4.13: Resilience score for the qualitative indicators that fall under the mobility and transportation variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Resilience (Capacity to Cope)	Mobility and transportation	Modes of transportation	Majority of the community relies on public transportation	Highly likely	Neutral	Low resilience	0
		Frequency of inter-provincial travel	Majority of community members are required to travel between provinces (homestead, work, etc).	Likely	Neutral	Moderate resilience	1

4.4.2 Access to essentials and energy

The participants explained that the majority of the local shops, such as spaza shops, in Melusi were not usually crowded but did sometimes experience high volumes during certain times of the day. As such, the 'Crowded local shops' indicator scored a '1' for moderate resilience (Table 4.14). Similarly, larger stores typically located outside of the settlement do not always experience crowding, unless it is pay-day or some other extraordinary circumstance, therefore the 'Crowded large stores' also scored '1' for moderate resilience (Table 4.14).

The presence of spaza shops allowed for the continued access to food and other household essentials for the community. Furthermore, through established relationships within the community, access to essentials in some instances remains, as indicated by a focus group participant who said,

"*In Melusi, we are one big family. For instance, if there is somebody who is sick, they will go to the tuck-shop on their behalf and ask for donations or generally check up on them. The community is very united."*

Table 4.14: Resilience score for the qualitative indicators that fall under the access to essentials variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Resilience (Capacity to Cope)	Access to essentials	Crowded local shops	Majority of local stores such as spaza shops are always crowded	Highly unlikely	Neutral	Moderate resilience	1
		Crowded large stores	Majority of large stores such as value marts are always crowded	Likely	Neutral	Moderate resilience	1

The percentage of households that use electricity, solar power, gas, and coal all fall below 33% respectively, thus each indicator was scored a '0' for low resilience (Table 4.15, Figure 4.7). The percentage of households that use paraffin as an energy source is above 67%, thus the paraffin indicator scored a '2' for high resilience (Table 4.15, Figure 4.7). The 'Energy source – wood' indicator scored a '1' for moderate resilience as 36% of households indicated that they use wood as an energy source (Table 4.15, Figure 4.7). The participants noted that households could depend on more than one energy source. For instance, one given household could make use of both solar power and gas.

The reliance on energy sources was further analysed by grouping the energy and the households their sources of energy into the following three categories of resilience: low resilience (one energy source), moderate (two energy sources), and high (three or more) (Table 4.16). This categorisation revealed that 28% of households relied on one energy source, indicating that a proportion of 28 of the community has low resilience (Table 4.16). Additionally, 38% rely on to energy sources and 34% of households rely on three or more energy sources, suggesting that an estimated 72% of Melusi's community is moderately resilient. From the 1667 households interviewed in the COPC household survey, 19 indicated that they do not rely on any source of energy, which may be as a result of limitations during the data collection process, such as the refusal to disclose the information. As such, these have been eliminated from the final tallies depicted in 4.16.

Table 4.15: Resilience score for the quantitative indicators that fall under the access to essentials variable, based on the household survey data.

Domain	Variable	Quantitative Indicators	Indicator Description	Data Value	Level	Score
Resilience (Capacity to Cope)	Access to essentials	Energy source - Electricity	Percentage of households that use electricity in dwellings	28%	Low resilience	0
		Energy source - Solar power	Percentage of households that use solar power in dwellings	26%	Low resilience	0
		Energy source - Gas	Percentage of households that use gas in dwellings	15%	Low resilience	0
		Energy source - Paraffin	Percentage of households that use paraffin in dwellings	67%	High resilience	2
		Energy source - Wood	Percentage of households that use wood in dwellings	36%	Moderate resilience	1
		Energy source - Coal	Percentage of households that use coal in dwellings	8%	Low resilience	0

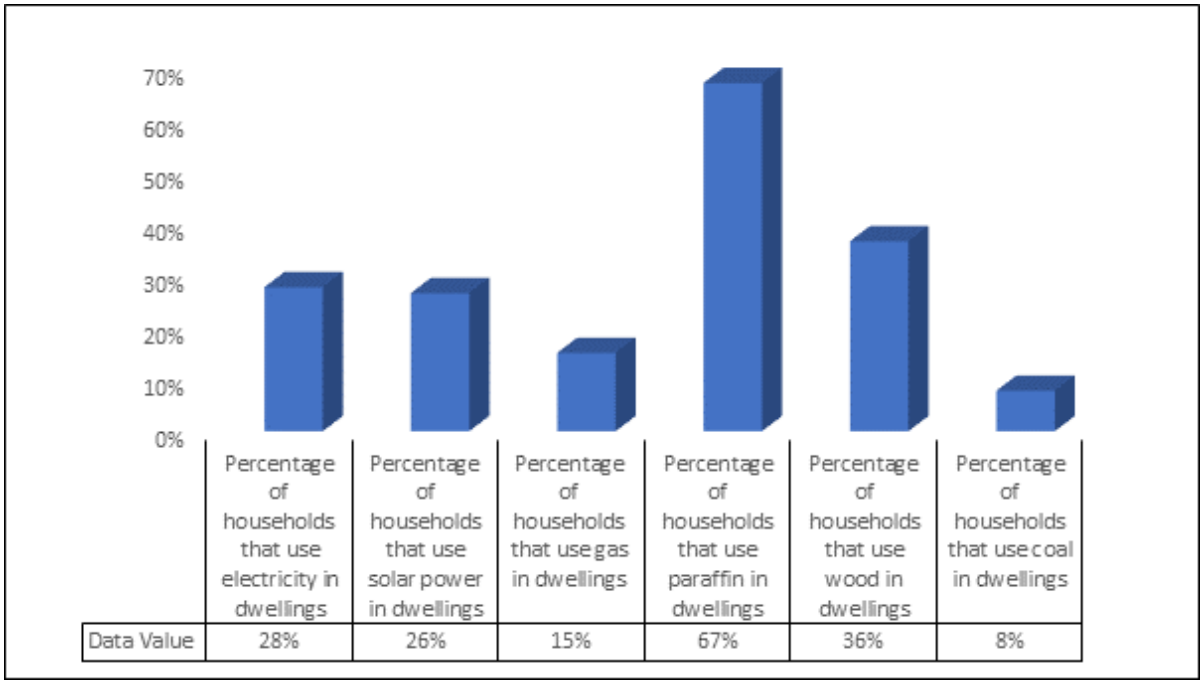

Figure 4.7: Household distribution according to energy source used.

Table 4.16: Number of energy sources relied on per household.

Domain	Number of energy sources household relies on	Number of households	Proportion of households in survey	Level	Score
Resilience (Capacity to Cope)	One	457	28%	Low resilience	0
	Two	627	38%	Moderate resilience	1
	Three or more	564	34%	Moderate resilience	1

4.4.3 Community attitude

Throughout the entire focus group discussions, one of the most prominent themes to arise was that people in Melusi did not acknowledge COVID-19 as anything worth paying too much attention to, particularly due to the lack of confirmed cases in the settlement. Therefore, because the majority of the community did not fear COVID-19, the indicator 'COVID-19 fear' scored a '1' for moderate resilience (Table 4.17).

Cases of stigmatisation towards COVID-19 were not that common in Melusi, as such, the 'COVID-19 stigma' indicator scored a '2' for high resilience (Table 4.17). One of the participants reflected on the notion of stigmatisation by saying:

> *"The people in the community know us, the minute they see me, most times when I am in uniform, they will call me and ask me about COVID-19, but they will never say, "I don't want you next to me because you might have COVID".*

It was also noted that any cases of stigmatisation were limited to the early stages of the pandemic and did not go beyond passing commentary.

The 'COVID-19 vaccine hesitancy' indicator scored a '1' for moderate resilience as there was a portion of the community who rejected the vaccine (Table 4.17). From the perspective of the participants, the rejection of the vaccine stemmed mostly from the youth of the community, who were often misinformed by social media and negative rhetoric around the vaccine. At this, the participants were visibly annoyed when discussing vaccine hesitancy because it directly interfered with their line of duty. However, there were also brief moments of laughter, particularly in group 1, when some participants admitted that they too were sceptical of the vaccine at first,

"We heard stories of people fainting form the vaccine. Only after Participant C went (to get vaccinated) and we saw he was fine, then we all went. So, I don't blame people for being hesitant. They just need motivation."

However, despite this, the 'COVID-19 vaccine hesitancy' indicator was scored a '1' instead of a '0' because of the willingness of the older population to get vaccinated.

Table 4.17: Resilience score for the qualitative indicators that fall under the community attitude variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Resilience (Capacity to Cope)	Community attitude to COVID-19	COVID-19 fear	Majority of the community fear COVID-19, so they do not frequent public spaces	Highly unlikely	Neutral	Moderate resilience	1
		COVID-19 stigma	Majority of the community has a stigma toward COVID-19	Highly unlikely	Positive	High resilience	2
		COVID-19 vaccine hesitancy	Majority of the community has a strong willingness to get vaccinated.	Likely	Neutral	Moderate resilience	1

4.4.4 Income structure

The majority of the community is employed through temporary contracts. As such, the 'Common forms of work' indicator was scored a '0' for low resilience (Table 4.18). The nature of employment in Melusi was raised by both the key informants and focus group participants as a key issue in COVID-19 context. This is because many community members either lost their jobs or were subject to significant reductions in earnings. As a result, the well-being of a household or multiple households, in some cases, would be the responsibility of one family member. Therefore, by majority of the community being employed through temporary contracts, majority of the community are not in the position to cope during the pandemic scenario.

Table 4.18: Resilience score for the qualitative indicators that fall under the income structure variable, based on the overall response from the focus group participants.

Domain	Variable	Qualitative Indicators	Indicator Description	Likelihood	Impact	Level	Score
Resilience (Capacity to Cope)	Income structure	Common forms of work	Majority of community members work in areas where they are permanently employed.	Highly unlikely	Negative	Low resilience	0

The questions pertaining to household income in the COPC data were mostly unanswered. This was indicative of the sensitive nature of the topic, as regarded by the community and assumed by the participants. The key informants (i.e., the COPC and Daspoort Clinic facilitators) had also conveyed that community members are not often forthcoming with information regarding their source of income.

This topic of discussion was the most sombre, as participants discussed how some community members, including themselves, were negatively affected by the lockdown and the restrictions on employment that came with it:

> *"Most of the people here work by contract. If it is like a 1-year or 6-month contract, and it is a level 5 lockdown, they won't pay you."*

> *"My brother had lost his job at that time. I was then expected to care for two families, mine and the one back at home."*

> *"I remember also the first time the truck came with the food; it was almost like a stampede because people were fighting for food. It is not good when you have a child crying, not knowing where the next meal is coming from."*

Furthermore, there was a level of incongruity in the participants' responses when they were asked about whether the community would be better prepared and able to cope in the event of another lockdown – with some participants holding out faith for the community, and others believing that there would be an uproar in response to the announcement of another national lockdown.

4.5 Chapter conclusion

The greatest contributors to Melusi's vulnerability include the types of dwelling structures; water access types (both taps and water tanks); lack of handwashing facilities; the inability to self-isolate; and poor cleanliness associated with bucket toilets. Melusi's state of preparedness to COVID-19 related impacts is compromised by the community's attitude to wearing masks, using sanitizer and practising social distancing. Finally, aspects in Melusi that negate the community's ability to be resilient to the effects of COVID-19 include the reliance on public transportation within the community and the forms of employment typically associated with people in the community.

The analysis of the results from the key informant and focus group discussions, and the household survey data reveal that the level of COVID-19 risk in Melusi varies across space and is determined by certain variables that exist within the settlement. Therefore, based on the results presented, it has been demonstrated that the COVID-19 risk assessment framework allows researchers to identify the key areas of concern that should be prioritised within the informal settlement. In the proceeding section, the results will be further discussed, distinguishing between the indicators that may contribute the most to increased COVID-19 risk, and those that may have a more positive or neutral impact.

5 DISCUSSION

5.1 Chapter overview

Studies have suggested that one of the most challenging aspects of informal settlements is the lack of data on these areas that would assist in cultivating adequate responses to emergencies (de Albuquerque et al, 2019; Wilkinson *et al*, 2020; Gibson & Rush, 2020). However, in response to the socio-economic ramifications of the COVID-19 pandemic, studies on informal settlements were undertaken, exploring the dynamics that may render a population susceptible or ill-equipped to deal with a national lockdown (Gibson & Rush, 2020; Matamanda *et al*, 2021; Van Wyk & Reddy, 2022; Wilkinson *et al*, 2020).

In this study, the current research on COVID-19 was expanded upon to develop a COVID-19 risk assessment framework. This framework was developed at the informal settlement scale by focusing on the factors that make informal settlements areas characterised by high levels of poverty and vulnerability. Subsequently, the framework was used to assess the COVID-19 risk of the Melusi community in terms of vulnerability, preparedness, and resilience. Therefore, in this chapter, the indicators that were considered to exacerbate COVID-19 risk in the community will be further discussed, as these would be the areas where more rigorous intervention would be required. The chapter will then focus on the indicators that could reduce the level of COVID-19 risk, but would still be pertinent to community vulnerability, preparedness, and resilience.

5.2 Negative indicators of COVID-19 risk

5.2.1 Vulnerability indicators

The inability to self-isolate in Melusi (i.e., the ‘Self-isolation feasibility’ indicator) is determined by the physical structure of the dwellings (Table 4.3). Dwellings in Melusi are shacks that have rooms that are not entirely sealed from one another. However, despite the inability to practice social distancing or self-isolation, this study did not find a direct correlation between the inability to self-isolate and a high incidence COVID-19 cases in Melusi. This finding is therefore in contradiction to the concerns raised by Gibson and Rush (2020) in their study on the proximity between dwellings in informal settlements which might impede people’s ability to practice social distancing causing a rapid transmission of the disease. It is, however, important to acknowledge that the low number of cases may be indicative of under-reporting in the community, which may have been due to the lack of willingness to get tested. The willingness to get tested may be further attributed to the community’s attitude towards COVID-

19, as highlighted in Chapters 4.4.1 and 4.4.3. Therefore, under-reporting is an important consideration when consolidating the issues around the inability to self-isolate with the outbreak data available. Therefore, although there may be underlying occurrences that may undercut the initial findings from the focus groups and key informant interviews, the inability to self-isolate should remain an area of focus as the COVID-19 recommendations that include social distancing is a challenge for those residing in these dwellings as they do not offer much space (de Kadt *et al*, 2020; South Africa, 2021; WHO, 2021).

With 98% of the households in Melusi living in shacks (Table 4.4), the vulnerability of the community was increased. These types of dwellings do not offer the ability to practice social distancing and isolation due to their small size. Furthermore, shacks often have poor ventilation (Manderson & Levine, 2020, cited in Van Wyk & Reddy, 2022) and get hot to the extent that occupants may struggle to breathe (Koitsioe, 2020). Therefore during the implementation of intervention strategies and measures, it is important to be cognisant of the types of dwellings in the informal settlement as COVID-19 preventative measures and recommendations tend to include social distancing and ensuring adequate ventilation in a given space (WHO, 2021).

Both the water access via taps and water access via water tanks indicators increased community vulnerability (Table 4.5) The main reason for this is that to get water from either the taps or the tanks, household members are required to go outside. This supports the research done on water access in informal settlements and the challenge that adhering to COVID-19 restrictions presents (Muzondi, 2014; Wilkinson *et al*, 2020; Matamanda *et al*, 2021). Therefore, vulnerability is increased as having to leave the dwellings increases the chance of interactions with other members of the community (de Kadt *et al*, 2020; Wilkinson *et al*, 2020).

With 77% of the households indicating that they do not have handwashing facilities in or by their toilets, COVID-19 vulnerability is increased (Table 4.6). The inability to employ appropriate hand hygiene practices creates an environment that may allow for the transmission of the virus between individuals and through contact with surfaces (Who, 2020b).

The poor cleanliness of the bucket (portable) toilets in Melusi contributed to increase the community's level of vulnerability (Table 4.7). These same toilets are shared between several households within Melusi. This occurrence is in line with national data research which found that many households living in informal settlements are often forced to share toilet facilities (Stats SA, 2016 cited in SERI, 2018). Instances where facilities are shared increases the

likelihood of forced interactions, increasing the possibility of COVID-19 transmission, and the inability to practice social distancing and isolation (de Kadt *et al*, 2020, Wilkinson *et al*, 2020). Additionally, poorly kept toilet facilities may increase the risk of getting other illnesses or infections, which could compromise the immune system, making individuals vulnerable to severe COVID-19 infection (de Kadt *et al*, 2020).

5.2.2 Preparedness indicators

The attitude towards masks, sanitizers, and social distancing in Melusi received low scores according to the risk assessment framework developed in this study (Table 10). The correlation between positive COVID-19 cases in Melusi and the practice of wearing masks, using sanitizers, and exercising social distancing does not support existing research. Existing studies have suggested that there is a link between the rise in COVID-19 cases in South Africa and poor adherence to the guidelines and increased mobility (Moonasar *et al*, 2021). The high COVID-19 mortality rate in Brazil due to the negation of mandatory mask-wearing also serves as a case for the efficacy of masks and guidelines as an appropriate measure in mitigating the spread of the virus (Canineu & Muñoz, 2021).

5.2.3 Resilience indicators

The ‘Modes of transportation’ indicator contributed towards negatively influencing community resilience because the majority of the people in Melusi rely on public transportation for day-to-day movement (Table 4.13). The reliance on public transport means that a greater portion of people’s access to goods and services was severely limited, further exacerbating the ability to cope. Additionally, taxis and buses are enclosed spaces that offer little chance to practice social distancing and are limited in ventilation (de Kadt *et al*, 2020; Wilkinson *et al*, 2020). In Melusi, this concern extends further to children’s transportation, where it was explained that it was often observed that the children were not being effectively guided into wearing their masks, particularly on private transportation. In addition to the concern around the children of the community, this concern extends further to the behaviour exhibited at the community bus stop. At this bus stop, it is observed that many people interact without practicing any COVID-19 protocols. Therefore, the lack of resilience is multi-faceted as the majority of the community’s ability to commute to work is compromised, and the community members are at greater risk of infection when public transportation is used. It is worth noting, however, that despite the regulations put in place on public transportation (South Africa, 2020; South Africa, 2021) the participants explained that access to transport did not become a major challenge.

As the majority of the Melusi community work on temporary/part-time contracts or contractor agreements, the community's resilience is lowered as a consequence (Table 4.17). The pandemic resulted in South Africa being locked down, restricting economic activity and individual movements (South Africa, 2020; South Africa, 2021). Temporary workers and people working non-fixed term contracts may have been most at risk (de Kadt *et al*, 2020). Being under this type of employment suggests that the household may be limited in the ability to save enough money, in the event of an economic shutdown that prevents household members from going to work. This was evidenced in how many community members struggled during the earliest stages of the pandemic, with one participant relaying the frantic nature in which food parcels provided by the government were collected by community members.

5.3 Positive and moderate indicators of COVID-19 risk

5.3.1 Vulnerability indicators

As 50% of the dwellings in Melusi are occupied by one person (Table 4.2) it indicates that the 'Household population' indicator is a low contributor to exacerbating community vulnerability (Gillies *et al*, 2022). Furthermore, this finding may explain why, at the time of the study, Melusi had no significant number of COVID-19 cases. This finding is similar to other studies that did not find informal settlements to be COVID-19 hotspots, as was initially expected at the beginning of the pandemic (Solymári *et al*, 2022). However, unlike other similar informal settlement case studies (Matamanda, *et al*, 2022), Melusi's population density is low, illustrating how characteristics may differ between informal settlements.

Melusi's age demographic would be of low risk as the community is made up mostly of working-age individuals (Table 4.1). As it had been identified that the elderly (i.e., individuals 60 years old and above) were most at risk of severe COVID-19 infection (WHO, 2022a; Galal, 2021), Melusi consisting of a younger population put the community at less risk.

In Melusi, the fact that it is more common for households to share a yard (Table 4.1) as opposed to sharing a single dwelling reduces the opportunity for COVID-19 transmission as there is no resultant overcrowding in dwellings (de Kadt *et al*, 2020). However, there remains an element of risk as yard mates may be forced to interact with one another.

The majority of the dwelling structures in Melusi are made up of material, mainly corrugated iron (Table 4.3). This material does not adequately seal and separate rooms and is often associated with structures that have little ventilation (Manderson & Levine, 2020, cited in Van Wyk & Reddy, 2022; Koitsioe, 2020). In this way, these attributes that are synonymous with shacks make practicing self-isolation in Melusi dwellings nearly impossible, especially in times of illness, because if one person is not able to isolate away from other household members, then there is an increased risk of COVID-19 transmission between individuals in a single dwelling (de Kadt *et al*, 2020).

Furthermore, as 54% of the dwellings in Melusi do not have windows for every room and 52% of the dwellings have less than two rooms (Table 4.4), both indicators point towards making the community moderately vulnerable, meaning that in Melusi, there is not an urgent requirement for intervention with regards to alleviating housing density.

Although the water access indicators, namely ‘Water access – taps’ and ‘Water access - water tanks’, negatively contributed towards community vulnerability, it is important to consider the indicator ‘Crowding at water points’. This is because the result of this indicator showed that crowding at communal water access points was not a common occurrence (Table 4.5), therefore suggesting that the concern of forced interactions is lowered.

The community’s attitude towards handwashing (Table 4.5) may add further weight to the 'Handwashing facilities’ indicator which contributed to high vulnerability in Melusi. Practicing preventative hygiene such as handwashing has been regarded as important in transmission mitigation (DoH, 2020). Managing people’s willingness to take steps to ensure that they practice preventative hygiene is a challenge and may make the overall community more vulnerable if the majority of households do not adhere to this requirement.

In Melusi, 51% of households had pit latrines in the yard and 32% of households indicated that they used bucket toilets or portable chemical toilets (Table 4.8). The use of bucket toilets is of particular concern to the well-being of community members, as it was revealed that those who use bucket toilets would often discard the bucket contents in the communal portable toilets or just dump them on the sides (Figure 4.4), leaving a significant portion of the community vulnerable to health risks associated with water-borne diseases or contribute to the transmission of COVID-19 if not properly maintained (de Kadt *et* al, 2020; Wilkinson *et* al, 2020; Matamanda *et al*, 2021). Furthermore, the contradiction between the ‘Toilet type - bucket toilet or system or chemical toilet (communal)’ indicator and the feedback from the focus groups is an example of the relevance in using a mixed method approach. The

feedback from the participants offers a narrative that the quantitative data does not immediately present.

5.3.2 Preparedness indicators

Masks and sanitizers are suggested to be important tools in mitigating the transmission and spread of the COVID-19 virus. Masks act as a physical barrier that may help prevent the virus from being transmitted from an infected person to another individual (NICD, 2020b). In the absence of water and soap, alcohol-based sanitizer works as an alternative to maintaining good hygiene, thus eliminating germs on the hands (DoH, 2020, WHO, 2021). Since community members in Melusi had access to masks and sanitizers, be it from the local shops or the initiatives run by the COPC that made these things available, community members in Melusi were moderately prepared to deal with the COVID-19 pandemic (Table 4.9). This preparedness may be compromised by the attitude of the community, as described in chapter 5.2.

Based on the result of the 'Common food in households' indicator scoring a '2' for high preparedness (Table 4.10), it can be assumed that under normal circumstances, community members maintain a stable diet, and as such, are highly prepared to deal with extraordinary events such as a pandemic. Were the community not able to meet its nutritional needs, community members may be at greater risk of severe infection or COVID-19 effects (de Kadt et al, 2020). It is worth noting that when considering this indicator in isolation, Melusi may be prepared. However, in considering other factors such as the impact the pandemic had on employment, both in Melusi and nationwide, (BusinessTech, 2022), the level of preparedness for the community is compromised.

Access to food in the community appeared to vary, with there being a portion of the community who found accessing food difficult, particularly during the pandemic (Table 4.10). This was a similar result to that of the study done by Matamanda *et al* (2021), which found that during the earliest stages of the lockdown, many people's access to food was compromised due to the restrictions put in place on movement and local retail operations (South Africa, 2020; South Africa, 2021).

If there were food programmes and initiatives that had existed before the pandemic and continued running after the pandemic, then the community would have been considered to be highly prepared. Instead, in this study, the 'Community food programme' indicator scored a '1' for moderate preparedness (Table 4.10) due to the lack of initiatives in place, apart from

the school programme discussed in chapter 4.3.2. The benefit of having had these food programs in Melusi during the pandemic prevented poorer households from experiencing more severe hunger (Van der Berg *et al*, 2021).

Food sharing between households could open an avenue for exposure to disease (Wilkinson *et al*, 2020). As such, because food sharing is not a commonality in Melusi (Table 4.10) the community is better positioned in terms of preparedness.

Access to healthcare in Melusi remained consistent during the pandemic due to the presence of the mobile clinic located within the settlement, elevating community preparedness (Table 4.11). This means that those with underlying illnesses are not compromised in getting their treatments, therefore providing access to those more vulnerable to severe infection (de Kadt *et al*, 2020).

The community health workers ensured that community members continued to receive the necessary treatments, hence the 'Community comorbidity management' indicator scoring '2' for high preparedness (Table 4.11). This is despite the fact there were cases of some community members who had neglected to get their necessary treatments. In the context of informal settlements, the ability to manage comorbidities is important as these communities often face a number of barriers to access, including suitable healthcare services (Wilkinson *et al*, 2020).

Typically, due to the conditions of informal settlements, residents are often exposed to respiratory diseases such as tuberculosis (Matamanda *et al*, 2021). The South African health system continues to struggle with managing cases of HIV and tuberculosis (TB) (Van Wyk & Reddy, 2022). In this way, Melusi experiences a contradictory phenomenon whereby 96% of the households in the community have zero TB-positive individuals (Table 4.12). In this way, the community is in a position of high preparedness, as community illness is not of major concern.

5.3.3 Resilience indicators

Inter-provincial travel in Melusi contributed towards moderate resilience (Table 4.13) as a significant proportion of the community's population is made up of in-migrants. In this way, the risk of COVID-19 transmission is increased as it has been previously suggested that higher mobility facilitates the spread of COVID-19 (Wilkinson *et al*, 2020).

The inability to maintain a certain physical distance between individuals serves as a major barrier to COVID-19 mitigation efforts. In the case of Melusi, it was found that crowding was neither a common day-to-day occurrence in the large stores (such as bulk grocers) nor at the local spaza shops located within the settlement (Table 4.14). Therefore, the ability of the community to cope is moderate as social distancing is a vital aspect of COVID-19 mitigation efforts, to the extent that it formed a key part of the COVID-19 legislation (South Africa, 2020; South Africa 2021). Furthermore, although crowding in these public spaces was not regarded as common, there were still instances of crowding that were highlighted.

The majority of households in Melusi would rely on more than one source of energy supply, which could positively contribute towards community resilience. However, even though 72% of the households rely on two or more energy sources, it should be recognised that some of these sources are often more dangerous than electricity in the informal settlement context and may potentially compromise the overall quality of life (Musango, 2014). This illustrates that the quantitative household data provides an indication of the reliance on specific sources of energy, but through the focus groups and key informant discussions, the nature of energy dependence was described and provided insight into the community's well-being.

The majority of the community did not live their lives in fear of contracting COVID-19 due to the lack of COVID-19 cases in the community (Table 4.16). Dinaweng informal settlement (Matamanda *et al*, 2021) presented a similar result whereby the majority of respondents indicated that they did not know anyone infected with COVID-19, as such many community members continued with their days without concern for the virus. The explanation for this occurrence varies, however, in the case of Melusi, many community members did not see the importance of wearing masks or social distancing because of the lack of observed cases within the settlement. This type of behaviour may compromise the community's resilience as the indifferent attitude towards COVID-19 may lead to behaviours that further facilitate the spread of the virus, as opposed to mitigating it.

Stigmatisation, 'COVID-19 stigma', in Melusi was not prevalent (Table 4.16), which suggests that, as a collective, the community may be highly resilient and are better suited to cope with the socio-economic effects of COVID-19, without the undertones of discrimination against specific a specific group of people (UNICEF, 2020).

Vaccine hesitancy was prominent throughout the community, with the younger population being particularly sceptical about receiving a dosage. However, there was observed compliance from the older population, which resulted in the community being

regarded as moderately resilient in the context of vaccine hesitancy (Table 4.16). Vaccines are a vital component of protecting an individual from disease (NICD, 2022b). Without the administration of vaccines on a grand scale, the viral transmission may continue.

5.4 Chapter conclusion

In this study, assessing risk in terms of vulnerability, preparedness, and resilience has allowed for the collection of information that encompasses multiple aspects that shape the socio-economic environment in Melusi.

Based on the analysis of the results, it is evident that there is a requirement for a certain level of intervention in Melusi to reduce the vulnerability, improve the preparedness and strengthen the resilience of the community. However, by recognising the importance of analysing qualitative and quantitative information about the settlement, it has been demonstrated that Melusi is an informal settlement that is not subject to as many of the circumstances often ascribed to informal settlements. Therefore, this result serves to validate the development and implementation of the COVID-19 risk assessment framework.

6 CONCLUSIONS

This research aimed to develop a framework that would be used to assess the COVID-19 risk for the community of Melusi, in an informal settlement. To meet this aim, objectives were set around the design, implementation, and evaluation of the proposed risk assessment framework. The framework design was developed by consulting past risk assessment studies for communicable diseases, including COVID-19 (Dicken *et al*, 2013; Kienberger and Hagenlocher, 2014; CSIR, 2020; de Kadt *et al*, 2020). To collect the data required, a mixed method approach was applied and was informed by the risk assessment framework as it determined the variables to be considered for analysis. For this study, risk was defined according to vulnerability, preparedness, and resilience. To analyse the data that was collected through the focus groups and the secondary COPC data, a scoring matrix was developed. The final results of the study allowed for the identification of key areas of high COVID-19 risk in Melusi.

From this study, it was identified that the following indicators would exacerbate the community's vulnerability to COVID-19: the majority of the community resides in shacks, the inability to self-isolate, the type of water access and lack of handwashing facilities, and the poor cleanliness of the bucket toilets. The type of dwellings that people reside in may be one of the most important factors in managing the transmission of COVID-19 as being able to practice social distancing and isolation in times of illness is crucial. Water and sanitation may exacerbate community vulnerability as shared water points and toilet facilities force continued interactions between community members, increasing their risk. Therefore, improved housing with adequate toilet facilities needs to be provided to those previously deprived of this level of access. However, the unpredictable nature of informal settlement establishment and growth will continue to be a challenge to address.

The attitude that the majority of the community displayed towards the COVID-19 guidelines, namely wearing masks, using sanitizers, and social distancing, were identified as indicators that could contribute the most to compromising community preparedness. A lack of compliance in this regard creates the opportunity for infectious diseases to potentially spread between community members.

Lastly, the community's chances of coping during and after the pandemic were thought to be lowered due to the type of energy source often relied upon and the type of employment

common amongst community members. Energy sources such as gas and coal are more hazardous in terms of health implications and physical risks, and thus make coping in the context of a pandemic more difficult. Similarly, temporary or contractor employment suggests that the income being earned is not enough to be put away, which may increase risk as the ability to cope in times when access to jobs is impeded.

Even though COVID-19 was not observed to be prominent in Melusi, it is still important to prioritise certain factors that may put the community at greater risk of viral infection. This will not only be for the sake of managing the outbreak of infectious disease, but it will also serve in uplifting communities as their standards of living are raised through improved living conditions.

Therefore, what is required in the context of communicable diseases is more focused assessments of risk in terms of vulnerability, preparedness, and/or resilience for informal settlements. Furthermore, sound government intervention remains critical for the management of COVID-19 and other communicable diseases. As best surmised by Matamanda *et al* (2021), the responses to disease pandemics require a well-concentrated effort from stakeholders and should be considerate of the needs of the poor. Therefore, the best measures that are implemented would be those that are specific to the area of focus and should acknowledge the dynamics within the settlement.

The strengths of this study include the following: The data in this study was collected based on an extensive list of qualitative and quantitative indicators that provided an adequate description of COVID-19 risk in terms of either vulnerability, preparedness, or resilience. Furthermore, the methodology of the study can be replicated across informal settlements and communicable diseases, and the risk assessment framework could be adjusted to accommodate the disease of focus. The study also showed that the method of prioritising aspects for intervention should not be based on general assumptions of the dynamics within the settlement.

The methodological limitations of this study consisted of the following: The participants of the focus group interview (who were community health workers and field workers) were not systemically split according to the zone in which they either live or are stationed. As the moderator was not entirely fluent in the language of the participants, some questions may have been slightly misinterpreted or not answered to the degree they could have been answered had there been a more fluent translator on site. The scoring matrix developed to assess COVID-19 risk according to the risk assessment framework may require refinement

as the scoring system may be too subjective and could have benefitted from a 5-tier scoring system as opposed to 3-tiers.

If the methodology of this study were to be replicated, it is recommended that researchers consider increasing or diversifying the participant sample group. A limitation of this study was that the qualitative information was from the perspective of the community health workers and could have benefited from gaining insights from other members of the community.

As there is often limited qualitative data on informal settlements, researchers are encouraged to use the mixed method approach in order to get the qualitative data, and create a database of quantitative information, that could be used for future research and intervention strategies.

Therefore, this study has demonstrated the requirement for increased studies of informal settlements in the context of assessing the risk of communicable diseases. It is acknowledged that due to the nature of these settlements, conducting studies may often present challenges related to data access and data credibility. Informal settlements in South Africa remain subject to under-reporting, and yet there remains a requirement for such data collection as appropriate interventions are determined by the level of risk in these settlements. Furthermore, the requirement for rigorous government intervention strategies remains at the crux of managing communicable diseases and the continued housing crisis in the country that contributes to the origination of informal settlements.

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8 APPENDIX

8.1 Appendix A: Questionnaire for Melusi community health workers

Questions for Melusi Community Health Workers

Aim: To understand factors that may impact the Melusi community's vulnerability, preparedness and resilience to COVID-19

1. How do **household dynamics** impact COVID-19 vulnerability, preparedness and resilience in Melusi?

How would you describe the typical household structure in Melusi? (Young families? Family sizes?)

How many people, on average, live in a dwelling (shack)?

Is it common for more than one household to share a dwelling?

Do you have any issues of concern relating to the structure of the households in the context of COVID-19 (for example is there a large elderly population or household members with comorbidities to be concerned about?

2. How does the **internal layout of dwellings** impact COVID-19 vulnerability, preparedness and resilience in Melusi?

How are dwellings generally used/organised internally?

Are you aware of other concerns in relation to COVID-19 about how dwellings in Melusi are laid out and used?

3. How does **access to water** impact COVID-19 vulnerability, preparedness and resilience in Melusi?

Where do most community members get their water from? Are there other options than piped water and water tanks?

Are there specific times when the water tanks around Melusi experience crowding or queuing? (If somebody has to self-isolate, would community members supply them with water so that infected people do not have to stand in queues?)

What is the general handwashing practice in Melusi?

Are you aware of any behaviours, relating to water, that may be of concern, in the context of COVID-19?

4. How does **sharing of sanitation** impact COVID-19 vulnerability, preparedness and resilience in Melusi?

Is it common practice to share toilets between households? If yes, which kinds of toilets are shared? Is there any possible infection risk?
Are there certain ways that people share toilets that you regard as a concern in relation to COVID-19?

5. How does the **mobility and main transportation mode of the community** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
What are the main modes of transportation for community members of Melusi?
Do members of Melusi households frequently travel between provinces? If so, in what capacity, e.g. to visit the family homestead or for work?
Did households adapt their mobility or travelling behaviour due to COVID-19 restrictions on their movement? And if yes, how (e.g. frequency of travelling, time of day for travelling, different transportation mode, different route or destination)?
Are there any COVID-19 related concerns about transportation modes and mobility in Melusi?

6. How does **access to essentials** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
Do people buy paraffin, food and other essentials from street hawkers, in Spaza shops with confined spaces or supermarkets where there could also be crowding or queuing?
What is the main source of energy in Melusi? For energy sources that have to be collected, such as wood, where and how often are they collected? Are they collected by individuals or in groups?
If somebody has to self-isolate, would community members support them with paraffin, food, wood, and other essentials so that infected people do not have to risk infecting others?
What other concerns do you have about the community' behaviour to access essentials in the context of COVID-19?
7. How does the **community social distancing and sanitizing habits** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
Do community members have masks, and if yes, are they used appropriately?
Are there sanitizing stations at any of the public spaces gathering places, and are they used appropriately?
Do you think the community is aware of the importance of social distancing?
And is there a concern that people are not willing to social distance?
Do you have any other concerns related to the community's ability and willingness to socially distance and sanitize?

8. How does **food availability** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
What is the common diet for households in the community?
Is food sharing between households a common feature in Melusi? If yes, how do households go about sharing food?
Are there programmes or initiatives that have been put in place to assist the community in having (nutritious) food available, e.g. distribution of food parcels, during the COVID-19 pandemic?
With COVID-19, what were (and are still) some of the difficulties related to food availability?

9. How does **community healthcare** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
Do community health workers or medical practitioners still conduct homes visits in the pandemic? Did you change your protocol or process regarding home visits and monitoring community health?
Do you think the community changed their behaviour and did not manage their comorbidities as well as before?
Is the community aware that there is a space available for self-isolation in Melusi or in the surrounding area, e.g. to self-isolate in a local church?
Do you have any other COVID-19 related concerns related to community healthcare?

10. How does the **community's attitude** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
Are people more apprehensive to seek treatment for comorbidities or other illnesses because they fear contracting COVID-19 from other people or at public spots such as the medical container?
Do you think community members live in fear of being exposed to COVID-19?
Is there a stigma around COVID-19? If yes, has this caused people to refuse to test for it?
Is there a stigma around the COVID-19 vaccine? Are people in the community hesitant to get the vaccine?
Anything else you would like to mention about the community's attitude about COVID-19?

11. How does **people's income structure** impact COVID-19 vulnerability, preparedness and resilience in Melusi?
What is the most common form of work amongst community members? (e.g. street vending, essential workers, etc.)

How were the livelihoods of community members impacted by the restrictions imposed during the pandemic? How did they adapt?

Did community members support each other in sustaining their livelihoods during the pandemic?

Are there any COVID-19 related concerns about the community's ability to sustain their livelihoods during the pandemic?

8.2 Appendix B: Ethical clearance form

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Ethics Committee

E-mail: ethics.nas@up.ac.za

16 July 2021

ETHICS SUBMISSION: LETTER OF APPROVAL - AMENDMENT

Dr V Rautenbach
Department of Geography Geoinformatics and Meteorology
Faculty of Natural and Agricultural Science
University of Pretoria

Reference number: NAS128/2019
Project title: Producing spatial knowledge with the community to empower them

Dear Dr V Rautenbach,

We are pleased to inform you that the **Amendment** conforms to the requirements of the Faculty of Natural and Agricultural Sciences Research Ethics Committee.

Please note the following about your ethics approval:

- Please use your reference number (NAS128/2019) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.
- Please note that ethical approval is granted for the duration of the research (e.g. Honours studies: 1 year, Masters studies: two years, and PhD studies: three years) and should be extended when the approval period lapses.
- The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

Ethics approval is subject to the following:

- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.
- **Applications using GM permits:** If the GM permit expires before the end of the study, please make an amendment to the application with the new GM permit before the old one expires.
- **Applications using Animals:** NAS ethics recommendation does not imply that Animal Ethics Committee (AEC) approval is granted. The application has been pre-screened and recommended for review by the AEC. Research may not proceed until AEC approval is granted.

Post approval submissions including application for ethics extension and amendments to the approved application should be submitted online via the ethics work centre.

We wish you the best with your research.

Yours sincerely,

Prof VJ Maharaj
Chairperson: NAS Ethics Committee

8.3 Appendix C: Data analysis scoring systems

8.3.1 Risk scoring matrix – qualitative data

Table 8.1: Risk assessment matrix for the qualitative indicators under vulnerability.

			Impact on livelihood		
			Positive	Neutral	Negative
			Scenario that does not require an immediate response or action.	Mild implications, small scale response might be required.	Major associated implications, immediate and rigorous response/intervention is required.
Likelihood of occurrence	Highly likely	Mostly prevalent across the community.	Low vulnerability	Moderate vulnerability	High vulnerability
	Likely	Prevalent in the community but does not apply do the majority.	Low vulnerability	Moderate vulnerability	High vulnerability
	Highly unlikely	Prevalence is low or virtually non-existent.	Low vulnerability	Moderate vulnerability	High vulnerability
Score			0	1	2

Table 8.2: Risk assessment matrix for the qualitative indicators under preparedness.

	Impact on livelihood		
	Positive	Neutral	Negative
	Scenario that does not require an immediate response or action.	Mild implications, small scale response might be required.	Major associated implications, immediate and rigorous response/intervention is required.

Likelihood of occurrence	Highly likely	Mostly prevalent across the community.	Low preparedness	Moderate preparedness	Low preparedness
	Likely	Prevalent in the community but does not apply do the majority.	Low preparedness	Moderate preparedness	Low preparedness
	Highly unlikely	Prevalence is low or virtually non-existent.	Low preparedness	Moderate preparedness	Low preparedness
Score			2	1	0

Table 8.3: Risk assessment matrix for the qualitative indicators under resilience

			Impact on livelihood		
			Positive	Neutral	Negative
			Scenario that does not require an immediate response or action.	Mild implications, small scale response might be required.	Major associated implications, immediate and rigorous response/intervention is required.
Likelihood of occurrence	Highly likely	Mostly prevalent across the community.	High resilience	Moderate resilience	Low resilience
	Likely	Prevalent in the community but does not apply do the majority.	High resilience	Moderate resilience	Low resilience
	Highly unlikely	Prevalence is low or virtually non-existent.	High resilience	Moderate resilience	Low resilience
Score			2	0	1

8.3.2 Risk scoring matrix – quantitative data

Table 8.4: Risk assessment matrix for the quantitative indicators

QUANTITATIVE DATA RISK SCORING			
Level	Low vulnerability	Moderate vulnerability	High vulnerability
	Low preparedness	Moderate preparedness	High preparedness
	Low resilience	Moderate resilience	High resilience
Value	0% < value ≤ 33.3%	33.3% < value ≤ 66.7%	66.7 < value ≤ 100%
Score	0	1	2

8.4 Appendix D: COVID-19 risk assessment framework

Table 8.5: Susceptibility (vulnerability) as a domain of risk and the qualitative variables and indicators that are classified under it.

Domain	Variable	Qualitative Indicators	Indicator Description	Rationale
Susceptibility (vulnerability): Existing conditions - economic, social, and/or cultural - that render a population sensitive to the negative impacts of a virus.	Household dynamics *Household size and demographic determine overall proneness to illness and ability to conform to preventative measures.*	Dwelling sharing	Majority of households share a dwelling or a yard with other households (de Kadt et al, 2020)	The ability to practice effective social distancing becomes increasingly difficult as the number of people sharing a dwelling or yard increases, increasing the level of vulnerability to COVID-19. Increased number of sharing households results in increased exposure.
	Housing structures *Structural organisation of dwellings determines the ability to social distance, quarantine or self-isolate.*	Material used to separate rooms in a dwelling	Majority of dwelling rooms are divided using non-brick material	Housing structures where rooms are partitioned using iron sheets or sheets/blanks, rather than brick or cement, make it difficult to self-isolate in times of illness and prevent transmitting COVID-19.
		Self-isolation feasibility	Majority of community members can self-isolate in their current dwellings	The risk of COVID-19 infection increases in dwellings where an infected individual cannot self-isolate
	Water	Crowding at water points	Water access points such as taps, and	The risk of COVID-19 infection increases where there is no practice of social distancing.

	Maintaining social distancing is unfeasible at shared water access points due to forced interaction between households (de Kadt et al, 2020). Employing hygiene practices to prevent COVID is difficult where water is not easily accessible.		tanks are always crowded	
		Handwashing attitude	Majority of residents are very strict about handwashing.	The risk of COVID-19 infection increases where there is no urge to practice preventative hygiene such as regular handwashing
	Sanitation *Sharing of toilet facilities between households means forced interactions that impede practicing social distancing (de Kadt et al, 2020). Shared toilet facilities mean*	Pit toilet cleanliness	Hygiene of the majority of the pit toilets is well-maintained	COVID-19 risk increases where surfaces are not kept clean. This increases the risk of COVID-19 spread through surface contact.
		Bucket toilet cleanliness	Hygiene of the majority of the bucket toilets is well-maintained	COVID-19 risk increases where surfaces are not kept clean. This increases the risk of COVID-19 spread through surface contact.

	good hygiene practices are difficult to maintain (de Kadt et al, 2020)			

Table 8.6: Susceptibility (vulnerability) as a domain of risk, and the quantitative variables and indicators that are classified under it.

Domain	Variable	Quantitative Indicators	Indicator Description	Rationale
Susceptibility (vulnerability): Existing conditions - economic, social, and/or cultural - that render a population sensitive to the negative impacts of a virus.	Household dynamics *Household size and demographic determine overall proneness to illness and ability to engage in preventative measures.*	Household population	Percentage of dwellings with more than one occupant	The ability to practice social distance becomes increasingly difficult as the number of people in a given household increases, increasing COVID-19 vulnerability.
		Age demographic	Percentage of the community above the age of 60 years old	People over the age of 60 years old are considered more at risk of COVID-19 infection and adverse effects, increasing vulnerability.
	Dwelling structures *Structural organisation of dwellings determines the*	Informal housing type	Percentage of households living in a shack	COVID-19 risk increases where social distancing and self-isolation are not feasible. Informal dwellings are often close-together, with few rooms and space, limiting the practice of social distancing and isolation.
		Housing ventilation	Percentage of dwellings where every room has a window	Ventilation indoors is advised for limiting COVID-19 transmission. Informal dwellings are often poorly ventilated.

	ability to social distance, quarantine or self-isolate.	Informal housing space	Community with dwellings that have on, average, more than 2 rooms (de Kadt *et al*, 2020)	Few rooms in a dwelling make practicing effective social distancing more difficult. This is because, with there being fewer rooms, household members are forced into interactions as they share rooms.
		Informal housing size	Average size of total floor space of dwellings in a given settlement	Dwellings with smaller floor space make effective social distancing unfeasible.
	Water *Maintaining social distancing is unfeasible at shared water access points due to forced interaction between households (de Kadt et al, 2020). Employing hygiene practices to prevent COVID is difficult where water is not easily accessible.*	Water access - taps	Percentage of households with no taps in the yard	Shared water sources such as taps force interactions between different households. This limits the ability to implement effective social distancing.
		Water access - water tanks	Percentage of households who use communal water tanks	Shared water sources such as water tanks forces interactions between different households. This limits the ability to implement effective social distancing.
		Handwashing facilities	Percentage of dwellings with toilet handwashing facilities	Without access to adequate handwashing facilities, the ability to practice preventative hygiene is limited.

	Sanitation *Sharing of toilet facilities between households means forced interactions that impede practicing social distancing (de Kadt et al, 2020).* *Shared toilet facilities mean good hygiene practices are difficult to maintain (de Kadt et al, 2020)*	Toilet type - pit latrines	Percentage of households with pit toilets in the yard	Sharing of toilet facilities between households limits the ability to practice effective social distancing as households are forced to interact.
		Toilet type - bucket toilet system	Percentage of households that use bucket toilet system	Sharing of toilet facilities between households limits the ability to practice effective social distancing as households are forced to interact.
		Toilet sharing	Percentage of households that share toilets with other households	Sharing of toilet facilities between households limits the ability to practice effective social distancing as households are forced to interact.

Table 8.7: Preparedness (capacity to anticipate) as a domain of risk and the qualitative variables and indicators that are classified under it.

Domain	Variable	Qualitative Indicators	Indicator Description	Rationale
Capacity to anticipate (preparedness): The set of adequately	Use of masks and sanitizers, and social distancing *Masks mitigate viral transmission through direct*	Attitude towards masks	Majority of community members readily adhere to mask-wearing regulations and recommendations	Masks are advised as an important preventative tool. Managing the spread of COVID-19 becomes challenging if groups of people refuse to wear masks, particularly in direct interactions.

stipulated strategies or programs that are made available before the virus hazard arises)	*contact (WHO,2020b). Alcohol-based sanitizers work to eliminate infectious agents on hands (DoH,2020). Social distancing reduces person-to-person transmission of a virus (WHO, 2021).*	Access to masks	Majority of community members struggle with getting access to masks	Masks are advised as an important preventative tool. Managing the spread of COVID-19 becomes challenging if community members generally struggle to get access to masks.
		Attitude towards sanitizer	Majority of community members readily use sanitizers	The risk of COVID-19 infection increases when sanitizers are not readily used, particularly in public spaces.
		Access to sanitizer	Majority of community members have access to sanitizer in public spaces within the community, and their homes	The risk of COVID-19 infection increases when sanitizers are not readily available for use, particularly in public spaces but also in housing structures
		Attitude toward social distancing	Majority of community members readily adhere to social distancing regulations and recommendations	Challenges in preventing COVID-19 spread arise when people willingly disregard the call to be at least 1 meter apart.
	Food Availability *An inability to meet daily nutritional needs is an aspect that may increase the risk of infection (de Kadt et al, 2020)*	Common food in households	Majority of community members have food that would be considered a stable diet	Individuals who can meet adequate nutritional requirements are better able to deal with adverse COVID-19 effects.
		Community food access	Majority of community members have adequate access to food	Where there is a lack of access to food, it puts the community at risk of suffering severe hunger, which may further bring challenges in immune systems, workforce productivity

		Community food programmes	Normally, food program initiatives are running in the community.	Challenges in supporting a community arise when there are no food programmes put in place, particularly during a national lockdown where community members are forced to stay home, preventing them from earning an income at work.
		Food sharing between households	Majority of households in the community share meals and food expenditures with other households	Food sharing results in forced interactions between households, making it challenging to mitigate COVID-19 spread. Food sharing also creates the challenge of dependence - whereby those affected by the national lockdown may mean compromised food access for more than one household.
	Community Healthcare *An inability to access healthcare leaves community members unable to get treated for pre-existing conditions or COVID-19 symptoms (de Kadt et al, 2020).*	Provision of healthcare	Majority of community members have access to healthcare services	An inability to access healthcare due to aspects such as costs of travel, crowding, and refusal of services - will make a community more at risk due to a national lockdown.
		Community comorbidity management	Majority of community members get their required medical treatments.	Failure to receive adequate health treatments due to laziness or general unwillingness creates challenges in managing comorbidities and ensuring that the most at-risk populations are receiving their basic medication.

Table 8.8: Preparedness (capacity to anticipate) as a domain of risk and the quantitative variables and indicators that are classified under it.

Domain	Variable	Quantitative Indicators	Indicator Description	Rationale

Capacity to anticipate (preparedness): The set of adequately stipulated strategies or programs that are made available before the virus hazard arises)	Food Availability *An inability to meet daily nutritional needs is an aspect that may increase the risk of infection (de Kadt et al, 2020)*	Food level	Percentage of households with enough food	The inability to meet nutritional requirements is likely to increase a person's risk of COVID-19 infection and the adverse effects that come with it.
		Food availability	Percentage of households that sleep hungry	The inability to meet nutritional requirements is likely to increase a person's risk of COVID-19 infection and the adverse effects that come with it.
	Community Healthcare *An inability to access healthcare leaves community members unable to get treated for pre-existing conditions or COVID-19 symptoms (de Kadt et al, 2020).*	Tuberculosis cases	Percentage of community members with TB	People with pre-existing medical conditions are more at risk due to their medical needs, and the increased risk of severe COVID-19 infection.
		HIV/Aids cases	Percentage of community members with HIV	People with pre-existing medical conditions are more at risk due to their medical needs, and the increased risk of severe COVID-19 infection.
		Hypertension cases	Percentage of community members with hypertension	People with pre-existing medical conditions are more at risk due to their medical needs, and the increased risk of severe COVID-19 infection.
		Diabetes cases	Percentage of community members with diabetes	People with pre-existing medical conditions are more at risk due to their medical needs, and the increased risk of severe COVID-19 infection.

Table 8.9: Resilience (capacity to cope) as a domain of risk and the qualitative variables and indicators that are classified under it.

Domain	Variable	Qualitative Indicators	Indicator Description	Rationale
Capacity to cope (resilience)	Mobility and transportation	Modes of transportation	Majority of the community relies on public transportation	Use of public transportation means greater exposure to other people in a space where social distancing is not feasible - increasing the potential for COVID-19 transmission., particularly during peak travel times.

The ability of communities to utilise available resources to deal with the adverse conditions that may arise as a result of a pandemic	*Greater access to transportation modes allows for increased access to services. Sufficient internal management of public transportation means controls on the viral spread of COVID-19.*	Frequency of inter-provincial travel	Majority of community members are required to travel between provinces (homestead, work, etc).	Travelling between areas of varying viral spread makes managing COVID-19 spread more challenging as some individuals may act as carriers that could make an entire community infected. Informal settlements are the direct result of immigrants establishing informal living areas due to the country's inability to accommodate immigrants through housing.
	Access to essentials *Without access to basic services such as electricity, settlements continue to struggle to live away from poverty (PENN IUR, 2021) and complete day-to-day household tasks. Where access to stores is compromised, people cannot*	Crowded local shops	Majority of local stores such as spaza shops are always crowded	Informal establishments such as spaza shops in informal settlements are not as regulated as traditional convenience stores. Lack of enforcement of COVID-19 guidelines in these stores, such as regulating the number of customers in the store, mask-wearing & sanitizing, creates challenges to mitigating COVID-19 spread.
		Crowded large stores	Majority of large stores such as value marts are always crowded	Large stores in the formal sector are regulated by security and other enforcement.

	obtain the resources necessary for survival.			
	Community attitude to COVID-19 *If community behavioural responses neglect to employ preventative practices, despite the health response that is advised, combatting transmission and viral spread may be difficult.*	COVID-19 fear	Majority of the community fear COVID-19, so they do not frequent public spaces	A lack of genuine concern around COVID-19 (its transmissibility, and possible adverse health effects) makes implementing mitigation measures difficult because it is not viewed as a legitimate health threat.
		COVID-19 stigma	Majority of the community has a stigma toward COVID-19	Where there may be a stigma around COVID-19 and those who have contracted it, people with the virus may forgo treatment to ensure that nobody finds out that they have contracted the virus, making the management of viral transmission difficult in the presence of little transparency.
		COVID-19 vaccine hesitancy	Majority of the community has a strong willingness to get vaccinated.	Vaccine hesitancy makes it a challenge to combat COVID-19 transmission.
	Income structure *If the majority of community members work temporary or contractor jobs, adjustments to their salaries or*	COVID-19 fear	Majority of the community fear COVID-19, so they do not frequent public spaces	A lack of genuine concern around COVID-19 (its transmissibility, and possible adverse health effects) makes implementing mitigation measures difficult because it is not viewed as a legitimate health threat.

	working times will affect their ability to survive.			

Table 8.10: Resilience (capacity to cope) as a domain of risk and the quantitative variables and indicators that are classified under it.

Domain	Variable	Quantitative Indicators	Indicator Description	Rationale
Capacity to cope (resilience) The ability of communities to utilise available resources to deal with the adverse conditions that may arise as a result of a pandemic	Access to essentials and energy *Without access to basic services such as electricity, settlements continue to struggle to live away from poverty (PENN IUR, 2021) and complete day-to-day household tasks. Where access to stores is compromised, people cannot obtain the resources necessary for survival.*	Energy source - electricity	Percentage of households that use electricity in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.
		Energy source - solar power	Percentage of households that use solar power in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.
		Energy source -Gas	Percentage of households that use gas in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.
		Energy source - Paraffin	Percentage of households that use paraffin in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.
		Energy source - Wood	Percentage of households that use wood in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.
		Energy source - Coal	Percentage of households that use coal in dwellings	The source of power and energy in a household serves as a proxy of poverty. In dwellings where more risk-prone energy sources are used, the overall quality of life decreases.

	Income structure *If the majority of community members work temporary or contractor jobs, adjustments to their salaries or working times will affect their ability to survive.*	Employment	Percentage of households that have at least one individual who is employed	Households that are heavily reliant on government grants are most at risk as they would lack the financial stronghold required to cope with the economic ramifications of a national shutdown.