Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo

Submitted in fulfilment of the requirements of the degree of Master of Management Sciences in Public Administration – Business Administration

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November 2017

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Date:

ABSTRACT

Access to clean water is a human right and a basic need. Yet, many South African communities, the villages of the Aganang Municipality included, are still living in areas where access to clean water remains a challenge. They face, among other problems, a longer waiting time in long queues; walking long distances despite the topography of the villages; waiting for water at night when numerous consumer's taps are closed is then that water can reach other areas; or simply buying water from other community members who trade it with donkey carts as a commodity.

The researcher used a mixed method to understand the challenges of water infrastructure in the municipality. The research's main findings reveal that these challenges result from a number of factors including but not limited to vandalism, shortage of personnel; lack of resources human, financial and spare parts; leaking and breaking of pipes, and under qualified/poorly trained personnel. These issues lead to dissatisfaction of the beneficiaries and mixed feelings around water quality. Indeed, whilst majority of respondents believe the quality of water is good, others disagree whilst others claim that they do not receive water at all.

The solutions to these problems are also multifaceted. They include yard connections, reporting theft and vandalism to the police, imposing fine to the offender, employing water inspectors and security guards, discouraging illegal connections, educate the communities. The reporting mechanisms could include social media, free transportation of both the personnel and individuals who have identified the issues, and recruiting local people and transferring skills to the community members.

The respondents have different views on different aspects of water infrastructure and access to clean water.

DECLARATION

I declare that this full dissertation report submitted to the Durban University of Technology entitled “Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo”; has never been submitted by me or any other person for a degree in any other university, and that it is my own work and any other author’s work herein had been acknowledged.

I declare that this is a true copy of my dissertation, including any final revisions herein as approved by my supervisor.

_____

Matlou Lesley Mokgobu

I hereby approve the final submission of the following dissertation:

_____

Dr Baruti B. Amisi

Declared at the Durban University of Technology on this _____day of

_____, _____

ACKNOWLEDGEMENTS

I would like to express my gratitude to everybody who supported me during my years of study at Durban University of Technology. Special thanks go to my supervisor Dr. Baruti B. Amisi, who supported, guided, led and encouraged me through all the years of research. Sara Bibi Mitha, librarian, who always provided me with information when it was requested deserves a thank you. The residents of Aganang Municipality who sacrificed their time for their willingness to give input through meaningful data, by responding to questionnaires and interviews in an effort to make sure that research reaches the end. Lastly and most importantly thanks to my wife Tshepiso Mokgobu and children who never complained in my absence from them for my studies.

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LIST OF ABBREVIATIONS

BSU- Business Studies Unit

CCM- Constant Comparative Method

CCTV- Closed Circuit Television

CDM- Capricorn District Municipality

CSIR- Council for Scientific Industrial Research

CWSs- Community Water Systems

NCWSs- Non Community Water Systems

DWAF- Department of Water Affairs and Forestry

Fig. - Figure

FM- Frequency Modulation

GDP- Gross Domestic Products

IDP- Integrated Development Planning

MDGs- Millennium Development Goals

N/n- Number

N1/ N11- National road/ route 1/ 11

NRW- Non-Revenue Water

NWA- National Water Act 36 of 1998

NWR- National Water Resource

NWSC- National Water and Sewerage Corporation

Prof - Professional

R521- Route/ Road 521

RCR- Responsible Conduct of Research

RDP- Reconstruction and Development Programme

RSA- Republic of South Africa

SA - South Africa

SABS- South African Bureau of Standards

SANCO- South African National Civic Organisation

SAPA- South African Press Association

SDGs- Sustainable Development Goals

SMS- Short Message Service

SPSS - Statistical Package for the Social Sciences

UGS- Urogenital Schistosomiasis

UN- United Nations

UNICEF- United Nations Children's Fund

US- United States

USA- United States of America

USEPA- United States Environmental Protection Agency

WAR- Water Allocation Reform

WHO- World Health Organization

WSA - Water Services Authority

WSP- Water Services Provider

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Communities that live in areas where there is a constant supply of clean water, i.e. selected cities and towns and the Metropolitan areas, enjoy the fruits of democracy as stipulated in the Constitution of the Republic of South Africa, 1996- Chapter 2: Bill of Rights [Act No. 108 of 1996] (South Africa 1996). Limpopo Province is largely rural and is classified as one of the poorest provinces in South Africa with limited water resources (Limpopo Department of Finance and Economic Development 2004 cited in Odiyo 2012: 136). After twenty-two years into democracy, there are still people living in areas where to have constant supply of water is a dream which never comes true. Maserumule (2008 cited in Modisha and Mtapuri 2013: 268) asserts that "municipalities are no longer instruments of service delivery, but are also assigned a role as agents of economic development in their areas of jurisdictions around the country". Communities with a constant water supply are facing water leaks which even if they are reported take longer periods for maintenance and repairs.

The streets in Aganang Municipality [1]are always wet from water leaks, some of which is flowing in the streets on a daily basis with neither success of maintenance nor repairs. However, the question remains, are these leaks reported to the municipality? Municipalities rely on the information supplied by their communities to report any damage, vandalism, leaks and so on for their infrastructures such as water, electricity, roads and telephone networks and so on to be repaired beside regular maintenance.

This study will investigate the challenges of the repair and maintenance of water infrastructure in the Aganang Municipality because these interlinked and complex problems contributed significantly to the water crisis in this municipality (Bessa and Facchina 2014:

[1] Aganang municipality has been disestablished with the new portions forming parts of Blouberg Local Municipality, Molemole Local Municipality and Polokwane Local Municipality (Thupana 2016: 13).

151). These problems also necessitate appropriate solutions, change in policy-making and implementation for the water sector in the Aganang Municipality in the province of Limpopo. Some of those interlinked and complex problems include the following:

- Water crisis;
- Increasing demand compared to the capacity of the existing infrastructure;
- Vandalism to water infrastructure;
- Ageing infrastructure like water pipes, water pumps and so on; and
- Water pressure drops due to high and simultaneous usage.

South Africa's 98.6% of the consistent yield of water for the whole year is already allocated (Department of Water Affairs and Forestry 2008 cited in Eales 2010: 2). The known fact is that South Africa however tops the world with regards to the number of dams, and this makes the country to own 40% of Africa's large and medium sized dams (Turton 2000 cited in Eales 2010:2).

1.2 Background of the study

Aganang Local Municipality is rural and is situated within the tribal authorities of Moletji, Matlala, Maraba and Mashashane. Greater parts of this municipality are situated on a slope that has a gentle rise and fall with some hills and mountains spreading across the area. EnviroXcellence (2009: iv) states that the slopes within the municipality are rated at 0-9% for the larger parts of the area and 9-25% on the hills and mountains respectively. These percentages reveal that from the total area of land occupied by Aganang Municipality, 0-9% is sloping surfaces and 9-25% is made out of hills and mountains.

The municipality's mission statement is "to provide integrated quality services to all communities through community participation, good governance, efficient administration and local economic development". The municipality's vision is "a unified and effective municipality with sustainable quality of life for all" (Aganang Municipality 2013/14: 55).

According to EnviroXcellence (2009: iii) this local municipality is situated between the

Tropic of Capricorn in the Northern side and 24^0 $00^{'}$ South, also limited by the N1 highway and R521 road on the eastern side with the N11 highway on the western side. The municipality experiences most of its rainfall during the summer season between the months of November and May with dry winters. The average rainfall experienced by the municipality annually is 550mm. The difference in temperatures between Winter and Summer seasons vary between 7-24 degrees Celsius and 26-32 degrees Celsius respectively.

Aganang is rated as one of the smallest economies when comparison is made with all the other local municipalities of the Capricorn district. This local municipality's contributions towards the Gross Domestic Products are: Agriculture-1%, Mining-8.8%, Manufacturing-3,5%, Electricity and Water–3%, Construction–2.9%, Wholesale and retail, catering & accommodation–10.8%, Transport and communication–8.5%, Finance and business–15.9%, community, social and other personal services–5.4%, General Government services–40.3%. The municipality experienced an annual economic growth rate between 1995–2004 averaging 3.1% with a slight decline of 2.5% between 2005 and 2006 (EnviroXcellence 2009: iii).

The majority of the population is poor and unemployed with free basic services such as water and electricity as their means of survival. Unemployment rate is at 60%, no income earners stands at 25.6% of the total population and those living below the poverty line (under R1300 per month) are 30.7% of the population. Primary and secondary schools match the population but there is no tertiary institution. Provision of basic needs such as water, sanitation, electricity and additional classrooms at schools are still a challenge to the municipality. There is only one hospital serving the entire municipal area with twelve clinics which are closer to the users (EnviroXcellence 2009: iii).

The level of sanitation is below the Reconstruction and Development Programme (RDP), 1.4% of the communities uses flush toilets and septic tanks, 77% pit latrines, 20% have absolutely no sanitation. Electrification of the villages stands at 93.5%. The municipality is proud of itself with good road networks be it primary and secondary roads. There is a

balance of 574 kilometres of gravel roads which still need tarring and are in poor condition (EnviroXcellence 2009: iii-iv).

The municipality has different types of vegetation categorised by mixed Makhado bushveld, Arid sweet veld in minor portions, Mamabolo Mountain Bushveld surrounding Mogoshi mountains in Matlala; including Polokwane plateau grassland vegetation. The types of trees found are Acacia species (A caffra, A erioloba, A karoo), Marula trees, Terminalis species, and Euphorbia ingens. There is sensitive vegetation such as Mamabolo Mountain Bushveld. Environmental sensitivity revealed that 80% of Aganang is under the classification of low to moderate sensitivity and 20% is highly sensitive (EnviroXcellence 2009: iv).

1.3 Rationale of the study

The study is triggered by the complaints of the communities affected by the delay on repairs and maintenance on leaking pipes, broken machines, broken pumps, leaking valves, stolen cables and electrical transformers and other waterborne infrastructure of Aganang Municipality. These non-repairs of water infrastructure and water interruption challenges leave the communities without water for longer than a week; this is said from the point of view as a resident in the area.

This obliges some people to fetch dirty water from rivers, springs and wells, whereas others are buying water of the same quality from members of the community. According to the CSIR (2006: 2), numerous shortfalls in the maintenance of municipal infrastructure were experienced in the country. However, it also highlighted a significant success in the improvement of restoration and maintenance in some municipalities around the country. In addition, Whelton *et al.* (2007: 64) argue that changes in visual appearance of water i.e. colour, clarity, taste and odour represent the main source of complaints around the quality of water.

The quality of water entering the water reticulation system is the most important

performance indicator of the water treatment plants, and these standards are laid down by the SABS 241-2001 “Drinking water” (CSIR 2006: 4). Water shortages had been highly mentioned in many discussions wherein conclusions were reached, but the country still needs to have a sense of urgency when it comes to the repair and maintenance of water infrastructure in rural communities.

Sapa (2012) contends that in Lebowakgomo Zone A, residents complained that the water pipes and connections had fallen into a state of disrepair and as such water consumption had become very difficult. In a court case between South African National Civic Organisation versus Capricorn District Municipality and Lepelle-Nkumpi Local Municipality, the North Gauteng High Court in Pretoria ordered the two municipalities to replace and repair all leaking water pipes and defective water meters in Lebowakgomo Zone A within a year (Sapa 2012).

In rural areas, there are many streets where water is just flowing in the open without repairs. In his State of the Nation address Zuma (2013), the President of the Republic of South Africa contends that the National Development Plan is a roadmap to a South Africa where all South Africans will have water, electricity, sanitation, jobs, housing, public transport, adequate nutrition, education, social protection, quality healthcare, recreation and a clean environment.

1.4 Context of the research

Many water related problems including the leaking water pipes and water being sold illegally to community members were brought to and discussed in community meetings. The conclusions of these meetings are reported on regular basis by the municipality but officials take a long time to attend to these issues. Communities are getting water in the street sections, some of whom have to wait till midnight just to get clean running water. Many channels of reporting any illegal acts against the infrastructure should be opened to the communities for ease of reporting. These channels may, amongst others, include toll free telephone lines, offices located within communities operating 24 hours, two way

radios, and free short message services and so on.

Whenever the Integrated Development Planning (IDP) is drawn up, the community must take the centre stage because there are issues directly involving them. Mukwevho and Mtapuri (2014: 45) highlight that IDP was introduced by the South African government in 1998 to help municipalities and its citizens to plan ahead for new good long-term developments. Modisha (2013: 10) concurs with community involvement on policy formulation and feedback on their successes, augmenting public accountability and reinstatement of trust and acceptability in the system of local governance.

A well-designed water distribution network should be affordable with provision of minimum pipe sizes for the current demand and be considerate of population growth and extensions of settlements (Roodie cited in Muinamia 2015: 14). The influx of people coming to reside in the villages which have some basic socio-economic facilities make it impracticable for the existing storage facilities to cope with the demand, because of the population increase and a substantial number of the elderly who cannot walk for long distances to fetch water for their day-to-day activities. It is indeed reported by Mukhuhlani and Nyamupingidza (2014: 144). They assert that the challenges of lack of access to clean water affected women more negatively than men because women are forced to walk long distances to search for water in addition to other responsibilities in the households. Communities are receiving running water according to timetables regardless of their needs. This “water-shedding” constrains people to alter activities of their daily routines to accommodate water-shedding schedules (Mukhuhlani and Nyamupingidza 2014: 146). This is done because water is a very important resource and people and other living creatures’ lives depend on it for their sustainability (Jain 2011: 215).

There are interferences by community members in establishing their own illegal connections thereby disrupting water supply due to leaks and other related problems (Holliday 2012: 29-30). The local authority is failing to engage communities on the negative impacts of unattended leaking pipes or any other property related to water infrastructure. In a warning to individuals who damage the property, President Zuma (2013:12) in his State

of the Nation Address reiterated that, “it is unacceptable when people’s rights are violated by perpetrators of violent actions, such as damage to property and the destruction of valuable public infrastructure”.

There is no report back to the communities, as to what happens to the criminals who are alleged to have stolen electric cables, water pumps, electrical transformers and so on, and as a result of such actions, there are water supply interruptions. Whose responsibility is it between the Local or District Municipalities and Department of Water Affairs and Forestry when there are issues of water interruptions and lack of repairs to infrastructure? This research will answer these important questions and will also investigate the outcomes of deliberate actions of the communities which destroy water infrastructure and the far-reaching results of these actions given the time it takes to report the damages until they are repaired.

Rural areas are usually the ones that are hard hit by most of the water related challenges. Mothetha, Nkuna and Mema (2013) outline that the reason behind the majority of South African rural areas finding it challenging to access water services is because they cannot afford the services rendered by their municipalities. Schreiner, Tapela and Van Koppen (2010: 1) confirm that there is a challenge in the supply and limited access to water by a large number of rural communities. People finally resort to illegal connections and high consumption levels because of the dissatisfaction in their needs with regards to access to water (Cousins and Smits 2005: 2). Furthermore it is acknowledged that there are sources of water and infrastructure in many rural communities, the challenge becomes maintenance which is not attended to (Mothetha, Nkuna and Mema 2013).

1.5 Research problem, aims and objectives

1.5.1 Research problem

A problem is defined as a situation where there is lack of continuation between the tangible and the anticipated ultimate results (Business Studies Unit 2013: 24). The research

problem includes the delay of much needed repair and/ or maintenance of burst pipes and water cut-offs; lack of legal and administrative actions to deal with illegal water connections, and stolen water infrastructure and vandalism in the Aganang Municipality. In fact, it became the norm that more than a trimester passes by without any repair is made to water pipe breakdowns and leakages, stolen cables and electrical transformers are reported. In addition, one hardly ever hears that a criminal had been arrested for stealing these infrastructures. This in turn forces the communities to live in dire conditions related to a water shortage. These deliberate actions of disruption or destruction of water infrastructure has major negative effects on the economy and environment; it creates political and social chaos, and also causes mass illness and even death (Tularam and Properjohn 2011: 284).

Matji (2003: 23) states that there are however best practices and guidelines for the operation and maintenance of water supply systems. These consist of the following:

- Unauthorised water connections must be monitored and be reduced;
- Water supply systems need to be equipped with the latest technology;
- All the water tariffs must be agreed upon with the communities and must include the Operation and Maintenance;
- Operation and Maintenance of the schemes must be done with the involvement of water committees;
- Communication mechanisms amongst all the stakeholders must be effective;
- The project life cycle must be with the involvement of the communities;

Maintenance of the water infrastructure must be the key aspect incorporated into the planning of any municipality which intends serving the interests of the people. Political heads, municipal managers and other officials need education about serving the people's interests and maintaining the infrastructure which is planned to operate longer. Buthelezi (2012:1) shares the same view that the schemes in rural areas are fully working, however particular attention is required on aspects such as operation and maintenance and regular review by management to suit at least the minimum Reconstruction and Development standards (RDP). In order for the infrastructure to operate for the life span that it is

designed for, consideration of maintenance must be the key. Water leaks in particular must be given high priority when maintenance plans are drawn up and be allocated the budget it deserves. Cousins, Smits and Chauke (2007: 1) share their opinion about the poorly designed infrastructure, operation and maintenance as factors contributing towards recurring breakdowns and as such resulting in an untrustworthy supply.

1.5.2 Aims of the study

The study's aim is three-fold. The study firstly intends to explore the challenges of repairs and maintenance of water infrastructure and other related issues in the Aganang Municipality, from the perspective of stakeholders with the intention of improving the standard of living of people of this geographical location. Secondly, this research will explore better mechanisms that can be used in the reporting of the broken water pipes and other water infrastructure related issues, to reduce the waiting periods between reporting and repairs. Thirdly and lastly, the study will investigate the possibilities of creating awareness for both the municipality staff and community beneficiaries of water infrastructure with the intention of creating community ownership and preventing vandalism of much needed water infrastructure.

1.5.3 Objectives of the study

The objectives of this dissertation include the following:

- To investigate what generally hinders the repairs and maintenance; and what triggers vandalism and stealing of water infrastructure in the Aganang Municipality;
- To investigate the better mechanisms to be applied in curbing the problem of stolen electrical cables, generators, submersible pumps, transformers and other water infrastructure related connections;
- To define mechanisms which could reduce the delay between reporting time and actual repair and maintenance of water infrastructure related problems.

1.5.4. The Research questions

The main research questions are:

- What are the challenges that Aganang Municipality encounters in repairing and doing maintenance of water infrastructure?
- What solution could be appropriate in ensuring that the time taken to report burst pipes, stolen, vandalised or damaged infrastructure is reduced?
- How would the Aganang Municipality (government officials) and other stakeholders address these challenges?
- Why are the perpetrators of these recurring criminal activities like theft and vandalism to water infrastructure not brought to justice?
- What proposal can anyone suggest to make sure that the water infrastructure is protected from the effects of theft and vandalism?

1.6 Definition of key terminologies

Aeration – is a procedure whereby intimate contact of liquid with air is expedited, for example by bubbling air through the liquid, by passing the liquid over a waterfall or by spraying the liquid through the air (Povey and Kwezi V3 Engineers 2009: 38).

Auditor General – is an office established by the Constitution of the Republic of South Africa, 1996-Chapter2: Bill of Rights [Act No.108 of 1996] and is one of the Chapter nine institutions aimed at supporting democracy (Auditor-General, South Africa: 2016).

Catchment Area – De la Harpe and Ramsden (1999: 15) define a catchment area as the land area from which rainfall will drain into the watercourse, by means of surface flow (river as an example) to a collective point.

Conservancy tank – is a covered tank used to receive and retain sewage requiring draining at intervals (SABS 2015: 6).

District Municipality – is a municipality that has the executive and legislative authority in

the area that includes more than one Municipality as described in Section 155 (1)(c) of the Constitution of South Africa as a category C Municipality (South Africa 1996: 75).

Flocculation – is the binding together of fine elements in water by gently mixing after the addition of coagulant chemicals to form larger flocs (Povey and Kwezi V3 Engineers 2009: 39).

French drain – is a trench filled with suitable material used to dispose of liquid overflow from a septic tank or waste water (SABS 2015: 7).

Infrastructure – is defined as engineering services such as the facilities of water supply, removal of sewage and so on (Povey and Kwezi V3 Engineers 2009: 40).

Integrated Development Planning (IDP) – is a constituted super plan for an area that gives an overall background for development (Capricorn District Municipality 2013/14: 10).

Local Municipality – is a category B municipality sharing the executive and legislative authority in its area with a category C municipality within its areas of jurisdiction as described in Section 155 (1) (b) of the Constitution of South Africa (South Africa 1996: 75).

Pit latrine – is a type of a toilet used for the disposal of human excreta that requires no water for flushing.

Sedimentation – is a process of settlement experienced by solid particles from the water under treatment (Povey and Kwezi V3 Engineers 2009: 41).

Septic tank – is a tank intended to receive sewage and to preserve it for a period in a manner of securing sufficient decomposition (SABS 2015: 10).

Sewage – is waste water, soil water, industrial effluent and other liquid waste flowing separately or combined, excluding storm water (SABS 2015: 10).

Tribal Authority – also known as Traditional Authority is an authority observing a system of customary law and to exercise powers and perform functions conferred upon it in terms of indigenous law, customs and statutory law, with its powers and functions incorporating the administration of communal land (Ntsebeza 2004: 78).

Water Service Authority – refers to any municipality or rural council as defined in the Local Government Transition Act, 1993 [Act No. 209 of 1993], responsible for ensuring access to water services (Capricorn District Municipality 2013/14).

Water Service Provider – means any person who provides water to consumers or to another water service institution but does not include a water service intermediary (Capricorn District Municipality 2013/14: Table 20).

Water shedding – is a process of shutting off the water supply in sections or completely and restored after the period agreed upon.

White Paper – is a provisional report presented by government outlining information or suggestion of a certain issue.

1.7 Organisation/ structure of the thesis

Chapter 1 presents the introduction to this dissertation with factual arguments about the study on; challenges of the repairs and maintenance of water infrastructure, a brief highlight with description of people's feelings and experiences that they are faced with on a daily basis.

Chapter 2 brings the literature review i.e. all the relevant sources consulted will be outlined in this chapter.

Chapter 3 outlines the research methodology. A Qualitative method will be employed using structured interviews whereas quantitative methodology will be used to assess the views of the participants around the challenges of repairs and maintenance of water infrastructure.

Chapter 4 deals with the data analysis of important aspects not leaving behind the views of other authors; agreements and disagreements will also be noted.

Chapter 5 deals with the discussion of the research findings.

Chapter 6 is related to the summary of key findings, recommendations and conclusions.

1.8. Conclusion

Executions of certain municipal functions require people who are experienced in order for the work to proceed professionally and smoothly. Repairs and maintenances of municipal water infrastructure are specialised functions that require certain skills. It remains the prerogative of the senior municipal staff to recruit suitable staff into positions, in order for municipal services to be rendered to communities with fewer or no complaints. The new style of doing things is also another factor to be considered, as this may be another hindrance to service delivery. Staffs need to be motivated and be taught adaptability to new technologies and new ways in which things are done so that work can progress for the benefit of the community.

Water interruption as a result of illegal actions is a great drawback for any municipality as it angers the community because they suffer the results. Whatever happens to the water infrastructure in the municipality, be it vandalism, breakages, blockages and so on, go back to the end users in terms of cost of repairs, setbacks suffered during interruption and so on. The challenge faced by Aganang Municipality in terms of repairs and maintenance of the infrastructure may be a thing of the past if there is cooperation between the community, municipal staff and the police. The cooperation required is in the form of communication between the three and all other stakeholders.

Communities within municipalities are the best indicators of good or bad service delivery, however, the complaints they raise need good ears to listen. Complaints from the community need to be attended to swiftly because the municipality also depends on its community for sustainability. Wherever the service is poor the community is always dragging their feet to pay for services. Communities should also be involved as role players for the protection of municipal infrastructure against theft, vandalism, illegal handling and so on. It should be borne in mind that these infrastructures are within communities before they are with municipal employees.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This literature review intends to achieve three main objectives. It firstly looks at different arguments that explain the challenges of repairs and maintenance of water infrastructure. Secondly, the literature review links these arguments to international agreements, such as the Sustainable Development Goals, and local national legislations, including the National Water Act No 36 of 1998 and subsequent reforms, which reinforce in different ways access to clean water at the community level. Thirdly, the literature presents some of the consequences of both a lack of and inadequate provision of clean water to residents in some countries and the Aganang Municipality.

According to Grimsey *et al.* (2002: 108), investment in infrastructure is believed to offer "basic services to industry and households", "key inputs into the economy", and "a crucial input to economic activity and growth", even though what is "basic", "key" and "crucial" differ from country to country and from one period to another. This chapter will also investigate the impacts of delays of repairs and maintenance on the affected communities of the Aganang Municipality and some beneficiaries' reactions.

The argument in this chapter is, the provision of clean water is a human right and a critical service which need to be delivered to the people of Aganang Municipality and South Africa at large. Inefficient, or a lack of, access to clean water represents therefore one of biggest challenges of municipalities across South Africa in the post-apartheid epoch. This problem results from inefficient management of both human and financial resources which should monitor and take preventive actions, to deal with water infrastructure rather than taking reactive mechanisms when the system does not function.

This literature review has eight sections. Section one is the introduction. Section two represents the main theoretical arguments which support this research. Section three refers to the challenges of access to clean water. Section four brings international treaties and national legislations which reinforce access to water. Section six examines the problems of repairs and maintenance of water infrastructure. Section seven looks at the challenges of water infrastructure. Section eight concludes this chapter.

2.2 Theoretical underpinnings of the research

This research is based on the system theory, agency theory, and project management theory to understand the topic that is being investigated.

2.2.1 System theory

The system theory is relevant to repairs and maintenance since the researcher looks at water infrastructure as a system, a whole rather than a sum of different independent units. As a result, any change, positive or otherwise, or any dysfunctionality in one of the components of the whole – e.g. pipes, pumping machines, ball valves, social, political, technical – of its components affects the entire system of water production, transportation, and distribution to consumers (Mele, Pels and Polese 2010: 127). This is so because there are continuous interactions and relationships between the various parts of the water infrastructure system. A water leak or burst pipe in one segment of the system affects the provision of water in that particular community and by extension the entire system through pressure drop, the quality and quantity of water etc. The leaderships of water infrastructure management at different levels of responsibility and components of the system are encouraged to look at and plan their activities accordingly to motivate the employees for a maximum efficiency and effectiveness of service delivery in this sector (Mullins 2010). This approach is important because this sector remains characterised by endemic problems of lack of capacity, cost overruns, slow or absence of service delivery.

2.2.2 Agency theory

The agency theory is handy in this research since it deals with diverging and sometimes conflict interests, risks, and goals between the worker and the management. Differing goals and risks to achieve them dictate their behaviour in the decision-making processes and implementation of the vision and policies of the company they are working for and so lead to unintended consequences. In fact, Eisenhardt (1989a: 59-60) states, the agency theory deals with the risks that individuals face and subsequent attitudes they display when they have different interests and goals.

The agency theory is preoccupied by two critical issues. The first set of problems compromises those which arise in the agency relationship between the manager and the employee with uneven access to information. Indeed, there is on one hand the manager. He/she represents the company and is aware of both the policies and implementation processes of different tasks to achieve optimum results. On the other hand, there is the employee with limited or no access to vital information around the past, present and future of the company. The manager delegates work to the employee who performs the allocated task. Manager and employee are rational agents who take different actions to achieve their individual objectives within the system they are involved in. Some members of the staff may perform their duties as prescribed in their contracts; others may be interested in corrupt practices for personal gain. The second set of issues is related to the most effective contractual agreement between the two individuals because their relationship is bound by the contract. This aspect of their relationship needs attention because they are both rational individuals driven by self-interest and risk aversion. The institution they are involved in may have various goals for these individuals and they have unequal access to information. This picture is important in the water sector characterised by cost overruns, delivery delays and corruption.

2.2.3 Project management[2] theory

This research considers water infrastructure schemes as projects with six phases of project management: the initiation phase, definition phase, design phase, development phase, implementation phase and follow-up phase (Baars 2006). So a water infrastructure should be run like a project for practical reasons since these phases optimise the possibilities of success of the water infrastructure. It is easier to identify problems in a segment or phase of the project than investigating the causes of failure of the water infrastructure in the entire system. Koskela and Howell (2002) identify two theories within the project management theory: the theory of project and the theory of management despite some weaknesses of this theory. The study will elaborate on these sub-theories later.

Koskela and Howell (2002) insist that the project theory is based on the "*raison d'être* of project management". The space of management implies that a satisfactory quantity of work is done; uneconomical work is not done to prevent wasteful expenditure; and the work that is done provides the stated trade purpose. In other words, the project management intends to manage work through conceptualisation. Work can be achieved by breaking down the total work effort into smaller manageable pieces of work or activities. In the context of this research, repairs and maintenance of water infrastructure could be broken down into smaller activities such as involvement of beneficiaries, regular surveillance and reporting structures, a standby team for rapid intervention wherever the need arises. As for the theory of management, it includes the concept of planning. The planning processes are articulated around essential processes (scope planning, scope definition, activity definition, resource planning, activity sequencing, activity duration estimating, cost estimating, schedule development, cost budgeting and project plan development). The theory of project management includes also the concept of controlling. The latter is framed around performance reporting and overall change control. Whilst essential sections are recommended for the performing

[2] "Management is the art, or science, of achieving goals through people … management can be interpreted to mean literally "looking over" – i.e., making sure people do what they are supposed to do. Managers are, therefore, expected to ensure greater productivity or, using the current jargon, 'continuous improvement" (Olum 2004: 2).

processes based on the former, changes are prescribed for planning processes based on the latter. Insufficient repairs and shortcomings in the maintenance of water infrastructure and thus lower productivity are attributed to poor supervision and a lack of competent and visionary managers.

2.3 The challenges of access to clean water for human consumption in the world

This section explores the problems of provision of clean water at both the international and South African levels.

2.3.1 International experiences

Globally, Howard (2011: 123) confirms that over a billion people lack access to clean drinking water, while the average person consumes at least twenty-six gallons of water on daily basis for survival and satisfaction of health needs, with a death rate of over 5 million people annually as a result of water related illnesses. It is evident that water should be taken care of; whenever water leaks are detected people must try to make sure that they get attended to as a matter of urgency. Any water contaminant elements must swiftly be reported to curb the threat on the lives of humans, birds, animals and trees from being exposed to danger. A contract with a private company City Water to supply water to Dar es Salaam between 2003 and 2005 was prematurely terminated because of (a) the slow progress of addressing water shortages, (b) revenue collection declined dismally and (c) illegal connections (Schouten and Buyi 2010: 434).

In a study on access to water in India, Pakistan and Sri Lanka, Sohail, Cavill and Cotton (2005: 2) reveal that these countries introduced options of community-based approaches for the operation and maintenance of their water infrastructure. There was also a service user encouragement internationally as a way of making sure that the neighbourhood infrastructure is kept in a respectable condition. The reason behind the initiative of involvement of service users was to boost increased efficiency, benchmarking, promoting awareness, national growth contribution, wastage reduction, upgrading the allocation of resources and improving competitiveness. This was done

because it was recognised that neither of the two, the community and government, could operate alone in sustaining the infrastructure, the latter required the partnership. The most important indicator of citizens' contentment with urban services is the operation and maintenance which eventually informs better governance. Municipalities are tasked to take the centre stage with regards to the centralised systems of operation and maintenance but there is no delivery.

Yet, in India, Muller (2007: 43) argues that there is a widespread resistance against dams and the utilisation of water by international businesses like Coca Cola accused of consuming extreme quantities of water at the expense of rural community farming and domestic consumption. Indeed, dams for both irrigation and generation of hydropower occurred with dispossession of local communities of their land and water and exclusion of these communities from having access to these natural resources. In addition, the multinational corporations are also accused of depleting the water table where there are no dam schemes. This research also reveals that Karachi, in Pakistan, experienced a failure in water supply services after the completion of the utility- and community driven water supply project. The anticipated reimbursements have never yielded good results and that resulted in wasteful investment. Sohail, Cavill and Cotton (2005: 2) point in the same direction arguing that service delivery constraints are not only the problem faced by the developing countries. The delivery of clean water and other services to disadvantaged communities is an international problem. It is caused by the lack of resources in the public sector, poor management, inefficiency and accountability eventually resulting in insufficient services. Developed countries such as the USA have their share of these challenges. Indeed, according to Schnoor (2016: 581), in Flint, Michigan, drinking water was contaminated with lead and other pollutant agents and the entire supply exposed the health of children to danger. Flint's population complained about smelly water from taps with the suspicious appearance of red, yellow and brown colours with rusty deposits. A study conducted by Misra and Malhotra (2011: 23) in the New Delhi region revealed that, the possibility of continuous water supply depends on the water supply networks' improvement, water supply auditing, water conservation education to the communities, rainwater harvesting, and the construction of underground reservoirs in different places for uninterrupted and proper distribution.

Buthelezi's (2012: 18) research on the access to potable water in the Sub-Saharan African region revealed that a potable water supply in rural areas accuses a decline at the level of sustainability due to unsuitable legislation or guiding principles, unmanageable financing mechanisms, lack of technical capacity and background, inadequate organisational support, and fruitless management systems. The extraordinary records of limited access to safe drinking water concealed the disproportions amongst the rural and urban settlements of the sub-Saharan region (Chisenga 2014: 3). In Uganda, Mugisha (2007: 2-3) revealed that the National Water and Sewerage Corporation, a public entity, wholly owned by the Ugandan government, experienced several problems of an inefficient workforce with roles that conflicted. As a result, more than 50 percent of water was unaccounted for; poor customer care; low collection efficiency in the region of 71%; high debts with age analysis of 14 months and corrupt field staff. A lack of access to clean water has resulted in the outbreak of Urogenital Schistosomiasis, diarrhoea, cholera and typhoid as a result of using river water which was contaminated with sewage and agricultural effluent in the Asamama community in Ghana (Kosinski *et al.* 2016: 5). This is so because only 38% of Ghanaian households have access to water for human consumption through springs, rivers and wells which are considered to be unprotected sources (Whittington *et al.* 2009: 705).

2.3.2 South African experience

Many South African communities are still living in areas where access to clean water remains a challenge. They face, among other problems, a longer waiting time in long queues; walking or travelling long distances; waiting for water at night when numerous consumer's taps are closed is then that water can reach other areas; and simply buying water from other community members conveying water with donkey carts. These challenges result from a number of factors including the broken pipes and machines, a lack of maintenance, a long waiting period for repairs and maintenance, deliberate actions of vandalism and water contamination to name a few. This issue occurs despite Section 152 (1) (b) of the Constitution of the Republic of South Africa, 1996 [Act No. 108 of 1996] which recommends local government to ensure the rendering of services to the communities in a sustainable manner (South Africa 1996: 74).

The provision of water to the communities and the suggestion of the installation of water treatment facilities intend to overcome waterborne diseases such as cholera, typhoid and nagana. The water pipes installed for the Aganang municipality communities in the streets, apart from vandalism, are forever leaking without being fixed. The water supply interruptions, leaking pipes, vandalism and illegal water connections, fluctuation of water flows, the absence of water in same communities, endemic water supply backlog combined with inefficient water operators, a lack of maintenance, and communication breakdown between municipal officials are detrimental to the survival of the municipality (Dau 2010: 17; Mothetha, Nkuna and Mema 2013). Aganang Municipality is one of the driest regions with low sporadic rainfall patterns affecting availability of water sources (Capricorn District Municipality 2015). Most water schemes in this area rely heavily on underground water and that is not sustainable (Howard 2011: 123). Water shortage is worsened by the problem of illegal connections in every village and these connections are done by people who do not have the technical skills of connecting water pipes. A study conducted by EnviroXcellence (2009: 125) in 2009 supports these claims. Furthermore, vandalism contributes to serious waste and limits lawful use.

However, Hlokwa la Tsela (2016) and Bila (2013: 2016) reveal that local communities engage in illegal water connections as a sign of protest when there are water interruptions by the municipality. When the water is restored the pipes start leaking because the broken pipes were not repaired or installed correctly. These challenges are not unique to this municipality. The community of Dilaeneng village in the Bochum area under Blouberg Municipality which is sharing borders with the Aganang municipality faces the same problems of water shortages, interruptions and water shedding. In the latter municipality, some community members use their social grants money to purchase water from private borehole owners.

Holliday (2012: 28) confirms that the turbidity, colour, iron and manganese elements in the majority of boreholes in Enkanyezini and Kwangwanase rural water supply projects at Manguzi near Kosi Bay fell within classes 2 or 3, which according to the Department of Water Affairs and Forestry's standards for drinking water is marginal-to-poor quality. Similarly, Craun *et al.* (2001: 230) warn about the investigation of the outbreaks in which

mention is made that there are issues which investigators have to consider, amongst others are recognition of the source of water, the difference in consumption habits of children, the aged, the immune compromised persons, and other types of people. In addition, it takes a lot of time between the outbreaks' recognition and the start of an investigation, which is lengthy. After recognition of the outbreaks which normally takes days or even weeks since the contamination of water took place, there may be additional time delay as a result of;

- the patient's visit to health care provider of their choice;
- the different tests conducted on the patient, referred to the physician and diagnosis made;
- reports handed to health officials after diagnosis and laboratory findings are obtained;
- reports review by health officials.

2.4 International treaties and national policies on access to water

The challenges of access to clean water motivates the United Nations and national governments to formulate policies and ratify treaties which intend to speed up access to clean water around the world with quantifiable deliverables, and monitory and evaluation mechanisms.

2.4.1 Sustainable Development Goals

Moran *et al*. (2008: 470-471) defines Sustainable Development Goals (SDGs), like the Millennium Development Goals which came before, as a representation of a commitment to human well-being advancement, with the added limitation that this development requires to take place within the ecological limits of the biosphere. SDGs were adopted by the United Nations and by extension all countries as a clear policy goal, however in 2003 the survey conducted in 93 countries revealed that only one country met the minimum requirements. These goals are linked to access to national policies and international guidelines on access to clean water and the need for the repairs and maintenance of water infrastructure since SDG 3 "sustainable water

security" emphasises that water is a source of life. It must therefore be secured for sustainability. Water infrastructure needs to be repaired and maintained so that it does not halt supply. Similarly, SDG 1 "thriving lives and livelihoods" for example cannot sustainably happen without provision of clean water to all; SDG 2 "sustainable food security" needs water for irrigation, and for crops to grow; SDG 4 "universal clean energy" is relevant to water through from the source or water reservoir to different consumers both humans and non-humans. SDG 5 "sustainable ecosystems" reminds of the dependency between plants and animals, and between animals and humans to supply them with water, and animals supply humans with milk, meat, wool, and so forth. SDG 6 "governance for sustainable societies" requires good governance of both financial and human resources necessary for water infrastructure and service delivery.

2.4.2 The National Water Act No. 36 of 1998

According to the RSA (1998) and Letsoalo (2012: 19), the National Government is responsible and has full authority over the management of water resources, as well as equal distribution and beneficial utilisation of water for the public. The use of water is only allowed on condition that it conforms to the provisions of this Act. The act serves as a regulatory legislation for consumption, storage, activities in an effort to reduce flow of streams, wasteful discharges and disposals. Water is rare and is not evenly circulated but is a national resource belonging to all individuals, who were previously prohibited by the inequitable injustices of the past and were not allowed equal access and use of water. National policies on access to and international guidelines and treaties on access to water do not necessarily translate into access to water in South Africa. As a result, reforms and amendments are introduced to address these shortcomings.

2.5 Water Allocation Reform and challenges of access to water in South Africa

National government introduced the Free Basic Water Policy in 2001. This policy recommends the government to provide 25 litres per day to each person or 6000 litres of water per month due to the water crisis (Bessa *et al.* 2014: 151). The Act requires the

cost of this service to be covered through cross-subsidisation. The idea here is to cover the cost of poor consumers by the wealthy who usually consume and sometimes waste enormous quantity of water within municipalities, with the intention of addressing the legacy of apartheid and inequalities of the past through the Sections 24 and 27 of the Bills of Rights of the 1996 Constitution [Act No. 108 of 1996], the Water Law Review Process which replaced the "White Paper on National Water Policy for South Africa of 1997, and the promulgation of National Water Act in August 1998 [Act No. 36 of 1998], and the 2004 National Water Resource Strategy (Muller 2007: 36). Yet, these legislations have not brought satisfaction to the beneficiaries from poor background, as the next section will illustrate.

2.5.1 Service delivery protestations

South African municipalities have been characterised by endemic protests around poor or a lack of service delivery across the country because of three principal reasons. First, municipalities are either inefficient or dysfunctional, or both, to provide the basic services including water and sanitation to the public (Bretteny and Sharp 2016: 11; De Wet *et al.* 2015: 61). These challenges could be addressed through proper allocation of resources at the national and local government levels especially in rural areas (Bretteny and Sharp 2016: 18). Second, the culture of non-payment of services rendered including potable water supply systems, bulk electricity supply, domestic waste-water and sewage systems, municipal roads, firefighting services and municipal health services (Thornhill 2006: 318; Maloba, 2008: 13). Inability of municipalities to set development priorities and allocate efficiently and spend funds constrains some municipalities to give back their annual budgets to the national treasury. Alexander (2010: 25, 29) attributes this situation to "a pervasive sense that the state disrespects people by lying to people at election times and by failing to listen to them at other times". He warns that sustained local protests around the basic services may lead to the rebellion of poor people against the existing structures if the dissatisfaction of the poor is not attended to. Dau (2010: 14) slightly disagrees with the previous author arguing that there has been a considerable improvement of service delivery in many urban and

formal townships and emphasises that political conflicts are the ones that incite protests.

Thirdly, Moitsi (2015) argues that the delivery of services is also negatively impacted by labour unrests which occur across the province with a particular focus in the following municipalities: Blouberg, Aganang, Mogalakwena, Vhembe, Thulamela, Mutale, and Greater Tzaneen. They are also familiar in the Mopani District (Moitsi 2015). Service delivery protests do not represent a new phenomenon. They have their origins in the apartheid era to highlight the plight of individuals who were denied their humanity and livelihoods since the early 1990s when they led to the emergence of social movements (Alexander 2010: 25; Hanyane *et al.* 2015: 241; Manala 2013: 519-520; Whittington *et al.* 2009: 698). The reason South African citizens resort to violent protests is because of "municipal ineffectiveness in service delivery; poor responsiveness of municipalities to citizens' grievances, and a conspicuous consumption entailed by a culture of self-enrichment on the part of councillors and staff". (Atkinson 2007: 53 cited in De Wet 2015: 61).

In the villages where people cannot not afford to buy water from rural borehole owners, they resort to fetching water from rivers, wells and springs and these sources are not treated and may be harmful for human consumption. This water may cause the outbreak of waterborne diseases which affect more children than adults if the sources are not protected (Mothetha, Nkuna and Mema 2013; Skinner 2009). Communities are encouraged to harvest rainwater but the use of tank water for irrigation and flushing toilets is wasting water for human consumption (Gardiner 2010: 100; Villarreal *et al.* 2005: 11). Craun *et al.* (2001a: 64) share the same opinion that 619 waterborne diseases outbreaks reported since 1971-1998 were from Community Water Systems (CWSs) and Non-Community Water Systems (NCWSs). Upgrading the observation and recording of the activities can help trace the outbreaks and decrease the time needed to investigate (Frost *et al.* 1996, Rodman *et al.* 1997 cited in Craun *et al.* 2001b:230).
The communities in this municipality depend mostly on boreholes to meet its daily need of water supply. Aganang Municipality (2013: 26) states that the average depth to reach the water in this municipality is in the region of 10 meters to 20 meters in the Northerly

parts, and ranges between 20 meters and 30 meters in the Southerly parts. Communities are still drilling boreholes in almost every village in the municipality. It was reported on Thobela FM (2014) that there is a demand for drilling more than 500 boreholes in Limpopo Province every month, and the borehole company, Bonamanzi, cannot keep up with the demand. Boreholes are rapidly becoming the quickest means of water supply in both urban and rural settlements (Foster *et al.* 2009: 68).

2.6 Repairs and maintenance of the water infrastructure

The significance of project maintenance is being reiterated more often these days, because of project failures as a result of procedural deficiencies (Ngowi 1997: 325). It is therefore vital to encourage the communities to protect and efficiently utilise domestic water infrastructure to reduce the cost of maintenance and to pay for services achieving the twin objectives. It would reduce the cost of water provision. This approach would also present a source of income for the municipalities for further improvement of water provision through purchasing of spare parts and routine and much needed maintenance of the water infrastructure (Tshikolomo 2012b: 12). Maintenance expenditure is extremely important. However, it would require less funds (Foster *et al.* 2009: 28) as compared to taking reaction measures when the system is no longer functional (Graham *et al*. 2007: 2). In Africa the reason for failure of water infrastructure is the lack of maintenance (Skinner 2009:1).

Previous research on delay of repairs and maintenance elsewhere attributes the failure of water systems to blocked or burst pipes, vandalism, poor design and construction, and weak water sources (Phillips 2007: 243). In addition, there are challenges of materials and equipment that do not arrive on time at the projects. This leads to poor planning as well as a lack of understanding of project management techniques and subsequent projects' failure (Burke 2010: 279). The role of project management is also emphasised by Cleland and Ireland (2007: 295) who postulate that in an organisation, project managers play a critical role in terms of planning. Maintenance is one of the key

aspects to keep the smooth running of the infrastructure, and to keep the environment clean from the effects of leaking pipes and contaminated water.

In the USA, the Association of Metropolitan Water Architects (Gartner *et al.* 2014: 314) states that the operations and maintenance costs of the drinking water and waste water infrastructure is estimated to be $448-944 billion in the year 2050 in order to bring it under proper control of the effects of climate change. The USA Environmental Protection Agency (USEPA 2008, 2009 cited in Vedachalam *et al.* 2015: 1) reveals an estimated amount of $300 billion for capital improvements required in each of the drinking water and wastewater infrastructure for the next 20 years in order for them to keep up with the current standards.

The challenges of water infrastructure do not affect the provision of water to households only in terms of pressure drops, insufficient provision of water for domestic consumption and industrial use, or a lack of access to clean water. They also have a negative effect on other sectors of the economy as well. These include roads through road closures, flooding and damage to property, sinkholes, and school interruptions to list just a few (Vedachalam *et al.* 2015: 1).

Government officials in charge of repair and maintenance of water infrastructure need to consider also the life span of the infrastructure – estimated to be 80 years (Lienert *et al.* 2014: 109) – to replace it at different stages. Otherwise, they may be constrained to face the terminal replacement of pipes, boreholes, shut off valves, electrical transformers, and several other components of water supply infrastructure. In the same vein, Baird (2010: 74) argues that the longer the installed water infrastructure is used, the more the vulnerability of it to fail, these failures are attributable to the following reasons: the age of infrastructure, the designs which are inadequate, and the poor installation of infrastructure. In other words, aging water infrastructure is very expensive to repair and maintain after being unused for a long period of time as illustrated below.

Figure 1: Dilapidated Steel water tower being dismantled in Lephalale Municipality after 20 years without being used (Kruger 2016: 13).

Repair and maintenance of water infrastructure is critical in the Waterberg District Municipality due to water losses through leaks and continuous replacement of breaking asbestos pipes which represent a health hazard (Lephalale Municipality 2016: 4). The municipality is also developing a reliable implementation plan in an effort to manage water losses. This plan would work better if recommended to Aganang Municipality for managing their water loss. The plan for upgrading the water infrastructure is also looking into doubling the capacity of the current installation. The refurbishment will interrupt the supply of water to the communities of Onverwacht, Lephalale Town, Marapong and extend to the rural areas.

The challenges of repair and maintenance are not unique to the Aganang Municipality. Other municipalities in South Africa are also affected. McKensie *et al.* (2012: iii) indicate that according to the information obtained from 132 of a total of 237 South African local

authorities, 75% of the overall volume of municipal water supply indicates that presently the level of Non-Revenue Water in the whole country is predicted at 36.8%. From that amount 25.4% is lost through physical leakage. Targets for water losses reduction were set but there are no hints of tangible losses and how to separate between Physical Leakage (Real Losses) and Commercial Losses (Apparent Losses).

When reporting the water leaks, Ngcukana (2015: 14) indicate that the Nelson Mandela Bay metro's midterm budget and performance report of 2014/15 pointed out that on average 40% of water was lost between July and November 2014 as a result of water leaks. Water leaks are also encountered by Aganang municipality and there seems to be a slow pace in fixing these leaks. Price *et al*. (2012: 12) contend that water leaks represent one of the greatest problems within Nelson Mandela Bay Municipality as well.

The CSIR (2006: 2) concurs that water leaks are the most common problem experienced with water reticulation systems. What is more, there are other reasons which contribute to water leaks. These reasons include the use of incorrect procedures during the installations, excavating closer to the pipes causing damages, the use of inappropriate materials, inappropriate repair procedures, ageing of pipes with illegal connections worsening the situation (CSIR 2006: 5). The most challenging issue above all is the maintenance of the breakdowns of the infrastructure.

Heare (2007: 24) explains the challenges of repair and maintenance of water infrastructure arguing that there are three key issues that water utilities are faced with in the early twenty-first century in formation of infrastructure's "perfect storm" namely (a) the need to substantial reinvestment for the replacement of existing infrastructure to be upheld; (b) the need to expansion and upgrading of the infrastructure, for gains maintenance in public health and environmental protection as agreed in the face of population growth; and (c) the need to make investments for the achievement of the public health and environmental protection the nation seeks.

Hunaidi *et al.* (2004: 1-2) agrees with the previous author. He highlights that the water transmission and distribution networks deteriorate as they age and eventually their

water tightness are no longer the same as during the time of installation. Furthermore, these deteriorations are caused by different reasons which include but are not limited to amongst others, installations in environments surrounded by corrosions, unstable soil conditions, defective construction standards, unstable water pressure, and movement of heavy vehicles causing vibrations. Leakage management should therefore be articulated around four main components: the total quantity of the lost water, leak monitoring mechanism, leak detection and repair, a pressure-monitoring system

2.7 Analysis of the Challenges of Water Infrastructure

This section investigates the issue of water infrastructure at the levels of provision to the communities, treatment of this vital resource or the lack thereof or inadequate purification of water for domestic consumption and other uses.

2.7.1 Provision of water to communities

A country running short of sufficient water supply to satisfy its citizens is water scarce (Tshikolomo *et al.* 2012a: 27). WHO (2011 as cited in Abubakar 2016: 44) stipulates that access to safe drinking water means, when there is a water source, it should be situated not more than one kilometre from home or within thirty minutes walking distance.

Yet, in the year 1994, the safe water provision backlog of access to clean water was estimated at 14 million (35% of the population) with 21 million backlogs on basic sanitation (53% of the population) in South Africa (Matjuda 2010: 25). This rate is important but below the average backlog of rural sub-Saharan Africa, excluding South Africa, estimated at 45% whilst the residents of metropolitan settlements number only 20% (WHO and UNICEF 2009 cited in Chisenga 2014: 3). In a separate research, Rollins *et al.* (1997: 186-187) express their views with regards to the water infrastructure maintenance, renovation and upgrade with two pivotal economic questions namely, what is the cost involved for the achievement of adequate water servicing level?

Because of the decrease in the current expenditure trends from public sources, where to find adequate sources of funds?

Mamakoa, Maponya and Mothetha (2013) outline their findings of the breakdowns of most borehole systems as being the old technology which had exceeded their lifespan. The breakdowns of borehole systems are associated with the insufficient attention given to operation and maintenance. This was revealed in a study that was conducted in the four villages namely Kgotlopong, Dresden, Mailamapitsane and Mukondeni under the District Municipalities of Sekhukhune and Vhembe. Furthermore, the study findings revealed the following challenges:

- other newer systems were also in a bad state;
- getting spares from suppliers by the municipalities was a struggle;
- agreements to guarantee continued supply of spares were never signed with suppliers;
- the new agreements which were now entered into with suppliers of spares were short term;
- planning and budget allocations for day to day operation and maintenance were major challenges faced by the municipalities;
- security requirements for borehole systems;
- insufficient training for borehole operators to cope with the new technological advancements in borehole systems.

Moreover, the study recommended that these non-technical issues required the municipalities' revision of the strategies, with a new approach that takes into cognisance community-based initiatives in rural water supply.

Heare (2007: 24) states that there are three key issues that water utilities are faced with in the early twenty-first century in the formation of infrastructure "perfect storm" ready to disrupt the provision of water to the people of South Africa. These issues include the need to substantial reinvestment for the replacement of existing infrastructure to be upheld; the need to expansion and upgrading of the infrastructure, for gains maintenance in public health and environmental protection as agreed in the face of

population growth; and the need to make investments for the achievement of public health and environmental protection the nation seeks.

South Africa's seven of the nine provinces obtains over 50% of water through inter basin transfers (Grey and Sadoff 2007: 557). Cothren (2013: 17) states that the Parliament of South Africa enacted two laws, and these laws were within the administration of the Department of Water Affairs and Forestry, and this brought the establishment of provisional standards for the supply of water and legal frameworks for the management of water resources which followed the policy guidelines for Reconstruction and Development Programme the acts are: The Water Services Act of 1997 [Act No. 108 of 1997] and the National Water Act of 1998 [Act No. 36 of 1998]. The Water Services Act then gave birth to:

- basic water supply standards;
- tariffs positions;
- cross-subsidies for cost recovery and
- the explicit articulation of the local government's responsibilities as water service authorities and providers. Table 1 below shows the number of villages and households supplied with water and those still outstanding.

These standards are far from improving access to water for the poor in the Aganang Municipality as the table 1 demonstrates.

Table 1: The status of Water provision for the municipality

Villages with yard connections	Villages within RDP standard	Villages below RDP standard	Total served households	Outstanding households
15	43	47	21123	12795

Source: (Aganang Municipality 2014/15: 31)

Aganang Municipalty (2014/15: 45, 47-50) states that in working together with communities after comments of the challenges of developments within their villages

were raised, prioritisation of certain services came into play. The priorities consist of amongst others primary, secondary and other different services with special attention given to wards and villages. The resource allocation is guided by the priorities with reference to Integrated Development Plan/ Budget review cycles from time to time. Having discussed the challenges of repair and maintenance of water infrastructure, the next sub-section explores associated impacts of these challenges on treatment facilities.

2.7.2 Water Treatment Facilities

The Aganang Municipality has two water schemes namely Houtrivier and Mashashane. EnviroXcellence (2009: 74) contends that this municipality relies solely on ground water for domestic use and agriculture. The ground water extraction system is used for pumping water into the water storage facilities, and gravitates back into the reticulation networks without any purification or treatment taking place. Some community storage tanks have sand particles from the underground water. These sand particles are blocking the ball valves in the water tanks from opening and closing. This situation causes some tanks to overflow and in some instances to completely shut off due to lack of sand filters which are parts of the water treatment plant. This poor design increases the need for repair and maintenance of these infrastructures and the risk of waterborne diseases.

2.7.3 Cholera and other waterborne diseases

Sapa (2008) reported that there had been two reported cases of cholera deaths in Limpopo province. Two deaths occurred in Tubatse and an additional 19 cases were reported in Musina and Modimbo. There were also 21 suspected cases of cholera in Botlokwa in Molemole municipality, and 10 confirmed cases in Ga-Matlala in Aganang municipality. Cholera also hit the Vhembe area. The outbreak of cholera motivated the partnership between the Departments of Health and Water Affairs and the Forestry Department to fight the disease. The Capricorn District Municipality responded to the

outbreak of cholera by purchasing 12 trucks at a total cost of R8.4 million to deliver clean water to the villages (Matlala 2009). One could wonder if repair and maintenance could not be a sustainable, cost effective, and efficient approach to deal with waterborne diseases since trucks arrive with their own maintenance and operational cost which may lead to corruption and additional costs.

The existing knowledge on the problems of repair and maintenance discussed in this chapter has significantly informed stakeholders on numerous issues around the topic. However, very little is known about the Aganang Municipality. This dissertation will fill this gap and point to new research topics.

2.8 Conclusion

This literature intended to evaluate the main contributions of different theoretical arguments on the repair and maintenance of water infrastructure. It reveals interesting findings.

Theoretical arguments that underpin this research point to water infrastructure as a system rather than a sum of different sections of water provision. Any change, positive or otherwise, in one component affects the entire system and vice versa. The problems of water infrastructure are related to project management. They need good management and governance to be proactively resolved. These problems are also a consequence of opposing and sometimes conflicting interests between the manager and ordinary employees. A holistic approach is necessary to address securing their interests in both short and long terms.

Repair and maintenance of water infrastructure at the catchment, treatment, and transportation levels present challenges to both industrialised and developing countries, and communities even though the latter are more negatively affected than the former. International treaties and national policies emerge to address these challenges and speed up provision of clean water to residents across the world. The lack of or

insufficient access to clean water often leads to social and politicised protests which often destroy the infrastructures which could assist the water schemes and the municipalities to meet their demands.

Civic education is important to direct and improve the attitudes of the different communities toward protection of water infrastructure and cost recovery of the services rendered to sustain this system through preventive repair and maintenance of these facilities. There is also the need to involve the beneficiaries – democratically elected leaderships and ordinary members with a focus on women and the youth whose voices are absent from different decisions which affect them – in different stages or components of the water infrastructure system to ensure transparency and community ownership. This approach would require providing training and sharing the costs and benefits to all community members.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presented the research design and methodology of research. The chapter further discussed the target population, sampling method, data collection tools, data analyses, and the validity and reliability/ trustworthiness of the research applied to reach the research objectives and answer to the main research questions.

3.2 Research design

Welman, Kruger and Mitchell (2005: 52) define research design as a plan from which the research participants and collection of information is to be obtained. Modisha (2013: 50) defined research design as a plan to be followed in order to recognise research objectives or hypotheses. It is a representation of the master plan that specifies the methodology and processes applied for collection and scrutiny of the necessary information.

This is a descriptive study which collected data through questionnaires, interviews and observation. It exposed and explained the ways in which people in a particular setting understand, account for, take action in manage their situations, problems and difficulties encountered (Welman, Kruger and Mitchell 2005: 193). The research design utilises the strength and the qualitative research and quantitative research through mixed methods. In fact, the qualitative research collects and analyses the participants' experience, feelings, viewpoints of the issues under investigation and the lessons learned from the situations to the situation at hand through the following data collection methods interviews, focus groups, questionnaires and participant observation (BSU 2013: 56-58). The quantitative research uses techniques that measure precisely the variable under study (Cooper and Schindler 2006).

3.3 Population

Population is defined by Business Studies Unit (BSU 2013: 33) as a complete group of individuals, events or things which are considered to be of interest such that the researcher wishes to scrutinise. The population of Aganang Municipality is 131 164 with total households of 33 918 (Frith 2011). This local municipality consisted of 105 villages which were all incorporated within 19 wards. The sample population is a subgroup or a subset of the population.

The sample population used 63 participants – i.e. 50 interviews and 13 pilot interviews, included in the total is the focus group which consisted of four members. This sample was representative of the 19 wards of the municipality.

3.4 Sampling techniques

A Purposive sampling method was used to select the participants according to the research's interests in different communities included in the sampling area (Welman, Kruger and Mitchell 2005: 69). The research selected equal numbers of participants from each of the 19 wards of the Aganang Municipality for this research with the intention of getting a fairly balanced understanding of the issues under investigation.

The sampling area was 105 villages of the Aganang Municipality in the Province of Limpopo.

Sampling size was anticipated to a maximum of 66 participants:

- 4 traditional leaders,
- 6 councillors,
- 3 Ward Committee members,
- 2 directors of municipality, 4 business owners,
- 38 ordinary community members,
- 5 community development workers, and
- 4 municipal workers.

The research considered gender and age differential, employment status and the sector of employment status to have balanced views from different groups. The following key stakeholders or participants were purposively selected at the phase of research proposal. However, several government employees declined to participate in the study because they might have been intimidated by or failed to get the authorisation from their line managers. Those who accepted the request participated in their individual capacities. Individuals who refused to participate were replaced by community members who availed themselves.

3.5 Data collection methods

Data collection methods represent systematic approaches to collect information about the objects of investigation i.e. individuals, objects, social phenomena to just list a few and the environment in which research interests occur to obtain a thorough and truthful representation of research interest(s) (Chaleunvong 2009). The data collection instrument used was a written questionnaire. Firstly, the structure of the questionnaire outlined the researcher's details, the course being studied and the purpose of the study.

Secondly the questionnaire outlined the confidentiality of supplied information, personal details of the respondent; open-ended questions of section a, and section b closed ended questions.

3.5.1 Primary data collection

Primary data collection occurred through 59 in-depth interviews, one focus group which consisted of 4 participants, and participant observation from November 2016 to January 2017; and transcribed between 12 January and 1 August 2017. The duration of the interviews was one and half hours allocated to the focus group. A notepad was used to capture the information for each group member, and information transferred to the questionnaire for each of the four group members. Participants were interviewed in the

language of their choice in order for them to express their views with freedom, depending on whether the researcher understood the language chosen.

Participants who wished to withhold their identity remained anonymous; and those who were not comfortable to answer some questions were allowed to do so. In instances where interviewees were not comfortable to answer certain questions in front of others, they were allocated time for one-on-one interaction. Similarly, where and when a respondent did not have time to attend to the questionnaires, a suitable date was agreed upon for another appointment. Personal observations of the projects underway, in progress, completed, incomplete and abandoned equally served as sources of the information required for the study.

The researcher attributed fake names to different participants during preparation of data for analysis to preserve their identities and prevent victimisation in the Aganang Municipality. Participants who wished not to answer specific questions for work or personal reasons were allowed to do so. With the exception of the focus group discussions, interviewees were not asked to participate in the interviews in front of others to avoid bias. Participants were kept informed or reminded of the outcome by email, fax, text messages or telephone calls, and any information obtained will not be divulged to any other external person.

3.5.2 Secondary data collection

Secondary data is defined by Mouton (2013: 71) as written sources (inclusive of the internet) discussing, commenting, debating with the interpretation of the original work of primary sources of information. Secondary data were obtained from published and unpublished books, journals, articles, Integrated Development Planning (IDP), policies, annual reports, other municipal forums, newspapers, and the Internet. Reports of community meetings and social gatherings have also played a pivotal role in getting meaningful information on concerns raised by communities.

3.6 Data analysis

The Responsible Conduct of Research (RCR) (n.d.) defines data Analysis “is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data”. Tania (2014) defines data analysis and interpretation as the process of assigning meaning to the collected information, and determining the conclusions, significance and interpretation of the findings. The study used mixed method approach of qualitative and quantitative data analysis. Two methods were used to analyse data. Qualitative analysis used the Constant Comparative Analysis, quantitative analysis occurred through the SPSS software.

3.6.1 Qualitative data analysis

Qualitative data analysis was used to analyse Section C of the questionnaire used for interviews and a focus group discussion through the Constant Comparative Method (CCM) with the intention of bringing the participants’ experience and feelings in their own words around the challenges of repairs and maintenance of water infrastructure in the Aganang Municipality.

Maykut and Morehouse (1994) argue that CCM comprises discovery, data unitising, categorising and writing the guidelines for inclusion. This was because “words are the way that most people come to understand their situations; we create our world with words; we explain ourselves with words; we defend or hide ourselves with words” (Maykut and Morehouse 1994: 18). The same scholars insisted that in CCM, the investigator focuses on finding patterns inside those words and to present those patterns for others to examine whilst “at the same time staying as close to the construction of the world as the participants originally experienced it” (ibid).

The Constant Comparative Method (CCM) involves breaking down data into distinct units i.e. words or sentences and coding them into categories. Using those categories to go through the changes of content and definition as units are compared and categorised, and as comprehension of the properties of categories and the associations between categories were developed and polished over the course of the analytical

process (Lincoln and Guba 1985). In CCM, the researcher simultaneously coded and analyses data in order to develop concepts. The investigator improved those concepts, classifies properties, investigates their associations to one another, and combined them into a coherent explanatory model through continually comparing specific incidents in the data (Taylor and Bogdan 1984: 126).

The analysis of the solution to identified problems of water infrastructure led to categories. The first category was a recruitment of “skilled personnel”. This category had 4 sub-categories namely regular maintenance, training local people, 24-hour surveillance, and accurate reporting. The second category was “reduce reporting time”. This category did not have any sub-categories. The third category was building “improved community-municipality relationship”. It had the following sub-categories “provide a time-frame for repairs”, “create ad-hoc committee”, “village committee”. The last category was permanent and free “transportation”. It did not have any sub-categories.

3.6.2 Quantitative data analysis

Quantitative research presented human experiences and opinions into numbers (Duffy and Chenail 2008). Once the interviews were completed and transcribed, the researcher handed all the data to a professional statistician to begin the analysis through the Statistical Package for Social Science SPSS. This software presented the findings by creating charts and tables. It was one of the most used computer software packages for analyses of quantitative data in social science (Bryman and Bell 2007). The research used descriptive analysis to summarise the data numerically to provide exact measures and graphically to demonstrate patterns in the data.

The analyses included graphs, tables and charts to sketch out the responses received for examination and discussion in chapter 5. The reasons for using this procedure were to make it easier for the reader to compare and understand the findings. The aim of the analyses was to provide a run through of the opinions and perceptions of the challenges of repairs and maintenance of water infrastructure in the Aganang Municipality. The

analyses will look to address the objectives of the research as stipulated in Chapter One.

3.7 Trustworthiness/ validity and reliability

3.7.1 Trustworthiness

Trustworthiness is defined as the way in which the person who inquires is able to convince the listeners, that whatever the study discovered is worthwhile for consideration and that the research is of high quality (Maree 2007: 305).

- **Credibility**

Credibility is defined by (Maree 2007: 305) as the guarantee that the researcher's conclusions have been obtained from the data. The findings would have to be believable and considerable, not forgetting to report negative findings, in order to enrich the study convincingly. Credibility of the findings was achieved through the following tools: (1) taking up well established research methods; (2) developing early familiarity of the Aganang Municipality, (3) selecting the participants randomly with the sample; (4) the involvement of interviews, focus group, participant observations, and promotion of ethics/ honesty of the participants (Shenton 2004: 64-66).

- **Transferability**

Transferability is the degree to which generalisations can be made from the data and framework of the research study to the broader population and settings (Maree 2007: 305-306). It is also the way in which the reader's ability to take what they have discovered and transfer them to other contexts. In the context of this study, transferability was provided by (1) mentioning the number of institutions involved in the study; (2) criteria of inclusion and exclusion; (3) sampling size; (4) data collection method employed; (5) number and length of interviews; (5) data collection period (Shenton 2004: 70).

- **Dependability**

Maree (2007: 305) contends that “dependability refers to the degree to which the reader can be convinced that the findings did indeed occur as the researcher said they did”. A strong research protocol which was presented in Sections 3.2 and 3.6 with a clear research design and its implementation, measuring tools, appraisal of the research project addresses the question of dependability (Shenton 2004: 71-72).

- **Confirmability**

Confirmability is defined as the degree to which the outcomes of a research could be confirmed by other researchers (Baxter and Eyles 1997). It is “concerned with establishing that data and interpretations of the findings are not figments of the inquirer’s imagination, but are clearly derived from the data” (Tobin and Begley 2004: 392). A detailed description of methodology in this chapter ensures the readers and other researchers to define how far the data may be accepted.

3.7.2 Validity and reliability

Validity determines whether the research actually reflects what it was intended to measure or how truthful the research outcomes are. In other words, do the research instruments allow the research to get accurate results as expected? Reliability refers to “the extent to which results are consistent over time and an accurate representation of the total population under study” and if the results of a study can be reproduced under a similar methodology (Joppe 2000: 1). A mixed methods research that entails collecting, analysing and integrating both quantitative and qualitative research and which was used in this dissertation attend to this concern. In fact, the weakness of each one was nullified by the strength of the other.

3.8 Delimitation

It was ideal for research to be conducted in an area within easy reach for the researcher (Dau 2010: 44) to achieve its goals and objectives and contribute to the body of knowledge in a realistic time. This research was conducted in the 105 villages of the Aganang Municipality in the Province of Limpopo. It was a vast geographical area but its findings cannot be generalised because the research did not use probability sampling, even though other municipalities within the same province may face similar problems around water infrastructure.

3.9 Ethical considerations

Mouton (2013: 238) describes ethics as the capacity of an individual to distinguish between the right and wrong things when research is conducted. Furthermore, the conduct of the researcher has to comply with the generally acceptable norms and values. This study intended to obtain information from human beings. Each respondent had given his/ her consent to be part of the study. The researcher had also requested and obtained permission from local authorities.

Welman, Kruger and Mitchell (2005: 181) highlight the issues in relation to ethical considerations which are plagiarism and honesty, especially when recording the outcomes. They further recognised that during a research project, ethics play a role in three stages namely, when participants are engaged during the involvement in the process undergone during measurement, and when the research outcome is released. This research was executed with a high level of honesty and truthfulness. In this study, the researcher had acknowledged information from other sources with particular references and citations. Respondents of this study have been notified about its aims and impact so that whoever participated did so willingly.

According to Mouton (2013: 238) there are however other pillars of ethical conducts which researchers must adhere to namely, relationship to the practice of science

(professional ethics), relationship to society, relationship to the subjects of science, relationship to the environment. These pillars were explained in detail below: relationship to the practice of science (professionalism): impartiality and honesty in research are upheld, creation and misrepresentation of data, own data recording and ethical practices of publishing. Relationship to society: no secret or concealed research, free and open distribution of research outcome is obligatory, the research funders and sponsors are in charge.

3.10 Conclusion

This chapter dealt with the methodology used to answer to the research questions with the intention of achieving the aim and objectives of this study on the problems of repairs and maintenance of water infrastructure in the Aganang Municipality.

Purposive sampling was used because the research intended to uncover specific issues around water infrastructure that the researcher would like to understand and share with the public.

In-depth interviews and one focus group with four group members as well as participant observation were used to collect participants' insights on the issues as primary data. Secondary data include published and unpublished research, newspaper articles and the Internet.

The Constant Comparative Method was used to analyse qualitative data whilst the SPSS software was very useful in the analysis of quantitative data. The study observed strict research protocols to achieve the validity and reliability of quantitative research and different tools to confidently present the results of the qualitative research. The next chapter presents the research findings.

CHAPTER FOUR: ANALYSIS AND INTERPRETATION OF COLLECTED DATA

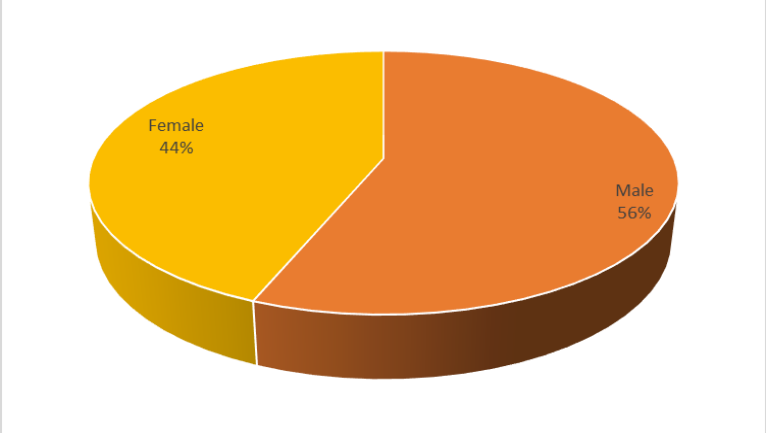
4.1 Introduction

This chapter presents the data collected through the interviews, focus group discussions, and participant observations. The research used graphs, charts and tables to display the findings for analysis in chapter five. Chapter four first looks at the demographic details of the participants i.e. age, gender, level of education, marital status, number of children, access to employment, access to grants, and salary scales, Secondly, this chapter looks at the views of the participants on different aspects of water infrastructure in the Aganang Municipality perceived and real challenges and some suggestions to address these problems achieving the objectives of this study.

4.2 Demographics of the population

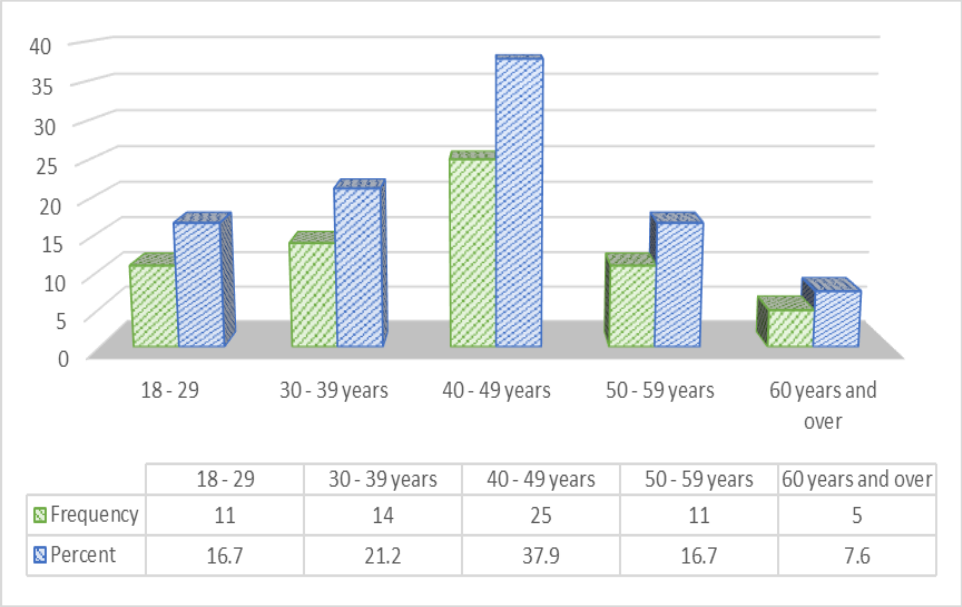
The researcher required the personal information of respondents. It includes gender, age, level of education, marital status, place of residence, employment status, grant recipient and salary. Demographical information was useful in determining and comparing patterns amongst different categories of the research participants.

Forty-four percent of respondents were females whereas 56% represent male respondents.



Graph 4. 1: Gender of respondents

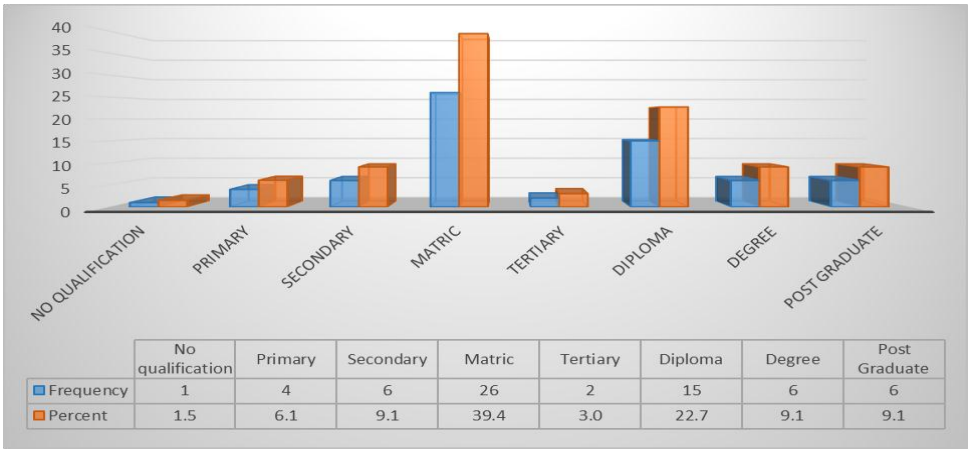
Graph 4.2 reveals that 77.6% of respondents are between 18 and 49 years of age. The remaining 16.7% and 7.6% represent individuals between 50 and 59, and 60 and over respectively.



	18 - 29	30 - 39 years	40 - 49 years	50 - 59 years	60 years and over
Frequency	11	14	25	11	5
Percent	16.7	21.2	37.9	16.7	7.6

Graph 4. 2: Age of respondents

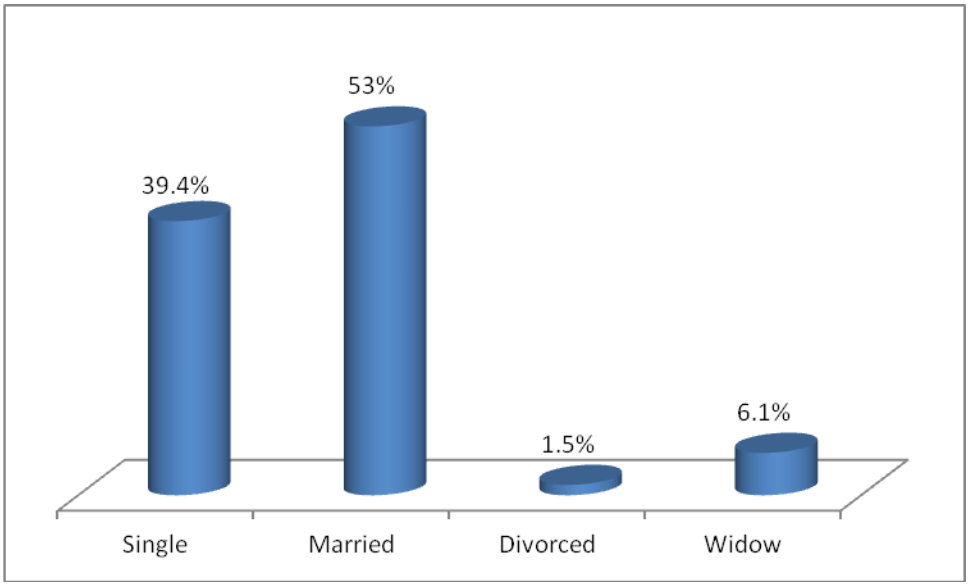
The majority of respondents, 39%, have a matric level qualification. Access to primary education followed by the level of Diploma, 22.7%. Only 9.1% have a Bachelor's degree.



	No qualification	Primary	Secondary	Matric	Tertiary	Diploma	Degree	Post Graduate
Frequency	1	4	6	26	2	15	6	6
Percent	1.5	6.1	9.1	39.4	3.0	22.7	9.1	9.1

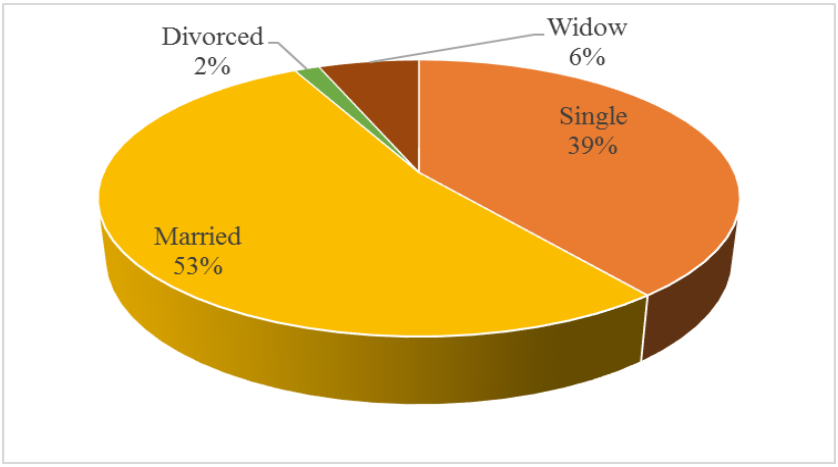
Graph 4. 3: Level of education

The majority of respondents are married. 39% are still single whereas 2% are divorcees.



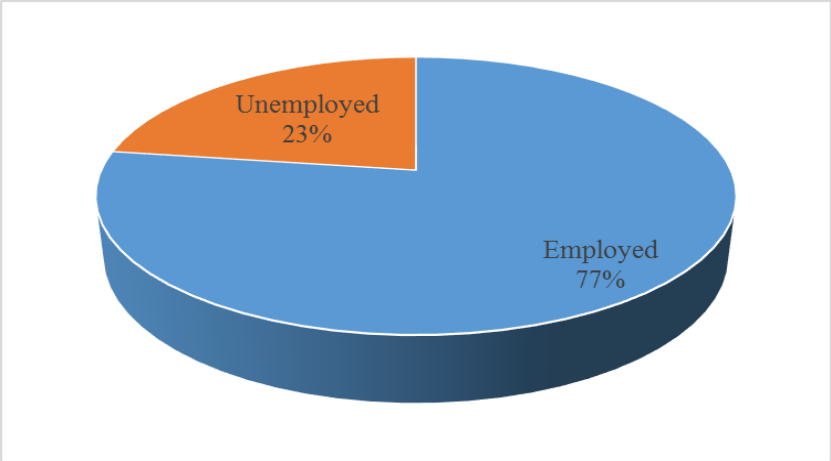
Graph 4. 4: Marital status

The majority of respondents (77%) have access to formal or informal employment. This statistic does not reflect the level of security of respondents.



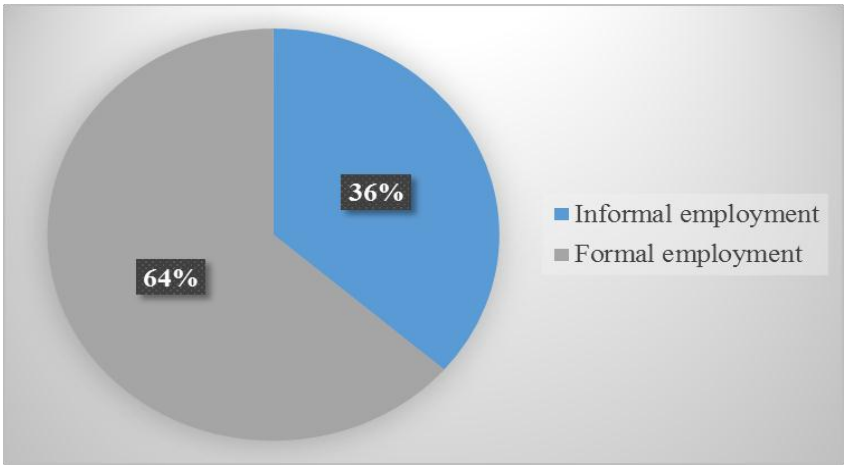
Graph 4. 4:1 Marital status

Many respondents (77%) are employed in this municipality whereas 23% are unemployed.



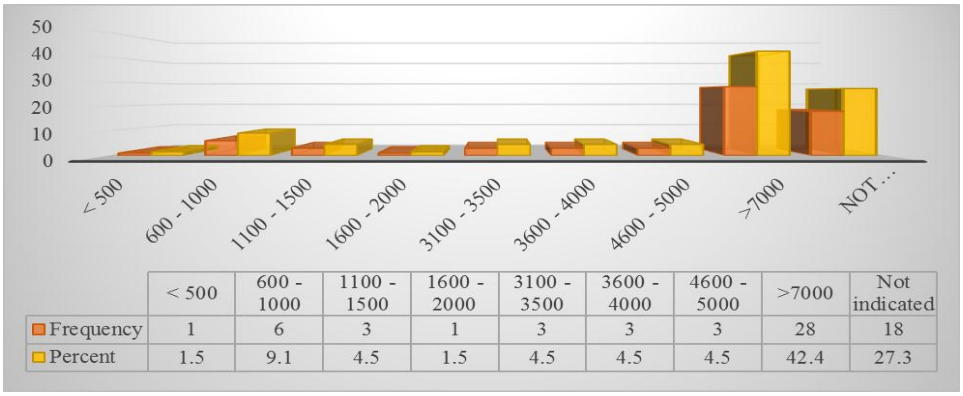
Graph 4. 5: Access to employment

Of the 77% of respondents who are employed, 64% are active in the formal Employment sector and 36% are involved in the informal economy. The Aganang Municipality represents the main source of employment followed by the provincial government.



Graph 4.5:1 Sector of employment

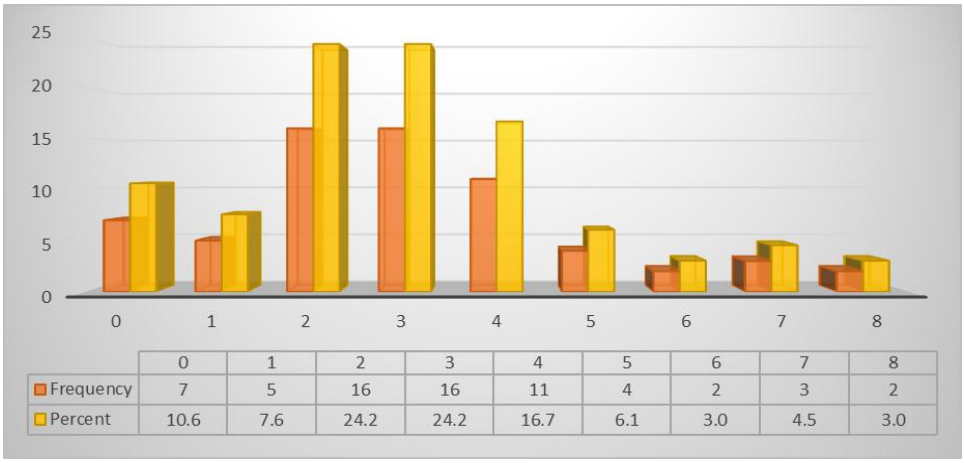
Wages are very low in the formal sector. In fact, only 42.5% of respondents earn more than R7000 per month whilst 27.3% declined to disclose their salaries.



	< 500	600 - 1000	1100 - 1500	1600 - 2000	3100 - 3500	3600 - 4000	4600 - 5000	>7000	Not indicated
Frequency	1	6	3	1	3	3	3	28	18
Percent	1.5	9.1	4.5	1.5	4.5	4.5	4.5	42.4	27.3

Graph 4. 6: Salary scales for formal sector

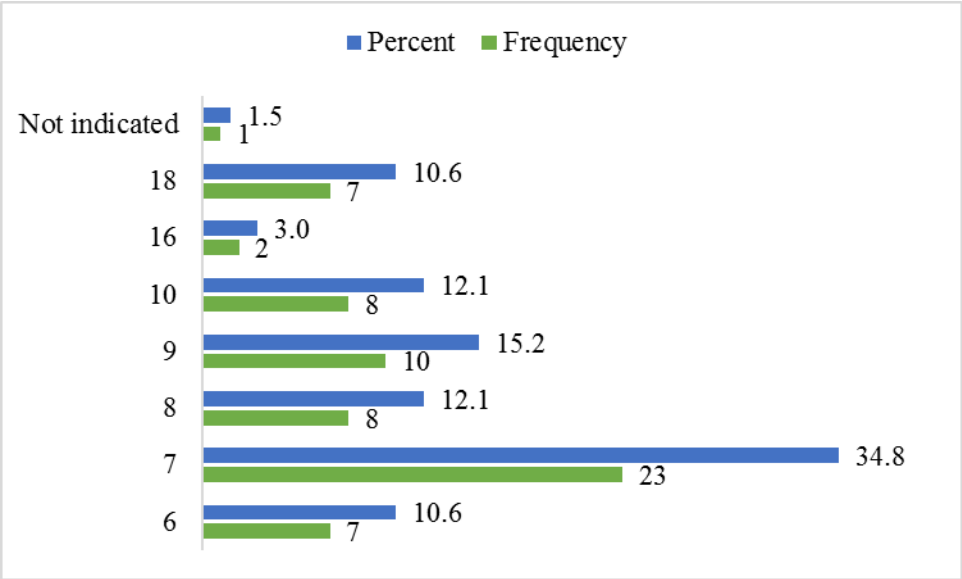
Twenty-four percent of respondents have 2 children; the same percentage has 3 children whilst 16.7% of respondents have 4 children.



	0	1	2	3	4	5	6	7	8
Frequency	7	5	16	16	11	4	2	3	2
Percent	10.6	7.6	24.2	24.2	16.7	6.1	3.0	4.5	3.0

Graph 4. 7: Number of children per household

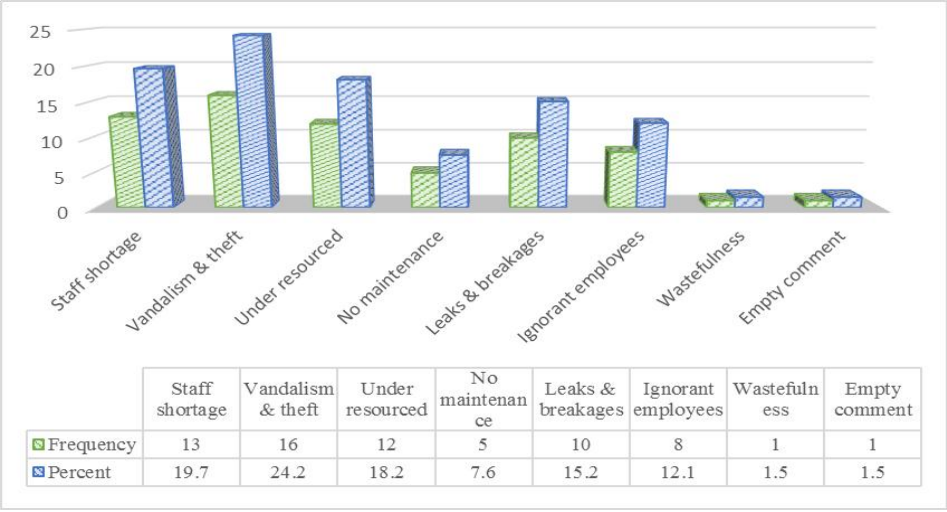
The distribution of the respondents by wards reveals that many participants come from Ward 7 (34.8%), followed by Ward 9 (15.2%), Ward 10 and Ward 8 with 12.1% each. The remainder share the balance.



Graph 4. 8: Distribution of the participants per Ward

4.3. Challenges for water infrastructure and respondents' feelings

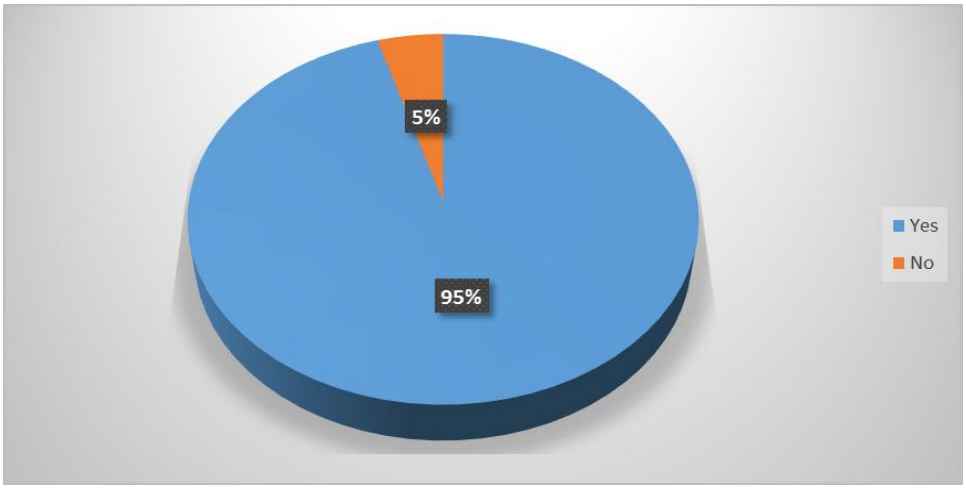
The main challenges of water infrastructure consist of a wide range of complex issues. These include vandalism and theft (24.2%), staff shortages (19.7%), lack of enough resources (18.2%), leaking and broken pipes (15.2%), and under-qualified and poorly trained staff (12.1%).



	Staff shortage	Vandalism & theft	Under resourced	No maintenance	Leaks & breakages	Ignorant employees	Wastefulness	Empty comment
Frequency	13	16	12	5	10	8	1	1
Percent	19.7	24.2	18.2	7.6	15.2	12.1	1.5	1.5

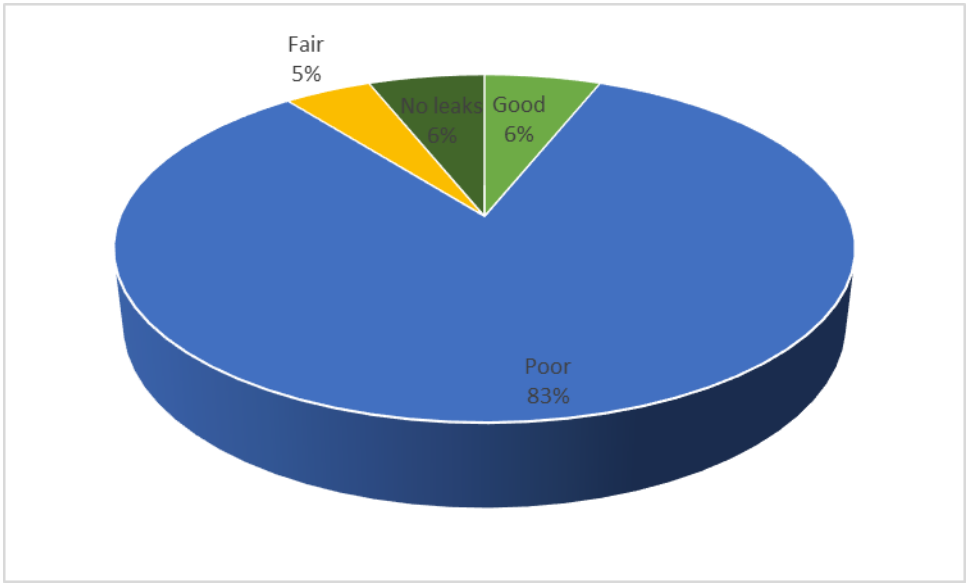
Graph 4. 9: Challenges for water infrastructure

These issues have strongly impacted on the respondents' reactions and feelings toward water infrastructure and supply to different villages of the Aganang Municipality as several graphs demonstrate below. Almost all respondents (95%) are dissatisfied with the water supply in the Aganang Municipality.



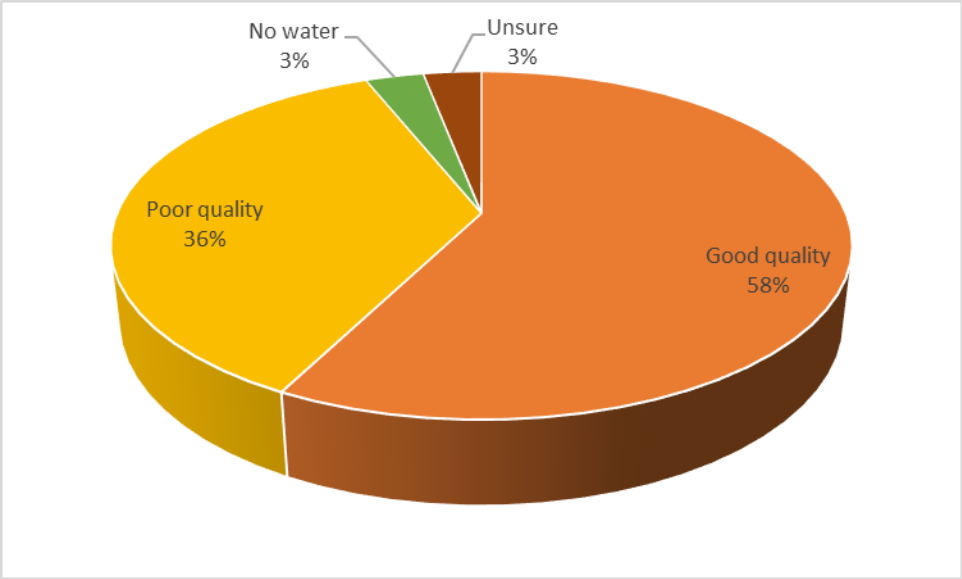
Graph 4. 10: Level of satisfaction of residents of the Aganang Municipality

Eighty-three percent of respondents believe that the Aganang Municipality response to water leaks is poor; whilst the remainder argue fair (5%), good (6%), and no leaks (6%).



Graph 4. 11: Respondents' perceptions of Aganang Municipality's response to water leaks

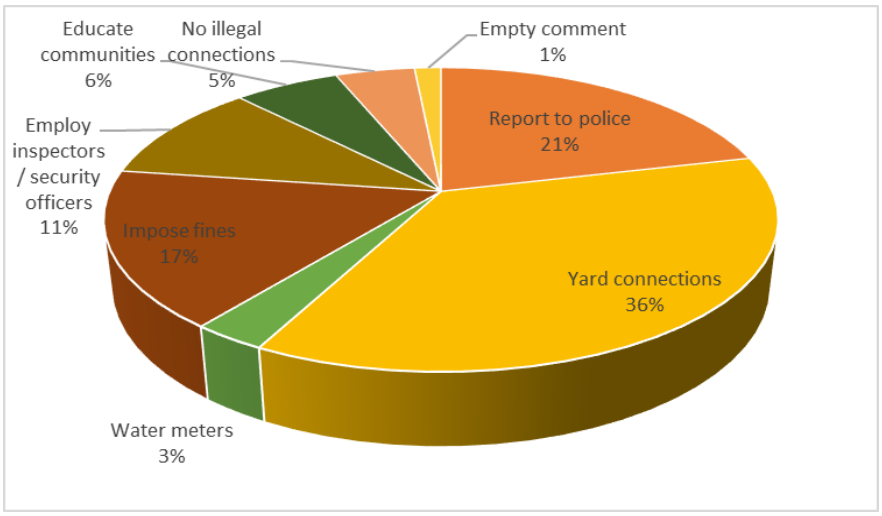
Graph 4.12 reveals that 58% of respondents like the good quality of water supplied by the Aganang Municipality; 36% disagree arguing that the quality of water is poor.



Graph 4. 12: Respondents' reactions to the quality of water supplied

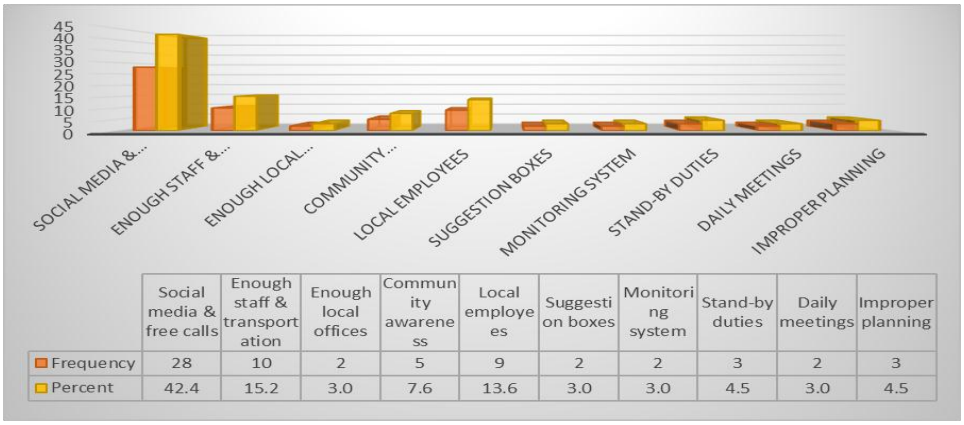
4.4 Solutions to the problems of water infrastructure

Thirty-six percent of respondents believe individual connections would bring positive change to the problems of water infrastructures whilst 21% advise to report to the nearest police stations and 17% believe that imposing fines on the perpetrators could reduce vandalism and other related challenges.



Graph 4. 13: Solutions to the challenges of water infrastructure.

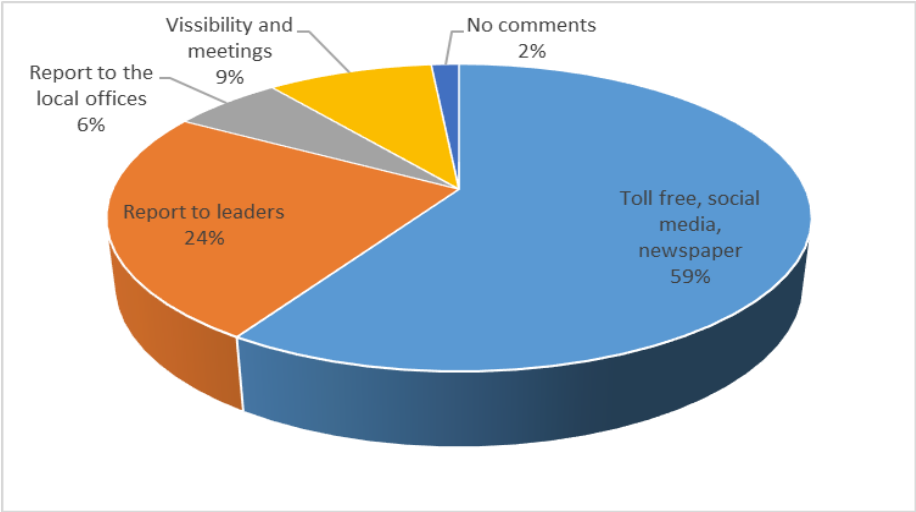
Forty-two percent of respondents believe that social media and free calls could be used by the residents to quickly report leaks and burst pipes, 15.2% point to free transportation for maintenance and repairs, and 13.6% the Aganang Municipality could hire local people to speed up the repairs and maintenance.



	Social media & free calls	Enough staff & transport ation	Enough local offices	Commun ity awarene ss	Local employe es	Suggesti on boxes	Monitori ng system	Stand-by duties	Daily meetings	Improper planning
Frequency	28	10	2	5	9	2	2	3	2	3
Percent	42.4	15.2	3.0	7.6	13.6	3.0	3.0	4.5	3.0	4.5

Graph 4. 14: Suggestions to speed up the process of water infrastructure repairs.

Reporting mechanisms have numerous challenges. More than half of the respondents argue that toll free number, social media, and newspaper could be used to allow all beneficiaries to report the leaks and burst pipes. Twenty four percent contend the reports should be send directly to the leaders. Nine percent argue that all they need is visibility and meetings in order to report to the specific individual.

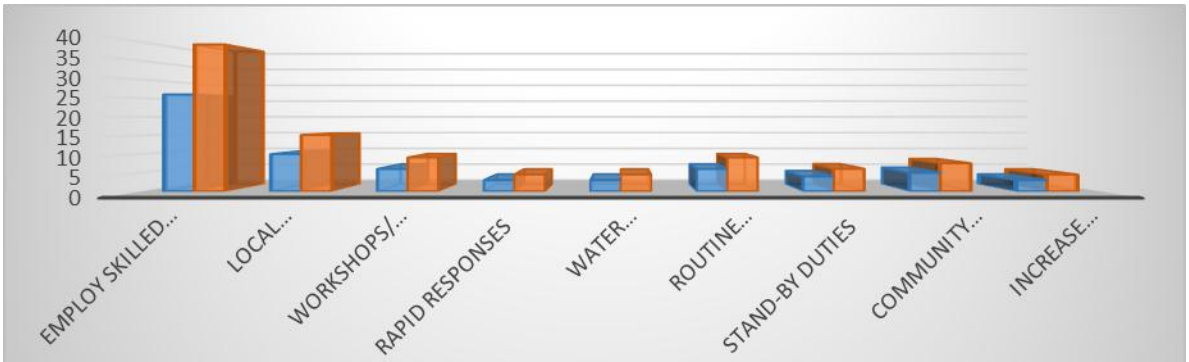


Graph 4. 14:1 Suggestions for improved communication around water Infrastructure.

4.5 Participants' views on different aspects of water infrastructure and access to water

The questionnaire used open-ended and closed question as well ranking (see Questionnaire annexure 1) to collect the participants' perceptions and feelings around water infrastructure in the Aganang Municipality.

Indeed, on the suggestions to the municipality to speed up repairs and maintenance, 39.4% point to the need to employ skilled staff; 15. 2% support skills transfer through local employment, 9.1% insist that building workshops/depots in every village is the answer; the same percentage also support routine maintenance to prevent or minimise the problems; 7.6% reveal that involving the communities would solve the challenges; 6.1 % believe having standby personnel would eradicate the issues; 4.5% argue that increasing the capacity for rapid responses; 4.5% support the idea of a water committee; and 4.5% argue that having a rapid response mechanism is the answer.

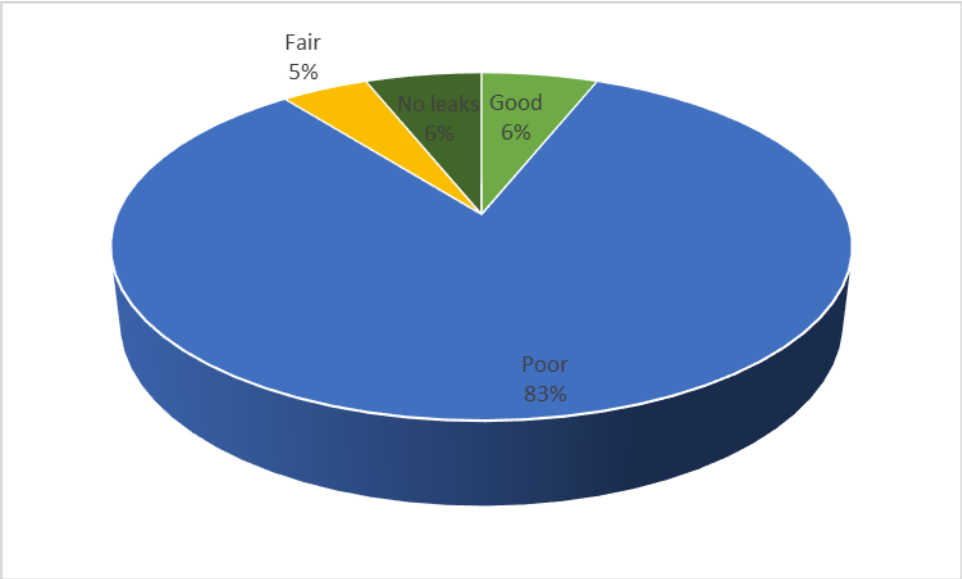


	Employ skilled staff	Local employment	Workshops/ depots every village	Rapid responses	Water committees	Routine maintenance	Stand-by duties	Community involvement	Increase infrastructure capacity
Frequency	26	10	6	3	3	6	4	5	3
Percent	39.4	15.2	9.1	4.5	4.5	9.1	6.1	7.6	4.5

Graph 4. 15: Suggestions to Aganang Municipality to speed up the process of water infrastructure repairs.

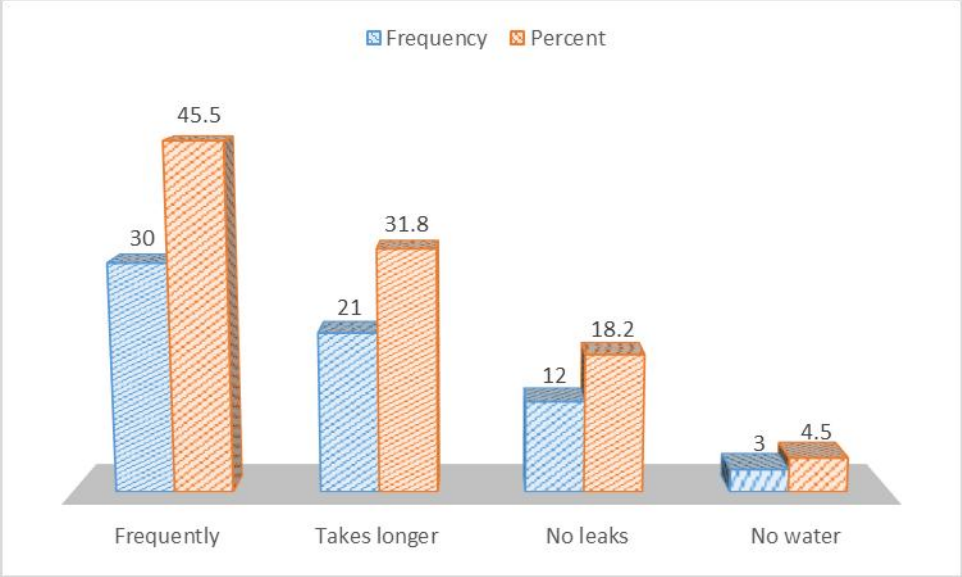
Water interruptions negatively affect the lives of 95% of participants since they spent 30 days without water and the current storage dam is too small to supply the community- “the pump is forever faulty and takes time to be fixed”. Five percent disagree. They contend that they are not affected by water interruptions. The participants had different views on the meaning and the implementation of “better life for all”. Twenty-one percent agree that “better life for all” is indeed becoming a reality but 79% disagree. One of the participants commented “Not at all. Better life is for those who hold top positions at the municipality. Clean water means purified water and not from a borehole then straight to communities. Water from wells or rivers are not good for human consumption but at Aganang such water is clean”.

The respondents had various views on the prevention of leaks. Indeed, whilst almost all participants (83%) claimed that the prevention mechanisms are poor, 6% argue that these mechanisms are good, 5% state they are fair, and 6% denied to have observed any leaks in their areas.



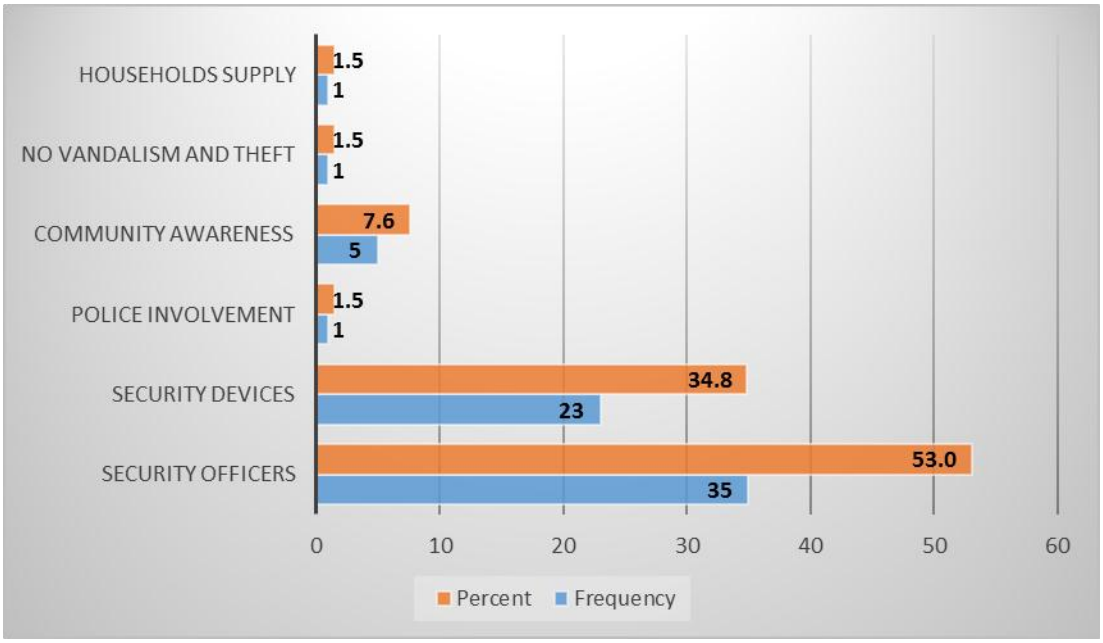
Graph 4. 15: Respondents' perceptions of Aganang Municipality's response to water leaks.

Yet, these responses are challenged by Graph 4.17 below. It describes that water leaks are frequent (45.5%) and they take longer to be repaired (31.8%). However, 22.7% deny to have witnessed any.



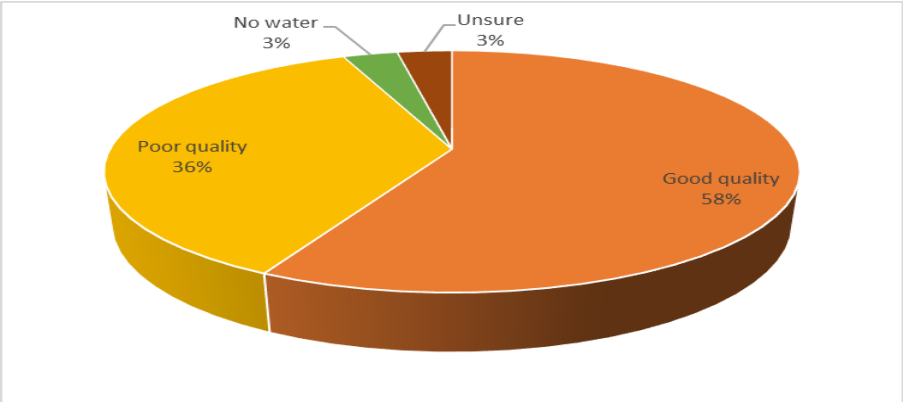
Graph 4. 16: Frequency of water leaks within communities

On security of water infrastructure against vandalism and theft, 53% stated that the municipality should employ enough security officers from communities, 34.8% suggested that security devices should be installed to detect theft and vandalism, 7.6% said that it is important to create awareness on the negative impacts of vandalism and theft within the communities.



Graph 4. 17: Security and protection of water infrastructure from vandalism and theft.

Regardless of the challenges described in this chapter and the cholera outbreak in the villages of this municipality, Graph 4.19 reveals that 58% of participants still believe that the water quality is good; 36% contend that quality is poor; 3% are not sure; and 3% had no comments because they do not receive any water, so they have no comments.



Graph 4. 18: Water quality supplied to Aganang Municipality's communities

4.6 Qualitative analysis

The analysis of the solutions to poor or a lack of repairs and maintenance of water infrastructure in Section C and the focus group discussion reveals four categories and sub-categories where applicable.

Category one is "skilled personnel". This category has 4 sub-categories: "regular maintenance", "training local people", "24-hour surveillance", and "accurate reporting". Category two is "reduce reporting time". It does not have any sub-categories. Category three is "improved community-municipality relationship". It has three sub-categories: "provide a time-frame for repairs", "create ad-hoc committees", and "village committee". Category three is "free and permanent transportation". It does not have any sub-categories. Category four is "improved community-municipality relationship". This category has the following sub-categories: "provide time-frame for repair", "create ad-hoc committee", and "training and creation of village committee". Category five is "better life for all".

a. Skilled personnel

The respondents state that the water utility responsible for water supply in the Aganang Municipality should employ skilled personnel to deal efficiently with the challenges of

repairs and maintenance through regular maintenance, skill transfer to beneficiaries, surveillance and accurate reporting, and interpretation of what need to be done.

Regular maintenance

Regular maintenance has the potential to prevent or at least reduce the interruption of water supply to the beneficiaries as one of the participants below insist:

> "Routine maintenance of infrastructure will assist the municipality in speeding up water infrastructure repairs. If the maintenance of infrastructure is done on a regular basis, the need for repairs will be minimum as the infrastructure will always be in good condition as a result of routine maintenance." (Phuti, 49 years old, married and father of 5, BA Education, Manager).

Another respondent agrees arguing that:

> "The municipality must assign additional maintenance personnel to help in identifying where and when to repair. Should more maintenance personnel be looked at and put to use, they will help in identifying where the repairs are required and it will be up to the Municipality to repair in time (Lelau, 28 years old, single and father of 1, Matric, General Worker).

In support with the two previous participants, and pointing to localised interventions through empowered beneficiaries, a forty year old Ward Councillor argues:

> "… every village should have a qualified maintenance engineer to fix emerging problems…" (Tlou, 40 years old, divorcee and father of 3, Bachelor's degree, Ward Councillor).

Training local people

Most beneficiaries are local people. They live and work in the areas where water infrastructure under discussion is located. Skill transfer would empower them to take charge of basic and intermediate tasks in repairs and maintenance as the two quotes below illustrate:

> "An ad-hoc committee needs to be established to deal with water crises. This committee should consist of properly trained people to liaise with the municipality about measures to curb water crises. The municipality must request funds from the government." (Abraham, 48 years old, single and father of 2, G12, security guard).

Another participant points to the same direction. He argues:

> "Train people that live within communities how to repair and use the infrastructures." (Marcus, 21 years old, single and male, University Student).

24-hour surveillance

Skilled personnel would be able to understand the rationale for permanent surveillance of water infrastructure to prevent the interruption of water supply through prompt responses to reported incidents.

> "There should be an office that is operating on 24 hour basis within the municipal building fed with a hotline and also people with knowledge of water infrastructure activities should be on standby to deal with any report that comes from the community." (Tsoyi, 42 years old, married and father of 1, Grade 12, Police Officer).

24-hour surveillance could also protect water infrastructure from vandalism and theft.

> “Let the municipality employ people who will ensure that infrastructure is secured and protected from vandalism and theft. Let them have their own “rangers” 24/7.” (John, 53 years old, married and father of 4, Hours Degree, Educator).

A 35-year single mother of 4 agrees, arguing:

> “All infrastructures need to be protected 24 hours a day.” (Koena No.2, 35 years old, single and mother of 4, Grade 12, unemployed).

Accurate reporting

Skilled personnel would place efficient reporting mechanisms through a toll free number and social networks. Two participants with different responsibilities share this view:

> “There must be a toll free number and free speed dials.” (Tlou, 47 years old, married and mother of 2, Diploma, Educator);

Communication strategies need to be diversified and include social networks as the respondent below confirms:

> “The municipality must introduce social networks.” (Thakamangana, 23 years old, single male and no children, Matric, unemployed).

b. Reduce reporting time

The participant observation technique combined with the contributions of the participant reveal that reporting time is often too long in the absence of the involvement of the beneficiaries. The establishment of water committees in each village would decrease the reporting time since the committees would report to the Ward Councillors and create political accountability of both the technicians and Ward Councillors as the respondents below insist:

> “Each community should have water committee which will report to the ward committee that will report to the ward councillor who will report to the municipal manager.” (Phillemon, 46 years old, married and father of 3, Diploma, teacher).

In fact, the female participant below argues:

> “A toll-free line should be introduced, because presently one has to report to the Ward Committee and Ward Committee reports to the Councillor and then the report goes to the municipality.” (Nare, 36 years old, single and mother of 3, Grade 10, informal trader).

c. Free and permanent transportation of technicians

The lack of free and permanent transportation undermines the ability of technicians to assess the challenges of water infrastructure and respond efficiently. The leak may occur, the pipe can burst, or the pump can break down. These challenges delay the repairs and maintenance programme. A 55 year old complains below:

> “Shortage of staff, a lack of transportation to areas where assistance is required in different villages and communities.” (Kwena, 55 years old, married and father of 4, Diploma, Administrator).

Another respondent agrees with the previous one arguing:

> “The lack of transportation hinders service delivery. Indeed, the municipality and the Department of Water Affairs should provide free transportation to technicians, village communities and individuals who may be willing to report leaks. Free facilitation could facilitate the inspection of water infrastructure in numerous villages.” (Ernest, 55 years old, married and father of 4, Diploma, unemployed).

d. Improved community-municipality relationship

Building a sustainable relationship between the beneficiaries and the service provider will support both government and community efforts to deal with the challenges of water infrastructure in the Aganang Municipality.

Provide time-frame for repairs

A good relationship will provide a platform for dialogue between the community structures and the Municipality around burning issues such as a lack of a time-frame for repairs and vandalism prevention as the participant below elaborates:

> "The municipality must be able to give us the time frame when they will attend to our complaints, so that if they did not come we know further action to be taken. Employment of competitive staff." (Kwena, 55 years old, married and father of 4, Diploma.

In addition,

> "Building pump house, electrified, hire security guard and install alarms. By doing so the rate of vandalism and theft will be less. Monitoring, facility maintenance unit must have a schedule of those infrastructures." (Joyce, 39 years of age, single and mother of 3, N6, Administrator).

Create ad-hoc committee

Ad-hoc water committee would create community ownership of water infrastructure and the need for protection against vandalism and theft.

> "Every village should have a street committee that will oversee this problem. These committees should also work hand-in-hand with the police. The villagers should also be taught about the importance of protecting water infrastructure from vandalism and theft." (Phuti No.1, 49 years old, married and father of 5, School Principal).

One security guard agrees arguing,

> “An ad-hoc committee to be established to deal with water crisis. This committee should consist of properly trained people to liaise with the municipality about measures to curb water crises. The municipality must request funds from the government.” (Abraham, 48 years old, single and father of 2, Grade 12, security officer).

Training and creation of village committees

Skills transfer has two main advantages. It would create employment for local people who could not be employed otherwise. Training will bring semi-skilled and skilled personnel where they are most needed. In fact, as the student below explains:

> “Training the beneficiaries who live within communities how to repair and use thewater infrastructure properly.” (Marcus, 21 years old, single and no child, University student).

One of the Police Officers who participated in this research contends,

> “I think well trained people with regards to water infrastructure related activities need to be employed and be placed on 24 hours shifts and stand-by duties.” (Tsoyi, 42 years old, married and father of 1, Grade 12, Police Officer).

e. Better life of all

The political slogan “… better life for all…” has different meanings to different people. In fact, a 48 year old single father of 2 laments the lack of political will to address the provision of an uninterrupted supply of water to his village.

> "No, the phrase is not applicable to the community of Aganang. Residents experience water problems continuously and the municipality does nothing to address the issue." (Abraham, 48 years old, single and father of 2, Grade 12, Security Guard)

Other respondents including government officials and self-employed artisans, males and females, point to a different direction. They agree that efforts are made by the government to provide a better life for all through provision of clean water in these terms:

> "…Yes, clean water is provided to the community or is available to the communities even though the reservoirs are not enough to those communities …" (Frans, 42 years old, married and father of 1, Grade 12, Police Officer)

> "Aganang Municipality is trying its best to provide a better life for all by providing clean water 80% of the time in a week and this is good way of service delivery e.g. addressing basic needs." (Esther, 40 years, married and mother of 2, Honours, Community Practitioner).

It is hoped that the next chapter will discuss some of these contradictions that emerge within the same communities facing the same challenges.

4.7. Conclusion

This chapter focussed on the quantitative analysis and qualitative analysis of empirical data gathered from the fieldwork. It includes the participants' views, feelings and perceptions of the problems under investigation.

The demographic profile of respondents:

- 44% of respondents were females whereas 56% represent male respondents;

- 77.6% of respondents are between 18 and 49 years of age. The remaining 16.7% and 7.6% represent individuals between 50 and 59 and 60 and over respectively.
- 31.8% of participants have at least a diploma qualification
- The majority of respondents are married. 39% are still single whereas 2% are divorced;
- Of the 77% of respondents who are employed, 64% are active in the formal employment and 36% are involved in the informal economy. The Aganang Municipality represents the main source of employment followed by the provincial government.
- Wages are very low in the formal sector. In fact, only 42.5% of respondents earn more than R7000 per month whilst 27.3% declined to disclose their salaries.

The challenges of water infrastructure:

- The main challenges of water infrastructure consist of a wide range of complex issues. These include vandalism and theft (24.2%), staff shortages (19.7%), lack of enough resources (18.2%), leaking and broken pipes (15.2%), and under-qualified and poorly trained staff (12.1%);
- These issues have strongly impacted on the respondents' reactions and feelings toward water infrastructure and supply to different villages of the Aganang Municipality as several graphs demonstrated above. Almost all respondents (95%) are dissatisfied with the water supply in the Aganang Municipality;
- Eighty-three percent of respondents believe that the Aganang Municipality's response to water leaks is poor; whilst the remainder argue fair (5%), good (6%), and no leaks (6%).

Solutions to the problems of water infrastructure:

- Thirty-six percent of respondents believe individual connections would bring positive change in the problems of the water infrastructure whilst 21% advise to report to the nearest police stations, and 17% believe that imposing fines on the perpetrators could reduce vandalism and other related challenges;

- Forty-two percent of respondents believe that social media and free calls could be used by the residents to quickly report leaks, and burst pipes, 15.2% point to free transportation for maintenance and repairs crews and 13.6% the Aganang municipality could hire local people to speed up the repairs and maintenance.

In addition to these numbers, the qualitative analysis reveals that the problems of water infrastructure could be resolved through:

- Skilled personnel capable to investigate, assess and solve the problems;
- Free and permanent transportation of technicians within and between villages;
- Improved community-municipality relationship which may lead to skills transfer to the beneficiaries, community ownership of water infrastructure and protection of water infrastructure.

Suggestions to speed up the process of water infrastructure repairs:

- More than half of the respondents argue that toll free telephone calls, social media, and newspapers could be used to allow all beneficiaries to report the leaks and burst pipes. Twenty four percent contend the reports should be send directly to the leaders. Nine percent argue that all they need is visibility and meetings in order to report to specific individuals.

CHAPTER FIVE: DISCUSSION OF THE RESEARCH FINDINGS

5.1 Introduction

This chapter serves to present the discussions of the research findings around maintenance and repairs of water infrastructure in the Aganang Municipality according to the objectives of the research. Its purpose is to interpret the respondents' contributions to this research in relation to the research questions and research objectives through the prism of international experiences where applicable. The chapter presents new insights into the problems of water provision as a basic right guaranteed by the 1996 Constitution of the Republic of South Africa [Act No. 108 of 1996] with the intention of drawing some lessons for local, national and international institutions. This chapter also lays the foundations for the recommendations to the Aganang Municipality in the next chapter.

5.2 Research findings and discussions

5.2.1 Socio-demographic characteristics of the participants

This research considered gender balance (56.1% males; 43.9% females) since men and women are differently affected by the problems of access to clean water. It was thus important to give them a fair chance to express their views. Participants' responses from the focus group discussion and the responses from the interviews were captured for the SPSS software. The statistics in this research were inclusive of that of the focus group. Responses of the focus group were also inline with the responses of the individual respondents. The responses of focus group form part of the appendices already attached.

The age groups and socio-economic statuses of respondents were also considered to record the contributions of individuals who are differently affected by the delayed repairs and maintenance and lack of repairs thereof. Almost 38% of respondents were between

18 and 39 years old; 37.9% were between 40 and 49 years old; 24.3% were over 50 years old. Thus, majority of the respondents are active individuals who contribute to the development of their communities in various ways.

The level of education is relatively high with 39.4% having a matric level; whereas 31.8 % had either a diploma (22.7%) or a Bachelor's degree (9.1%) or post-graduate degree (9.1%). The majority of respondents are employed (77%); only 23% are unemployed. The percentage of individuals who are employed is very high compared to the overall unemployment and socio-economic discontents in the country which lead to endemic protests. Among the individuals who are employed, 64% are actively involved in the formal sector with relative good salaries depending on the cost of living in the villages (42.4% earning more than R7000 per month); 36% work in the informal sector. The remainder are involved in the formal sector representing 9% earning between R3600 and R5000 per month; whilst 27% of the participants declined to disclose their incomes.

Objective One: To investigate what generally hinders the repairs and maintenance and triggers vandalism and stealing of water infrastructure in the Aganang Municipality.

5.2.2 Challenges for water infrastructure and access to clean water

The respondents had different views on the problems of water infrastructure in the Aganang Municipality. They argue that there are four main challenges around water infrastructure: vandalism (24.2%), shortage of qualified personnel (19.7%), a lack of resources (18.2%), water leaks and breakages of pipes (15.2%), and poorly trained or untrained personnel (12.1%). These issues need to be addressed without any delay to provide to the communities their basic rights and improve the standard of living of the residents.

The assumption here is that qualified personnel could identify the problems quickly and respond efficiently. Qualified personnel could identify the issues and attend to them

efficiently. They would therefore reduce the delay in maintenance and repairs as the respondents below state:

> "The municipality must assign additional [qualified] maintenance personnel to help in identifying where and when to repair… in time." (Lelau, 28 years old, single and father of 1, Matric, General Worker).

In support to the previous participant, another one responds:

> "… every village should have a qualified maintenance engineer to fix emerging problems…" (Tlou, 40 years old, divorcee and father of 3, Bachelor's degree, Ward Councillor).

24-hour surveillance could protect water infrastructure from vandalism and theft as the educator below insists:

> "Let the municipality employ people who will ensure that infrastructure is secured and protected from vandalism and theft. Let them have their own "rangers" 24/7." (John, 53 years old, married and father of 4, Honours Degree, Educator).

Qualified personnel would install water infrastructure mechanisms in a manner that protects water infrastructure against other challenges such as vandalism (Hlokwa la Tsela 2016; Bila 2013), a lack of resources through proper planning, and water leaks and breakages of pipes through preventive initiatives that reduce the cost of repairs and maintenance (Foster *et al.* 2009: 28; Vedachalam *et al.* 2015; CSIR 2006: 2) as well as communication breakdown among different stakeholders (Dau 2010; Mothetha, Nkuna and Mema 2013). Qualified individuals would do so because they understand that water infrastructure and subsequent repairs and maintenance as a whole rather than a sum of different individual units (Mele, Pels and Polese 2010); that there are diverging and sometimes conflicting interests, goals and risks in both water infrastructure and repairs and maintenance (Eisenhardt 1989a: 59-60); and that water infrastructure and repairs and maintenance are related to project management (Baars 2006).

These problems, if they remain unattended to, could lead to waterborne diseases, the delay of attaining the United Nations SDGs (Moran *et al*. 2008) and water reform in South Africa. These issues magnify the three main problems (the need to substantial reinvestment for the replacement of existing infrastructure to be upheld; the need to expansion and upgrading of the infrastructure for public good; and the need to make investments for the achievement of public health and environmental protection) which will speed up the "perfect storm" of water disruption in South Africa (Heare 2007: 24).

These findings are in line with Schouten and Buyi's (2010) and Howard's (2011) research findings which contend that worldwide, over one billion people lack access to drinking water due to delay or a lack of political will to fix water leaks, inefficient water schemes and illegal water connections.

Yet, the challenges of repair and maintenance are not unique to the Aganang Municipality. Other municipalities are also affected in South Africa. Indeed, 75% of the overall volume of municipal water supplies indicates that presently the level of Non-Revenue Water in the whole country is predicted at 36.8%. From that amount 25.4% is lost through physical leakage (McKensie *et al.* 2012: iii). Nelson Mandela Bay Municipality faces the same challenges of water infrastructure. It has lost 40% of water between July and November 2014 due to water leaks and so revenues from this precious resource (Price *et al*. 2012: 12). The CSIR (2006: 2, 5) points in the same direction arguing that water leaks are the most common problems experienced with water reticulation systems because of the use of incorrect procedures during the installations, excavating close to the pipes causing damages, the use of inappropriate materials, inappropriate repair procedures, ageing of pipes with illegal connections worsening the situation (CSIR 2006: 5). The most challenging issue above all is the maintenance of the breakdowns of infrastructure.

Developed countries have similar problems of water infrastructure. In the USA, (a) water infrastructure has the challenges of a lack of substantial reinvestment for the replacement of existing infrastructure to be upheld; (b) the need to expansion and

upgrading of the infrastructure for gains, maintenance in public health and environmental protection as agreed in the face of population growth; and (c) the need to make investments for the achievement of public health and environmental protection the nation seeks (Heare 2007: 24). In Canada, Hunaidi *et al.* (2004: 1-2) argue that the water transmission and distribution networks deteriorate as they age and eventually their water tightness decreases, among other reasons, installations in environments surrounded by corrosions, unstable soil conditions, defective construction standards, unstable water pressure, and movement of heavy vehicles causing vibrations. It is important to articulate leakage management around the total quantity of the lost water, leak monitoring mechanism, leak detection and repair, and a pressure monitoring system

Objective Two: **To investigate the better mechanisms to protect water infrastructures.**

5.2.3 Solutions to the problems of water infrastructures

The challenges of water infrastructure are complex. They therefore need a blend of strategies to address them. These include stopping illegal water connections, good and free reporting mechanisms of issues, involvement of community and political leaders, village committees, skills transfer to local communities, and community ownership of water infrastructures.

The participants believe that a partnership between the municipality, political and traditional leaders and the beneficiaries would address some challenges of water infrastructure. Indeed,

> "Each community should have a water committee which will report to the ward committee that will report to the ward councillor who will report to the municipal manager." (Phillemon, 46 years old, married and father of 3, Diploma, teacher).

In addition, the municipality should recruit and train more staff to improve technical capacity and support the water infrastructure and provision of clean water (Buthelezi 2012: 18) and customer care in public owned institutions characterised by poor or a lack of mechanisms to do so. The municipality could also provide free and permanent transportation to technicians to facilitate the work.

> "Shortage of staff [both in quality and quantity], a lack of transportation to areas where assistance is required in different villages and communities." (Kwena, 55 years old, married and father of 4, Diploma, Administrator).

In addition, another participant continues,

> "The lack of transportation hinders service delivery. Indeed, the municipality and the Department of Water Affairs should provide free transportation to technicians, village communities, and individuals who may be willing to report leaks..." (Ernest, 55 yearsold, married and father of 4, Diploma, unemployed).

Some efficient strategies consist of introducing community-based approaches for the operation and maintenance of their water infrastructure, and service users involvement to boost increased efficiency, benchmarking, promote awareness, national growth contribution, wastage reduction, upgrade the allocation of resources and improved competitiveness as studies from India, Pakistan and Sri Lanka showed (Sohail, Cavill and Cotton 2005: 2). One respondent to this study support these international study findings. He argues,

> "Every village should have a street committee that will oversee this problem. These committees should also work hand-in-hand with the police. The villagers should also be taught about the importance of protecting water infrastructure from vandalism and theft." (Phuti No.1, 49 years old, married and father of 5, School Principal).

In Sub-Sahara Africa, Buthelezi (2012: 18) argues that there is need for suitable legislation or guiding principles, financially sound mechanisms, skilled personnel, adequate organisational support, and effective management systems which should prevent or least minimise water leaks.

The strategy which should be excluded from the list of tools to solve the issues of water infrastructure is privatisation. This tool considers privatised service as a commodity which needs to be provided through the cost-recovery basis i.e. available to individuals who can afford its cost of production. The reason is simple. It will worsen the legacy of apartheid and nullify all efforts and resources spent since the end of the apartheid system.

The challenges of water infrastructure do not affect the provision of water to households only in terms of pressure drops, insufficient provision of water for domestic consumption and industrial use, or a lack of access to clean water. They also have a negative effect on other sectors of the economy as well. These include roads through road closures, flooding and damage to property, sinkholes, school interruptions to just list a few (Vedachalam *et al.* 2015: 1).

It then becomes imperative to investigate what the respondents think about the solutions to these challenges. In this research, 36% of respondents believe individual connections would bring positive change to the problems of water infrastructures whilst 21% advise to report to the nearest police stations, and 17% believe that imposing fines on the perpetrators could reduce vandalism and other related challenges. The qualitative analysis of this research supports these statistics by pointing to numerous options as the quotes below describe. They contend:

> “An ad-hoc committee [should] be established to deal with water crises. This committee should consist of properly trained people to liaise with the municipality about measures to curb water crises. The municipality must request funds from the government.” (Abraham, 48 years old, single and father of 2, Grade 12, security officer).

In addition,

> “Training the beneficiaries who live within communities how to repair and use the water infrastructure properly.” (Marcus, 21 years old, single and no child, university student).

Furthermore,

> “I think well trained people with regards to water infrastructure related activities need to be employed and be placed on 24 hours shifts and stand-by duties.” (Tsoyi, 42 years old, married and father oof 1, Grade 12, Police Officer).

Ngowi (1997: 325) states that the necessity of project maintenance is more emphasised, because of project failures due to procedural deficiencies. He advises to encourage the community ownership of water infrastructure projects to reduce the cost of maintenance and to pay for service rendered for these twin objectives. It would reduce the cost of water provision and present a source of income for the municipalities for further improvement of water provision through purchasing of spare parts and routine and much needed maintenance of water infrastructure (Tshikolomo 2012b: 12).

On reducing the reporting time and speeding up identification and repairs and maintenance, 42% believe that social media and free telephone calls could be used by the residents to quickly report leaks and burst pipes, 15.2% point to free transportation for maintenance and repairs crews; and 13.6% believe the Aganang Municipality could hire local people to speed up the repairs and maintenance.

Objective Three: To describe appropriate mechanisms to improve repairs and maintenance.

The challenges of repairs and maintenance are complex and multifaceted. They therefore require a blend of three sets of strategies, directed identification and reporting

mechanisms, building efficient partnerships between the communities and service provider(s) or improving the existing ones.

The first set encourages the use of social media and the availability of a free call service (42.4%), recruiting enough staff and provision of free transportation to the technicians to move around easily and attend to repairs and undertake maintenance (15.2%), and employing [and transferring] skills to local people (13.6%). Other suggestions include to raise awareness on the benefits of water infrastructure and the need to protect it (7.6%), to have technicians on standby duties (4.5%), improving planning to repairs and maintenance before they occur, monitoring the water system, opening of several offices within the villages, and organising daily meetings to update the community and political leaders and the beneficiaries.

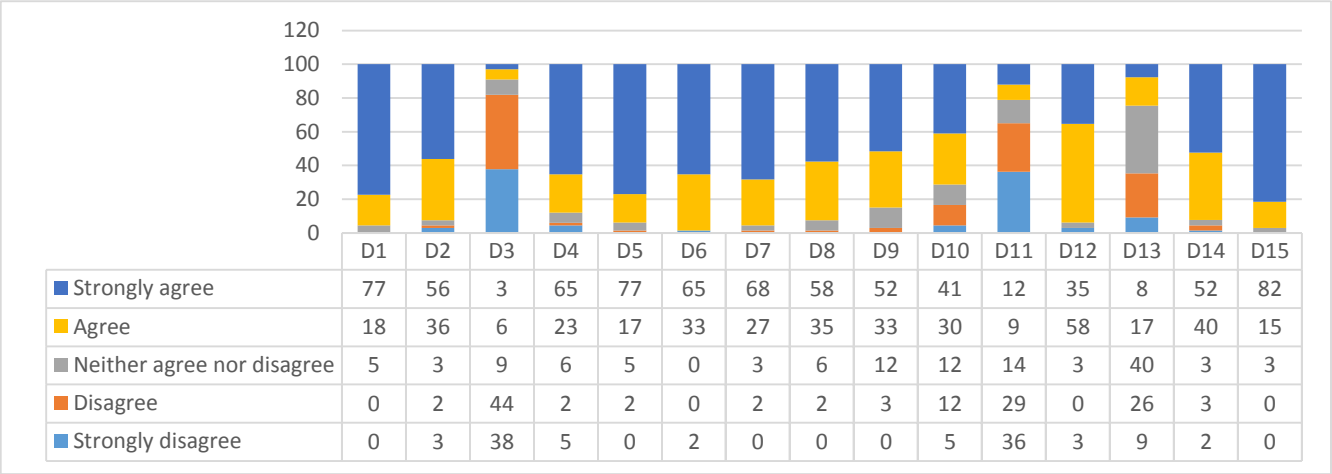
The second set refers to good communication between the municipality and the beneficiaries' needs to improve. This can take place through toll free numbers and easy accessibility to free calls (59%), reporting to local leaders (24%), increasing visibility of the police or security guards along the infrastructure (9%) to just mention a few.

The third set includes preventing or at least minimising water theft. Indeed, individual water connections in their residences (36%), reporting to and involving the police (21%), imposing fines to the offenders of vandalism and illegal connections (17%), recruiting water inspectors and security guards to look after water infrastructure (11%), educating the beneficiaries (6%), preventing illegal connections (5%), and introducing individual water meters (3%).

5.2.4 Participants' views on different aspects of water infrastructure and access to water

Table 2 below describes the overall results of different responses to the 15 questions of Section D of the Questionnaire and not result per item. An example is: under a third of the respondents are agreeing to 3 of the 4 items and 40-50% are in agreement. The

patterns of responses however are different for the third item where almost 70% are agreeing. Start from general picture to the slightly specific.



	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
Strongly agree	77	56	3	65	77	65	68	58	52	41	12	35	8	52	82
Agree	18	36	6	23	17	33	27	35	33	30	9	58	17	40	15
Neither agree nor disagree	5	3	9	6	5	0	3	6	12	12	14	3	40	3	3
Disagree	0	2	44	2	2	0	2	2	3	12	29	0	26	3	0
Strongly disagree	0	3	38	5	0	2	0	0	0	5	36	3	9	2	0

Table 2: Views on aspects of water infrastructure and access to Water

Based on the summary statistics supplied in Table 2, responses on views on different aspects of water infrastructure and access to water are centered around neutral to slightly positive, with M = 47.1% SD = 55.5%.

	Mean	Std. Deviation	N
D1	4.71	.555	62
D2	4.37	.891	62
D3	1.90	1.020	62
D4	4.42	1.033	62
D5	4.69	.642	62
D6	4.60	.664	62
D7	4.63	.607	62
D8	4.50	.695	62
D9	4.34	.809	62
D10	3.98	1.180	62
D11	2.31	1.398	62

D12	4.24	.803	62
D13	2.85	1.069	62
D14	4.37	.834	62
D15	4.77	.493	62

Table 3: Descriptive statistics for views on different aspects of water infrastructure and access to water (n = 66).

The Aganang Municipality needs to hire at least one skilled and experienced employee in each village to speedily and efficiently attend to different challenges of the water infrastructure to minimise delays, prevent water interruption and water losses. In addition, the Aganang Municipality needs to transfer skills and hire community members to rapidly attend to local challenges since they live in these villages. Furthermore, improved relationships between the communities and government officials, easy and free reporting mechanisms of issues and the installation of security devices such as cameras, alarms, electric fences, and cages would facilitate detection of issues and discourage the would-be offenders. In doing so, the Aganang Municipality would make the motto “better life for all” a reality to all inhabitants of this municipality.

5.2.5 Relationships of selected variables

This sub-section intended to establish relationships between selected variables which could influence some outcomes in this research project in the Annexure 2 through Chi-Square Tests.

Access to water and place of residence

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	83.692[a]	72	.163
Likelihood Ratio	60.930	72	.821
Linear-by-Linear Association	.588	1	.443
N of Valid Cases	66		

Using Chi-squared test X^2 (72) =83.692, p = 0.163, since the p>0 0.05. This implies that there is no association between access of water and place of residence.

The participants from different villages are equally affected by interrupted or a lack of access to clean water. So the Aganang Municipality needs to invest in all villages to make access to clean water as a basic human right a reality and provision of better life for all South Africans a reality.

Access to grant and place of residence

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	82.299[a]	54	.008
Likelihood Ratio	61.850	54	.216
Linear-by-Linear Association	.023	1	.880
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =82.299, p = 0.00, since the p<0 0.05. This implies that there is an association between grant recipients and place of residence.

Residents who live in well-developed villages and those who live around the cities have better access to grants than those who live in small and isolated villages. This situation requires that funding and political will should target the villages with fewer grant recipients to provide a better social security to all individuals who qualify for this social security.

Access to employment status and place of residence

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	42.717[a]	54	.866
Likelihood Ratio	42.390	54	.874
Linear-by-Linear Association	.192	1	.662
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =42.717, p = 0.866, since the p> 0.05. This implies that there is no association between employment status and place of residence.

Access to formal and informal employment does not depend on the place of residence. The municipality seems to be creating opportunities across the villages of this municipality to fight the triple challenges of unemployment, poverty and structural inequality.

Marital status and place of residences

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	55.005[a]	54	.436
Likelihood Ratio	60.362	54	.257
Linear-by-Linear Association	.398	1	.528
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =55.0, p = 0.436, since the p> 0.05. This implies that there is no association between marital status and place of residence. Single individuals have an equal chance of getting married in all villages regardless of the geographical locations they live in.

Sector of employment and place of residence

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.057[a]	18	.589
Likelihood Ratio	19.647	18	.353
Linear-by-Linear Association	.303	1	.582
N of Valid Cases	66		

Using Chi-squared test X^2 (18) =83.692, p = 0.589, since the p> 0.05. This implies that there is no association between sector of employment and place of residence. The respondents' access to both formal and informal employment does not depend on where they live. So resources should be spent in all the villages to create salary employment and promote entrepreneurship for self-employment and job creation.

Level of education and income

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	62.832[a]	56	.247
Likelihood Ratio	60.682	56	.311
Linear-by-Linear Association	.145	1	.703
N of Valid Cases	66		

Using Chi-squared test X^2 (56) =60.68, p = 0.311, since the p> 0.05. This implies that there is no association between level of education and income. The level of education should, everything remaining equal, impact the income. This is not the case in the Aganang Municipality. One explanation could be that individuals who are employed in the formal sector might be working in different spheres of government where recruitment is often based on political membership and networking rather than qualifications. The implication of this situation could be that there may not be incentive for children to go to school and the youth to further their education to earn more money and increase their contribution to the socio-economic development of these villages and the province at large. This in turn could perpetuate the migration of skilled labour from other municipalities and in so doing keeping the residents of different villages of this municipality in the cycle of unemployment and vulnerability.

5.3 Conclusion

The challenges of repairs and maintenance in the Aganang Municipality are multifaceted. They therefore need a mix of solutions to address them to comply with national legislations and international conventions and treaties on access to clean water. The international experiences are available to the Aganang Municipality. They could adapt to local socio-economic and political realities to improve access to uninterrupted and inclusive access to water.

Yet these solutions should avoid the privatisation of water infrastructure since this approach to the provision of water considers water as a commodity which could be made available only to individuals who can afford its cost. If applied, the privatisation of water schemes would worsen the legacy of the apartheid government which had excluded the majority of South Africans from numerous human rights.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Introduction

The researcher was interested in the problems of repairs and maintenance and the solutions thereof in the Aganang Municipality in Limpopo province through the lenses of international experiences, treaties and conventions as well as national legislations on access to clean water and the Bill of Rights of the 1996 Constitution of the Republic of South Africa [Act No. 108 of 1996]. Access to clean water is a basic need and not a luxury. It is also a human right guaranteed by the Constitution of South Africa. So all South Africans, the residents of different villages of this municipality included should have access to water in both the cities and rural areas of South Africa.

Addressing basic needs and human rights such as shelter, clean water and electricity is one of the pillars of election campaigns of different political parties. They differ on the modality. Whilst some advocate for free access to these services, others believe that the beneficiaries need to contribute to the provision of these services since free access to these services is not sustainable in the long term. The political rhetoric of free access to basic needs and rights resonate well in the minds of the respondents despite the fact that there are costs involved in the production, transportation where applicable and distribution of these needs and the experiences from around the world.

6.2 Rationale of the research

The importance of this research is that it contributes to the understanding of these challenges and suggests some possible solutions with two-fold objectives. The outcomes of this research will first contribute to improve the standard of living of the beneficiaries through the realisation of mainly the SDGs 1, 2, 3 and 4 (Moran *et al*. 2008: 470-471). Indeed, SDG 1 “thriving lives and livelihoods” for example cannot sustainably happen without provision of clean water to all; SDG 2 “sustainable food, security” needs water, from the source or water reservoir to different consumers both

humans and non-humans. Similarly, SDG 3 “sustainable water security” emphasises that water is a source of life. It must therefore be secured for sustainability. Secondly, the findings of this study would assist the Aganang Municipality to optimise the cost of production, transportation, and distribution of water thanks to timely repairs and regular maintenance, a partnership between the municipality and communities, awareness of vandalism and community ownership of water infrastructure.

6.3 Re-statement of the problem

The research problem comprises of the delay of much needed repair and maintenance to water pipes that burst and leak, water cut-offs and a lack of legal and administrative actions to deal with illegal water connections, stolen water infrastructure, and vandalism in the Aganang Municipality. These deliberate actions have two main consequences. First, they disrupt and destroy water infrastructure and consequently deprive citizens of their constitutional right of access to clean water. Second, these actions have negative impacts on the economy, socio-cohesion and peace in this municipality, and can spread waterborne diseases.

6.4 Re-statement of objectives of the research

This research had three objectives. Firstly, it tried to understand and to investigate what generally hinders the repairs and maintenance and triggers vandalism and stealing of water infrastructure in the Aganang Municipality. For instance, this research aimed to comprehend why repairs and maintenance are delayed and why do some individuals vandalise the same infrastructure that they desperately need in both the present and future. Secondly, this research focussed on investigating the better mechanisms to be applied in curbing the problem of stolen electrical cables, generators, submersible pumps, transformers and other water infrastructure related connections to reduce the cost of repair and maintenance of water infrastructure and provide an uninterrupted water supply to the villages of this particular municipality. The absence of vandalism would speed up socio-economic development and wellbeing of the beneficiaries.

Thirdly, this research looked at the description of the mechanisms which could reduce the delay between reporting time and actual repair and maintenance of water infrastructure related problems because it could hinder service delivery.

6.5 The methodology of research

This descriptive study gathered data through questionnaires, interviews and observations. The research design utilised the strength of mixed methods to collect and analyse data. Indeed, the qualitative research collected the participants' experience, feelings, and viewpoints of the issues under investigation. It used the Constant Comparative analysis to analyse qualitative data. The quantitative research analysed data through the SPSS software to measure the variable under study.

6.6 Summary of key findings

6.6.1 Demography

The Aganang Municipality has a high rate of people who have either a diploma or degree but income does depend on the level of education. The majority of the participants is of active age (18-59 years) and earns more than R7000 per month.

6.6.2 Challenges of repairs and maintenance of water infrastructure

- Vandalism and theft
- Shortage of personnel
- Lack of resources
- Leaks and breakages of pipes
- Poorly trained or unskilled staff
- Lack of regular maintenance

6.6.3 Solutions to the challenges of repairs and maintenance

The solutions to the problems of repairs and maintenance of water infrastructure are articulated around three angles. First, there is a need to shorten the reporting time. It can be done quickly through:

- Social media and free telephone calls
- Recruit more personnel and provide free transportation
- Recruit and transfer skills to local people
- Have technicians on standby to respond to issues

Second, it is critical to reduce or avoid the delay of repairs and maintenance. The municipality should therefore:

- Have proper and free reporting mechanisms
- Recruit trained and qualified personnel
- Build good partnerships between the municipality and the communities
- Create awareness around the negative impacts of vandalism and need to protect water infrastructure
- Create a sense of community ownership of water infrastructure

Thirdly, water infrastructure needs to be protected against vandalism and theft, and should not be used as tools of protest as they both are considered as crimes punishable by law. In order to protect water infrastructure, the municipality should:

- Introduce yard connections
- Report theft to the police
- Impose fines on the offenders
- Recruit water inspectors and security guards
- Installation of security devices
- Educate the communities

6.7 Recommendations

Given identified challenges and suggested solutions to address them, this study recommends the following:

a. Employment of artisans who are qualified to do the job or skills transfer to local people who live in the different villages in the water supply division. Employees in the water supply division need to receive regular training to upgrade their skills in the ever-changing work environment.

b. Two Pump Operators should be recruited to each village so that services are not halted by the absence of one. Additional staff should be recruited to remain on standby for emergency with free transportation.

c. Installation of security devices such as closed circuit cameras, alarms, burglar bars, razor wires, and so on around the borehole chambers in every village. Every household must be equipped with at least a 5000 litre water tank, to catch rain water from the roofs for other uses except drinking as a relief for the already overloaded infrastructure.

d. Water reticulation must include all extensions, with regular monitoring mechanisms in terms of the supply capacity.

e. Provision of reservoirs must cater for the extended areas and not only the previously existing areas. The reservoirs installed must be big enough to cater for the communities and also allow for future extensions.

f. Pump Operators must undergo the proper recruitment process and must be appointed on merit. Every ward or village must be equipped with a workshop where all the spares and materials are kept to ease repairs and maintenance of the water infrastructure.

g. Free access to water is not sustainable in the long run. Without privatising the water facility, the Aganang Municipality should initiate a dialogue around paid water at a subsidised rate to begin to recover some money which could be used for repairs and maintenance.

h. The supply chain of materials and machinery needs to be supervised by an independent body through clear and fair tender processes to reduce repetitive repairs and extend the time of maintenance.

- **Further Research**

  This study is not the end in itself since there are still several other issues to be investigated. There is a need for further research to explore avenues that were not accessible or apparent to the researcher. The issues surrounding water infrastructure repairs and maintenance are dynamic, and this study does not closeout any further researches from being undertaken.

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APPENDIXES

Appendix 1: Questionnaire

My name is Lesley Mokgobu, I am a student at the Durban University of Technology. I am currently studying for a Masters in Technology of Business Administration. This questionnaire has been prepared for the fulfillment of the title *"Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo"*.

The aim of the study is to explore the challenges of the repairs and maintenance of water infrastructure in Aganang Municipality in the Province of Limpopo.

In order to achieve this aim, this study has the following objectives;

- To investigate what generally hinders the repairs and maintenance; and triggers vandalism and stealing of water infrastructure in the Aganang Municipality;
- To investigate the better mechanisms to be applied in curbing the problem of stolen electrical cables, generators, submersible pumps, transformers and other water infrastructure related connections;
- To define mechanisms which could reduce the delay between reporting time and actual repair and maintenance of water infrastructure related problems.

The information supplied will be treated as confidential.

Thank you for participating in this study.

Please fill in the information below:

Section A: Demographic Details

Name:

Surname:
Gender:
Age:
Education:
Marital status:
Number of children:
Place of interview:
Ward number:

Section B: Economic Security

Formal employment: Yes. What do you do?:
Informal employment: No. What do you do?
Salary: 1: < R500
2: R600-1000
3: R1100-1500
4: R1600-2000
5: R3100-3500
6: R3600-4000
7: R4100-4500
8: R4600-5000
9: R5100-6000
10: R6100-6500
11: >R7000
Unemployed: No. If yes why?
Grant recipient? If yes, which one(s)
If not, why?

Section C: Repairs and Maintenance

1. What suggestion can you bring to Aganang Municipality in speeding up the process of water infrastructure repairs?

2. Are you affected by the problems related to water interruptions in your community? Please elaborate.

3. “A better life for all” is this phrase applicable to the communities of Aganang Municipality in terms of the provision of clean water? Please elaborate.

4. Is the water being supplied to your community sufficient? Please elaborate.

5. What is your perception about the response of Aganang Municipality in addressing water leaks? Please elaborate.

6. How often do water leaks occur in your community?

7. What is your suggestion to Aganang Municipality about securing and protecting the water infrastructure from vandalism and theft? Please elaborate.

8. Is there a need for additional reservoir in your community? Please tell me why?

9. How is the quality of water supplied to your community? Please elaborate.

10. What solutions do you recommend to the municipality for shortening the time taken to report problems related to water infrastructure? Please explain each one.

11. Suggest to Aganang Municipality and the community a better communication channel in reporting problems related to water infrastructure? Please explain why.

12. What challenges do you think Aganang Municipality experiences with the water infrastructure? Please explain.

13. What suggestions/ recommendations can you make to Aganang Municipality in handling illegal water connections? Please elaborate.

Section D: Views on different aspects of water infrastructure and access to water

Indicate the extent to which you agree with the following statements, by marking a cross (x) against the appropriate answer using the scale below:

1- Strongly disagree; 2- Disagree; 3- Neither agree nor disagree; 4- Agree; 5- Strongly agree

1. Every village must have two employees who have the knowledge of water infrastructure related activities; so that when one employee is sick services don't come to a halt.

1		2		3		4		5	

2. The communities of Aganang Municipality are concerned about water shortages and vandalism to water infrastructure because their daily lives are interrupted.

1		2		3		4		5	

3. There are sufficient water sources in Aganang Municipality.

1	X	2		3		4		5	

4. The water supplied to the communities of Aganang Municipality should be free of charge for everybody, elderly or the sick, unemployed and so on.

1		2		3		4		5	

5. The water must be supplied to the communities on 24 hour basis without interruption.

1		2		3		4		5	

6. 24 hours stand-by duties must be performed for any emergencies that may arise.

1		2		3		4		5	

7. 24 hours hotline must be established to report acts of vandalism and theft.

1		2		3		4		5	

8. Security Officers/ devices are required to be on borehole sites.

1		2		3		4		5	

9. Insufficient and lack of skilled staff cause the delay in water infrastructure repairs.

1		2		3		4		5	

10. Insufficient funds to purchase spares/ materials also contribute to the decline in the water infrastructure repairs.

1		2		3		4		5	

11. A pre-paid water metering system must be introduced to generate money to purchase spares for broken water infrastructure.

1		2		3		4		5	

12. Turnaround time for repairing water infrastructure must be made known to Aganang Municipality communities.

1		2		3		4		5	

13 Vandalisers are well known to the communities.

1		2		3		4		5	

14. Vandalism proof devices must be installed on all exposed water infrastructure facilities.

1		2		3		4		5	

15. Vandalism must be treated as the first priority by the communities and reported to the police swiftly.

1		2		3		4		5	

Appendix 2: Demographical information and selected tests

Demographical information

The researcher required the personal information of respondents, this included gender, age, level of education, marital status, place of residence, employment status, grant recipient and salary. Demographical information was useful in determining and comparing patterns amongst different categories of the research participants. Table 4 provides the demographic data of the quantitative survey:

Table 4: Demographic detail of sample respondents

Demographical information		Frequency	Percent
Gender	Male	37	56.1
	Female	29	43.9
Age	18 - 29 years	11	16.7
	30 -39 years	14	21.2
	40 - 49 years	25	37.9
	50 -59 years	11	16.7
	60 years and over	5	7.6
Level of education	No qualification	1	1.5
	Primary	4	6.1
	Secondary	6	9.1
	Matric	26	39.4
	Tertiary	2	3.0
	Diploma	15	22.7
	Degree	6	9.1
	Post graduate	6	9.1
Marital status	Single	26	39.4
	Married	35	53.0
	Divorced	1	1.5
	Widow	4	6.1

Place of residence	Lonsdale	8	12.1
	Ga-Phaka	4	6.1
	Juno	7	10.6
	Prospect	2	3.0
	Tibanefontein	8	12.1
	Kgabo Park	8	12.1
	Cloetesdam	3	4.5
	Kordon	3	4.5
	Vlakfontein	3	4.5
	Boratapelo	4	6.1
	Moetagare	2	3.0
	Ramalapa	1	1.5
	Mamphulo	1	1.5
	Kgomoschool	2	3.0
	Mahoai	2	3.0
	Mpone	1	1.5
	Ntlolane	1	1.5
	Ga-matlala	5	7.6
	Ga-Mokobodi	1	1.5
Employment status of respondents	Formal	39	59.1
	Informal	10	15.2
	Unemployed	13	19.7
	Pensioners	4	6.1
Salary	<R500	1	1.5
	R600 - 1000	6	9.1
	R1100 - 1500	3	4.5
	R1600 - 2000	1	1.5
	R3100 - 3500	3	4.5
	R3600 - 4000	3	4.5
	R4600 - 5000	3	4.5
	> R8000	28	42.4

	Not indicated	18	27.3
Grant recipient	Children grant	8	12.1
	Employed	44	66.7
	Pensioner	4	6.1
	Unemployed	10	15.2
	Total	66	100.0

Summary the above table

Reliability

The internal consistency of the views on different aspects of water infrastructure and access to water scale was calculated using Cronbach's Alpha and the average inter-item correlation. These values are presented in Table 5.

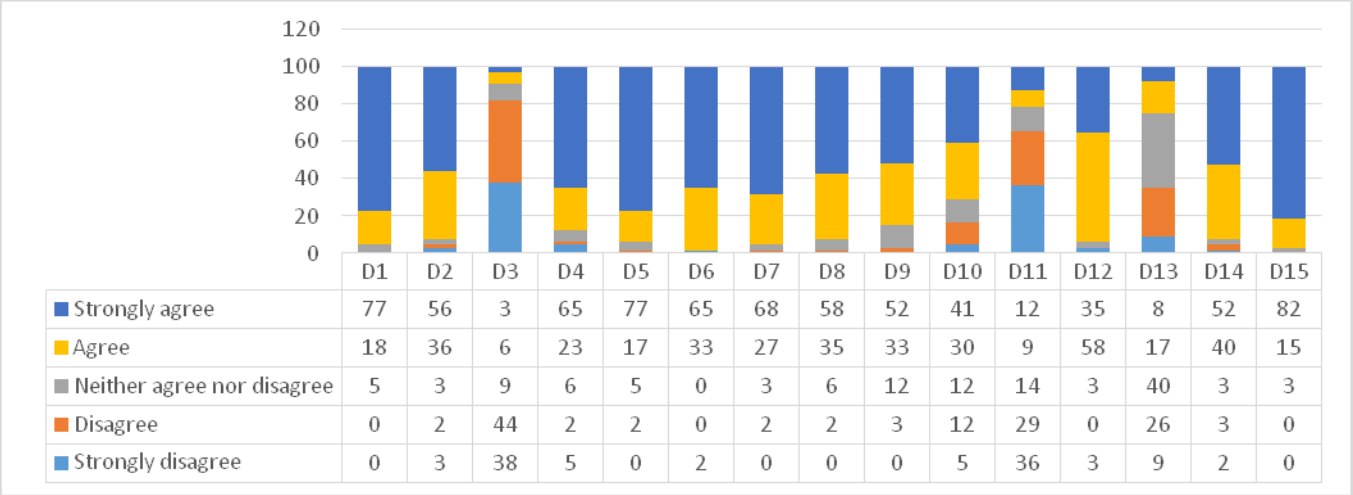
Table 5: Internal consistency reliability values of scales

Scale	Cronbach's Alpha	Average inter-item correlation	Number of item
Views on different aspects of water infrastructure and access to water	0,511	0,081	15

The values of Cronbach's Alpha are acceptable for both scales if they are greater than the minimum acceptable value of 0.6. Furthermore, the value of the average inter-item correlation is greater than the minimum acceptable value of 0.3. However, the table above shows Cronbach's Alpha of 0.511 and Average inter-item correlation of 0.081, which is lower than acceptable Cronbach's Alpha and average inter-item correlation of 0.6 and 0.3 respectively.

Results

Views on different aspects of water infrastructure and access to water



	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15
Strongly agree	77	56	3	65	77	65	68	58	52	41	12	35	8	52	82
Agree	18	36	6	23	17	33	27	35	33	30	9	58	17	40	15
Neither agree nor disagree	5	3	9	6	5	0	3	6	12	12	14	3	40	3	3
Disagree	0	2	44	2	2	0	2	2	3	12	29	0	26	3	0
Strongly disagree	0	3	38	5	0	2	0	0	0	5	36	3	9	2	0

Figure 2: Summary of responses to items measuring views on different aspects of water infrastructure and access to water (n = 66)

Describe the results overall and not per item. An example is: Under a third of the respondents are agreeing to 3 of the 4 items and 40-50% are in agreement. The pattern of responses however are different for the third item were almost 70% are agreeing. Start from general picture to the slightly specific. (This is not the time to be linking with literature_ you do that in the discussion session)

Descriptive statistics for views on different aspects of water infrastructure and access to water.

Table 6: Descriptive statistics for views on different aspects of water infrastructure and access to water (n = 66)

	Mean	Std. Deviation	N
D1	4.71	.555	62
D2	4.37	.891	62
D3	1.90	1.020	62

D4	4.42	1.033	62
D5	4.69	.642	62
D6	4.60	.664	62
D7	4.63	.607	62
D8	4.50	.695	62
D9	4.34	.809	62
D10	3.98	1.180	62
D11	2.31	1.398	62
D12	4.24	.803	62
D13	2.85	1.069	62
D14	4.37	.834	62
D15	4.77	.493	62

Based on the summary statistics supplied in Table 6, responses on views on different aspects of water infrastructure and access to water are centered around neutral to slightly positive, with M = 47.1% SD = 55.5%. (summarise the table above)

Place of residence * Access to water (D4)

Crosstab

Count

		D4					
		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Total
Place of residence	Lonsdale	0	1	1	1	5	8
	Ga-Phaka	0	0	0	0	4	4
	Juno	0	0	0	0	7	7
	Prospect	0	0	0	0	2	2

	Tibanefontein	0	0	1	2	5	8
	Kgabo Park	0	0	0	5	3	8
	Cloetesdam	0	0	0	1	2	3
	Kordon	0	0	0	1	2	3
	Vlakfontein	2	0	0	0	1	3
	Boratapelo	0	0	2	1	1	4
	Moetagare	0	0	0	1	1	2
	Ramalapa	0	0	0	0	1	1
	Mamphulo	0	0	0	0	1	1
	Kgomoschool	0	0	0	0	2	2
	Mahoai	0	0	0	2	0	2
	Mpone	0	0	0	0	1	1
	Ntlolane	0	0	0	1	0	1
	Ga-matlala	1	0	0	0	4	5
	Ga-Mokobodi	0	0	0	0	1	1
Total		3	1	4	15	43	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	83.692[a]	72	.163
Likelihood Ratio	60.930	72	.821

Linear-by-Linear Association	.588	1	.443
N of Valid Cases	66		

Using Chi-squared test X^2 (72) =83.692, p = 0.163, since the p>0 0.05. This implies that there is no association between access in water and place of residence.

Place of residence * Grant recipients

		Grant				Total
		Children grant	Employed	Pensioner	Unemployed	
Place of residence	Lonsdale	1	4	0	3	8
	Ga-Phaka	1	2	1	0	4
	Juno	1	6	0	0	7
	Prospect	0	1	0	1	2
	Tibanefontein	0	7	0	1	8
	Kgabo Park	0	5	0	3	8
	Cloetesdam	2	1	0	0	3
	Kordon	1	2	0	0	3
	Vlakfontein	1	2	0	0	3
	Boratapelo	1	3	0	0	4
	Moetagare	0	2	0	0	2
	Ramalapa	0	1	0	0	1
	Mamphulo	0	1	0	0	1
	Kgomoschool	0	0	1	1	2

	Mahoai	0	0	2	0	2
	Mpone	0	1	0	0	1
	Ntlolane	0	1	0	0	1
	Ga-matlala	0	5	0	0	5
	Ga-Mokobodi	0	0	0	1	1
Total		8	44	4	10	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	82.299[a]	54	.008
Likelihood Ratio	61.850	54	.216
Linear-by-Linear Association	.023	1	.880
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =82.299, p = 0.00, since the p<0 0.05. This implies that there is an association between grant recipients and place of residence.

Place of residence * Employment status of respondents

		Employment status of respondents				
		Formal	Informal	Unemployed	Pensioners	Total
Place of residence	Lonsdale	5	2	1	0	8
	Ga-Phaka	2	0	1	1	4
	Juno	4	2	1	0	7
	Prospect	1	1	0	0	2
	Tibanefontein	6	1	1	0	8
	Kgabo Park	4	0	3	1	8
	Cloetesdam	1	1	1	0	3
	Kordon	2	0	1	0	3
	Vlakfontein	2	0	0	1	3
	Boratapelo	3	0	1	0	4
	Moetagare	2	0	0	0	2
	Ramalapa	1	0	0	0	1
	Mamphulo	1	0	0	0	1
	Kgomoschool	0	1	1	0	2
	Mahoai	1	0	0	1	2
	Mpone	0	1	0	0	1
	Ntlolane	1	0	0	0	1
	Ga-matlala	2	1	2	0	5

	Ga-Mokobodi	1	0	0	0	1
Total		39	10	13	4	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	42.717[a]	54	.866
Likelihood Ratio	42.390	54	.874
Linear-by-Linear Association	.192	1	.662
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =42.717, p = 0.866, since the p> 0.05. This implies that there is no association between employment status and place of residence.

Place of residence * Marital status

		Marital status				
		Single	Married	Divorced	Widow	Total
Place of residence	Lonsdale	0	8	0	0	8
	Ga-Phaka	0	4	0	0	4
	Juno	4	2	0	1	7
	Prospect	2	0	0	0	2

	Tibanefontein	5	2	0	1	8
	Kgabo Park	4	3	0	1	8
	Cloetesdam	2	1	0	0	3
	Kordon	2	1	0	0	3
	Vlakfontein	0	3	0	0	3
	Boratapelo	0	3	0	1	4
	Moetagare	1	1	0	0	2
	Ramalapa	0	1	0	0	1
	Mamphulo	1	0	0	0	1
	Kgomoschool	0	2	0	0	2
	Mahoai	0	2	0	0	2
	Mpone	1	0	0	0	1
	Ntlolane	0	1	0	0	1
	Ga-matlala	4	0	1	0	5
	Ga-Mokobodi	0	1	0	0	1
Total		26	35	1	4	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	55.005[a]	54	.436
Likelihood Ratio	60.362	54	.257

Linear-by-Linear Association	.398	1	.528
N of Valid Cases	66		

Using Chi-squared test X^2 (54) =55.0, p = 0.436, since the p> 0.05. This implies that there is no association between marital status and place of residence.

Place of residence * Formal

		Formal		Total
		Informal employment	Formal employment	
Place of residence	Lonsdale	4	4	8
	Ga-Phaka	3	1	4
	Juno	1	6	7
	Prospect	0	2	2
	Tibanefontein	2	6	8
	Kgabo Park	4	4	8
	Cloetesdam	2	1	3
	Kordon	1	2	3
	Vlakfontein	1	2	3
	Boratapelo	1	3	4
	Moetagare	0	2	2
	Ramalapa	0	1	1
	Mamphulo	0	1	1
	Kgomoschool	1	1	2

	Mahoai	2	0	2
	Mpone	0	1	1
	Ntlolane	0	1	1
	Ga-matlala	2	3	5
	Ga-Mokobodi	0	1	1
Total		24	42	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.057[a]	18	.589
Likelihood Ratio	19.647	18	.353
Linear-by-Linear Association	.303	1	.582
N of Valid Cases	66		

Using Chi-squared test X^2 (18) =83.692, p = 0.589, since the p> 0.05. This implies that there is no association between sector of employment and place of residence.

Salary * Level of education. Crosstabulation

Count

		Level of education								
		No qualification	Primary	Secondary	Matric	Tertiary	Diploma	Degree	Post graduate	Total
Salary	<500	0	0	0	0	0	1	0	0	1
	600 – 1000	0	1	2	0	0	2	0	1	6
	1100 – 1500	0	1	1	0	0	1	0	0	3
	1600 – 2000	0	0	0	0	0	1	0	0	1
	3100 – 3500	0	0	0	0	0	1	0	2	3
	3600 – 4000	0	1	0	1	0	0	0	1	3
	4600 – 5000	0	0	0	2	0	1	0	0	3
	> 8000	0	1	0	16	2	3	5	1	28
	Not indicated	1	0	3	7	0	5	1	1	18
Total		1	4	6	26	2	15	6	6	66

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	62.832[a]	56	.247
Likelihood Ratio	60.682	56	.311
Linear-by-Linear Association	.145	1	.703
N of Valid Cases	66		

Using Chi-squared test X^2 (56) =60.68, p = 0.311, since the p> 0.05. This implies that there is no association between level of education and income. Therefore education does not affect income.

Appendix 3: Letter of request to Aganang Municipality (First request).

Matlou Lesley Mokgobu
Telephone: 082 403 0689
Email Address: mokgobul72@gmail.com
P.O Box 119
JUNO
0748
01 October 2014

The Municipal Manager
Aganang Municipality
P.O Box 990
JUNO
0748

Dear Sir/Madam

APPLICATION FOR CONDUCTING RESEARCH IN AGANANG MUNICIPALITY

I wish to apply for permission to conduct research in your municipality through in-depth interviews with government officials working for the Aganang Municipality.

I am currently a postgraduate student in Management Sciences at Durban University of Technology. I would like to investigate "The Impact of Turnaround Time in the Repair of Water Infrastructure in Aganang Municipality".

This research is important to the municipality and the community at large because it will therefore contribute to our understanding of service delivery from different perspectives in this particular municipality.

I furthermore request permission to conduct interviews with your staff members and to distribute questionnaires.

Thank you for your cooperation.

Yours sincerely

[redacted]
Matlou Lesley Mokgobu.

Cell: 0824030689/ 0824173612
Email: mokgobul72@gmail.com

OFFICE OF THE MUNICIPAL MANAGER
AGANANG MUNICIPALITY
[redacted]
2014 -10- 0 1
P.O. BOX 990 JUNO 0748
LIMPOPO PROVINCE

Appendix 4: Letter of request to Aganang Municipality (Second request).

Appendix B (Gate keeper's letters)

Matlou Lesley Mokgobu
Telephone: 082 403 0689
Email Address: mokgobul72@gmail.com
P.O Box 119
JUNO
0748
13 May 2016

The Municipal Manager
Aganang Municipality
P.O Box 990
JUNO
0748

Dear Sir/Madam

APPLICATION FOR CONDUCTING RESEARCH IN AGANANG MUNICIPALITY

I wish to apply for permission to conduct research in your municipality through in-depth interviews with government officials working for the Aganang Municipality.

I am currently a postgraduate student in Management Sciences at Durban University of Technology. I would like to investigate "Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo".

This research is important to the municipality and the community at large because it will therefore contribute to our understanding of service delivery from different perspectives in this particular municipality.

I furthermore request permission to conduct interviews with your staff members and to distribute questionnaires.

Thank you for your cooperation.

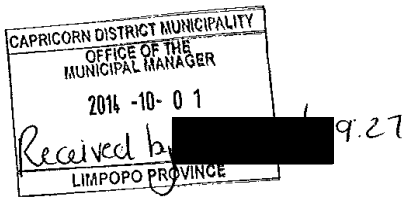
Yours sincerely

[redacted]

Matlou Lesley Mokgobu.

Cell: 0824030689/ 0824173612
Email: mokgobul72@gmail.com

Appendix 5: Letter of request to Capricorn District Municipality (First request).



Matlou Lesley Mokgobu
Telephone: 082 403 0689
Email Address: mokgobul72@gmail.com
P.O Box 119
JUNO
0748
01 October 2014

The Municipal Manager
Capricorn District Municipality
P.O Box 4100
POLOKWANE
0700

Dear Sir/Madam

APPLICATION FOR CONDUCTING RESEARCH IN CAPRICORN DISTRICT MUNICIPALITY

I wish to apply for permission to conduct research in your municipality through in-depth interviews with government officials working for the Capricorn District Municipality.

I am currently a postgraduate student in Management Sciences at Durban University of Technology. I would like to investigate "The Impact of Turnaround Time in the Repair of Water Infrastructure in Aganai Municipality".

This research is important to the municipality and the community at large because it will therefore contribute to our understanding of service delivery from different perspectives in this particular municipa

I furthermore request permission to conduct interviews with your staff members and to distribute questionnaires.

Thank you for your cooperation.

Yours sincerely

[redacted]

Matlou Lesley Mokgobu.

Cell: 0824030689/ 0824173612
Email: mokgobul72@gmail.com

Appendix 6: Letter of request to Capricorn District Municipality (Second request).

Matlou Lesley Mokgobu
Telephone: 082 403 0689
Email Address: mokgobul72@gmail.com
P.O Box 119
JUNO
0748
13 May 2016

The Municipal Manager
Capricorn District Municipality
P.O Box 4100
POLOKWANE
0700

CAPRICORN DISTRICT MUNICIPALITY
OFFICE OF THE MUNICIPAL MANAGER
2016 -05- 13
Received by [redacted]
LIMPOPO PROVINCE

Dear Sir/Madam

APPLICATION FOR CONDUCTING RESEARCH IN CAPRICORN DISTRICT MUNICIPALITY

I wish to apply for permission to conduct research in your municipality through in-depth interviews with government officials working for the Capricorn District Municipality.

I am currently a postgraduate student in Management Sciences at Durban University of Technology. I would like to investigate "Challenges of the Repairs and Maintenance of Water Infrastructure in Aganang Municipality in the Province of Limpopo".

This research is important to the municipality and the community at large because it will therefore contribute to our understanding of service delivery from different perspectives in this particular municipality.

I furthermore request permission to conduct interviews with your staff members and to distribute questionnaires.

Thank you for your cooperation.

Yours sincerely

[redacted]

Matlou Lesley Mokgobu.

Cell: 0824030689/ 0824173612
Email: mokgobul72@gmail.com

Appendix 7: Editing certificate

N J Nel
PO Box 365,
BENDOR PARK
0713
Tel: 0741849600

CERTIFICATE

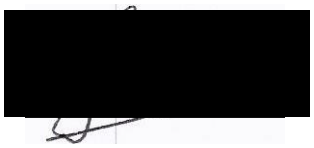
This serves to certify that I have language edited the Dissertation of

Mr Matlou Lesley Mokgobu,

Student number: **21143673**

entitled:

"THE CHALLENGES OF REPAIRS AND MAINTENANCE OF WATER INFRASTRUCTURE IN AGANANG MUNICIPALITY IN THE PROVINCE OF LIMPOPO"



N J Nel

Lecturer of English, Department Applied Languages
Tshwane University of Technology
(Retired)
31/ 10/ 2017

Appendix 8: Turnitin Originality Report