A waste site production-based analysis of the informal waste recycling sector

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DECLARATION

I, LUCKY LAZARUS MOTLHOKI (Student number: 23333502), hereby declare that this research is my original work. Unless specifically stated, all the references contained in this study have been duly acknowledged. The work in this dissertation is a record of work that has been done by me and has not been previously accepted for any higher degree or professional qualification at any other educational institution. I further more grant that copyright of the dissertation in the favour of the North West University (Mahikeng Campus**).**

Signed ……..

LUCKY MOTLHOKI

Date……..

Thesis has been submitted with my approval as a university supervisor and I certify that the requirements for the applicable MSc degree rules and regulations have been fulfilled**.**

Signed ……

PROF. T.M. RUHIIGA

Date ……..

DEDICATION

I dedicate my dissertation to my twin boys Orearabile and Oreneile who always encouraged and persuaded me to work hard and achieve my dream for higher education. They have always created an environment of asking how far am I with my studies and when do I graduate. I belief this will be positive encouragement for their future to advance in education as I have set an example for them. Second, I dedicate this work to my beloved wife, Annah Seleke Motshoane who made it possible for me to complete the work. I will not forget my brother in law Jimson Galebodiwe Motshoane who has been an inspiration and undivided support for this study since the initial planning to study further. I want to thank my friend Lucky Steenkamp for being supportive and his assistance to make data collection a reality for the study.

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ABSTRACT

The study set out to understand the dynamics of the production process of the informal waste recycling, using selected landfill sites in local municipalities in the North West Province. The purpose of the study was to assess informal waste recycling from the point of participants. Stratified random sampling applied to the selection of landfill sites followed by normal random sampling for participants at each of the landfill sites in the sample. Primary data was collected through site observations followed by the administration of interviews to selected respondents. Data analysis included the use of Excel™ descriptive statistics which were further run through Pearson's correlation and regression. Using y=income per week, the results indicated an r=.522 for grade 10 education, an adjusted R-square=22.1% and an F-ratio=4.912. There were no major differences in income for all respondents, the gender participation results displayed a high percentage of females, general participation rates are increasing each year, mean income per respondent is affected by the type and quantity sold, reducing the volumes of waste hauled to the landfill sites and create sustainable market by commercialization of the sector. The informal recycling sector is poorly understood and lacks recognition. In addition, critical constraints are on a lack of formalization, absence of waste pickers' cooperatives and limited official support from municipalities. The findings indicate that: participants operate as individuals with hardly any structures in place to represent their common interests. It is noted that education appears to be a major determinant of the likelihood of participation. Participation is spread across both females and males with marital status playing an insignificant role.

TABLE OF CONTENTS

4.1 LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ANOVA	Analysis of Variance
CAD	Computer Aided Design
CBO	Community based organization
DEA	Department of Environmental Affairs
DTI	Department of Trade and Industry
GDP	Gross Domestic Product
HL 1	White paper
IV	Income Value
IWMP	Integrated Waste Management Plan
MRF	Material Recovery Facilities
MSW	Municipal Solid Waste
NEMA	National Environmental Management Act
NWMS	National Waste Management System
NWP	North West Province
PET	Clear bottles
PLM	Mix plastics
PP	Polyprop
READ	Rural Environment Agriculture Department
SA	South Africa
SAWIC	South African Waste Information
SPSS	Statistical Programme for the Social Sciences
TPP	Total population of participants
UBC	Cans
UR	Unemployment Rate

DEFINITION OF CONCEPTS

Domestic waste: waste produced by households

Dumps: waste collection sites that are not designated as such but where the public dumps its waste

Industrialisation: is the period of social and economic change that transforms a human group from an agrarian society into an industrial one.

Landfill: is a site for disposal of waste materials by burial.

Leachates: is any liquid that is passing through matter, extracts solutes, suspended solids or any other component of the material through which it has passed.

Quantitative Method: a research method where systematic empirical investigation of social phenomena through statistics or mathematical techniques is applied.

Random Sampling: a subset of individuals chosen from a larger set.

Recycle: goods that can also be regarded as waste by some individuals but can be recycled.

Resource recovery: selective extraction of disposed materials for specific next use such as recycling.

Scavenging: refers to searching through for salvageable material; such as looking through waste storage bins for food.

Solid waste management: controlling the generation, storage, collection, transfer and transport, processing and disposal of solid waste.

Urbanisation: the physical growth of urban areas that results in migration and even suburban concentration of people into cities.

Waste: any substance, whether or not that substance can be reduced, re-used, recycled and recovered that is surplus, unwanted, rejected, discarded or disposed off

Waste characterisation: grouping wastes according to their characteristics and composition.

Waste generation: quantity of materials that enter waste stream before composition

Waste Management: the collection, transport, processing or disposal, managing and monitoring of waste materials.

CHAPTER 1: INTRODUCTION AND PROBLEM STATEMENT

1.1 Introduction

The informal sector waste recycling is today a global phenomenon involving participants in developing and developed countries. Such participants, though informal by definition, are engaged in the mainstream process of production. Production, as a process creates goods for the market and makes it possible for a diversity of services to be available. Any one engaged in this process therefore does make a contribution to a country's GDP. Urbanization in the developing world has resulted in increasing amounts of waste generated. Recovery and recycling of post-consumer waste material has become a new norm (Damiano, 2013). Significant research has since been carried out on waste recycling to improve the properties of materials, first to improve their lifespan (as in case of reusable materials such as batteries and other portable electric devices) and secondly to attempt to keep household hazardous waste out of solid waste stream and then manage these waste (Liyanage *et al*., 2015).

The intention is for countries to commit to sustainable development by balancing broader economic and social challenges, while protecting environmental resources. For South Africa, this commitment meant having a new approach towards raw materials, product design, waste prevention and minimizing waste (DEA, 2012). These programs have gained momentum worldwide (Cohen *et al*., 2015) and in South Africa recycling of household materials is equally gaining increased interest due to public awareness, economic benefits and availability of appropriate technology (ILO, 2012). However, the available research in the context of developing countries places much emphasis on poverty reduction, livelihoods and community resilience (Matter *et al*., 2015), without considering the production nature of recycling, with job creation as a by-product. In South Africa, thousands of both formally and informally qualified people compete for employment. In reality only few of them can find a formal employment in industry or formal economy. The remaining majority are forced to look elsewhere for employment or any means of income. As a result a sizeable number earn a living by recovering recyclable materials from households and garbage dumbs (Samson, 2012). Their activities are

hailed as beneficial to the environment and have an economic impact (Samson, 2016). Despite their good deeds, informal pickers remain inadequately regulated (Komane, 2014) and are not formally recognized by authorities (Scheinberg *et al*., 2016). Informal recycling does not have a legal status and informal waste pickers feel left out from the main stream economy albeit their work in contributing immensely to the growth of the economy and the environmental benefits they bring about.

These programs have gained momentum worldwide (Cohen *et al*., 2015) and in South Africa recycling of household materials is equally gaining increased interest due to public awareness, economic benefits and availability of appropriate technology (ILO, 2012). However, the available research in the context of developing countries places much emphasis on poverty reduction, livelihoods and community resilience (Matter *et al*., 2015). Such studies remain weak in their theoretical basis in respect of both production economics and sustainable ecosystem services. They do not present the activities around recycling as any other economic sector and hence deserving the same tools of economic analysis that all economic activities, formal and informal, should attract. Secondly, the emphasis on the activity as a short term survivalist strategy often fails to create space for rigorous analysis. Using the concept “sector” to exemplify an industry or part thereof, studies that treat the informal sector using conventional tools of analysis as a basis for understanding its financial feasibility and its environmental sustainability remain poorly subscribed.

1.2. Problem statement

The analysis of the informal sector waste recycling is based on the dynamics of the production process. Landfill sites provide a critical opportunity for observing waste collection, sorting and recovery. This underpins the structure and operations of the sector across time and location but it hardly features in local contemporary literature. Yet, such an approach should provide an alternative methodology for understanding the pathways of income, household economies, impact on the local labour market and the extent of commercialization of the waste recycling industry. It is highlighted that the recyclers are green workers who are contributing to the green economy (Samson, M.2010). This

approach is justified on the grounds that the proposed platform could provide new insights into assessing the financial feasibility .and environmental sustainability of the activity remains poorly researched today.

The use of production theory together with conventional tools of analysis in studying informal waste recycling is fairly new in South Africa. To merely conclude that the recycling is a short term survivalist strategy remains a simplistic approach. The sector is an industry that can contribute to the market and the environment. Informal waste recycling is an economic sector that is poorly understood, lacks legal recognition and is often not formalised. But as a sector of any local economy, its participants are engaged in the process of production. This implies the need to understand the factors of production that are input into the activity and the pathways into which the outputs of the process are redistributed. The underlying theory of production becomes critical here. In addition, there are spinoffs into market theory, the theory of labour and the theory of entrepreneurship. These are treated against a background of sustainable livelihoods and environmental health. The proposed study that houses the informal waste sector recycling into these multiple layers of production theory, sustainable livelihoods and environmental health has not yet been carried out locally here in South Africa. This study intends to address such knowledge gap.

1.3 Research Aim

The aim of the study was to analyse the elements of informal waste collection and recovery as a first stage in solid waste recycling sector in selected local municipalities in North West province.

1.4 Objectives

Objectives of the study are stated as follows:

1. To describe the state of solid waste recycling industry at the provincial and national scale
2. To characterize informal waste collection, sorting and recovery at landfill sites
3. To compute mean income levels of participants in informal waste recycling

4. To build pathways of flow-line diagrams of recycled waste
5. To suggest methods for improving the performance of the informal waste recycling sector

1.5 General hypothesis

One research hypothesis advanced for this study states:

H_1: Household income from informal sector recycling (y) depends on a set of socio-economic parameters (X_1.....X_n). The y-here becomes the response or dependent variable while the X's become the explanatory or independent variables. Income is computed on a weekly basis and expanded to generate a household monthly income and an annual income. The null hypothesis, H_0, is of the form $\beta=0$ which is the opposite of the research hypothesis where $\beta\#0$. The null hypothesis posts the view that the effect of the *x*'s on *y* is zero. Where data analysis produces an F-test value outcome that disputes this condition, the null hypothesis is rejected.

1.6 Study area

North West province is located on the border of Botswana. The province covers about 8.7% of South Africa's total land area, and has about 6.8% share of the population (Statistics, 2012).

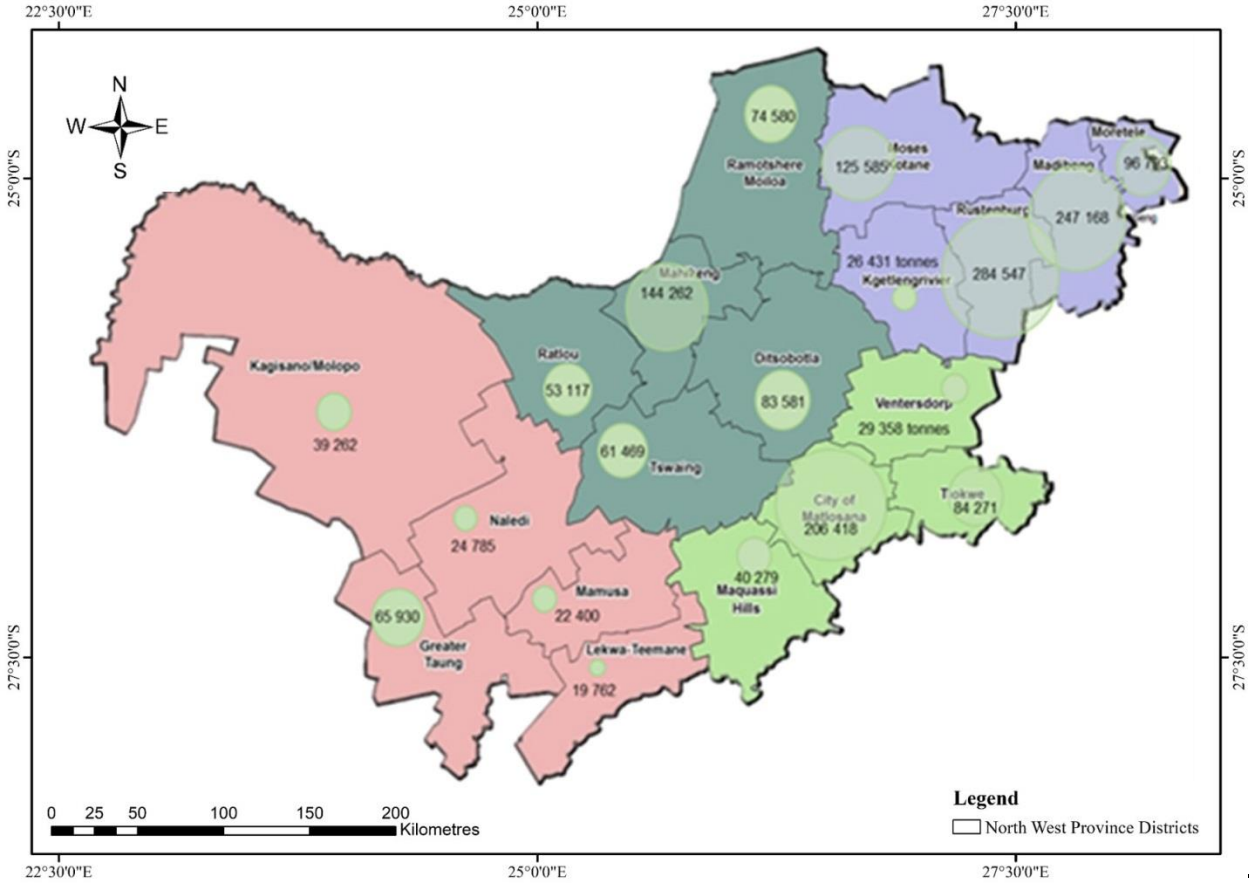

Figure 1. Estimated volume of waste generated, 2014
Source: Statistics from NW provincial IWMP review, 2015

1.7. Rationale

Informal sector waste recycling is today a global phenomenon involving participants in developing and developed countries. Such participants, though informal by definition, are engaged in the mainstream process of production. Production, as a process creates goods for the market and makes it possible for a diversity of services to be available. Any one engaged in this process therefore does make a contribution to a country's GDP.

1.8 Significance of the study

Once completed, this study should provide information to the national, provincial and local governments, researchers and informal waste pickers on the opportunities available in

considering landfill sites as a platform for economic development and sustainable ecosystem services. The data collected will provide concrete financially viable cases to prove that recycling of solid waste at landfill sites is an economic activity that requires further study and recognition. The information collected will add facts to the call for the formal recognition of informal waste pickers and show that informal recycling at landfills where solid waste is abundant has a reason to be considered as a sustainable economy.

1.9. Structure of the dissertation

The dissertation is structured in **(**5) five chapters as follows:

Chapter 1: Introduction and Problem statement

Chapter 1 provides an outline of the study. It contains information on how communities participate in the waste recycling sector. The mainstream process of production, recovery and recycling of post -consumer waste material. The significance of the research carried out on waste recycling and the intention of countries to commit to sustainable development while protecting the environment. The chapter looks into the South African context of both formally and informally qualified people compete for employment, and programs in South Africa of recycling household materials.

Chapter 2: Literature Review

This chapter reviews numerous journal articles of waste management and documentation of recycling on how to impact on the economy with new programs. It looks at the problem of waste in the worldwide and the emergence of solid waste management as a problem for policy makers in developing countries.

Chapter 3: Methods of Investigation

This chapter includes the research design, population, unit of analysis, sampling, data collection and application of analytical techniques**.**

Chapter 4: Results and Discussion

This chapter give results and discussion of the study.

Chapter 5: Conclusion and Recommendations

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews numerous journal articles concerning waste management approaches all around the world. It covers how waste is addressed in different countries in terms of handling, classification, MSW management practices, policies and the amount of waste generated. In South Africa landfill sites are constructed to keep waste from various households. More than 97 million tons of waste is disposed at landfills of which 10% was recycled (DEA, 2012). Recycling is documented to have positive impact on the economy with new programs now focused on assisting waste pickers (DEA, 2016). For the urban poor in developing countries, informal waste recycling is regarded as a common way to earn income. Incorporating waste pickers into solid waste management and recycling programs can be socially desirable, economically and environmentally sound. In the world, the economic impact of these activities is huge being estimated at R1 billion a year in Mumbai, India. In Jakarta it produces an economic impact of more than $50 million a year, and $178 million a year in Buenos Aires (DTI, 2012).

The problem of waste is not limited to Africa, or South Africa, it is a worldwide problem. The amount of waste generation comes with increasing population associated with change in the production and consumption patterns of consumers. To remove this waste all countries are agreed that waste pickers play a vital role but there are no decisive measures in dealing with their incorporation as an informal sector (Samson, 2015). Literature on sustainable development and world ecology shows that the use of landfills to keep waste out is not sustainable. This remains true because new hazards and other dangerous gases are formed which if not controlled or harvested pose a health hazard (Mohamed *et al.*, 2015). Recycling still has challenges of perception with people perceiving it as a poor man's work so much that government had to introduce levies to improve re-use and recycling (DEA, 2016).

In the South African specific context, there is a lack of literature to reflect on how effective these recycling processes and the necessary data on solid waste management are. In the North West municipalities there are no formal measurements to determine waste

generation per capita and thus producing only estimates. Through both literature review and case studies this research will provide new body of knowledge on actual data and the role played by informal pickers in waste management and how that role can be optimized.

Solid waste management is emerging as a major problem for policymakers in developing countries as the quantity of solid waste generated has increased significantly and its characteristics have changed due to people's lifestyles. However the capacities of developing countries to collect, process, dispose and reuse waste in a sustainable manner is highly limited (Liyanage *et al.,* 2015). Study results show recycling can impact garbage, recycling percentages and determine environmental and economic impact on collection systems (Maimoun *et al.,* 2016). Reduction of waste remains a critical process of sustainable management. Worldwide the use of informal pickers has played and continues to play a major role in recycling. They are acknowledged to have a positive environmental impact while providing income for them. In South Africa, there are plans in place to incorporate informal pickers into municipalities and formalize-their trade through co-operatives (DEA, 2016).

The other side of the coin holds where informal pickers are making a profitable business and which could track more into the future (Aljaradin *et al*., 2015). The integration of informal pickers will have to be matched with new work ethic, safety issues to avoid the high risk of infection and disease transmission which they are not aware of. This is true because they work at landfill sites without safety attire and worse so, some sleep at infection prone waste dump sites.

2.2 Overview of informal waste recycling

The informal recycling sector worldwide offers significant potential for employment creation (Samson, 2016, Reynecke, 2012). This potential has remained untapped because of legal challenges and regulatory framework (EP, 2016). The current set up of waste management in South Africa does not provide for sorting of recyclable material at source. In the absence of waste transfer stations (READ, 2016) the bulk of the waste is sent landfill sites. These sites, however, do not have material recovery facilities (MRF) to

divert recyclable material (Donaldson *et al*., 2010). Despite all the challenges facing recycling, waste is a means of earning an income for the unemployed urban and rural households. A new term namely 'waste economy', refers to the economy for the poor households who earn a living through recycling, has been developed.

As early as the beginning of the twentieth century, solid waste and its management has received attention from both academics and governments (Liyanage *et al.,* 2015). The main theme of attention has been the role and the potential of the informal economy in waste management. First, the studies on household characteristics suggest that waste pickers' profits are a key source of household income (Mkhize *et al.,* 2014). This further shows that waste pickers sell their products to the formal economy whereby waste that is collected is actually sold to formal enterprises such as middle-men and recycling companies. In short, their efforts have a value-addition to the economy. Secondly, every person can join the recycling business without prejudice in the sector. Recycling has become an occupation for a significant segment of the urban population (Nwosu *et al.,* 2015). Families depend on the products of recycling. It is open to the young and the old. The work of recycling will exist in future due to existence of waste, high unemployment and the demand for recyclables. In supporting the work of informal recyclers, Aljaradin *e*t *al.,* (2015) asserts that the sector can lead to grass-root development, poverty alleviation and environmental protection.

In their study Mkhize *et al.* (2014) report that an average waste picker has a turnover of R1, 566 (US $119) over a month which is a very low figure given the number of hours worked on the landfill site. Sentime (2011) found that in Braamfontein, Johannesburg, the income generated by waste pickers ranged between R50 and R250 a day. The same study showed that male waste pickers tend to earn more than female waste pickers but there is potential to earn more if systems could be put in place. Mashego (2012) singled out the highest waste picker in a landfill site in Pretoria making a maximum of R600, a day. It is important to note that these amounts are not stable. Buy back centres (BBC's) do not offer the same price for the materials they buy (Benson & Vanga-Mgijima, 2010). A problem cited was unscrupulous behaviour by middle-men, for instance where they pay very low prices for the waste collected (Mkhize *et al*., 2014). The other challenge that

influences turnover is the problem of long distances to sell their waste at buy back centres and the low number of buyers for the waste collected. The most prevalent challenge is that competition for collecting waste has increased (Viljoen *et al*., 2012). The number of informal waste pickers is on the rise. But from a production perspective, such competition is good for the sector because it takes out of the system those not capable of adjusting to a changing market climate.

Turning to the EU countries, the state of recycling recovery activities are relatively at an advanced level. In line with several EU directives since 1995, waste legislation, sorting at source, regulation, permitting and strict reinforcement have in turn created the widespread practice of illegal toxic waste dumping (Mazza et al, 2015). This is radical change from the past were most functions of municipal solid waste management were focused on removing waste and cleaning the streets, thus creating the dumpsites where waste was buried at huge cost. The role of waste pickers has not been acknowledged before. Several studies state that since 2006, informal recycling has kept out millions of tonnes of waste from landfill sites, saving the cities and households money, reducing greenhouse gas formation and supporting thousands of families worldwide (Wilson *et al.,* 2015; Scheinberg *et al*., 2016).

Acknowledging that recycling lies high in the value- chain of waste management, has led to informal recycling economy finding its space on the international agenda again (GIZ, 2015). Governments are gradually embracing the challenge of minimizing the waste that goes to the landfill sites through contracted workforce that collects recyclables (Mudau, 2015). However the amount of waste that they collect is far too small compared to what can possibly be collected. As this legislative requirement increases (for waste to be reduced) the municipalities are facing new pressures of seeking ways and means of collecting waste. They are gradually beginning to contend with the realities of facing dirt and real waste. The process has shown that the municipal authorities have little experience in prevention and recycling. In fact it requires consorted interest to meddle in the dirty business of the informal recycling economy. But a far more serious shortcoming seem to relate to the unwillingness of governments in developing countries in general to

invest in infrastructure necessary to sustain a modern waste delivery service (Ruhiiga, 2013a).

A perspective on informal waste recycling sector continues to be disorganized in Africa and remains a subject of negative perception (Nwosu *et al.,* 2015). In the absence of formal employment opportunities exacerbated by increasing rural and urban poverty, informal recycling has become a means of survival throughout the world (Deme, 2016). Without legal recognition where their trade is formalized, many municipalities do not recognize waste pickers at their landfill sites as they mostly work illegally, without express permission. Waste pickers normally work for very long hours and often spend time with their families (Mkhize *et al*., 2014). Municipal solid waste becomes their resource to enhance their wellbeing and reduce poverty. They usually perform their work in a very primitive way without any protective clothing or measures to their health and safety. They are exposed to hazards and unhealthy work place environment which, it seems, they are aware of (Aljaradin, 2015). This can easily lead to high risk of infection and possible disease transmission.

This interest supported by population growth in major cities around the world, has paved the way for growth in the informal economy. People who cannot find employment in the formal economy are now taking advantage of the inevitable potential of informal sector activities and their income generating potential (Schenck *et al.,* 2016). South Africa's informal economy, in particular in recycling has also become the place where significant numbers of people are trying to make a living in urban areas.

The income status of informal waste recycling pickers does not require specific qualifications but it would be unfortunate not to appreciate the skills that they develop through their experience. In time they develop knowledge that is essential for transforming landfill wastes into resources, which can be sold as inputs into the formal economy (Samson, 2015). Literature suggests that waste pickers are aware of what to collect, who to sell to and at what specific time. Buyers who purchase recyclable materials from

reclaimers also become active in assisting them to identify specific materials that they would buy from them, creating a new form of a symbiotic relationship.

As individual reclaimers became more adept at selecting and sorting the right materials, their incomes improved significantly and in some cases doubling from week to week as their skills progressed. Informal waste pickers also have learned to watch how prices changed and to shift materials receiving higher prices (Samson, 2015: 819). The knowledge gained, in time, through exposure to waste recycling results in infusing new value into the items cast aside as waste. Informal waste pickers have experience, contacts, expertise and above all interest to trade in the highly commercialized world of trading materials in the value chain (Scheinberg *et al.,* 2016).

Worldwide there is little willingness to acknowledge that informal activities are positively affecting solid waste and recycling systems in every country. Yet the numbers of waste pickers are sky-rocketing. People are finding economic refuge in informal recycling where they are not subjected to outright exclusions. Formal recycling is high end and to a large scale requires some form of qualification(s) to be considered for employment. Informal recycling and re-use activities are like a double-edged sword. They are seen as cause of health, safety and environmental problems and on the other hand they are a significant resource for cities and regions to improve recovery and re-use of materials.

To some degree municipal authorities can reduce the risks facing informal waste pickers through making available mobile clinics. Informal recycling and reuse material are encountering increasing competition for recyclable and reuse material coming from formal recycling industries and the space for legal operations is closing (Scheinberg *et al.,* 2016). Elsewhere formal second-hand shops, flea markets, are seeking to legitimize informal re-use operators stimulating a struggle for right to continue to commercialize re-usable. Waste pickers are in an increasingly difficult economic environment that is constraining their ability to keep their enterprises viable. The majority of waste pickers cite the lack of access to waste as a constraint (MKhize *et al.,* 2014). Waste management views the acts of informal pickers as making a mess, when extracting valuable material from bins and they make the streets dirty. This also applies to European countries where private

companies are paid per tonne, and they see any collection as theft of waste because it reduces the amount of waste to be collected.

Public participation is the driver of personal high esteem. It is a means of validation. Public view and voice influence our lives and actions. Reference to waste pickers differ from one country to another and how they are defined or called is influenced by the broader community. They are often called vultures, parasites, scavengers and in Egypt, (CID Consulting, 2008). The trade of informal waste pickers is carried out in public especially in opulent areas where there is higher quality garbage in which to find recyclable material. They have to contend with public gaze and the feeling of shame and humiliation. In responding to these emotional rejections waste pickers get accustomed to humiliation or find ways to cope with it (Dinler, 2016).

The humiliation does not decrease, but waste pickers develop “thick skin” to absorb the abuse and create a mind-set of pride in their work, saying it’s better than resorting to crime. Social issues related to stigma of trade and perceptions of society make the work of informal waste pickers difficult and uninviting. Handling garbage is not an attractive occupation, neither physically nor culturally and worse it is not an inspiring option for labourers. People do collect waste only so that they can make ends meets or earn a living.

Economic and environmental benefits in terms of the role in informal recycling by waste pickers’ saves municipalities money by reducing the amount of waste that was destined for landfill sites. In so doing they save the municipalities money that could be used for collection, transportation and compacting at landfills. The development of the informal waste-picking economy has the potential to generate an income for waste pickers and to create secondary opportunities for others such as recyclers and those who convert garbage to usable good (Donaldson *et al*., 2012). Waste picking activities reduce the amount of waste in landfill sites, thereby saving space and prolonging the lifespan of the sites.

The function of recycling frees up capital that could otherwise be spent on having to commission landfill sites or to buy new fleet responsible for waste collection. Informal

recycling contributes to the process of chain supply management, by providing recycled materials that are far less costly than virgin materials (Donaldson *et al*., 2012) and the amount of energy input required to recycling is less than the energy required for obtaining virgin raw materials, lowering the cost of the industry's operations.

Waste pickers composting activities also divert organic waste away from dumps and landfill sites, reducing the generation of greenhouse gases (GHGs) like methane. Source reduction and recycling can reduce GHG emissions at the manufacturing stage, increase forest carbon sequestration and avoid landfill methane emissions. Recycling of recovered material serves to protect natural resources and the environment (Aljaradin *et al*., 2015). Using recycled paper makes the product cheaper than the paper generated from pulp wood. The benefits of using recycled material bring in more value from informal pickers as they save industry a lot of costs for fuel and transport. Practically all the local authorities spend more than 80% of their budgets on collection and transportation of the refuse. From which a significant amount goes to salaries, allowances, wages, and maintenance as well as fuel costs. Most rural municipalities cannot afford to spend money on disposal, they lastly dump waste without spreading and compaction (Liyanage, 2015:66).

The accumulation of uncollected waste in public places and improper handling during transportation have resulted in major health and safety issues. Rodents are attracted to waste in dumps and spread communicable diseases, such as cholera and dengue fever. Using the waste pickers can minimize the problems associated with uncollected waste, considering the above information, it is very clear that waste pickers have a greater role to play in management of waste.

The concept is that informal recycling should generate its livelihood and sustain itself and the families by retrieving reusable and recyclable materials from the waste stream typically from the streets, garbage bins and garbage dumps. In doing so, it forms an essential service and is an integral, although frequently unacknowledged, part of the waste management systems in the cities where it works (Komane, 2014; 4).

Table 1: Classification of informal waste pickers

Occupation	Features found in Europe	Characteristics
1. Occupation 1 :Waste Pickers	Collect materials on foot, or with tricycle or motor cycle with a cart from street set out containers, illegal and legal dumps	Both recyclables and re-suable, they do not usually specialize.
2. Occupation 2: Itinerant waste buyers/ collectors	IWB's move along a routine and trade directly with household and business waste generators, buying recyclables and offering a private collection service	They are more likely to get materials as a donation. Variation is also to perform some paid service, like cleaning out an attic or helping with moving house, and have the right to take materials.
3. Occupation 3: Small dealers or small junk shops	First level of mobile of stationery traders who buy from waste pickers and IWC's. Premises are often without permits, and attracts fines from zoning officers.	A European variant's second hand traders who buy and upgrade or repair materials, evaluate whether they can market them into upper levels and antique markets and then sell them.
4. Occupation 4: Second hand operators	Not considered part of the informal recycling sector in countries like Brazil and India for own use is a common supplement to waste picking for recycling.	In Europe, re-usable are picked by street and container pickers, IWC's traders, transporters and merchants, and include those specialized in direct sales of re- usable via pop-up then stalls in formal markets and concession shops.
5. Occupation 5: second hand collectors, herders	Collectors of food waste and spent frying oil for animal feeding or soap. A common variant is to graze livestock on official dumpsite or unofficial waste heap.	Grazing of pigs on village dumps is common will or spent oil collection in Europe is usually an activity of formal sector.

(Source: Scheinberg *et al*. 2016:825)

They function in the informal sector of waste management collecting recyclable materials gathered from waste and sell the material to earn their living. At the moment there is no universally accepted name for waste reclaimers. References made to waste pickers differ from one country to another, being influenced by perceptions of the broader community. Samson (2010) describes waste pickers as people who reclaim reusable and recyclable material from what others have cast aside or throw away as waste. At the first world conference focusing on waste pickers held in Bogota, Colombia in 2008, it was universally

agreed to uphold the name “waste pickers” as it was seen to capture more broadly without a negative connotations the work of people involved in the collection phase of the recycling industry (WIEGO, 2011).

Recycling occurs at two main fronts, the informal and the formal economy. At the informal level, the economy is driven by 1% of the world population, owing to lack of formal education or paperwork, poverty and lack of employment opportunities. Formal recycling refers to those that are responsible for buying, processing and re-use of solid waste. Informal waste pickers live by primary extraction of discarded items or material from disposal points, and then sell them to the value chains. In Europe informal waste pickers are recognized and they are classified into five (5) occupations with specific features, (Scheinberg *et al*., 2016:825) in Table 1.

Municipalities have few material recovery facilities that are comprehensive to sort a waste and explore to create benefits including employment creation and income generation. The economic, social and environmental value currently provided as a free service by waste pickers requires a sustainable model to support them, by addressing issues such as environmental hazards and health safety. This support may include a formation of cooperatives or private-public partnerships with municipalities. Informal waste pickers can learn how to improve the quality of their lives (Donaldson *et al.,* 2012; Roberts, 2012; Quazi & Dobson, 2013). For their visibility, municipals can assist them with uniforms which will be relatively cheaper than having to invest on creating new Material Recovery Facilities (MRF). Sorting at source requires massive capital injection to procure fleet and new plastics or bins which might take forever over competing economic and social issues. For a pilot project municipalities may select areas where sorting at source happens with clearly marked containers. This process will surely require society buy-in where citizens are informed of the benefits of recycling. A specific co-operative should be allowed to collect at those particular points.

However, waste has always become a by-product of human interactions with life and nature. As populations increase waste has also registered exponential growth so much that it became a new cost consumer for municipalities. New vehicles and bulldozers had to be purchased to simply collect and bury waste in landfill sites. The current situation is

unsustainable for development and the costs of commissioning a new landfill are just too high. The European commission in order to respond to the damaging effect of dumping and harming the environment agreed that materials should be recycled and the amount of waste headed for the landfill sites must be reduced to become zero. Secondly the industries had to find ways to ensure that materials used in making raw materials are sustainable, re- usable and recyclable. This allowed for waste that is generated to be re-introduced into the economic cycle.

2.3 The extent of informal waste pickers in SA

Waste picker's prevalence in South Africa is nearly impossible to determine. First because they are unregistered and unregulated (Schenck *et al.,* 2015), secondly they are either career or transient waste pickers (Benjamin 2007; Schenck *et al*., 2012). For the latter, they separate between the waste pickers who work long periods of time and are acknowledgeable about their activities of scavenging waste to earn a steady income and those who periodically visit the landfill sites for specific purposes at specific times. Given these circumstances, waste picker numbers can only be estimated. The number is estimated from 37 000 waste pickers to 77 000 in 2012, (Schenck *et al*., 2012) and Komane (2014) suggesting an estimated 88 000 waste pickers operating in South Africa. Despite these numbers being estimates, they provide a confirmed increase on activities of waste recycling in South Africa and the growth of the Informal economy worldwide.

At the National level, the South African government has committed to the process of recycling and that recycling can help to sustain the livelihoods of the urban poor communities. In this regard the National Environment Management Act 59 of 2008, (NEMA) and National Waste Management Strategy (NWMS) have provided space for entrepreneurs to function through the support of government. Most studies carried out emphasize that there are no barriers to entering waste picking. No skill or education is required in informal recycling and any person can do it for a living or to augment their income (Viljoen et al., 2012). The same studies agree on the vast opportunities that waste picking provides for the people to survive and make a living, and calls on government to intensify strategies to enhance the income of waste pickers. There are growing calls for

the government to take a lead through legislation to have a solid commitment to build the capacity of municipal officials working with waste management departments to work together with informal pickers to get to understand the functioning of recycling as a practice. To institutionalize the working of waste pickers through policies and national strategies will assist in managing waste picking on streets and at landfill sites (Sentime, 2012; Komane, 2014).

It seems that waste pickers are aware of their exposure to harm in the process of collecting waste. Many studies report their awareness and concerns about their health and their unpleasant working conditions. Waste pickers are frequently exposed to dust and dirt on a daily basis. However their pressing concern is about criminal elements in their line of operation (Schenck *et al*., 2016; 44).This is not only a problem facing South Africa. Turkey faces high levels of labour market churning, limited access to health and high exposure to risk (Dinler, 2016).

Recycling activities are historically conducted outside the state by the private sector (Samson, 2015). The formal solid waste management focused on collection and disposal of waste. The market of local recycling systems was created informally by waste pickers as a means of survival through waste collection, re-use and recycling. Their work has not been easy, they faced state repression and adverse hostility from their communities. This treatment was driven by perception that they are doing dirty work (Samson, 2015), they are illiterate (Komane, 2014) and that they must literally fight to gain access to the garbage dumps and face harassment by the police (Mkhize *et al*., 2014). As a result many waste pickers have developed “thick skins” and are very resilient workers because of the ongoing battle against social stigmatization.

Waste reclaimers/ pickers function in the informal sector of waste management. Studies have suggested that the waste pickers’ functioning is made more challenging by the fact that they are not recognized. Firstly, the municipalities and local authorities do not value them and their contribution but rather see them as a nuisance. On the other hand, waste pickers often report bad experiences with metro police, because they assume that metro police do not support their trade (Schenck *et al*., 2012).

No recognition was given to the informal waste pickers who collect and sell to Buyback centres operate in Pretoria and Brits (Samson, 2012; Quazi & Dobson, 2013). The implication of this omission from policies and legislation is that the waste pickers function on the margins or outside of the formal waste management system and are excluded because they do not have a voice (Schenck *et al*., 2015: 43). In many countries such as Brazil, Argentina, Colombia and Bangladesh, waste pickers are already recognized. They are recognized because they are becoming visible, gaining validity and are having a voice (Quazi & Dobson, 2013). For example in Brazil waste pickers have been recognized in the Brazilian Clarification of Occupations (CBO) (Schenck *et al*., 2012). This does not mean now that they are formalized but at least they are recognized and accommodated within the municipal waste management systems (WIEGO, 2012).

The South African Department of Environmental Affairs (DEA, 2016) has called for more recognition of informal pickers by incorporating them into municipalities. This suggests a more recognition of the waste pickers as significant role players in the broader waste management system and for them to have a voice (Viljoen *et al*., 2012; Schenck *et al*., 2012). Evidence of recognition of waste pickers should entail allowing people to organize themselves in connection with how they function and operate in the landfill site. They are encouraged to organize themselves with their own committee which manages activities on the landfill site (Schenck *et al*., 2015:44).

In Tshwane, the municipality allows people access to waste on the landfill site, to organize themselves into cooperatives that can manage the site (Joubert, 2012). Similarly in Durban, Quazi & Dobson (2013) reported a similar project where informal pickers receive recognition and support from the local government, the private and public sectors, and from the Department of Social work at the University of South Africa's Bright site Project. This report further shows that merely allowing waste pickers on site is not enough, they would still require guidance and management by local government to increase their efficiency. This is not limited to enhancing access to waste, but also to provision of sorting materials, and basic amenities.

The recycling systems are by their nature informal. Waste pickers have over many decades become an unrecognized yet integral part of the municipal solid waste systems

which gives an unqualified service to municipalities. In South Africa today an estimated 88 000 waste pickers are at work removing huge amounts of recyclables from waste, which would otherwise be destined for dumpsites. Generally 20-23% of waste is recovered before going for collection and disposal saving municipalities' huge amounts of money, diverting recyclable, re-usable and organic materials.

The success of informal recycling depends on the availability of waste. Informal waste pickers collect waste for their own household use and items such as pots, pans for cooking, clothes and even food are salvaged (Schenck *et al*., 2012). In South Africa it is estimated that only 5% of waste production is actually recovered, before going to landfill sites. It is noted that about 52% of recyclable paper and board is currently processed, 18% of plastic chain and 26% of all non-returnable glass container are being recycled annually (Department of Labour, 2013). These figures are low compared to those in developed countries where close to 90% of paper is recovered. The rest still goes to landfill sites or is burned (Schenck *et al*., 2015).

Following on the statistics provided in preceding paragraphs one can assume that the current status quo for waste collection will not assist our country to reach a zero waste anytime soon as envisaged by government. Questions to be asked are 'What happens to the 95% of waste that remains uncollected for re use and recycling?' And then proceed to evaluate our entire solid waste management processes. The following questions need to be answered. 'Are we having the correct processes to collect waste?' 'Are the current processes efficient to reach our targets of zero waste?' 'If not what else needs to be done?'

Many researchers show that the informal waste pickers are an indispensable part of waste management. (Viljoen et al.,2012;Komane, 2014) .They further report that there seems to be an alienation of waste pickers in doing their work and more importantly they remain unrecognized in the service they offer to the municipalities (Viljoen *et al*., 2012; Komane, 2014; Schenck *et al.,* 2016). If they are not recognized and their role not acknowledged it seems as if waste pickers are not able to fully use their trade in the process of waste management. The role of waste pickers is not maximized even if they collect up to 30% of recyclables, before they are taken to landfill sites. In order to fully

comprehend the impact of informal waste pickers we will have to find their location within the law. This can be simply achieved by finding the defined legal role of waste pickers in solid waste management so that everybody contributes effectively towards the goal set of zero waste by 2030.

Samson (2010) describes waste pickers as people who reclaim reusable and recyclable material from what others have cast aside or thrown away as waste. Schenck *et al., (*2016) defines waste pickers as individuals who earn their living by collecting, re use and selling recyclable materials. Their activities are performed at landfill sites or on the streets. Waste pickers are ordinary South Africans who come from vulnerable social groups comprising of migrants, the unemployed, unqualified men and women, the elderly and children. They voluntarily participate in the informal economy for different reasons ranging from poverty, unemployment and a need to augment their social grants. The other group that enters the informal economy of recycling does so in order to earn a living and support their families.

Waste pickers generate their livelihoods and sustain themselves and their families by retrieving reusable and recyclable materials from the waste stream typically from the streets, garbage bins and garbage dumps. In doing so, they form an essential service and are an integral, although frequently unacknowledged, part of the waste management systems in the cities where they work (Komane, 2014; 4).

Waste pickers in South Africa are classified into three groups namely; landfill waste pickers, street waste pickers and itinerant (Schenck *et al* 2012; Samson 2016). Landfill waste pickers are those who are stationed at the landfill, collecting waste before it is burned or compacted (Donaldson *et al*., 2012); while street waste pickers are those working on the streets from the households and moving from one place to another (Mkhize *et al,* 2014), then the last group belongs to the itinerant. The itinerant are the waste pickers who only recycle at specific times when there are specific needs, they are working periodically. As a result they increase the difficulty of measuring the prevalence of waste pickers in general.

Waste pickers/ reclaimers generate their livelihoods and sustain themselves and their families by retrieving reusable and recyclable materials from waste typically from the streets, garbage bins and garbage dumps. In doing so, they form an essential service and are an integral, although frequently unacknowledged, part of the waste management systems in the cities where they work (Komane, 2014; 4). They function in the informal sector of waste management collecting recyclable materials gathered from waste and sell it to earn their living. At the moment there is no universally accepted name for waste reclaimers. References made to waste pickers differ from one country to another, being influenced by perceptions of the broader community.

The informal waste management sector continues to be disorganized in Africa and remains a subject of negative perception (Nwosu *et al*., 2015). In the absence of formal employment opportunities exacerbated by increasing rural and urban poverty, informal recycling has become a means of survival throughout the world (Demet, 2016). Waste pickers work without legal recognition where their trade is not formalized and many municipalities do not recognize them at their landfill sites as they mostly work illegally, without express permission.

Waste pickers normally work for very long hours and often spend time with their families (Mkhize *et al.,* 2014). Municipal solid waste becomes their resource to enhance their well-being and reduce their poverty. They usually perform their work in a very private way without any protective measure for their health and safety. They are exposed to hazards and an unhealthy work place environment which it is seems they are aware of (Aljaradin, 2015). This can easily lead to high risk of infection and transmission.

Waste pickers' main purpose is to collect waste and generate value out of that waste. They require waste for them to be able to function. Recent studies have shown a direct relationship between development and waste. As countries develop there is a registered increase in the tonnage of waste generated. There should therefore be enough material for informal pickers to collect. People or households that do not separate at source increase the amount of waste to be sorted which ends up being covered and compacted at landfills (Viljoen *et al*., 2012). At landfill sites it is not easy to pick up waste after

offloading because bulldozers are readily available to cover waste and do not allow for informal pickers to come and reclaim waste (Samson, 2015).

This problem is not unique to South Africa, it exists in countries such as Sri Lanka where waste is not separated at source. Of the total municipal solid waste generated, it is estimated that only 10% -40% is collected and the rest is dumped on the streets or in low lying areas (Donaldson *et al*., 2012). Security guards or municipal workers are still hostile to the existence of waste pickers at landfill sites, because they often work there illegally and or without permission (Komane, 2014). Other security guards prevent them from working at landfill sites blocking them from accessing waste and in particular, valuable items (such as metals) which they want to sell themselves for a quick cash (Sobuce, 2012).

There are more concerns about the behaviour of some waste pickers, in particular about the health risks of waste picking. In their line of duty they have to scratch through the waste in the bins or on the landfill sites. They collect waste that has been exposed for days (i.e. from Tuesday to Monday in a 7 day cycle) and it is sometimes contaminated. Essentially they work in filthy and fly-ridden conditions with limited accessibility to protective wear and health facilities (Schenck *et al.,* 2012). The same risks are reported by Mashego (2012) that waste pickers on a dumpsite near Pretoria recover expired food for their consumption claiming it is better than starving.

The situation can be improved. Landfills can be “converted” into proper trial workstations where mobile clinics can visit centres to provide basic health services at least twice a week (Quazi & Dobson, 2013). This supports the report by (Schenck *et al.,* 2012:13) that where there is reasonable waste, some BBC’s in Pretoria provided shelter for waste pickers and even transport was made available to the waste pickers if they had too much waste to be carried in their trolleys. In this instance an attempt is made to lift the potential health burden off the informal pickers. Waste pickers are generally poor and for them health is not a priority. The priority for them is to generate income and not focus on attending clinic.

The quantity of municipal solid waste generated worldwide has increased over the years as consumption increases. The primary sources of municipal waste are households and commercial establishments, while secondary sources are industries and hospitals. The other part of waste comes from organic waste generated by households, markets and slaughter houses. The organic portion consists of plants, tree cuttings, saw-dust and wood chips (Liyanage *et al*., 2015).

This confirms that waste is part of human habitation and contemporary households. Waste is largely made up of plastics, paper, glass, metal and organic waste (Donaldson *et al*., 2012). The municipal authorities cannot collect waste from dwellings and industries to transfer it to a landfill site where it is compacted or burned. This is where informed recycling activities find space; as soon as off-loading occurs, waste pickers collect recyclables before they are buried into the sand. The process is prone to incidents, where bulldozer are in the constant process of compacting and waste pickers are in a rush to collect re-usable and recyclable materials. What exacerbates the problem is the perception that waste pickers are operating illegally in landfill sites.

Informal waste pickers represent a system where people survive off habits of re-use and recovery of materials. They generate income by performing a collection process of waste where the municipalities cannot reach due to the escalating costs of solid waste management. This function is performed by the poor through their unrecognized system that feeds into the survivalist strategy (Nzeadibe & Mbah, 2015). Waste pickers salvage more than 50% of all ongoing waste collection in most cities at a cost to the city budget. The function of waste pickers has contributed to the increasing recycling rates in some developing countries making them more competitive than developed modern urban systems (Mkhize *et al.,* 2014).

The municipal household waste-removal process consists of waste collection at dwellings and its transfer to a municipal landfill site where it is buried in a manner prescribed by relevant legislation (Donaldson *et al.,* 2012). Stakeholder engagement has revealed that none of the local authorities are in any way actively encouraging waste recycling programmes. This situation is unsustainable and it works against the interventions of reaching zero waste. Filling up of landfill sites has a harmful effect of greenhouse gas

emissions which are equally damaging to the environment. It is better for the landfill sites to be managed to allow waste pickers to collect or salvage material for recycling. In so doing they will be freeing up space to prolong the lifespan of the landfill and developing the informal waste picking economy in order to generate an income for waste pickers, thereby creating secondary employment opportunities.

The developing country cities often collect only between 50% to 80% of waste generated, with open dumping the only disposal method available (Medina & Dows, 2000). The attitude of the formal waste management sector to informal recycling often very negative, regarding it as backward, unhygienic and generally incompatible with a modern management system (UN, 2005).In a number of countries, the informal sector also directly provides a waste collection service in areas where there is no formal municipal system in place (Coad, 2003; Haan *et al*., 1998; Scheinberg, 2001b).

The way informal recycling activities are organized has important consequences for income generation, working conditions and social status. The less organized the informal recycling sector is, the less the people involved are capable of adding value to the secondary raw materials they collect, and the more vulnerable they are to exploitation from intermediate dealers (Wilson, et al, 2013). Organizing and training informal recyclers into MSEs is a very effective way to upgrade their ability to add value to collected materials (Haan *et al*., 1998). Forming scavenger or waste picker cooperatives and associations can also enhance their position. They can then negotiate as a discrete entity with the local authorities and the private sector and this legitimizes their activities and increases income by circumventing middlemen, (Medina, 2000).

The degree to which a particular material is recycled depends on income levels, the existence of local and national markets, need for secondary raw materials, level of financial and regulatory governmental intervention, prices of virgin materials, international trade in secondary raw materials and relevant treaties (Wilson *et al*., 2006). The informal waste recycling systems that already exist in many developing countries reduce the cost of formal waste management systems as they reduce the quantity of waste for collection, resulting in less money and time spent on collection and transport (Haan *et al*., 1998; Scheinberg, 2001a).

Informal recycling has traditionally been practiced by outcasts and marginal groups in developing countries such as gypsies, rural migrants, immigrants and members of religious minorities (Berthier, 2003) As a result of their marginalization, they are often subject of harassment by the authorities and police and female scavengers in particular may be considered easy sexual targets (Eerd, 1996).

In African cities, informal waste workers, in addition to being active players in the urban economic space, are also a distinct and often heterogeneous social group (Nzeadibe & Anyadike, 2012) comprising a wide range of individuals and groups, namely waste pickers, scrap dealers, itinerant waste buyers, informal collectors or cart pushers, intermediary traders, and micro and small enterprises who make a living from collection, recycling and disposal of solid waste outside the state's regulatory sphere. .Policy neglect of the informal sector which includes IWM is rationalized by the tendency of some research to equate African informal economies with criminality and cultural dysfunctionality (Meagher, 2010).

Workers deployed to pick waste are more often than not remunerated on a piece-rate basis as their work is itinerant, barely formalized, and based on clear specifications of the pay-master's need regarding which materials are collected (Neilson & Stubb 2011). The workers choose when to go out on the job, are accountable to nobody and are not supervised to comply with state regulations about waste management. The intersecting own-account work in informal waste management is micro-entrepreneurship

2.4 Legislative framework in South Africa

In South Africa the constitution serves as a framework within which all legislation must operate. In aligning itself to the prescripts of the European Union, section 24, the constitution further allocates responsibilities for environmental governance amongst different spheres of government. In this context we shall refer to the National Waste Management Strategy (NWMS) to reflect on government's position on waste reclamation.

The NWMS provides for how to respond to waste management through several options. These are arranged in order of priority with disposal as the least preferred option.

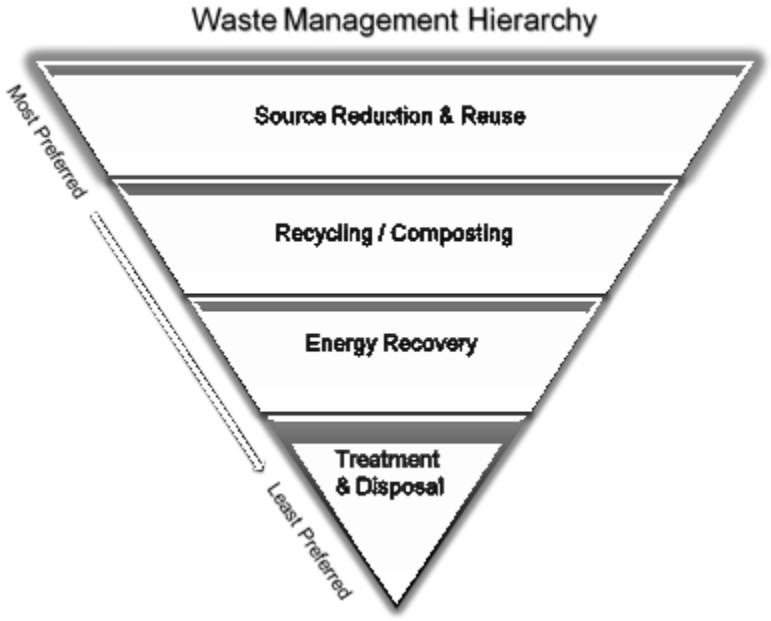

Fig 2: Waste Management Hierarchy

Source: (DEA, 2012)

It seems clear that in terms of this waste management hierarchy, informal waste pickers have a prominent role to play in solid waste management. They are currently the people who sort the recyclable material, by removing it from waste stream before they are disposed at landfills. Waste reclaiming clearly falls within the scope of the NWMS which deals with promotion of waste minimization, re-use, recycling and recovery.

Recycling in South Africa is relatively young, with the industry recording impressive growth rates. Due to the rapid increase of South Africa's solid waste production, particularly in urban areas and the decreasing landfill space availability, the high environment impact and with the use of waste management carts, recycling is expected to gain momentum for the foreseeable future (DTI, 2013).

In order to contribute to the emerging evidence that recycling has an economic value, the government through the Department of Environmental Affairs (DEA) has called for incorporation of waste pickers into municipalities (DEA, 2016). The understanding is

expected to harmonize relationships and maximize waste recycling. This call further locates the responsibility of providing leadership on waste recycling within policy formulation: NEMA and NWMS National Environmental Management Act (NEMA) was promulgated to give effect to provisions of section 24 of our Constitution. NEMA is designed to establish principles for decision making on matters affecting the environment which may apply throughout the Republic. At strategic level, NWMS undertakes to provide guidance to municipalities and industry on measures to improve the working conditions of waste reclaimers, establish Material Recovery Facilities and expand the role of SME and co-operatives in domestic waste services (DEA, 2011).

This strategy confirms thus, it is not up to local government, political and community dynamics to determine whether or not to accept waste pickers at landfills (Samson, 2012; Quazi & Dobson, 2013). It remains the competence of the government at national level to provide directives on solid waste management'. The Department of Environmental Affairs (DEA, 2016) has called for more recognition of informal pickers by incorporating them into municipalities. This suggests a more recognition of the waste pickers as significant role players in the broader waste management system and for them to have a voice (Schenck *et al*., 2012; Viljoen *et al*., 2012).

Evidence of recognition of waste pickers should entail allowing people to organize themselves as to how they function and operate in the landfill sites. They should be encouraged to organize themselves with their own committee which manages activities on the landfill site (Schenck *et al*., 2015:44). In Tshwane, the municipality allows people access to waste on the landfill site and to organize themselves into cooperatives that can manage the site (Joubert, 2012). This report further shows that merely allowing waste pickers on site is not enough, they would still require guidance and management by local government to increase their efficiency.

The European Union is host to the world's most developed and institutionalized waste management systems and with ambitious policy commitment to the informal economy (Scheinberg *et al;* 2016:1). Even with best intentions to improve the sector, those still in charge at municipal waste management see the informal sector as undermining the work and creating dangerous risks for public health and safety. On the other hand, waste

pickers feel left out in the economic niches that support their livelihood. These conflicts would require to be addressed. Waste reclaimers/ pickers function in the informal sector of waste management. Several studies have suggested that the waste pickers functioning is made more challenging by the fact that they are not recognized. First the municipalities and local authorities do not value them and their contribution but rather see them as a nuisance. On the other hand, waste pickers often report bad experiences with metro police, because they assume that metro police do not support their trade (Schenck *et al.,* 2012).

Waste pickers need to be recognized and to have their work validated. They require some assurance that they can work freely and without discrimination. Validity is an aspect of the recognition of waste pickers, which can be achieved when they are supported in their daily functioning. This is not limited to enhancing access to waste, provision of sorting materials, and basic amenities but extends to freedom to trade without harassment.

Waste pickers work as individuals and are vulnerable to crime and abuse from municipal authorities (Mkhize *et al*., 2014). As a result they have no bargaining power. First the recycling industry does not give them the necessary credit they deserve. The industry would prefer to work with large volume materials that are sorted, organized and processed. Their failure to organize has created space for middlemen who purchase materials from informal waste pickers at a minimum and then trade to buy back centres (BBC's). Their profits are shared with middlemen, and they end up with very little from their efforts.

By organizing into co-operatives, waste pickers can strengthen their bargaining position with industry and begin to have a voice in government. The results will be positive because they may maximize their earnings and earn better relationships with local municipalities. South African waste pickers are gradually finding their voice. The demand and competition for materials have led to a body of advocacy, research and projects on integrating the informal sector into processes of modernization of waste management systems.

Legislation and incorporation of informal waste pickers have demanded of them to organize into co-operatives or associations, to register and operate within the framework of the service chain. Once the informal waste pickers are organized, they may then challenge for formal integration. Formal integration refers to a situation where recycling is a recognized official occupation, and informal recyclers have a legal identity, are protected by law and decrees, are covered by social protection schemes and progressively are paid appropriately for the value of service they are providing to the city and the environment (Scheinberg *et al.,* 2016:822).

2.5 Summary

The informal recycling has an important role in the informed solid waste management in terms of waste reduction, minimization and material recovery in line with European Union Strategy that waste must be minimized and where it cannot be, the waste in the stream must be used as a resource. Recovered materials make the informal recycling a profitable business for the poor and such business has a future. As long as there is human interactions with environmental resources waste will remain. This makes waste pickers a permanent feature of the world's informal economy. All that is required is for the authorities to create new perspectives on informal recycling. At the moment their work is dismissed as poor man's occupation and the governments have not improved their policy viewpoints to incorporate the knowledge gained over years into how they can restore the dignity of waste pickers and then formalize their trade through legislation.

For the government to simply ignore informal pickers and municipalities to not incorporate them is a financial miss. They will not be appreciating the full social, economic and environmental benefits of waste recovery processes. The municipalities should incorporate the opinions of informal pickers in their strategic planning for solid waste management because they have experience and kill.

They have been engaged in the process for a reasonable period and can reduce the cost to municipalities thereby optimizing their profits. It is a win-win situation if they can be given protective wear and given access to landfill site with Material Recovery Facilities (MRF). In so doing municipalities can relegate the work of collecting, sorting and recovery

of waste to informal pickers. Once materials are sorted it will encourage industries to buy an organized “group” with more volume and adequate quality materials. Given their economic benefit, the informal pickers should be organized into co-operatives where the municipalities can easily invest in programs to improve their social, economic and health matters.

CHAPTER 3: METHODS OF INVESTIGATION

3.1 Introduction

This chapter is intended to provide a brief outlook on the methodologies used to investigate the problem statement. It considered methods used in determining current waste management practices.

3.2 Research design

In the study a quantitative research design was applied using a questionnaire, in order to address the quantifiable nature of variables used in the research. Primary data was generated from field observations and measurements at selected landfill sites. The first phase of observations were based on a pre-designed spread sheet format into which measures were recorded on the interval and ration scales. The second phase involved the administration of an interview to participants. The interview was designed on a structured spread sheet format allowing for the capture of responses in the form of numeric ratio and interval scale values. The fourth phase involved an informal interview with officials at the municipality level responsible for waste management. This was meant to cross check the validity of both the ground observations earlier recorded and the responses of the participants.

Secondary data was generated from local municipalities, district, provincial, and national offices covering population, household, socio-economic indicators, labour participation, trade & industry and finally waste management. The secondary data was collected from published sources about the concerned local municipalities, district, national and provincial offices.

The choice of methods deployed in this study was informed by the scale of data to be collected, the informal sector an economic sector of the national economy and the limited social profile of households from which participants are drawn. The observations and interviews were designed to solicit numeric responses measured on the ratio and interval scales to facilitate the application of conventional research statistics.

3.3 Population

The population for the study was conducted in twelve municipalities of the North West Province regarded as all the men and women, young and old involved in waste collection on the landfill sites only. Ordinary people who were collecting waste and involved in recovery of raw materials on landfill site only, were included in the study. The sample was collected from informal waste pickers and the selection of respondents was based on their availability and their willingness to participate.

3.4 The study area

North West is one of nine provinces, and mostly a rural area in South Africa. It has an area of 8.7% of South Africa (StatsSA, 2012). In Table 2, a selection of local municipalities (12) is indicated following categorisation in the context of annual volume of waste generated (READ, 2017) into three clusters.

Table 2: Selected local municipalities.

District	**Local Municipalities in terms of waste volume generated**		
	High	**Medium**	**Low**
Ngaka Modiri Molema	Mahikeng	Ditsobotla	Ratlou
Dr. Ruth Segomotsi Mompati	Greater Taung	Naledi	Mamusa
Dr. Kenneth Kaunda	City of Matlosana	Tlokwe	Ventersdorp*
Bojanala Platinum	Madibeng	Moses Kotane	Kgetlengrivier

*Ventersdorp municipality was absorbed into Tlokwe in 2016 to form J.B. Marks Municipality

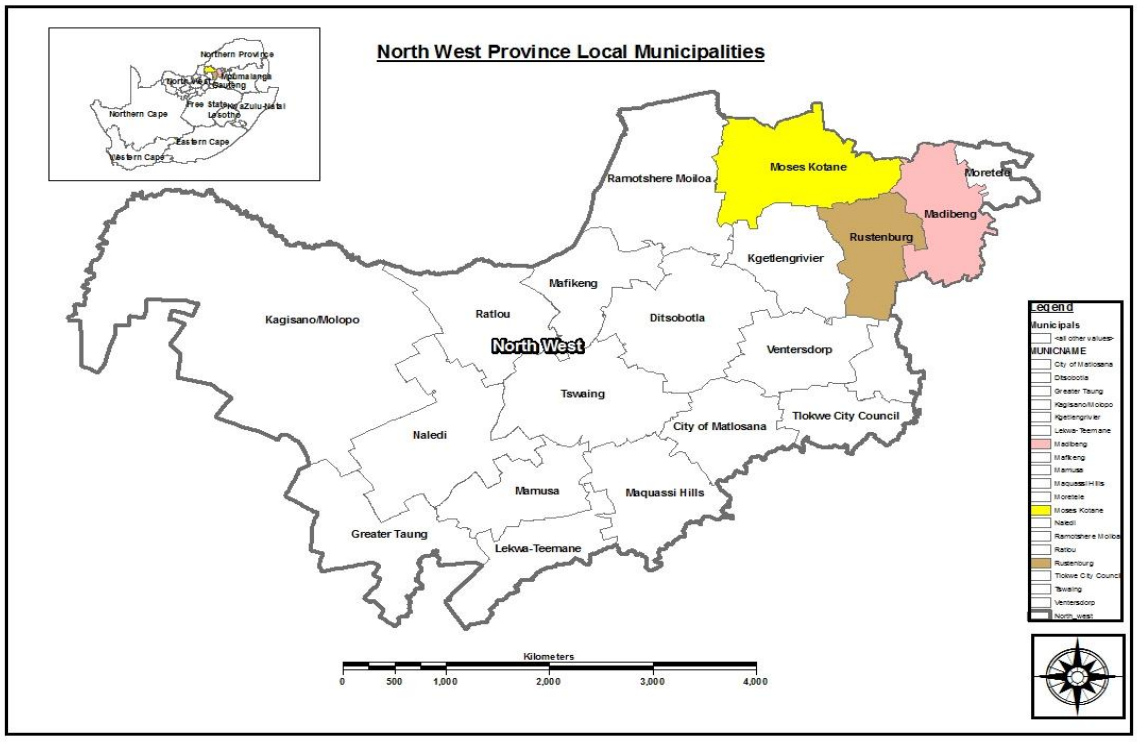

Figure 3. Provincial map

The North West province's economy is largely driven by the mining of minerals such as platinum, chrome and iron. Large parts of the North West are land which is arable, creating vast opportunities for farming, which has not been fully exploited.

In Table 3 shows the economically active population percentage of the North West province as per districts. Bojanala Platinum district seems to have an active economy compared to other districts in the province, with 38.483%, Dr Kenneth Kaunda with 32,600%, Ngaka Modiri Molema with 22,786% and finally Dr. Ruth Segomotsi Mompati at 20.684%. The North West Province is at 31.310% compared to the country's 35.986%.

Table 3: Socio-economic profile of households

	South Africa	North-West	Bojanala DM	Ngaka Modiri Molema DM	Dr Ruth Segomotsi Mompati DM	Dr Kenneth Kaunda DM
Total population	53 781 908	3 670 889	1 602 614	866 535	474 823	726 916
Population density (number of people per km²)	44,04	34.94	87.24	30.96	10.78	49.56
Economically Active Population (EAP) as % of total population, official definition	35,986%	31,310%	38,483%	22,786%	20,684%	32,600%
Number of households	15 341 533	1 098 814	526 384	231 248	127 189	213 993
Annual per household income (Rand, current prices)	168 920	135 990	124 676	104 618	92 209	155 794
Annual per capita income (Rand, current prices)	48 187	40 707	41 174	28 048	24 849	46 547
Gini coefficient	0,64	0,61	0,61	0,61	0,59	0,62
Formal Sector Employment	12 109 001	674 221	371 715	111 955	53 451	137 100
Informal Sector Employment	2 305 887	104 566	58 087	18 268	9 107	19 104
Unemployment rate, Official definition (%)	25,007%	26,196%	22,953%	30,229%	30,942%	29,308%
Share below the upper poverty line (StatSA defined)	46,475%	47,403%	39,831%	56,652%	59,106%	45,427%
Poverty gap rate (from upper poverty line)	28,378%	28,208%	27,466%	28,796%	28,892%	28,191%
Human Development Index (HDI)	0.626	5.578	0.608	0.531	0.500	0.603

Source: Statistics SA, (2016) Household Survey

The annual per capita income of Dr. Kenneth Kaunda is at R47 796 slightly higher than Bojanala Platinum district at R46 615 per capita, the North West province with R40 707 whilst South African average is at R48 187. The unemployment rate in Bojanala Platinum is a lower percentage of 22. 953% hence Dr. Ruth Segomotsi Mompati district has the highest unemployment rate at 30.942% followed by Ngaka Modiri Molema with 30.229%.

The unemployment in the North West Province is at 26.196% and the South African recorded unemployment rate is 25.007%. These figures were obtained as such and tend to be dynamic.

3.5 Pilot study

A pilot study was carried out at Madibeng and Moses Kotane. Both were sampled because of their proximity and the fact that their sample was representing high volume of waste generated (Madibeng) and medium volumes (Moses Kotane). The intention was to provide the researcher with an idea of the actual waste production at the landfill site and to test the availability of the questionnaire and the observation sheet. In phase I, the team of two field assistants tried to measure the actual size of the landfill and compare it with the values provided by the municipality, using a measuring tape. The values differed by a margin of about 2 metres. It was then decided to use the actual values provided by the municipalities.

The second (II) phase entailed confirming the types of waste generated at the landfill site and how informal waste pickers came to know of the actual mass of their recyclable materials. There is on-site measuring scale provided by the buy-back offices which results in amounts payable to the informal waste pickers. This was done to test the accuracy of values of waste generated, which are required in the questionnaire as it reflects on Annexure A.

3.6 Sampling technique

A stratified sampling technique was applied to cover both stratum I districts, and Stratum II, local municipalities in terms of their estimated volume of waste generated as of 2016. Stratum III composed of the largest town in the local municipality while stratum IV comprised the largest waste site, be it formal or informal. The number and gender of participants at each of the selected landfill sites was recorded through an enumeration exercise. Summation of this number across the twelve municipalities came to 444 people. This provided the population on the basis of which a standard 25% sampling fraction was

applied to the population of participants per municipality to generate the individual sample size distribution in Table 4. The sample size came to 111 participants.

Table 4: Sample size distribution

Municipality	Sample size	Municipality	Sample size
Mahikeng	11	Tlokwe	20
Ditsobotla	7	City of Matlosana	20
Ratlou	2	Ventersdorp	4
Greater Taung	13	Madibeng	7
Naledi	18	Moses Kotane	3
Mamusa	3	Kgetlengrivier	3

3.7 Sampling process

The unit of analysis for this study was done at two levels:

a) The household
b) The individual participant

Only those individuals involved in waste recycling were included in the initial ground census of participants, and focus was strictly on individuals engaged in the activity of recycling. This simply means that individuals participating in the recycling activity were observed and interviewed to gather data on the profile of the households that they belonged to and on the characteristics of their own recycling activity.

3.8 Planning

In the specific districts and local municipalities face to face meetings to obtain permission and to give a brief overview for the research were carried out. This process was done in October 2016 (See Annexure C). A follow-up meeting was held with the authorities in November 2016, with a view to agree on tentative dates for the observations, my presence at the sites and to draw a management plan on the most appropriate times to

conduct filed work. These visits provided clarity on the functioning of each municipality regarding control, availability and possible interactions with waste pickers. Authorisation was granted to directly work with gatekeepers at landfill sites in order to fast track the process, the following plan of action was agreed upon and summarised as follows:

A total of twelve municipalities were visited for the study which represented three municipalities per each district, namely Bojanala district municipality, Ngaka Modiri Molema, Ruth Segomotsi Mompati and Dr Kenneth Kaunda district municipality.

3.9 Data collection and Analysis

Primary data was acquired through field surveys, and observations at landfill sites (Appendix A). The information gathered through field surveys included.

- the determination of respondents' social profile
- the type of waste collected
- information about the material they collected
- challenges faced in executing their work
- viability of their trade

A combined interview and observation instrument was completed through the assistance of the researcher. This was to minimise on the possible barrier of the use of English by translating where required. Further information was sourced through direct interviews with municipal officials in order to gain more knowledge about their perceptions of informal waste pickers and how they interact with them (See Annexure B).

For each objective outlined in Chapter 1, the sources of data, data types and analytical techniques are specified; Excel ™-generated descriptive statistics applied to each data set provided conventional measures around mean, mode, range and standard deviation. This made it possible to characterise individual variables and to generate applicable graphics before further analysis. A visual screening of data tables was done to allow for outliers to be identified and eliminated.

Objective 1: to describe the state of solid waste recycling industry

Data source: Secondary information from national and provincial sources

Data type: Statistical data sets and information briefs.

Analysis: Descriptive statistics using Excel ™. Results are presented with applicable graphics and discussed with reference to various area scales.

Objective 2: to characterize informal waste recycling

Data source: Primary data from field work.

Data type: Base statistics in the form of ratio and interval scale

Analysis: This involved descriptive statistics using Excel ™ to generate mean, mode, range and standard deviation. Input elements here included age, gender, and length of participation, family size, family structure, residence, ward, and specialization in waste recovery, trade links, income generated, disposal options and pathways in recycling. Observation and measurements taken at the waste dump or landfill site to cover size variations, estimate of volume of waste at site and, estimates of life span. In phase III, the results compared with socio-economic profiles of households in each of the local municipalities in the sample as reported in the 2016 household survey.

Phase IV the use of Pearson's multiple correlation analysis to handle socio-economic variables of households' information earlier collected in phase I above. This was followed by two way ANOVA and multiple regression.

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

N	=	number of pairs of scores
Σxy	=	sum of the products of paired scores
Σx	=	sum of x scores
Σy	=	sum of y scores
Σx^2	=	sum of squared x scores
Σy^2	=	sum of squared y scores

.

Multiple correlation analysis is aimed at establishing the size, strength and direction of relationships between a *y*-dependent (response) variable and a set of *x*-independent (predictor) variables. The data sets here meet the conditions for use of linear regression and normal distribution. Two-way ANOVA was run in order to establish the strength of the *x*'s on the behavior of the *y*-variable. Multiple regression allows for the generation of the equation of the line on the basis of which outputs can be predicted for *y*.

For hypothesis testing, two research alternate hypotheses earlier referred to as H_1 and H_2 in Chapter 1 were re-stated together with the corresponding null hypotheses, denoted as $H_0(1)$ and $H_0(2)$ to use the F-test to determine the equality of variance used to test the two hypothesis variances. The test for equality of several means is carried out by the use of ANOVA. A 95% confidence level applies translating to an alpha of 1-0.95=0.05. The *p*-value is the probability that the observed statistic occurred by chance. The *p*-value is compared against the alpha in the print-out. If the *p-value is less or equal* to the alpha: we reject the null hypothesis. If the *p*-value is *greater than* alpha, we fail to reject the null hypothesis. Alternatively, the results of the F-ratio can be used to make a decision of acceptance and or rejection of the null hypothesis.

Objective 3: to compute the mean income levels of participants in recycling

Data: carried forward from objective 2.

Analysis: In phase 1, use of descriptive statistics to characterise income distribution at the household level. Use of applicable graphics to capture key trends. In phase II, the

population of participants in the informal sector waste recycling was derived from the ground census exercise. For each local municipality in the sample, this figure was adjusted to incorporate other smaller sites where the activity is practiced. Additional estimates from local waste-pay-back centres were incorporated ultimately to generate an estimated figure of total population of participants (TPP) per local municipality as of 2016. Phase III, secondary data on mean employment statistics periodically released by the Department of Labour, *Statistics South Africa* and in particular, the Household Survey. In phase IV, an income value (IVP) was generated for participants per year built around data on the returns (paid) to participants per unit weight of the waste sold. It is possible to relate TPP with IVP to compute the total income generated by the sector (TIG). Assuming that TIG is a major determinant of the unemployment rate at the LM level (UR).

In order to test hypothesis II, advanced in section 2.3, the F-Test was used. A 95% confidence level of translating to an alpha of 0.05 which is a widely used standard in survey research. The *p*-value is the probability that the observed statistic occurred by chance. The *p*-value is compared against the alpha in the print-out. If the *p-value is less or equal* to the alpha: we reject the null hypothesis. If the *p*-value is *greater than* alpha, we fail to reject the null hypothesis.

Objective 4: to build pathways of recycled waste.

Data: carried forward from objective 2 with respect to interview responses from participants

Analysis: Use of descriptive statistics to characterise pathways of recycled waste into the market. Outputs in the form of computer aided design (CAD) flow-line block diagrams.

Objective 5: Suggest methods for improving the performance of the sector

Involve a synthesis of key findings from each of the objectives 1, 2, 3, and 4.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter focuses on the results of the research as obtained through various means. They are for purposes of this report presented in two phases. Firstly the results are presented as an outcome of intensive information collected in field surveys through a questionnaire and then the quantitative results as they analyse the elements of informal waste collection and recovery of waste at an entry phase in selected local municipalities in North West Province. The results are presented as per the objectives: suggested

4.2 The state of solid waste recycling

4.2.1 Organisation

In this study, different landfill sites were identified per district, Bojanala Platinum, Ngaka Modiri Molema, Dr. Ruth Segomotsi Mompati and Dr. Kenneth Kaunda, and a plan on how to achieve the set objectives of the study was drawn up. The objectives involved visiting twelve landfills, three per district in the North West province. The observations and questionnaires were collated on the data sheets in addition photographs were also taken during the *in loco* visits.

4.2.2 Categorisation of the Y's

The initial results on the state of the solid waste recycling industry and related characteristics were processed using Excel ™ and thereafter subjected to Pearson's multiple correlation to compute mean income levels of participants in the informal waste recycling. The Y-dependent variable was *the income of participants per week.*

4.2.3 Districts population

The figure 4.1 below displays the population density of the North West province and the four district municipalities. The population represented from (StatSA 2013a).

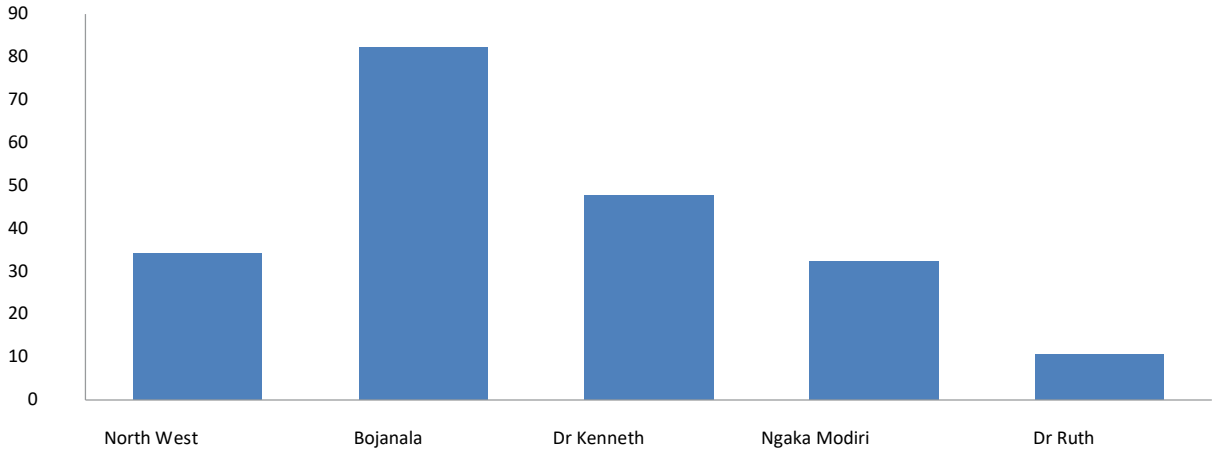

Figure 4. Population density per District (StatSA, 2013a)

4.2.4 Provincial population

The population density in Bojanala and Dr. Kenneth Kaunda has high numbers as presented in the report (StatSA, 2013) due to increased influx which can be encouraged by industries and the mining belt. In Ngaka Modiri Molema and Dr. Ruth Segomotsi Mompati the industrial infrastructure is very low, that is semi-rural with less opportunities for job creation.

4.2.5 Municipalities waste volumes

The information of the municipal areas in the North West Province of South Africa display waste generated by municipalities from 2004 and projected until 2014, by SAWIC. In a period of ten years an estimated increase of 46% was the projection for the waste volumes, in all the four municipal districts. The Bojanala Platinum district municipality shows fast growth from the year 2004 compared to other district municipalities. It is evident that urbanization and proper waste management have an effect on waste generators. General volumes in tones per annum display a record high of waste and also hazardous waste in the province. The mining industries seem to be the main contributors in Bojanala platinum and Dr. Kenneth Kaunda districts.

Table 5: General waste volumes in tones per annum

Municipal area	**Waste Generated 2004** (NWDACE, 2008b)	**Waste Generation Projection 2010**	**Waste Generated 2013** (Incomplete records, SAWIC, 2014)	**Waste Generation Estimation 2013** (at 46% increase on 2004 values)
Bojanala Platinum District Municipality	347 120	568 965	505 980	505 980
Dr Kenneth Kaunda District Municipality	199 100	362 310	186 168	290 218
Ngaka Modiri Molema District Municipality	178 100	226 339	26 990	259 608
Dr Ruth Segomotsi Mompati District Municipality	108 600	177 183	-	158 301

General waste volumes in tones per annum (t/a) for 2004 (actual), 2010 (projected), 2013 (actual & estimated) (NWDACE, 2008b; SAWIC, 2014)

4.3 Characterization of informal waste recycling

4.3.1 Specification of variables

The x-variables that fall within this focus appear in Table 6

Table 6: List of independent-variables appearing in this objective

	Name of Variable	Abbreviation (Crous,2009)	
X1	Clear bottles recycled in all municipalities	PET	Bottles
X2	Volumes of office white paper traded in a week	HL1	White paper
X3	Quantities of used Cardboard recycled	K4	Box
X5	Volume of Polyprop recycled per week	PP	Polyprop
X6	Mixed bottles recycled in quantities	PPETC	Mix bottles
X7	Volumes of recovered Mixed plastics	PLM	Mix plastic
X8	Quantity of aluminium & metal cans recycled	UBC	Cans
X9	Recyclable scrap metals	SCRAP	Scrap metal
X10	Gender number of participants	FEMALE	Gender
X11	Gender number of participants	MALE	Gender
X16	Maximum 5 years' experience	1-5 YRS	Participation level
X17	Maximum 10 years' experience	6-10 YRS	Participation level
X18	Maximum 15 years' experience	11-15 YRS	Participation level

An SPSS™ programme was used to run the first descriptive statistics using Excel™. Appendix C shows the primary data set. Descriptive statistics for mean, range and standard deviation. The following X's scored the lowest mean: X18 at 0.15 (Fifteen years participation level), X17 at 0.28 (Ten years participation level), X11 at 0.34 (Male participants) and X10 at 0.66 (Female gender participants). The highest mean was recorded at 270.49 by X1(Quantity of clear bottles recycled by all municipalities in the study area).

4.3.2 Base Data

Table 7: **Descriptive Statistics on characterisation**

Descriptive Statistics							
	N of Respondents	Range	Minimum per week	Maximum per week	Mean		Std. deviation
Income(Y)	111	900	150	1050	441.89	29.607	311.925
Clear bottles(X1)	111	4200	0	4200	270.49	65.974	695.079
Whitepaper(X2)	111	531	0	531	18.66	6.969	73.424
Box(X3)	111	1230	0	1230	88.59	23.792	250.665
Polyprop(X5)	111	365	0	365	7.74	4.301	45.311
PPET(X6)	111	3122	0	3122	81.16	33.911	357.270
PLM(X7)	111	341	0	341	14.30	4.851	51.111
UBC(X8)	111	92	0	92	3.80	1.571	16.551
Scrap(X9)	111	45	0	45	3.83	0.912	9.606
Female(X10)	111	1	0	1	0.66	0.045	0.477
Male(X11)	111	1	0	1	0.34	0.045	0.477
Five years(16)	111	1	0	1	0.64	0.046	0.482
Ten years(17)	111	1	0	1	0.28	0.043	0.451
Fifteen years(18)	111	1	0	1	0.15	0.034	0.362
Valid N (list wise)							

From table 7, variations in weekly income (row 4) are described by the value of range at R150. This indicates that across the study area, there are no major differences in income. However, a detailed breakdown of income per local municipality and per district may show variations that will require further explanation. The highest standard deviation is with reference to X1 at 695.079 for clear bottles while at the opposite end is X9 for scrap metal at 9.606.

4.3.3 Number of clear bottles recycled (X1)

From table 7, the results for variable (X1) show a data range of 4200 and a mean of 270.49. The standard error of the estimate scores 65.974 with a standard deviation at 695.079. These values are shown in Figure 5.

The scatter plot in Figure 5 shows a dispersal of individual points away from the mean which describes the extent of variation between individual points in the data. The significant standard deviation value arises out of this significant variability in the distribution of data for X1. This shows overall that there are major differences across the respondents in the number of clear bottles collected for recycling. The value for standard error in respect of X1 is the highest in Table 5. This value shows the extent of deviation between the sample mean and the population mean. The high score for this value shows low levels of accuracy in the way the sample represents the population.

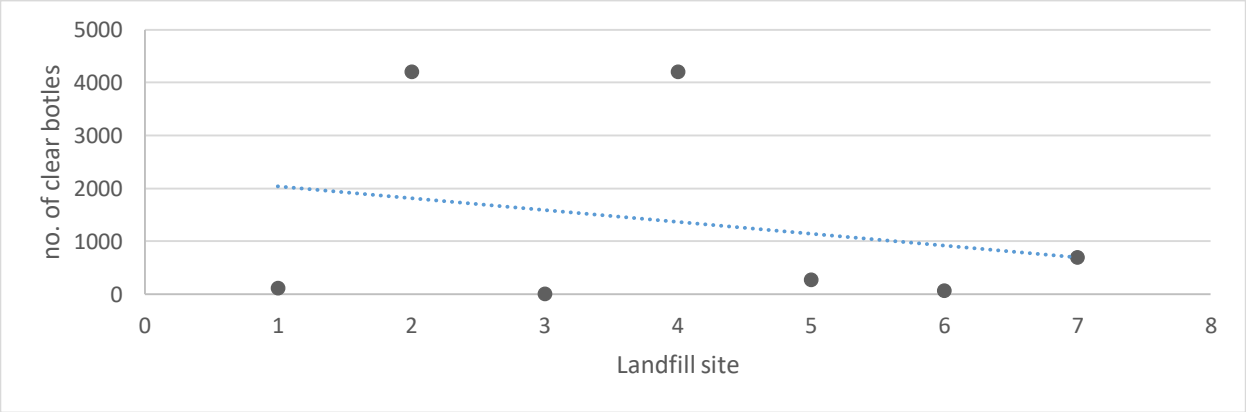

Figure 5. Scatterplot for clear bottles recycled

4.3.4 Volume of traded white paper (X2)

The results for variable (X2) show a data range of 531 and a mean of 18.66. The standard error of the estimate scores 6.969 with a standard deviation at 73.424. The scatter plot in Figure 6 shows a dispersal of individual values away from the mean which describes the extent of variation between individual points of data.

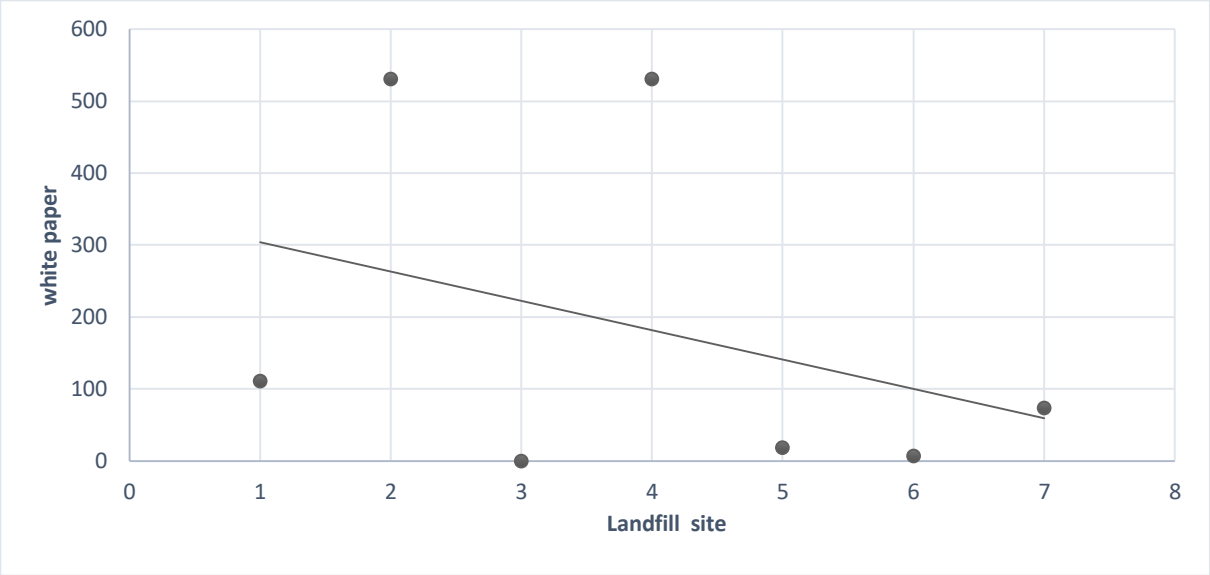

Figure 6 Quantities of white paper

The graphic presentation displays less relationship of the X2 card boxes to the “y” which is shown by sparse or scattered data variables.

4.3.5 Quantity of card boxes traded (X3)

From table 7, the results for variable X3 show a data range of 1230 and a mean of 88.59. The standard error of the estimate scores was 23.792 with standard deviation at 250.665.The scatter plot in Figure 7 shows a dispersal away from the mean which describes the variation between the individual points of data. There are a few variations in the individual values of the data set for variable X2. The graphic presentation displays less relationship of the card boxes (X3) to the “y” which is shown by sparse or scattered data variables.

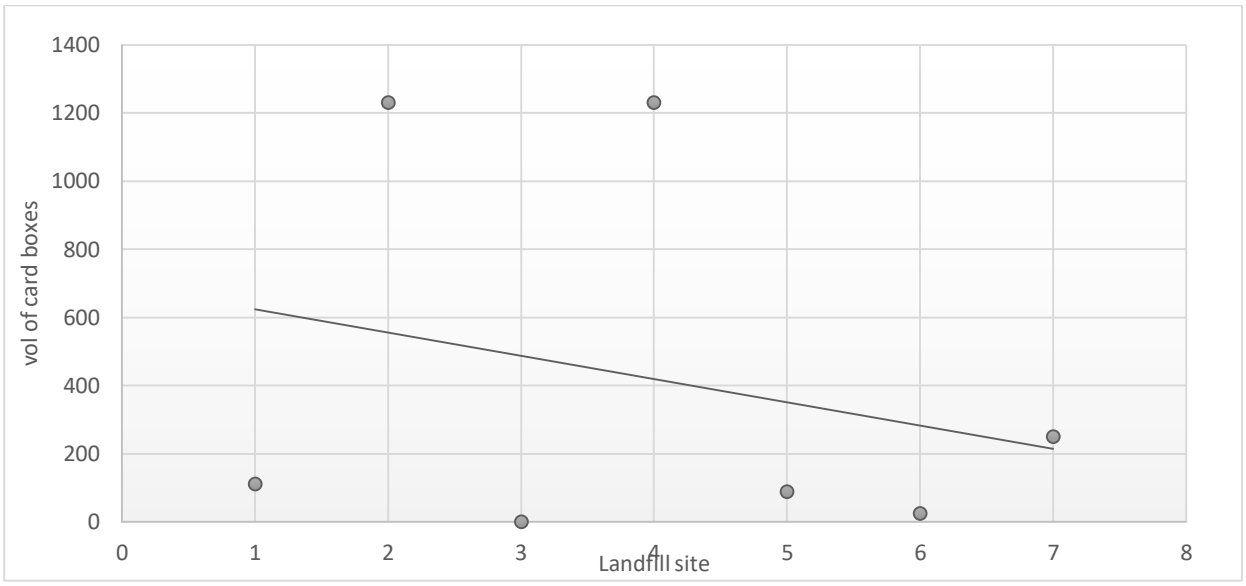

Figure 7. Card boxes

4.3.6 Volume of polyprop(X5)

From table 8, the results for variable X5 show data range of 365 and a mean of 7.74. The standard error of the estimate scores was 4.301 with a standard deviation at 45.311. The points in the scatter plot are not close to the mean, which is opposite of dispersal.

The graphic presentation displays less relationship of the card boxes (X5) to the “y” which is shown by sparse or scattered data variables.

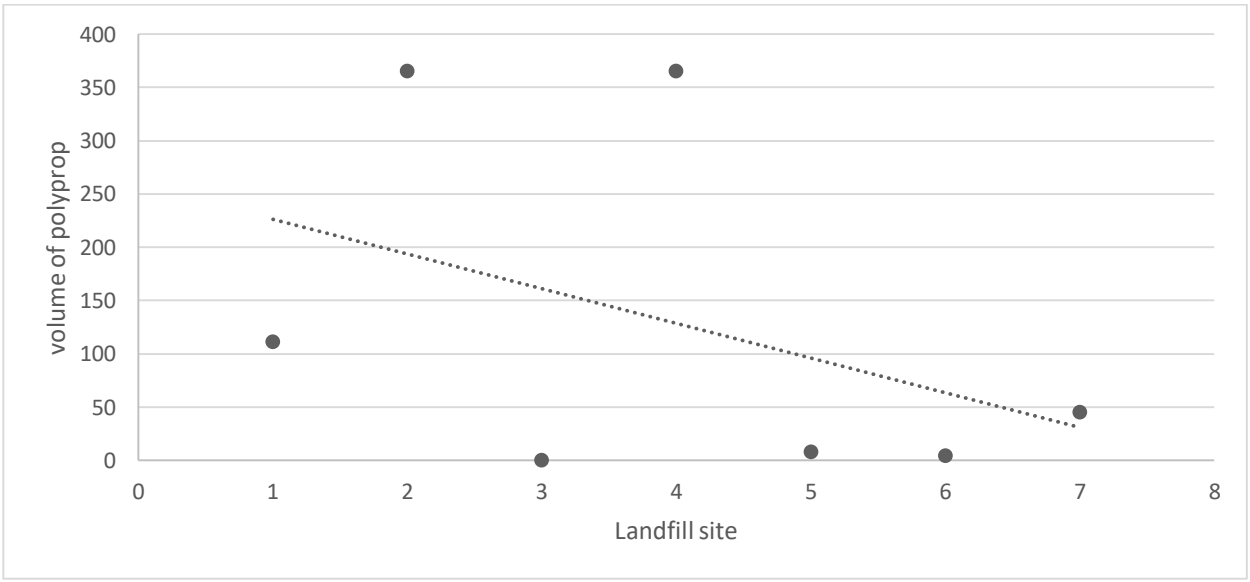

Figure 8. Volume of Polyprop

4.3.7 Mixed bottles (X6)

The results for variable X6 show a data range of 3122 and a mean 81.16. The standard error of the estimate scores was 33.91 with a standard deviation at 357.270. The scatter plot in Figure 9 shows a dispersal of individual points away from the mean which describes the extent of variation between individual points in the data. The significant deviation value arises out of this variability in the distribution of data for X6. The standard deviation is higher, the higher the differences and the higher is the value for the range. The graphic presentation displays less relationship of the card boxes (X6) to the “y” which is shown by sparse or scattered data variables.

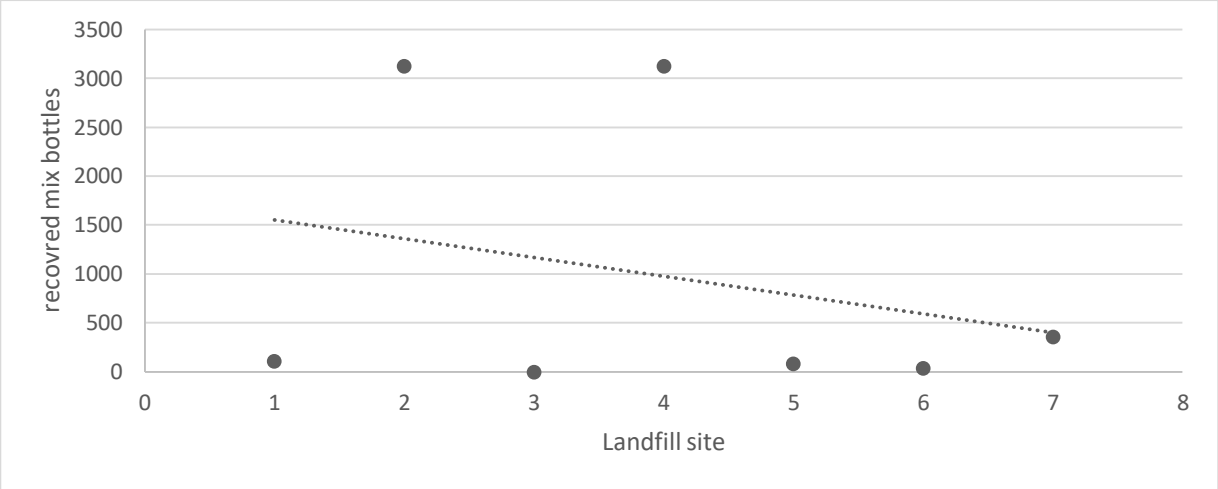

Figure 9. Recovered mix bottles

4.3.8 Volume of mixed plastics (X7)

The results for variable X7 show a data range of 341 and a mean of 14.30. The standard error of the estimate scores 4.851 with a standard deviation of 51.111. The points are running from the upper left to lower right, which makes it a negative correlation, for the X7 variable which is the volume of mix plastics. The graphic presentation displays less relationship of the card boxes (X7) to the “y” which is shown by sparse or scattered data variables.

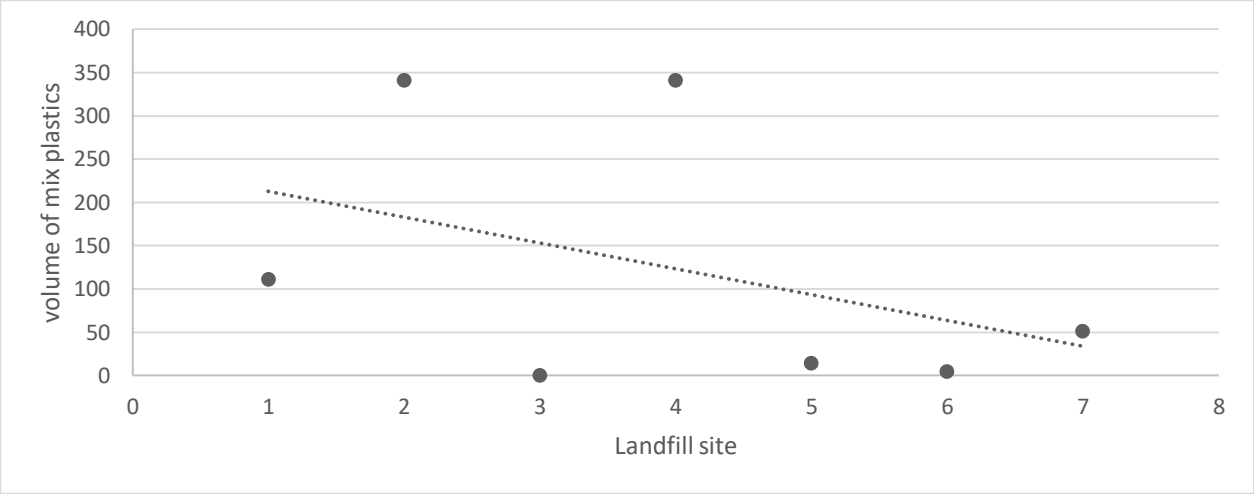

Figure 10. Volume of mix plastics

4.3.9 Quantity of cans recovered (X8)

The results for variable X8 show a data range of 92 and a mean of 3.80. The standard error of the estimate scores 1.571 with a standard deviation at 16.551. The scatter plot in Figure 11 shows individual points away from the mean which describes the extent of variation between individual points in the data. The points in a scatter plot display a negative correlation as they cluster from upper left to lower right. The graphic presentation displays less relationship of the cans(X8) to the “y” which is shown by sparse or scattered data variables.

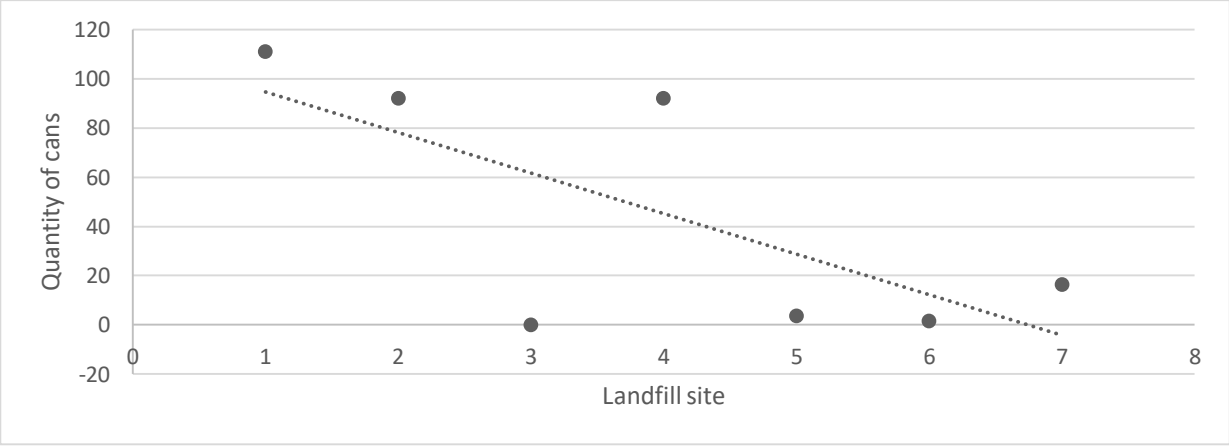

Figure 11. Quantity of cans

4.3.10 Scrap metals (X9)

The results for variable X9 show data range of 45 and a mean of 3.83. The standard error of the estimate scores 0.912 with a standard deviation at 9.606. The scatter plot in Figure 12 shows dispersal of individual points away from the mean which describes the extent of variation between individual points in the data. The graphic presentation displays less relationship of the scrap metal (X9) to the “y” which is shown by sparse or scattered data variables.

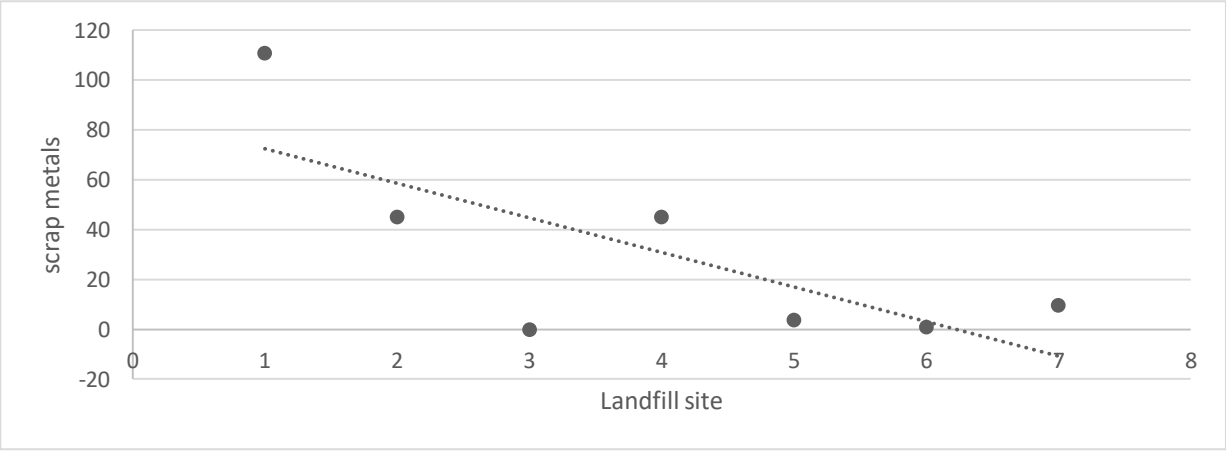

Figure 12. Scrap metals

4.3.11 Number of Female Participants (X10)

From table 13, the results for variable X10 show data range 1 and a mean of 0.66. The standard error of the estimates scores 0.045 with a standard deviation at 0.477. The points in the scatter plot are close to the mean which shows clustering of the points. The graphic presentation displays less relationship of the female participants (X10) to the “y” which is shown by sparse or scattered data variables.

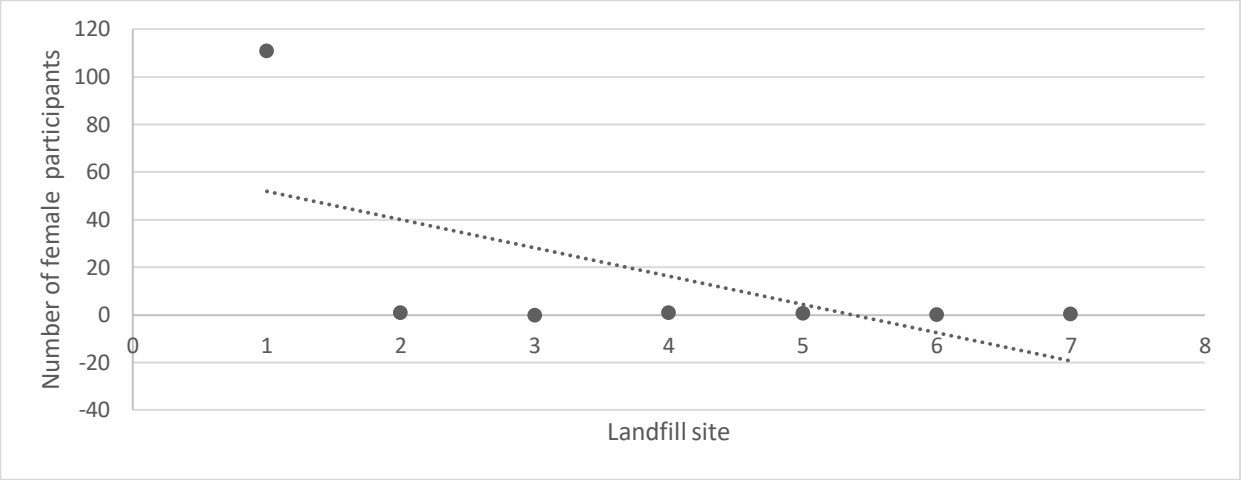

Figure 13. Female participants

4.3.12 Number of Male Participants (X11)

The results for variable (X11) show a data range of 1 and a mean 0.34. The standard error of the estimate scores 0.045 with a standard deviation at 0.477. The points in the scatter plot are close to the mean which shows clustering of the points. The graphic presentation displays less relationship of the male participants (X11) to the “y” which is shown by sparse or scattered data variables.

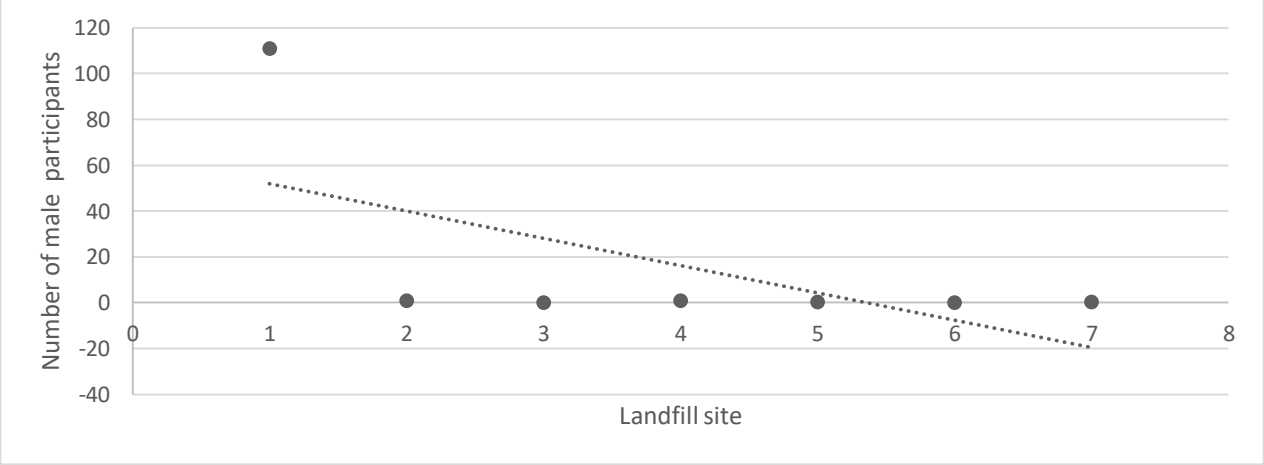

Figure 14. Male participants

4.3.13 Experience in waste recycling_1(X16)

The results for variable X16 show a data range of 1 and a mean of 0.64. The standard error of the estimate scores 0.046 with standard deviation at 0.482. The graphic presentation displays less relationship of the waste recycling (X16) to the “y” which is shown by sparse or scattered data variables.

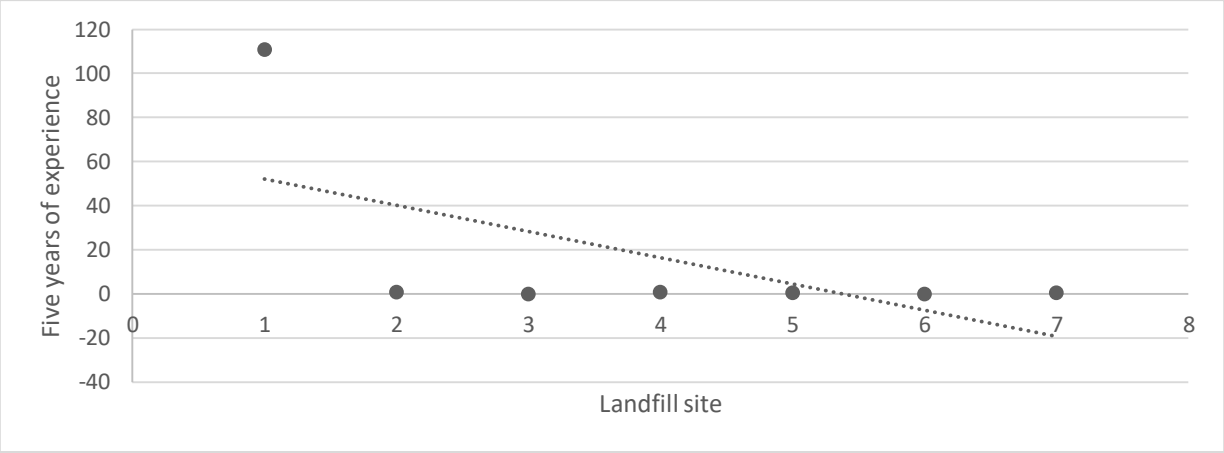

Figure 15. Five years participation level

4.3.14 Experience in waste recycling _(X17)

The results for variable X17 show a data range of 1 and a mean of 0.28. The standard error of the estimate scores 0.043 with a standard deviation at 0.451. The graphic presentation displays less relationship of the waste recycling experience (X 17) to the “y” which is shown by sparse or scattered data variables.

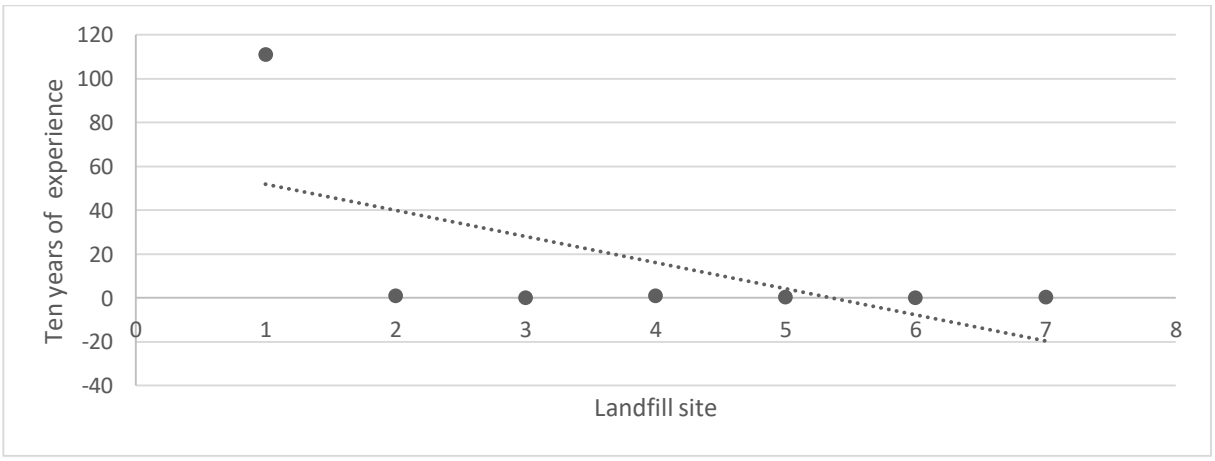

Figure 16. Ten years participation level

4.3.15 Experience in waste recycling _3(X18)

The results for variable (X18) show a data range of 1 and a mean 0.15. The standard error of the estimate scores 0.034 with a standard deviation at 0.362. The value for standard error, mean and standard deviation for variable X18 is lowest across the entire set of 18 variables. In Figure 17, none of the participants reach a 15 year experience limit. It is noted that where this was dealt with for ten years' experience in Figure 17, and 5 years' experience in Figure 15, a similar pattern persists. This indicates that across the various time periods, at least 100 of the participants cluster around 1 year of experience.

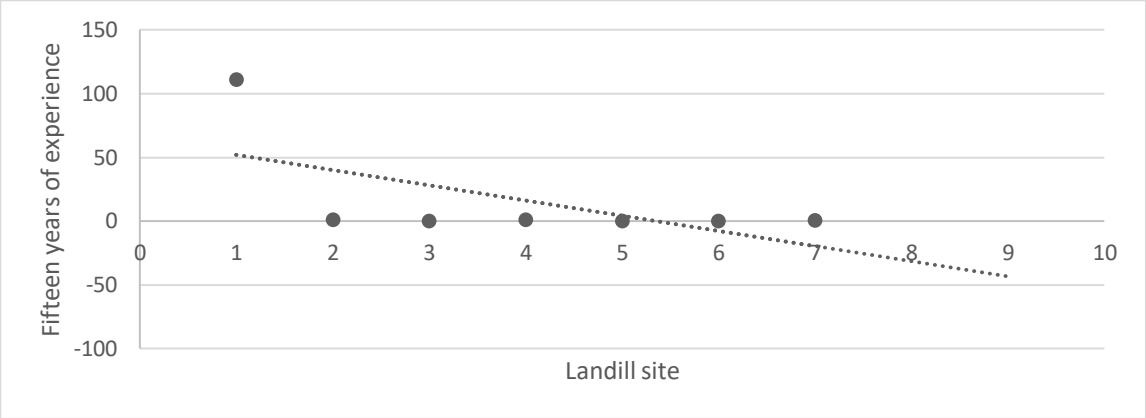

Figure 17. Fifteen years participation level

4.3.16 Income (Y)

Income on a weekly, monthly or annual basis is an important measure of labour participation. Respondents were asked to provide an estimate of what they made out of the waste recovery activity.

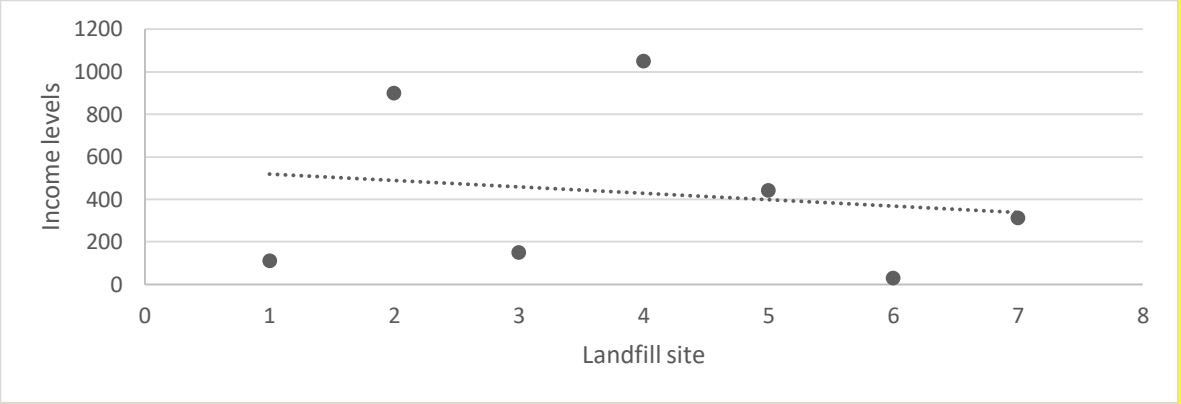

Figure 18. Weekly income generated

4.4 Computing mean income characteristics

4.4.1 Household Profiles

A set of variables were specifically designed to capture data on the households of participating respondents. These covered the level of education, gender distribution, family size, accessibility to waste sources for recovery and the marital status of respondents. These came to 9 explanatory variables, denoted as X1, X2.....X9 in Table 8. Weekly income of households is indicated 'y'. The SPSS™ was used to generate the descriptive statistics. It was noted that X3 recorded the lowest mean at 0.02 and X9 scored the highest with 2.77 and exclusively the y at 441.89.

Table 8: Descriptive Statistics

	Variable	Description	Mean	Std. Deviation	N
X1	Grade_5	Respondents with a up to grade formal education	0.41	0.495	111
X2	Grade_10	Respondents with...	0.59	0.495	111
X3	Post matric	Respondents with...	0.02	0.134	111
X4	Accessibility	Extent of accessibility to sources of waste for recovery	1.00	0.000	111
X5	Female	Gender status of the respondent	0.66	0.477	111
X6	Male	Gender status of the respondent	0.34	0.477	111
X7	Single	Marital status*	0.86	0.343	111
X8	Married	Marital status	0.12	0.323	111
X9	Family size	The number of people in the family	2.77	1.655	111
Y	y Income	Weekly income of the household	441.89	311.925	111

* There were no widows, widowers and divorcees in the sample.

On the basis of the data in Table 8, several characteristics stand out:

- Most respondents in the informal recycling sector have either no formal education or some primary education
- There are more female participants in the sector compared to the male component of the population
- All respondents reported that access to waste for recovery was guaranteed
- A weekly household income of R442 in the context of a mean family size of 3 people is rather low but it translates to an annual income of R21 216
- The low scores for both mean and standard deviation point to low variability in the individual measures that define households.

The second level of analysis involved the computation of Pearson's correlation coefficient using SPSS, version 25 (Microsoft, 2017). The results appear in Table 9.

4.4.2 Correlation analysis

In Table 4.5, the results of correlation analysis are presented at two levels of significance; 0.01 and 0.05. It is noted that the highest positive correlation values are for these variables: X1 and X2 at a significance level of 0.01.

Table 9: Pearson's correlation

	X1	X2	X3	X4	X5	X6	X7	X8	X9	y
X1 Grade 5 education Sig.(2-tailed)	1	.522** 0.000	0.024 0.806	.b	-0.125 0.190	0.125 0.190	-202* 0.033	-0.079 0.410	0.015 0.875	1
X2 Grade 10 education Sig.(2-tailed	.522** 0.000	1	-0.161 0.091	.b	-0.106 0.269	0.106 0.269	-0.119 0.215	0.022 0.818	-0.004 0.967	-.225* 0.017
X3 Post matric education Sig.(2-tailed	0.024 0.806	-0.161 0.091	1	.b	-.188* 0.048	.188* 0.048	0.051 0.577	-0.049 0.607	0.101 0.293	-0.110 0.249
X4 Access to waste sources Sig.(2-tailed	.b	.b	.b	.b	.b	.b	.b	.b	.b	0.004 0.971
X5 Gender-female Sig.(2-tailed	-0.125 0.190	-0.106 0.269	-.188* 0.048	.b	1	-1.000** 0.000	-0.008 0.938	0.027 0.782	0.005 0.958	.b
X6 Gender-male Sig.(2-tailed	0.125 0.190	0.106 0.269	.188* 0.048	.b	-1.000** 0.000	1	0.008 0.938	-0.027 0.782	-0.005 0.958	-.276** 0.003
X7 Marital status-single Sig.(2-tailed	-.202* 0.033	-0.119 0.215	0.054 0.577	.b	-0.008 0.938	0.008 0.938	1	-0.184 0.053	-0.054 0.573	.276** 0.003

X8 Marital status-married Sig.(2-tailed	-0.079 0.410	0.022 0.818	-0.049 0.607	.b	0.027 0.782	-0.027 0.782	0.184 0.053	1	0.033 0.733	.244** 0.010
X9 Family size Sig.(2-tailed	0.015 0.875	-0.004 0.967	0.101 0.293	.b	0.005 0.958	0.005 0.958	-0.054 0.573	0.033 0.733	1	-0.045 0.642
Y	1	-.225 0.017	-0.110 0.249	0.004 0.971	.b	-.276 0.003	.276 0.003	.244 0.010	-0.045 0.642	-0.009 0.927

*.Correlation is significant at the 0.05 level (2-tailed).

**.Correlation is significant at the 0.01 level (2-tailed).

b. Cannot be computed because at least one of the variables is constant.

c. List wise N=111

The results are reported in terms of interactions per row between an X variable and all other X's first. This is repeated against the response value-y.

Grade 5 Education

For X1 Grade 5 education scores a 0.522 coefficient against X2 which is significant at alpha 0.01 level and against X7 at -0.202 which is significant at alpha 0.05 level. The output against the y-dependent variable is 1 which is the single highest in the entire print out of table 9. This means that the low level of basic education has a significant impact in predicting potential income differentials across participating households.

Grade 10 education

For X2 Grade 10 education, scores a high coefficient of 0.522 against X1 with the rest consistently negative and low coefficients. It is noted that its impact on y- is significant at the 0.05 level. The possession of a grade 10 level of education appears to improve the earning power of individual participants.

Post matric education

For X3 post matric education, scores a significant -.188 against X5 and a significant 0.188 against X6 at an alpha level of 0.05. This would appear to indicate the role of education for both female and male participants is important. It is noted though, that for females in X5, the significance appear to be negative.

Access to Waste sources

For X4 this variable generated a constant (b) given that all participants essentially indicated that they had free access to landfill sites to recover waste.

Gender: Female

For X5 female gender, two coefficients stand out. A -.188 against X3 (post matric) and a -1.000 against X6 (gender male). It is noted that both the coefficients are negative implying that female participants with a post matric education are unlikely to reap additional benefits from waste recovery and or recycling.

Gender: Male

For X6 male gender we got coefficients that are opposite of those for females in X5. Correlation is significant for y at -.276 at the 0.05 level. Note that because the significance is negative, it can be concluded that just like for female participants, the male component of the sample is not necessarily at an advantage over female participants.

Marital Status

For X7 **(**single) and X8 (married), the print-out shows consistently low values for coefficients. It is however noted that against the y-dependent variable, both are significant at the 0.05 level. With such results, it can be concluded that marital status seems to impact on income generation potential of participants. Married participants score a higher

.244 that unmarried ones at .276. Marital status translates into greater responsibilities and the possibility of greater effort, seriousness and purpose.

Family Size

For X9 (Family size) the mean size came to 2.77 as reported in Table 4.4 with a standard deviation of 1.655. Correcting to the nearest, this translates to a mean of 3 people per family with a $\pm$1.7 on either side of the mean. This gives a relatively small family size. The results for this variable in table 9 show consistently low coefficients with none significant at either the 0.05 or 0.01 levels. This means that on the basis of the outputs, family size does not appear to influence variations in the income of participating households.

4.4.3 Regression analysis

Using the SPSS™ programme, the results from Pearson's correlation were input into least squares regression with the stepwise option. The aim was to progressively isolate those explanatory variables that strongly determine the variations in the y.

Table 10: Regression analysis

Model	Variable Entered	Variables Removed	Method
1	X9,X2,X8,X6,R,X7,X3,X1	X4 X5	Entered

a. Dependent Variable: Y;

b. Tolerance=0.000

Table 11: Model Summary

Model	Regression	R Square	Adjusted R Square	Std. Error of the Estimate
1	.527[a]	0.278	0.221	275.224

a. Predictors (Constant), X9, X2, X8, X6, X7, X3, and X1

The multiple correlation at 0.527 represents the relationship between the set of seven predictor X variables and the *y*-dependent variable. The R-Square value of 0.278 reduces to 0.221 for Adjusted R-Square which translates to 22.1%. This outcome means that the x-explanatory variables can only explain 22.1% of the variation of the *y*-dependent variable. The remaining 77.9% of the variation in *y* originates from other explanatory variables not included in the original data set.

4.4.4 Analysis of Variance

In Table 12, the values relevant to the least squares regression line coefficients are presented. The regression value of 2976376.245 in the first row represents the cumulative effect of the X's on *y*. The residual at 7726326.457 accounts for that portion of the impact on y that is not a result of predictor variables. The results display that the predictor variables are statistically significant at .000[b.]

Table 12: Analysis of Variance

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2976376.245	8	372047.031	4.912	.000[b]
	Residual	7726326.457	102	75748.299		
	Total	10702702.703	110			

a. Dependent Variable: Y; b. Predictors: (Constant), X9, X2, X8 X6, X7, X3, X1, N

Table 13: Standard Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
1	432.230	108.656		3.978	0.000	3.978	0.000
(Constant)	-3.169	0.879	-0.327	-3.605	0.000	-3605	0.000
N	-203,675	67.014	-0.323	-3.039	0.003	-3.039	0.003
X1	61.021	66.965	0.097	0.911	0.364	0.911	0.364
X2	-152.977	206.279	-0.066	-0.742	0.460	-0.742	0.460
X3	196.878	56.803	0.301	3.466	0.001	3.466	0.001
X6	210.007	80.420	0.231	2.611	0.010	2.611	0.010
X7	-44.788	83.819	-0.046	-0.534	0.594	-0.534	0.594
X8	-1.886	16.024	-0.010	-0.118	0.907	0.118	0.907
X9							

On the basis of the standard coefficients, the regression equation is

Income of households (y) =432.239(constant)-203.7(X1) +61.02(X2)-152.98(X3) + 196.88(X6) +210.0(X7) -44.79(X8) -1.89(X9).

From these results, the set of predictor variables- X1, X2, X3, X6, X7, X8 and X9 are statistically significant in relation to *y* the income of individual participating households. In addition, the regression model developed provides a good fit for the data.The F-ratio at 4.912 in the ANOVA output shows that the results do not support accepting the original null hypothesis as specified in chapter 1 section 1.5.

4.5 Pathways of recycled waste

4.5.1 Basic Structure

The basic structure for waste recycling in South Africa is comprised of five basic steps. Step 1 involves the recovery of waste from various waste sources formally and or informally. This is carried out either by informal free-lance waste pickers or by employees of small waste recovery companies. Step II involves the sorting and packaging on site of such waste in receptacles-often made available by waste sub-contractors

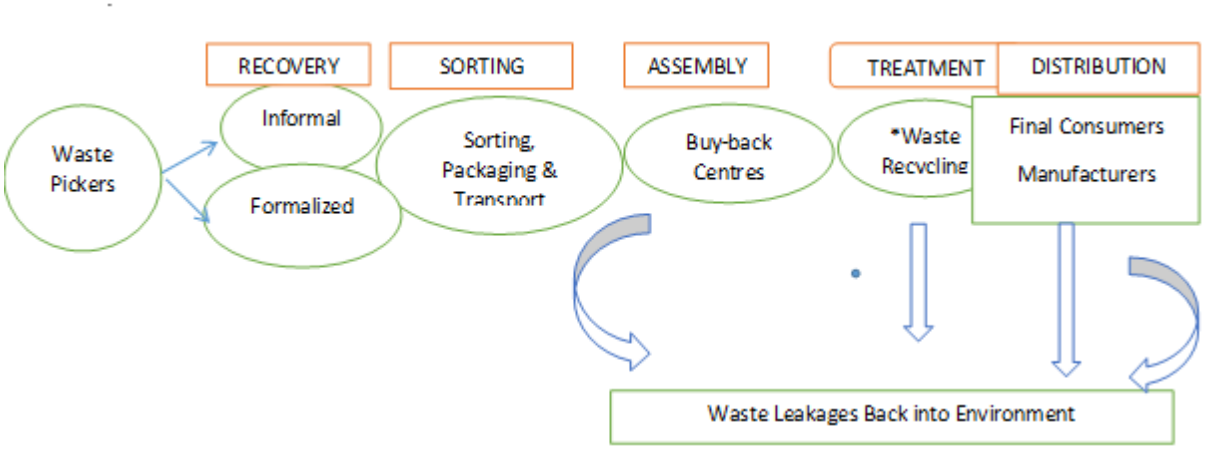

Figure 19. Pathways in industrial waste recycling

There is the option at this stage of waste pickers collecting waste from a diversity of sources other than landfill sites. Step III deals with waste assembly at buy-back centres or regional waste facilities which in turn arrange and forward such waste to Step IV of the structure.

At step III another option involves waste sub-contractors collecting waste from pickers at the landfill site and forwarding them either to waste buy-back centres or onward to step IV. Waste transporters operate at Step IV-treatment- in which waste is moved and delivered at recycling facilities. Step V involves distribution of new products, waste by-products and waste raw materials for the market.

4.5.2 Recovery and Resale

While Figure 4.16 gives a formal structure of the waste recycling industry, a significant level of flexibility does exist. A significant amount of recovered waste is introduced back

into the market through direct resale. Often waste pickers do this as it offers better and higher returns per unit than delivering at buy-back centres.

4.5.3 Re-use

From field work, it was established that some of the recovered waste is not normally taken in by operators of buy-back centres. This includes discarded furniture, timber pranks, certain types of non-copper cabling, clothing, footwear, wide range of plastic containers and plastic bags. Some of these items are retained by waste pickers for use at home while others are offered to the public for sale at a negotiated price.

4.5.4 Pre-selection of waste

There exists a preference in which certain waste types do have a ready market. The most popular types of waste for recycling include plastic bottles of specific soft drink brands, card board, metal, glass bottles and copper wire. Across the study area, it was noted that no buy-back centre accept plastic bags. This may explain why these bags are a major waste component at landfill sites. Apart from buy-back centres, there are scrapyards across provincial towns that buy from members of the public items such as used equipment**,** machinery, vehicles and their parts. Some of these have on site machinery for compressing and compacting steel and metal into pellets for delivery to steel mills. Others are more of specialised retail outlets and tend to deal mainly in motor vehicles, vehicle parts and used machinery. These acquire their stock either from public auctions or from dealers of accident recovered vehicles. In these cases, vehicles and machinery are stripped into parts which are in turn sold to the public on an “as is” basis.

4.5.5 Buy-back centres

During fieldwork, certain characteristics common to almost all these centres in NWP were noted and recorded. Buy-back centres are:

- Generally small in size in the context of capitalisation.

- Operate at basic low levels of technology and office mechanisation.
- Handle a small range of waste types.
- Operate packaging facilities which are low scale.
- Report seasonal fluctuations in the supply of waste by pickers and members of the public.
- Report low annual turnover due to small scale of operations.
- Are subjected to relatively high transport costs per unit tonnage of waste sent to recycling facilities.
- Report that facilities for industrial waste recycling are far thereby making transportation expensive.

4.5.6 Role of municipalities

Informal interviews conducted at local and district municipalities with regard to the operations of the informal waste recycling sector produced the following:

Only in one municipality was there evidence that an on-going programme was in place to organise waste pickers into some form of cooperative

Landfill site managers reported that they were responsible for the registration and control of waste pickers in order to achieve some order in their operations. Madibeng, Naledi and Tlokwe, they however conceded that their efforts were undermined by the lack of security at landfill sites and the failure to maintain the perimeter fence.

In some municipalities, local waste recovery companies deployed their own workers to recover waste at selected sites. They then sent in vehicles periodically to load and transport such waste to recycling companies

A common challenge across the entire study area was the practice of illegal waste pickers who often damage the perimeter fence to gain illegal access to landfill sites

More than 50% of formal landfill sites were not properly secured either in terms of a solid perimeter fence or gate security. This led to a situation where the general public not get

free access to the facilities but in some case have erected informal shacks where they live on site.

4.6 Discussion

On the basis of the findings, the discussion is built around several issues: (i) the state of the waste recycling sector;(ii) characterisation of informal waste recycling; (iii) household profile of waste pickers; (iv) pathways of recycled waste; and (v) how to address constraints as a means of improving performance. It is necessary to re-emphasize that the approach of this study is one that sees *recycling as a series of treatment options*. These include recovery and re-use, resale, composting and industrial recycling which involves the output of raw materials, semi-finished goods and final consumer products.

4.6.1 Recycling sector

This study has looked at the waste recycling sector from the perspective of informal waste pickers. This class of role players, however, provide the basic platform on basis of which the entire sector is built. Due to the small scale of operations, waste pickers focus on waste recovery, reuse and resale. Waste sub-contractors often with significant capital enter into service agreements with established industrial recycling plants. They are able to link informal waste recyclers and buy-back centres to these plants. The scope for growth is therefore immense. But the small size of the sector means that its potential impact in waste minimisation and employment creation remains unrealized. These results appear to support (Schenck *et al.*, 2010) and Wilson *et al.*, 2006)

4.6.2 Informal waste recycling

For informal waste recyclers, the findings indicate that:

- Participation is spread across both females and males with marital status playing an insignificant selection role of the informal waste participants.
- Income from the waste activity is low with a mean of R442 per week which does not show major variations across the various municipalities in the North West Province.

- .Participants operate as individuals with hardly any *structures in place to represent their common interests*. The result is that they cannot negotiate as a block with operators at higher levels of the hierarchy in waste recycling. It is understandable therefore why most respondents reported persistent cases of exploitation through low prices for what they deliver at buy-back centres. This finding is quite the opposite of conditions reported for Brazil in Viljoen, Schenck & Blaar (2012).
- It is noted that education appears to be a major determinant of the likelihood of participation. The cluster of respondents with up to grade 5 education remains the dominant players. Movement towards matric and post-matric shows a corresponding reduction in participation rates. This would appear to indicate that a lack of formal employment is a major driver of participation in the waste recycling sector.

4.6.3 Household profile

The nature of the research design for the study did not generate the type of data that could have allowed for a comparison between income levels of participating and non-participating households. Beyond family size and employment sector, little information was made available about the households where informal waste pickers belong. In general the household profile is characterised as with limited diversity in employment participation. Often the waste picker is the only bread winner in the household. That unemployment in the general population remains a key driver of participation in the informal waste recycling is borne out by research findings in Samson (2010) for reclaiming reusable and recyclable materials, in Tansel (1998) on economic development and labour force participation, and in the *National Waste Management strategy* (DEA,2011). Indeed, in line with this finding, a significant volume of literature reports on informal waste recycling as a survivalist activity (Kasinga & Tilley, 2018).

4.6.4 Pathways of recycled waste

A number of options in the pathways of recycled waste are noted in this study. The findings of this study point to internal constraints in the sector centred on the narrow range

of waste types taken up into recycling. This seems to point to the conventional manufacturing sector being reluctant to increase demand for inputs from the waste recycling sector. Studies elsewhere for the EU countries (Kitson & Michie, 2014), show a more advanced waste sector industry. In addition, government, to-date, has not yet introduced any noticeable incentives and or regulations to encourage the use of recycled raw materials. Until this occurs, the recycling industry will remain disadvantaged.

4.6.5 Performance interventions

From the discussion, interventions at improving performance have to be built around four cornerstones:

(i) the mainstream manufacturing sector,

(ii) formalisation of the informal waste recycling sector,

(iii) strengthening linkages with mainstream waste recyclers, and

(iv) protective legislation for the waste recycling industry itself.

The mainstream manufacturing sector makes use of raw material inputs that are conventionally harvested through primary production. It is possible to put into place a combination of *incentives, regulations* and *safeguards* that would make recycled raw materials cheaper and more competitive. This would encourage manufacturers to switch from conventional raw materials to a reliance on recycled raw materials. This could in turn give a boost to the entire value chain of industrial waste recycling in South Africa.

The formalisation of the informal sector recyclers could lead to the formation of local waste cooperatives with multipliers into commercial banks for accessing loan finance and better price negotiations with buy-back centres. This would at the same time strengthen linkages across the waste recycling hierarchy system. The provincial government could play a key role in selling this idea and supporting such cooperatives. Indeed, it would encourage higher participation levels than is the case today.

The argument for trade protectionism cannot be ignored off-hand as misguided or misinformed. A significant threat to the local manufacturing sector arises from liberal trade

policies that have seen the country flooded with cheap imports from Asian nations –China, Malaysia, Thailand and Taiwan. This leads to industrial decline due to factory closures and ultimately the loss of employment locally in South Africa (DEDAT, 2016). Local waste recycling operators should not be exposed to such threats because their potential growth is stifled in the process. Instead, local manufacturing concerns that opt to use recycled raw materials and semi-finished goods for further processing should benefit from a nationally sponsored incentive scheme (DEDAT, 2016). This would accelerate movement towards a circular economy, the new paradigm today of the green economy (DEDAT, 2016) and local economic development. It is noted, for example that China and India have become global leaders in the importation and re-processing of industrial wastes especially from the EU, Japan and North America (Desai, 2003).

CHAPTER 5. CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This study set out to understand and expose South Africa's commitment to sustainable development, while protecting environmental resources, using North West as the study area. The main aim of the study was to analyse the elements of informal waste recycling and recovery as a first stage in solid waste recycling in selected local municipalities in the North West province. Five objectives were set out in order to achieve this aim, namely;

- To describe the state of solid waste recycling industry at the provincial and national scale.
- To characterise informal waste collection, sorting and recovery at landfill sites.
- To compute the mean income levels of participants in informal waste recycling.
- To build pathways of flow line diagram of recycled waste.
- To suggest methods for improving the performance of the informal waste recycling sector.

A filed work exercise was carried out in order to gather both primary and secondary data for analysis purposes. A detailed scientific methodology was applied in order to process and analyse the data, in order to generate key findings as presented in chapter 4. This final chapter provides the conclusion, study limitations and recommendations for the study.

5.2 Key findings

The key findings of this study are reported in point format:

- The narrow range of waste types that buy-back centres specialise in means that waste pickers can only recover a limited range of waste for resale. The bulk of the waste generated and eventually delivered to landfill sites is not recovered, a situation quite the opposite of practices in Egypt, India, China and Brazil (Desai, 2014).
- Buy-back centres are widely distributed across towns in the study area. But, their low level of capitalisation undermines their growth potential. The practice of backward integration through recycling plants operate their own waste buy-back

centres is not yet developed in South Africa. This would have facilitated the commercialisation of informal waste recycling sector at a faster rate than is the case today. Conventional literature reports of such backward integration practices in Lagos (Adejonwo-Osho, 2016).

- Most unemployed men and women participate in the recycling sector as an income generating activity. There is sufficient research evidence in the literature review and from this study to show that informal recycling can support households. But for this to occur, radical changes are required in the informal recycling sector itself and in the structure of the mainstream waste recycling industry in South Africa (DEA, 2011).
- Sub-contractors play an important role in linking buy-back centres to waste recyclers. The participation of both gender plays an insignificant role in the informal waste recycling. This would appear to indicate increasing diversification of the local labour industry in the face of rapid modernisation. Similar studies on participation rates appear to emphasize the marginalisation of female participation in economic activity (Tansel, 1998). The findings of this study appear to debunk this position, at least with regard to informal waste recycling. If there are challenges to participation, these will not be due to gender identity but rather to issues around marital status and whether or not potential participants are mothers of young children (Samson, 2010).
- The mean weekly income of informal waste pickers is low across the North West province. Deviations between different municipalities were also low. Low mean income arise partly from the limited range of waste types that buy-back centres are interest in purchasing and the fact that the rest of the waste types are not demanded by the recycling market.
- The education level is critical in determining the potential for participation in informal recycling. The dominant players are concentrated in the cluster below the Grade 5 education level. The higher the mean level of education, the greater will be the possibility of people to search for formal employment away from the informal

sector. This finding agrees with the work of Samson (2010) and (Chisango, 2017) on the potential to grow informal waste recycling in semi-urban areas.

- A significant percentage of respondents reported that they were exploited by buy-back centres through low prices for delivered waste. This is made possible, as earlier reported from the results due to the absence of waste pickers cooperatives which would have given them collective bargaining power (Kasinga & Tilley, 2018).
- The formalisation of informal waste sector could assist to facilitate the formation of local waste cooperatives and make the sector competitive. Results from the interview with municipal waste management officials indicate a low priority awarded to supporting such initiatives. Studies in other parts of the developing world show benefits of such cooperatives in mobilizing the masses of the poor into pooling of resources (Godfrey *et al* 2015)
- The green economy can be fast-tracked through a policy shift at the municipal level in which the informal waste recycling sector could be taken on-board as a partner. Results of this study do not convey the impression that such a possibility has been considered by local municipalities in confronting the challenges of delivering a modern waste service.

5.3 Limitations of the study

This study was focused on the landfill sites as a central point to provide critical opportunity for observing waste collection, sorting and recovery. All information and data were generated from landfill sites and did not include amount of waste generated at households in the study area, and its local municipalities. It is not possible on the basis of this data to build a case against the perception that recycling is a survivalist strategy. Schenk & Blaauw (2011) as well as Dinler (2016) reported on the lack of data that could otherwise assist in showing the emerging nature of recycling as a sustainable means of survival with economic benefits above the breadline.

5.4 Conclusion

Waste pickers play a key role in mobilizing and delivering waste to buy-back centres which in turn convey packaged waste to industrial recyclers. Waste pickers therefore form the basic platform for the waste recycling industry. The informal activity, however encounters challenges around the absence of waste pickers cooperatives, the low prices offered for delivered waste and, the perceived lack of official interest from municipalities and the mean low returns of the activity.

5.5 Recommendations

The study supports the findings of several authors. It was found that there is an existence of several internal problems in the management of waste. To eliminate policy conflicts, it is recommended that the Department of environmental affairs spearhead a policy framework that will standardise or guide waste management bylaws of all municipalities in line with informal waste recycling. This study shows economic opportunities in informal waste recycling and the role played by informal waste pickers

Training and awareness

The informal waste pickers on most visited landfill sites complained for not being given training to assist them with new skills and empower them about how they can formalise their trading to participate positively in our economy.

Role of municipalities

Local municipalities are the closest structure to informal waste pickers. They are called upon to facilitate formalisation of cooperatives. That should assist in the management of solid waste, by registering groups that can be used in training and control of landfill site activities. This could influence their positive contribution of proper data recording for future studies.

Informal waste pickers play an important role in solid waste management by assisting municipalities on cost containment of waste disposal. Municipalities must draw up

engagement contracts on how to build extended work programs that involve work of informal waste pickers.

Waste forums

The Department of Environmental Affairs, provincial and local municipalities, as custodians of waste management, have a responsibility to initiate the waste forums. The waste forums are coordinated for these custodians and excludes the core waste generators. It could be informative to start community waste forums unlike sharing information with custodians, those who understand the legislation and by-laws. This forum should give waste generators an insight on how they can participate on sorting at source and other avenues of innovative business initiate.

Waste cooperatives should be set up and formalised through support from the provincial and national government. Such cooperatives could provide the means for members to pool resources and carry out collective bargaining in the pricing of what they deliver to the market.

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Appendix A: Observation Schedule for Informal Waste Pickers

District	Municipality	Mean weekly income in Rand	Volume of waste in 000.s Kg*
Ngaka Modiri Molema	Mahikeng	340	910
	Ditsobotla	423	880
	Ratlou	700	100
Dr. Ruth Segomotsi Mompati	Greater Taung	141	660
	Naledi	440	430
	Mamusa	260	360
Dr. Kenneth Kaunda	City of Matlosana	820	710
	Tlokwe	680	780
	Ventersdorp	300	855
Bojanala Platinum	Madibeng	1590	932
	Moses Kotane	765	1630
	Kgetlengrivier	643	1060

Appendix B: Base data

District	Municipality	Number of Participants	Years of Education		
			*Var5	Var10	Var14
Ngaka Modiri Molema	Mahikeng	11	5	6	0
	Ditsobotla	7	5	2	0
	Ratlou	2	1	1	0
Dr. Ruth Segomotsi Mompati	Greater Taung	13	5	8	0
	Naledi	18	8	10	0
	Mamusa	3	1	2	0
Dr. Kenneth Kaunda	City of Matlosana	20	9	11	0
	Tlokwe	20	6	14	0
	Ventersdorp	4	1	3	0
Bojanala Platinum	Madibeng	7	3	4	0
	Moses Kotane	3	1	2	0
	Kgetlengrivier	3	2	1	0

* var= variable

Appendix C: Primary data set of Responses from field work

	x1	x2	x3	x5	x6	x7	x8	x9	x10	x11	x16	x17	x18	Y
1	172	0	0	0	3122	0	0	30	0	1	1	1	1	450
2	45	0	0	0	542	0	0	12	0	1	1	1	1	450
3	0	0	0	0	1809	0	0	0	1	0	0	0	1	750
4	0	0	0	0	673	0	0	0	1	0	0	0	1	750
5	0	0	0	0	0	0	0	0	1	0	0	0	1	750
6	0	0	347	0	0	0	0	0	1	0	0	0	1	1050
7	0	0	0	0	0	0	0	0	1	0	0	0	0	1050
8	0	0	0	0	0	0	0	0	1	0	0	0	0	1050
9	0	0	0	0	0	0	0	0	1	0	0	0	0	1050
10	0	0	592	0	0	0	0	0	1	0	0	0	0	1050
11	1530	0	0	0	0	0	0	0	1	0	1	0	0	450
12	890	0	0	0	0	0	0	0	0	1	1	0	0	450
13	0	0	1230	0	0	0	0	0	0	1	1	0	0	450
14	210	0	0	0	0	0	0	0	0	1	1	0	0	450
15	0	0	0	0	0	0	0	0	0	1	1	0	0	750
16	4200	0	786	0	0	0	0	0	1	0	1	0	0	750
17	1600	0	0	0	0	0	0	0	1	0	1	0	0	750
18	1800	0	0	0	0	0	0	0	1	0	1	0	0	750
19	3000	0	0	0	0	0	0	0	1	0	1	0	0	1050
20	2750	0	0	0	0	0	0	0	1	0	1	0	0	1050

21	0	0	0	0	232	0	0	0	1	0	0	1	0	150
22	0	0	0	0	176	0	0	0	0	1	0	1	0	150
23	680	0	0	0	0	0	0	0	0	1	0	1	0	150
24	0	0	0	0	0	0	0	12	0	1	0	1	0	450
25	0	0	0	0	0	0	0	35	0	1	0	1	0	750
26	0	0	0	0	0	0	0	10	0	1	0	1	0	750
27	0	0	0	0	0	0	0	7	1	0	0	1	0	750
28	0	0	0	0	0	0	0	19	0	1	1	0	0	750
29	0	0	0	0	0	0	0	23	0	1	1	0	0	750
30	0	0	0	0	0	0	0	15	0	1	1	0	0	750
31	0	0	0	273	0	189	0	0	0	1	1	1	1	150
32	950	0	0	0	0	203	0	0	1	0	1	1	1	150
33	0	0	678	0	0	0	0	0	1	0	1	0	1	150
34	670	0	0	0	0	0	0	0	1	0	0	0	1	150
35	1070	0	0	0	0	0	0	0	1	0	0	0	1	150
36	0	0	967	365	0	0	0	0	1	0	0	0	0	150
37	0	0	0	0	0	0	0	0	1	0	0	0	0	450
38	0	0	0	0	0	0	0	0	1	0	0	0	0	450
39	0	0	0	0	0	0	0	0	0	1	0	0	0	750
40	0	0	654	0	0	0	0	0	0	1	0	0	0	750
41	0	0	0	0	0	0	0	0	0	1	1	1	1	150
42	0	0	0	0	0	0	0	0	1	0	1	1	1	150
43	567	0	0	0	0	0	0	0	1	0	1	0	0	150
44	0	0	0	0	0	0	0	0	1	0	1	0	0	150
45	0	0	0	0	0	0	0	11	1	0	1	0	0	150
46	0	0	0	0	0	0	0	0	1	0	1	0	0	150
47	321	0	0	0	0	0	78	0	1	0	1	0	0	150
48	0	0	0	0	0	0	45	0	0	1	1	0	0	450
49	0	0	0	0	0	0	92	0	0	1	0	0	0	450
50	0	0	732	0	0	0	69	0	0	1	0	0	0	450
51	0	0	0	0	0	0	0	0	0	1	1	0	0	750
52	0	340	0	0	0	0	0	0	0	1	1	1	0	150
53	0	531	0	0	0	0	0	0	1	0	1	1	0	150
54	0	187	0	0	0	0	0	0	1	0	1	1	0	150
55	782	0	0	0	0	0	0	0	1	0	0	1	0	150
56	0	0	176	0	0	0	0	0	1	0	0	1	0	450
57	0	0	0	0	0	0	0	0	1	0	0	0	0	450

58	654	0	0	0	0	0	0	0	1	0	0	0	0	450
59	936	0	0	0	0	0	0	0	1	0	0	0	0	450
60	0	0	0	0	0	0	0	0	1	0	0	0	0	450
61	0	0	0	0	0	0	0	0	1	0	0	0	0	450
62	789	0	0	0	0	27	0	0	0	1	1	0	0	150
63	0	0	0	0	0	120	0	0	1	0	1	0	0	150
64	652	0	0	0	0	89	0	0	1	0	1	0	0	150
65	0	0	0	0	0	52	0	13	1	0	1	1	0	150
66	0	243	0	0	0	0	0	0	1	0	1	1	0	150
67	0	0	0	0	0	0	0	0	1	0	1	1	0	150
68	0	0	0	0	0	0	0	0	1	0	1	1	0	150
69	0	0	0	0	0	0	0	0	1	0	1	1	0	150
70	0	0	0	123	0	0	0	0	1	0	1	0	1	150
71	0	0	0	98	0	0	0	0	1	0	1	0	1	150
72	0	0	0	0	0	0	0	0	0	1	1	0	0	150
73	0	0	0	0	0	0	0	0	1	0	1	0	0	150
74	0	0	0	0	0	0	0	0	1	0	1	0	0	150
75	0	0	0	0	0	0	0	45	1	0	1	0	0	150
76	0	0	0	0	0	0	0	32	1	0	1	0	0	150
77	0	269	0	0	0	0	0	0	1	0	1	0	0	150
78	0	0	132	0	0	0	0	0	1	0	1	0	0	150
79	0	0	0	0	0	0	90	0	1	0	1	0	0	150
80	0	0	0	0	0	0	48	0	1	0	1	0	0	150
81	0	0	0	0	0	0	0	0	0	1	1	0	0	450
82	0	0	87	0	0	0	0	0	0	1	1	0	0	150
83	0	0	0	0	0	0	0	0	1	0	0	0	0	150
84	0	0	0	0	0	0	0	23	1	0	0	0	0	150
85	3025	86	0	0	321	0	0	19	1	0	0	0	0	150
86	985	0	0	0	270	0	0	0	1	0	0	0	0	450
87	695	0	0	0	653	0	0	0	1	0	0	0	0	450
88	1051	0	0	0	0	0	0	0	0	1	0	0	0	750
89	0	0	0	0	0	0	0	0	0	1	1	0	0	750
90	0	0	962	0	0	0	0	0	0	1	1	1	0	1050
91	0	0	1073	0	0	0	0	0	1	0	1	1	1	1050

92	0	0	0	0	0	0	0	0	1	0	0	1	0	150
93	0	0	0	0	0	341	0	42	1	0	0	1	0	450
94	0	98	0	0	0	219	0	21	1	0	1	1	0	750
95	0	0	0	0	456	0	0	0	1	0	1	1	0	750
96	0	0	0	0	234	0	0	0	1	0	1	0	0	750
97	0	0	547	0	0	0	0	0	0	1	1	0	0	750
98	0	0	0	0	156	0	0	0	0	1	1	0	0	750
99	0	0	359	0	0	0	0	0	0	1	1	0	0	750
100	0	143	512	0	0	0	0	0	0	1	1	1	0	750
101	0	0	0	0	0	0	0	0	0	1	1	1	0	750
102	0	0	0	0	0	0	0	0	1	0	0	0	0	150
103	0	0	0	0	0	0	0	0	1	0	1	0	0	150
104	0	0	0	0	0	0	0	0	1	0	1	0	0	150
105	0	0	0	0	0	156	0	35	1	0	1	0	0	150
106	0	0	0	0	0	79	0	21	1	0	1	0	0	150
107	0	0	0	0	38	112	0	0	1	0	1	0	0	150
108	0	174	0	0	92	0	0	0	1	0	1	0	0	150
109	0	0	0	0	67	0	0	0	0	1	1	0	0	750
110	0	0	0	0	45	0	0	0	0	1	1	0	0	750
111	0	0	0	0	123	0	0	0	0	1	1	0	1	1050