

Intra-urban patterns of domestic solid waste recycling in sub-Saharan Africa: towards an exploratory search for insights in Gaborone, Botswana

Shamiso W. Mupara · Michael R. Nkuba · Thando D. Gwebu

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Abstract Botswana is among those developing countries that are rapidly transitioning from predominantly rural to urban societies. Gaborone, its capital city, is seriously confronted by formidable challenges of sustainable metropolitan management, including the proper handling of solid domestic waste. Although the international convention of the 3-Rs, namely, Recycle, Reduce, Reuse is generally accepted; its implementation remains elusive. It is therefore of utmost importance to unravel significant determinants of the gap between nominal acceptance and praxis in order to influence policy. This preliminary case study, consequently, sought to identify the underlying factors that differentiate waste recycling practices from high, medium, and low socio-economic areas Gaborone. Key informants, including municipal officials and company representatives, in charge of city solid waste management, were interviewed. A probit model was used to analyze those factors that could influence recycling and waste separation practices. Results showed that tenure, gender, income, affluence, location of house increase the likelihood of recycling while

age, education level, household size and source of waste management information did not influence the likelihood of recycling. Stakeholders should place greater emphasis on positive environmental awareness, and appropriate reward systems for recycling domestic solid waste and recycling should be tailored according to the locational needs.

Keywords Urban domestic solid waste · Recycling · Gaborone, Botswana

Introduction

Rapid urbanisation, population growth and changes in lifestyles, in low income countries, contribute to increasing per capita domestic waste generation (Mosler et al. 2006). Waste generation in sub-Saharan Africa is approximately 62 million tonnes per year. It is estimated that African cities generate waste at a rate of between 0.3 and 1.4 kg per capita per day, as opposed to the average 1.22 kg of waste generated in each developed country per capita per day (Achan-keng 2003).

With the increase of disposable incomes, the consumption of non-durable commodities, at the household level, has continued to expand and domestic solid waste generation has equally increased. Socio-economic factors affect both the quantities and types of waste generated, including its

S. W. Mupara · M. R. Nkuba · T. D. Gwebu (✉)
Department of Environmental Science, University of
Botswana, Gaborone, Botswana
e-mail: gwebutd@gmail.com

S. W. Mupara
e-mail: muparasw@gmail.com

M. R. Nkuba
e-mail: mnkuba@gmail.com

management, at the household level. As the standards of living improve, so does the tendency to generate more waste (Fiksel 2009). The increase in waste generation arises from the adoption of the western “throw away cultural syndrome” in sub-Saharan African cities (Yelda 2005). Solid waste generation has therefore emerged as a visible and tangible symbol of a materialistic and consumptive society.

Compared with more developed countries, most urban settlements in sub-Saharan Africa seem to be overwhelmed by waste management problems that threaten their environmental sustainability. Approximately 50–60% of the waste generated in urban areas in Africa is collected, while 40–50% of the waste remains uncollected in the streets (Bjerkli 2005). Some of the waste has been landfilled while most has either been deposited in dumping sites or openly incinerated (Adeyemi et al. 2001; Rotich et al. 2006; Kassim and Ali 2006; Al-Fares et al. 2009). The waste management failure has been attributed to the breakdown of; legislative instruments, awareness creation, technological and economic instruments. Moshia (2000) and Silitshena (1989) have added bureaucratic inertia and rampant corruption to the list of constraints.

In the UN Earth Summit, the agenda for the achievement of urban solid waste management (SWM), figured prominently. The bottom-up participation of the affected and interested parties, known as environmental planning and management (EPM), sought to elicit popular urban participation in SWM. EPM is currently being implemented, in the context of the sustainable cities program (SCP), in targeted cities in sub-Saharan Africa that include Accra in Ghana, Lusaka in Zambia and Dar es Salaam in Tanzania. The environmental sustainability discourse, that SCP ostensibly advocates, has however been critiqued for failing to view urbanization as a process of “socio-ecological change” (Swyngedouw and Kaika 2000).

The 2030 Agenda for Sustainable Development, including the sustainable development goals (SDGs), and the Addis Ababa Action Agenda of the Third International Conference on Financing for Development, also underscore the importance of sustainable urban solid waste management to environmental health. From a policy vantage point, it is therefore very germane to investigate whether the chronic urban waste—related environmental challenges could be attributed to either economic, political, social,

technological, and/or purely perceptual underpinnings, in order to provide evidence-based solutions.

Following this introduction, urban waste collection is examined within the context of environmental justice. Recycling within the framework of integrated urban solid waste management will then be discussed. A description of the study area will then be made followed by the methodology that was adopted to conduct the investigation. The results are then presented before summary and conclusion statements are made.

Urban solid waste management and environmental justice

The analytical approaches to urban environmental problems in Africa have been devoid of a substantive holistic perspective by confining themselves to physical planning, metropolitan governance and environmental factors. Such atomistic and unintegrated perspectives on these issues have led to frustrations in addressing and providing answers to urban environmental challenges in Africa, coherently and holistically.

The perspective of treating urban environments as uniform geographical entities has constrained a clearer understanding of the underlying economic, political and ecological dynamics that give meaning to environmental justice within cities. The disaggregation of the residential locations could assist in illuminating the urban political ecology perspective that is normally lost when the urban solid waste management problem treats cities as monolithic entities.

The beginning of the twenty-first century has brought fresh insights into the interpretation and understanding of the dynamics and complexities surrounding urban waste management. With specific reference to the topic under study, Robbins (2004) has made a bold claim that the political ecology of trash merits fundamental research attention. His observations have generated substantive urban waste research in human environmental geography (Nchito and Myers 2004; Moore 2011; Hartmann 2012). Urban political ecology has contributed significantly towards unravelling the interactive economic, political and cultural processes including the ecological dynamics, that create and recreate urban environments.

One of lasting vestiges of the apartheid regime in South Africa, for example, is the inferior provision of

service delivery and infrastructure to previously disadvantaged urban areas (McLennan 2012). The former ‘Whites-only’ areas have a frequent and reliable waste removal system that existed throughout the apartheid era and has even persisted into the era of democracy (Miraftab 2004). Residents of high income neighborhoods continue to have an efficient waste removal service where the waste is collected regularly from their doorsteps because they are able to pay for it (Miraftab 2004). However, the heavily populated Townships or formerly ‘Black’ areas are often forced to discard of their rubbish in open spaces or unsealed communal skips.

Preferential development agendas by provincial and local government policy makers therefore often seem to disfavor infrastructural development in low income neighborhoods where sanitation facilities, drainage systems, and solid waste collection bins are often inadequate or completely lacking (Cohen 2006; Amechi 2010). Furthermore, high population density in slum areas, coupled with a lack of structural or architectural design for residential houses and a lack of formally approved definitive residential layout completely distort the landscapes with apologetically unpleasant sceneries (Oyekale 2015).

In this context, there has been a tendency to standardise waste collection fleets, with the obvious objective of reducing the costs of maintenance and supervision in most African cities. However, the result has been that whole areas have been left out, because some of the streets are either too narrow, unpaved, or too sloping to be used by the huge waste collection trucks. Such areas often happen to be low income residential neighbourhoods, located either at the urban fringe or in densely-populated older city centres (Saungweme 2012).

Leaving these areas subserviced, subsequently affects environmental and public health conditions in the whole city. Where roads are too narrow for refuse trucks to conduct door-to-door waste collection, municipalities provide communal skips where residents deliver their refuse for the City Council to collect. The system invariably fails to cope with demand because waste is being generated faster than the rate at which skips are being emptied. This leaves skips overflowing with rotting waste, posing risks to local residents and the environment.

Tsiboe and Marbell (2004) have noted that in most African cities where a waste collection fee has been

introduced such as in Accra, Ghana, only high income areas are well-serviced because residents regularly pay for waste collection. On the other hand, the low income areas either rarely or do not receive waste collection services at all because residents fail or cannot afford to pay the required service fees.

Other political factors seem to play a role in the dynamics of urban solid waste management. A study of constraints on neighborhood activism in services upgrading in Nakuru, Kenya revealed that community action and partnering in service provision only produced very modest results (Post and Mwangi 2009). Although residents felt connected to their neighborhood such attachment failed to translate into concrete action to improve livability due to competing loyalties of citizens, antagonism between local leaders, pervasive influence of patronage and cronyism, chronic weaknesses of local government and tendencies of CBOs to become more exclusionary.

A case study of the various functional zones of Lusaka, Zambia (Myres 2006) posits the idea of exclusionary democracy and the concept of domestication of differences to explain that both the political and the planning dynamics of the last years of colonialism remain foundational to state-society relationships in contemporary Lusaka.

The above studies do highlight the fact that the urban geography of environmental justice in sub-Saharan Africa is highly mediated by political, historical, social, economic and ecological factors.

Recycling within the context of integrated urban solid waste management

In response to the ever growing global-waste management challenges, the international community has ratified a waste management hierarchy to which all countries have committed themselves. The hierarchy has laid down a standard base for methods of handling waste that incorporate recycling, reuse and reduction (3Rs). The main advantages of practicing the 3Rs include: diverting waste from landfills; maintaining environmental aesthetics; and creating wealth from waste. Depending on the socio-economic profiles of urban communities, the level and intensity of 3Rs practice differs. Such differences in practice emanate from several factors that have been noted by Tucker (1999).

There are three basic components of the waste management framework, namely; waste reduction, re-use and recycling. Waste prevention, also called “source reduction”, seeks to prevent waste from being generated. Waste prevention strategies include using less packaging and designing products to last longer. Waste prevention helps reduce handling, treatment, and disposal costs.

Re-use implies using a product more than once, either for the same purpose or for additional ones. Reuse does not require the reprocessing of materials and therefore has lower energy requirements. Re-use strategies include donating products to charity, reusing packaging such as boxes and bags, and using empty jars for the storage of other commodities.

Recycling involves collecting certain waste materials such as glass, metal, plastics and paper, and reprocessing them to make new materials or products. Some recycled organic materials are rich in nutrients and can be used to improve soils. Recycling could generate many environmental and economic benefits.

For example, it usually creates employment and income, supplies valuable raw materials to industry, produces soil-enhancing compost, and reduces greenhouse gas emissions and the number of landfills and combustion facilities. Not only does it reduce the amount of waste that ends up in the landfill, it also creates jobs, stimulates the growth of entrepreneurs, saves the environment from exploitation of resources, reduces pollution and provides raw materials for the growing industries (Bjerkli 2005; De Kock 1986).

From a recent study of waste management in Addis Ababa, it has been appropriately noted that up to now, the thrust of achieving an improved SWM, the municipality has focused on expensive ‘end of pipe’ efforts, involving the collection, transportation and disposal of solid waste (Bjerkli 2005). However, to find alternative ways of dealing with the increasing solid waste problem in urban areas in Africa, the focus has to shift. This is because reuse and recycling of solid waste are more effective ways of reducing the amount of waste needed to be collected, transported and disposed of by municipalities (Zerbock 2003) The promotion of recycling initiatives is therefore assuming top priority among policy makers as a way of reducing accumulation of waste with its cumulative environmental impacts (Oyekale 2015).

The generation rates and quantities of domestic solid waste in many cities in developing countries

have increased at an alarming rate over the years. The generation rates, source separation, re-use, recycling and disposal of domestic solid waste are, however, functions of several factors. These factors include income, household size, education level and awareness, religion, culture and attitude towards the environment.

City councils are now confronted with a momentous challenge of finding ways to reduce the amount of municipal waste produced by households; this includes introducing recycling in residential areas (Saungweme 2012). Cities have different structural and socio-economic profiles thus no one method appears to be appropriate for adoption across all household locations at each urban socio-economic setting.

In those countries where integrated solid waste management has been adopted, intensive research has been conducted to, firstly, identify those factors influencing waste recycling at household level. The results from such studies have been used to initiate systems that are compatible with the requirements of the respective community settings (Klundert 1999; Afroz et al. 2010; Ezeah and Roberts 2012). This suggests that each method should be adapted to different areas to be effective; thus the rationale for adopting the socio-economic disaggregation of urban neighborhoods in this case study of recycling solid domestic urban waste.

Despite intensive research into recycling practice in urban areas, a comparative analysis of practices by households in different socio-economic levels has received, relatively, less attention. Based on the insights gleaned from the foregoing studies, the aim of this investigation was to therefore conduct a comparative analysis of recycling profiles and possible determinants of recycling behavior differentials among householders living in three well-contrasted socio-economic residential strata, namely: low, medium and high income, in Gaborone the capital city of Botswana. The underlying assumption is that different residential locations, and their associated socio-economic and demographic profiles, influence their recycling practices (Lee and Paik 2011; Tonglet et al. 2004).

The specific objectives of this study were to:

- Investigate the extent to which socio-economic and socio-demographic variables influence recycling practices; and
- Identify and analyze obstacles experienced by residents to recycling.

Conceptual framework

The Pressure State Response framework provides an operational structure for the investigation and analysis of processes involved in environmental degradation. It has been adopted by many OECD countries and by the World Bank for environmental reporting (Segnestam 2002).

In context of this study, pressures are generated by urbanization impact on the state of the environment. This effect elicits the various types of responses from interested and affected parties (Barr et al. 2005). The residential component of the urban environment generates waste that impacts on the environment. The active agents in the process are households. They, in collaboration with local government and entrepreneurs, may formulate policies and instruments that affect the pressure of waste generated, on the urban environment. In this case, households may adopt recycling as one of their coping strategies.

Study area

The city of Gaborone is located in the southern part of Botswana and characterizes the typical municipal management problems of emerging metropolitan centers in sub-Saharan Africa. The city was established in the early 1960s and has continued to

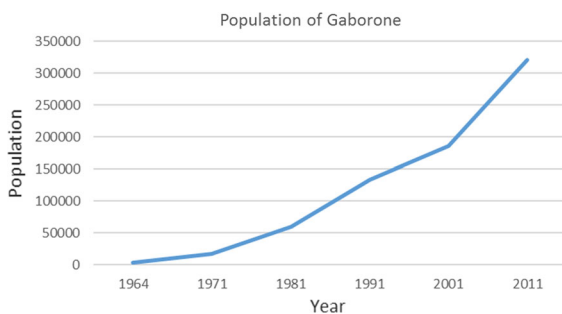


Fig. 1 The growth of Gaborone; 1964–2011 *Source:* Statistics Botswana 2011

experience rapid growth, particularly from the late 1990s, due to the country's economic boom (see Fig. 1). About 10% of the national population live in the capital city whose current the population growth rate is 3.4% per year.

This growth is most likely because the city has more developed infrastructure better job opportunities, better paying jobs, and better healthcare and education services all of which attract migrants.

Although the amount of waste has been increasing steadily, as shown in Fig. 2, a study by Kgathi and Bolaane (2001) showed that environmental quality has deteriorated due to improper solid waste collection and disposal methods used in Botswana. The poor state of domestic solid waste management in Gaborone can be attributed to several factors. Population growth without a commensurate improvement in service provision has put immense pressure on available waste management resources and services.

It is estimated that a substantial portion of the Gaborone City Council (GCC) budget is allocated to service health and domestic solid waste management (GCC 2014). Most of this money is being spent on waste collection, transport and disposal. Waste disposal cost rose from \$3.6/tonne in 2010 to \$13.6/tonne in 2013 (GCC 2014). The waste management budget has been increasing by approximately a million Pula every year, from \$1.6 million in 2010 to \$2.0 million in 2014 (GCC 2014) yet the problems appear to be worsening. Only 38% of the 250,000 tonnes of household waste produced in Botswana annually are actually delivered to disposal sites (Urio and Brent 2006).

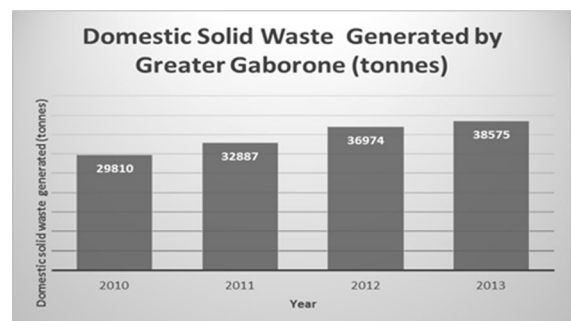


Fig. 2 Recent domestic solid waste generated *Source:* Gaborone City Council Health Department (2014)

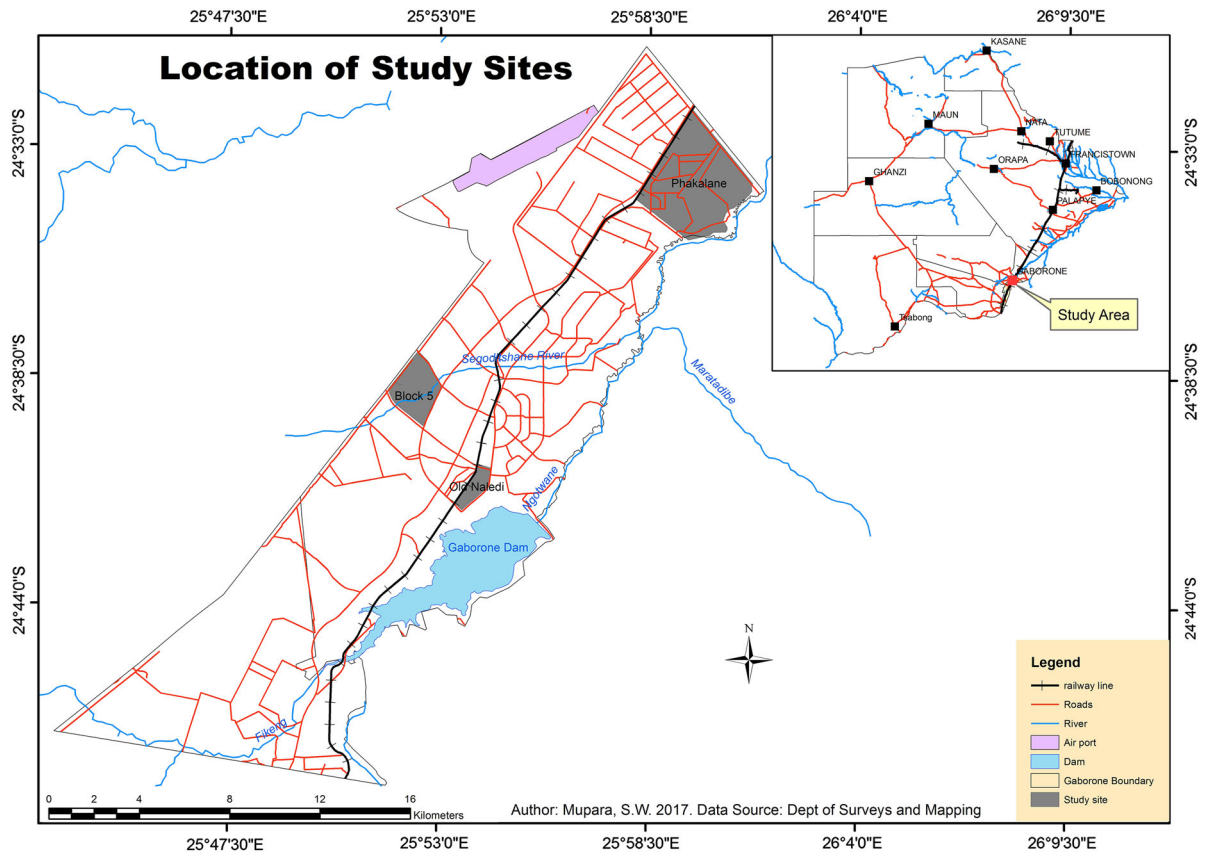


Fig. 3 The location of the study sites within Gaborone, Botswana *Source:* Mupara (2015)

Gaborone has over 10 residential suburbs that include, Old Naledi, Phakalane, and Block 5 (see Fig. 3). These constitute the focus of this study.

Table 1 summarizes the main characteristics of the study area.

The diverse environmental, socio-economic and socio-demographic composition of the three areas can be best understood within the context of their political ecology. All urban environmental problems can be better understood within the context of the political,

economic, and cultural processes that create, recreate and maintain them (Heynen 2003). Briefly, Old Naledi was regarded as an illegal squatter settlement that was excluded from municipal services until the late 1970s.

Its current environmental congestion, shown in Fig. 4. can therefore be understood in the context of municipal marginalization and neglect.

Block 5 was constructed to accommodate middle class families on land that the government had bought from Bonnington farms to the west of Gaborone from

Table 1 Main characteristics of the study areas *Source:* Department of Town and Regional Planning (2013)

Characteristics	Residential area		
	Old Naledi	Block 5	Phakalane
Population	19,075	7231	7028
No. of residential plots	1736	1049	2103
Economic level	Low	Medium	High
Access to utilities	Yes	Yes	Yes
Type of building	Low cost	Middle cost	High cost



Fig. 4 Old Naledi *Source:* Gwebu (2003)

the 1990s. Housing, shown in Fig. 5, was built by the Botswana Housing Corporation for the middle income working class, on state-owned land. It has well serviced waste management facilities.

Phakalane is an exclusive high income suburb that has been developed on private land. Typical housing is shown in Fig. 6.

Separating different types of waste components is an important step in the handling of waste. According to Khitoliya (2004), onsite storage of waste depends on the type of containers being used, public health issues, aesthetics and the collection method to be used. Different types of storage containers are used in different localities. In Gaborone, household wastes are stored in galvanized metal receptacles, high density polyethylene refuse storage receptacles, large metal refuse storage community skips, black polythene refuse plastic bags and cardboard boxes. On each day of waste collection, it is either collected by

municipal vehicles or private companies such as Daisy Loo, Skip Hire, Leaf Environmental Solutions and Cleaning Wizards.

The middle and high income groups can afford to purchase hard plastic and metal trash receptacles to store their domestic solid waste. Moreover, they can afford to pay fees for regular waste collection by the municipal fleet and private companies.

Low income residents rely on polythene trash bags. Low-income areas either rarely or do not receive waste collection services at all because residents fail or cannot afford to pay. As a result, Gaborone City Council provides communal skips where residents deliver their refuse for the City Council to collect. This system is not coping well because waste is being generated faster than the rate at which skips are being emptied. Skips overflow with rotting waste, posing a risk to local residents and the environment, as shown in Fig. 7.



Fig. 5 Block 5 housing *Source:* Gaborone City Council



Fig. 6 Phakalane housing *Source:* Gaborone City Council

Waste collection includes not only the gathering of domestic solid waste and recyclables, but also the transportation of these materials to some location where the vehicles get emptied. Urban solid domestic waste is eventually collected, by the Gaborone City Council, and transported to the Gamodubu landfill, some 30 km from the City, for disposal.

Gaborone City Council has no recycling facilities in place. However, there are several recycling companies such as Collect-A-Can (see Fig. 8).

Lebs Recycling, Simply-Recycle, Dumatau, and Recycle-It-Botswana. Somarelang Tigoloko, an environmental NGO, and Northside Primary School are also involved in recycling efforts, as shown in Fig. 9.

However, none of these organization provides a door-to-door collection service; they require residents to bring their recyclables to the collection site.

At most sites, there are different receptacles for the various categories of recyclables namely, glass, metal, newspapers, cardboard boxes, newspapers and plastic containers. Residents are required to wash their recyclables such as bottles, cans and jars before placing them in their receptacles. Each recycler organization either pays or does not pay for the delivered recyclables. After collection, the recycling company packages, transports and sells the recyclables in South Africa.

Despite intensive research into recycling practice in urban areas, a comparative analysis of practices by households in different socio-economic levels has received, relatively, less attention. In this paper “households in different economic level” designates low income, medium income and high income categories. The underlying assumption is that different residential locations, and their associated socio-economic and demographic profiles have a direct influence on their recycling practices (Heider et al. 2010; Martin et al. 2006; Miafodzyeva et al. 2013).

Data collection

Data for this research was collected though an interview-based household social sample survey that was conducted in 2014. According to Seale (2004),



Fig. 7 Typical communal skip in Old Naledi *Source:* Mupara (2015)



Fig. 8 Bales of flattened cans *Source:* Collect-A-Can

sampling is done to statistically represent a population. For the social survey, a stratified random sampling procedure was adopted. Firstly, residential areas in Gaborone were stratified into three distinct socio-economic groups namely; high-income, medium-income and low income categories, shown in Table 1.

From each stratum, residential areas were randomly selected. Most plots in Gaborone consist of more than one household unit making them multi-residential. In Phakalane and Block 5, a plot mainly consists of a main house and a cottage, however in Old Naledi, it usually consists of the main house and several other outer buildings that are occupied by different households. In this study, the main household was targeted

as the basic unit of analysis. Targeting the main house in a multi-residential set up is one of the limitations to this study as other households in the same plot might possess different demographic characteristics that determine their practice of waste management.

From each plot, the household head was targeted. In the absence of the household head, any resident occupant, above the age of twenty-one, provided the required answers. Where there was no potential respondent at a targeted household, the targeted plot was substituted by the next adjacent one. From each residential socio-economic area, the sample size of the number of plots was determined using Yamane (1967) simple statistical formula:



Fig. 9 Segregation receptacles at Northside School recycling drop-off center *Source: Mupara (2015)*

$$n = \frac{N}{1 + N(e)^2}$$

where n = targeted number of plots, N = total number of plots, e = margin of error.

The advantage of using the formula is that it provides 95% confidence limits for the sample size for a stipulated margin of error, which is 10% in this case. Using this formula, 95 plots were chosen from Old Naledi, 91 from Block 5, and 95 from Phakalane. However, because of time limitations, and considering that the case study was only preliminary, a 50% sampling fraction was used to select the actual number of household units from each residential stratum. Consequently, the numbers of units selected were 48, 45 and 48, respectively. Data was entered in SPSS and analyzed using STATA.

Empirical model

Momoh and Oladebeye (2010) investigated how household attitudes and environmental awareness influence household recycling participation in Nigeria, using the Chi square model. The study revealed that attitude towards waste, size of household, awareness of recycling information and employment status all

significantly influence the willingness of households to recycle. However, gender, age, educational level, size of household, income, house tenure, location of house and gender have no influence on the households' willingness to recycle.

Guerrero et al. (2013) examined the determinants of recycling participation in more than 30 cities in Developing Countries using the Spearman correlation matrix. Availability policies, education and awareness on recycling, more efficient collection system, better infrastructure, low cost recycling technologies and residents' participation in decision making all significantly influenced participation in recycling.

Vicente and Reis (2008) investigated the influence of attitude, incentives, availability of recycling information and presence of children in a household, participation in recycling, using the logistic regression model. The study revealed that attitudes and availability of recycling information to residents influences participation in recycling significantly, at the 1% level of significance. The study revealed that the presence of children in a household or incentives have little or no statistical significance in influencing households' participation in recycling at 5%.

Grazhdani (2016) examined the influence of various householders' characteristics and waste

management policy factors on the rate of solid waste generation and recycling using a linear regression model. The study revealed that, at 1% level of significance, pay-as-you-throw and expenditure on recycling education increases the recycling rate. Availability of curbside recycling and drop-off centers, educational level and household income are significant at 5% while size of household, type of housing unit, household with members with +65 years, age of building and time spent travelling to work have no statistical significance at the recycling rate.

Oyekale (2015) examined the factors influencing waste disposal and recycling by households in South Africa, using a bivariate probit model. The study revealed that income, receipt of social grants, perceiving littering as an environmental problem, race and attainment of formal education were all statistically significant in increasing the probability of recycling. However, gender had no statistical significance on increasing the probability of recycling.

Owusu et al. (2013) examined the factors that influence residents to participate in waste separation for recycling in Ghana, if given economic incentives, using a bivariate probit model. The research revealed that, given economic incentives, the following will significantly influence waste separation at 1%; education level, location of house, presence of children in a household, presence of a house-helper in a household, availability of open space to place a separation receptacle and size of yard. At the 5% level of significance, gender and the viewing of waste separation as a hygienic act, influence households to separate waste. Age, the number of storeys per building and the given media source separation information were not statistically significant in influencing residents to separate waste.

The empirical model for this study is specified as follows:

$$Y_{ij} = f(H, I, L,) + \varepsilon \quad (1)$$

where Y_{ij} ($j = 1, 2, 3, 4, 5$) representing practicing recycling, waste separation, segregation of waste, Earns recycling income, Recycle for the next generation, [$Y_{1i} = 1$, if the one practices recycling (0 otherwise)]. $Y_{2i} = 1$, if one practices waste separation (0 otherwise) $Y_{3i} = 1$, if one earns recycling income (0 otherwise), this is probit regression model.

1. Household characteristics (H): the level of education, age, gender, Household size, length of stay, Tenure
2. Informational sources (I): source of information about environmental education and awareness on recycling such as tv, radio, family friends, magazines, schools, newspapers
3. Location of residence (L): Low income area (Old Naledi), Middle income area (Block 5), High income area (Phakalane).

The variation inflation factor (VIF) test was done for the all models to check for multicollinearity. The VIF values for all the independent variables were below 6. This implies there was no problems of multicollinearity. The Breusch–Pagan/Cook–Weisberg test was used and the null hypothesis of homoscedasticity was found to be significant for 2 models. To correct for heteroscedasticity, the model estimations were conducted using robust standard errors. The use of robust standard errors does not change the significance of each model and the coefficients, but gives relatively accurate P values, and is an effective way of dealing with heteroscedasticity (Gujarati 2013; Wooldridge 2010).

Discussion of findings

Marginal effects of recycling and waste separation practices and earning of recycling income are shown in Table 2.

This study investigated factors that are likely to influence resident to participate in recycling activities. The subsequent paragraphs discuss the key findings.

Being a resident of Old Naledi increases the likelihood of participating in recycling activities by 55%. For Old Naledi, a low income residential area, recycling is a form of employment to the many unemployed residents. The majority of respondents from Old Naledi who recycle revealed that recycling is their only form of employment and only source of income. Being a resident of Phakalane increases the likelihood of participating in recycling activities by 72%. Only 24% of Phakalane recyclers are paid for this practice while 76% are not. The recyclers who don't get paid for their recyclables revealed that they recycle because it benefits both their environment and their community.

Table 2 Marginal effects of recycling and waste separation practices and earning of recycling income *Source: Mupara (2015)*

Variable	Recycling practice co-eff	Earn recycling income co-eff	Waste separation practice co-eff
Female			0.086
Male	0.390***	0.251***	
21–29 years	0.184	0.067	
30–39 years			
40–49 years		–0.050	
Own house	0.373***	–0.051	
Rent			–0.122
Stay 10	0.258		0.073
Stay 11–20	0.269	0.184	0.139
None			
Primary	0.161	0.142	
Junior secondary	–0.197	0.037	
Senior secondary		0.069	–0.165
Advanced			–0.207
hhsizel3	0.16	0.056	0.244
hhsizel46		–0.094	–0.097
hhsizel78	0.197	0.061	0.113
TV	0.21	0.113	0.075
Radio		–0.080	–0.118
Family/friends	0.361	0.209	
Magazines	0.289	0.186	
School			–0.173
Newspaper			–0.147
Naledi	0.551***	0.377**	0.180
Phakalane	0.717***	0.197	0.287**

*** Significant at 1%

** Significant at 5%

Being a resident of Phakalane increases the likelihood of separating domestic dry waste for recycling by 29%. This is probably because big yards and security fences and screen walls in Phakalane provide the space and security needed to store segregated materials. The study revealed that 56% of Phakalane resident separate their dry waste compared to 21% of Old Naledi and 16% of Block 5. A key informant interview with personnel from Somaraleng Tigoloko revealed that majority of residents who drop off recyclables at their depot are from high income areas. They usually drop off segregated bottles and cans because they have enough space to store the segregated recyclables. The study also revealed most respondents who send their

children to either Northside or Thornhill Primary School segregate their recyclables and drop them off at their schools in a bid to promote environmental awareness. A key informant interview with the Headmaster from Northside Primary School affirmed that they encourage both their students and parents to recycle.

Old Naledi respondents who do not segregate waste cited a lack of time as the main reason for not doing it while for those in Phakalane it is a lack of segregation receptacles. This shows that a provision of segregation receptacles to residents might only encourage Phakalane residents to segregate but not Old Naledi who also cited the second main reason for not segregating that

the segregation process is both cumbersome and tedious.

Recycling practices for the different socio-economic residential areas differ. Being an Old Naledi resident increases the likelihood of earning an income from recycling by 38%. This study revealed that 93% of recyclers in Old Naledi admitted they earn or get paid for their recyclables. They further revealed that recycling is their only a source of employment that they use to supplement their other sources of income. Most of them admitted they are not formally employed and recycling is therefore their only source of employment.

Key informant interviews with personnel from Lebs Recycle, Collect-A-Can and Somareleng Tigo-loko affirm that they buy all the recyclables they get from Old Naledi and other low income residential areas. Only 24% of Phakalane recyclers admitted they sell their recyclables. Phakalane is a high income area where most residents are formally employed and they regard recycling not as an income-raising strategy but because they value it as a sustainable way of managing waste in order to enhance the aesthetics of their environment (Hines et al. 1987).

Schools and newspapers are less likely to be sources of knowing about recycling income by 23 and 70% respectively. This could imply that individuals do not normally can get information on how recycling can generate income from the above two sources. As much as waste management has been included in the school curriculum, there is a lack of participation in recycling efforts by most public schools. A key informant interview with personnel from Collect-A-Can revealed that of the 51 schools that they had engaged in recycling of cans in 2010, only 5 are still participating in recycling efforts. This was also confirmed by personnel from Recycle-It-Botswana who said the only schools that they are involved with recycling are Northside and Thornhill Primary schools. Such a small number could imply that schools might not be very effective in getting recycling information to the general public.

The study revealed that only 6% of respondents use newspapers as a source of waste management information compared to 34% who use TV and 33% who use radio. An interview with personnel from Collect-A-Can revealed that they always place adverts in newspapers, especially The Voice which is a popular weekly. A copy of a newspaper costs P7, on average,

and most low income area residents admitted that they cannot frankly afford it. Thus advertising in a free newspaper such The Daily News or the weekly Advertiser might increase the number of people who gets recycling information. Most newspapers are written in English, which is not a universal language in Botswana. This could be another reason why newspapers might not be as effective in information dissemination.

Being a house owner increases the respondents' likelihood of participating in recycling efforts by 37%. The study revealed that 61% of house owners participate while 39% do not. This shows that majority of house owners recycle. House owners revealed that they feel a sense of ownership and a responsibility to keep their premises clean. Thus they are involved in the actual recycling practice to reduce waste that might end up in non-gazetted points such as roadsides, drains and bushes. They tend to invest their time in acquiring more knowledge about recycling so that they attain techniques on what and how to recycle solid domestic waste.

Being a male increases the likelihood of recycling by 39%, and the likelihood of earning an income from recycling alcohol containers by 25%. Household interviews revealed that 60% of recyclers are males. This could be because most males drink alcohol and are involved in the recycling of beer bottles and cans, (Weiser 2006). On the other hand, women are not as actively involved in recycling because most women are engaged in other household chores which leaves them with little time to participate in recycling. This leaves men with the actual task of dropping off the recyclables and receiving payment.

Key informant interviews with personnel from Somareleng Tikologo, Recycle-It-Botswana and Collect-A-Can revealed that males constitute a bigger number of people who drop off recyclables. Beer bottle recycling is higher as revealed by personnel from Collect-A-Can because Kalahari Breweries Limited packages 70% of their alcohol in bottles. The ease of recycling beer bottles makes it the most recycled material, especially by men. Recyclers of bottles revealed that they pick and sell bottles while they are drinking. The 660 ml and 750 ml bottles are sold for P1 to the liquor suppliers and recyclers use this money to buy cigarettes and food sold at the liquor marketing outlets.

Conclusions

The study examined Gaborone households' recycling behavior and explored selected factors that tend to influence recycling behavior. Based on the findings of this research, the following recommendations are made.

Since communities have different socio-economic characteristics, policy makers should come up with recycling structures that suit each individual community in order to encourage recycling (Chu and Chiu 2003; Perrin and Barton 2001). For example, Phakalane residents should be provided with segregation receptacles at their premises while Old Naledi residents could be provided with community drop off points which are accessible to each residential household. Other recycling structures could include a separate recyclables collection system that is separate from that of general waste management systems of the Gaborone City Council, with proper sorting facilities and a viable market with attractive prices for recyclables.

The study revealed that the majority of respondents, namely 82%, have never been exposed to waste management campaigns in their residential areas. One would have expected that policy makers are aware of the national waste management strategy. Their commitment and ability to translate the strategy into reality however remains questionable. In a recent study on potential constraints to promoting people-centered approaches in recycling in Gaborone, Bolaane (2006) found that although municipal officials in Gaborone are aware of the potential benefits of recycling, they are not committed to waste management reforms such as municipally-organized recycling schemes and show limited knowledge in expediting such schemes.

Our research has revealed, very clearly, that being a low income resident increases the likelihood of earning an income from recycling. Low income and marginalized social groups depend on recycling income for income generation and daily survival. Recycling is therefore influenced by incentives such as recycling income provided to urban residents involved. In other words, low income residents are biased towards separating materials for recycling that have known markets and are of significant financial value (Masocha 2006; Bartone 1988; Medina 1997; Mwanzia 2005; Tevera 1994). This suggests is an urgent need to introduce incentives for recycling such as, accessible transfer station, a direct weight-based waste-collection

fee, including other recycling support structures such as education and awareness creation, recycling drop-off points and marketing avenues (Hage et al. 2008).

Residents from wealthier neighborhood were more involved in paying for waste disposal and recycling. Also, the active participation of high income residents in recycling and waste segregation appears to be motivated by the positive attitudes of upper income groups towards environmental aesthetics. Therefore, addressing poverty and environmental awareness should constitute an integral part of a strategy aimed at promoting a safer and cleaner environment for all the urban residents.

Returns from recyclable incomes tend to benefit men mostly, particularly from the low income neighborhood of Old Naledi. This is in spite of the fact that women are bread winners for most households in the area. Their low participation in recycling activities could reflect the fact that women are burdened with multiple domestic roles that deny them the opportunity to engage in recycling. Because of a large proportion of female-headed households and higher unemployment rates among women, it would be socially—just to create accessible drop-off points and support the formation of women's recycling projects.

A participatory multi-stakeholder approach to domestic solid waste recycling (Chikarmane 2012), with the requisite and adequate political, technical, institutional and financial support, would expedite and capacitate synergies between Gaborone City Council, house-holds, NGOs and CBOs and the private sector in achieving a sustainable environment.

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