

Quantification of the domestic waste stream of the North West Province of South Africa for management purposes

F. R. Kizza Kadama & P. Serumaga-Zake

*Faculty of Commerce and Administration North West University,
South Africa*

Abstract

This paper provides information on the fractional and total quantity of domestic waste generated in each of the 21 local municipalities of the North West Province of South Africa. The paper was based on the results of a survey by Kadama ('An Analysis of the Generation and Management of Domestic Waste in the North West province of South Africa' PhD thesis, North West University, candidate) that determined the total and fractional composition of the domestic waste stream of the province. Using the 2001 and 2007 South African population figures as the variables P_1 and P_2 respectively in the equation $P_2 = P_1 e^{rn}$, the population growth rate (r) of the province for that period (n) was computed and used to predict the population for the period 2008 to 2015. The daily domestic waste load (DWL) generated in each municipality in a given year t was calculated by multiplying the population of the municipality in year t by 0.572kg being the domestic waste per capita (DWPC) of the province. It was assumed that economic factors would not adversely influence household consumption and were thus deemed to remain constant in the period of projection. The fractional proportions of the provincial domestic waste stream were applied to determine the quantity of recyclable material generated in each municipality. The results, which were presented in tabular form, gave an indication of the quantity of recyclable material that could be harvested from the individual municipalities. Among others, the paper recommended the adoption of public private partnerships to exploit the entrepreneurial potential identified.

Keywords: domestic waste, domestic waste load, domestic waste per capita, fractional analysis, population, recycling.



1 Introduction

The North West province (NWP) is one of the nine provinces that make up the Republic of South Africa. It lies in the Southeast quadrant between longitudes 22° 30' and 28° 30' and latitudes 24° 30' and 28° and covers a surface area of 106 512 km² (Hosie [2] and Statistics SA [3]). At its establishment in 1994 the NWP covered a geographical area of 116 320 Km² and in 2001 had a population of 3 669 349 (Statssa [4]). However, after the municipality re-demarcation process of 1999 – 2000, which created more financially functional municipalities, the geographical area of the province was reduced to 106 512Km² and recorded a population of 3 271 911 in the Community Survey 2007 (Statssa [4]). The province is divided into four district municipalities namely: Bojanala Platinum, Bophirima, Central and Southern. Each district municipality is further subdivided into local municipalities. There are 21 local municipalities in the province which in turn are subdivided into wards (Municipal Demarcation Board [5]).

In Kadama [1], to which this paper is a sequel, 2001 census results were applied and the findings, among other things, indicated that in the NWP:

1. The daily domestic waste load per household (DWLHH) was 2117.2g.
2. The daily domestic waste load of the province (DWLP) was 2406.6 tonnes.
3. Domestic waste per capita (DWPC) was 0.572kg.
4. The annual domestic waste load was 878190 tonnes in 2007.
5. The greater portion of domestic waste generated in a week's time could not be collected within the week of generation.
6. 95% of the municipalities did not have reliable records of domestic waste collected and delivered to landfills.
7. Waste management was locked in a culture of disposal rather than that of resource management.
8. Fractional analysis of waste from an average household showed that it consisted of 33% bio-waste, 16% garden waste, 12% plastics, 14% dry waste, 4% paper, 11% bottles, 2% metal, 1% textile, 5% cardboard, 1% hazardous waste and 1% others.
9. All municipalities based their waste management plans on 2001 census results.

These findings prompted the recommendation that all municipalities must keep detailed records of waste generation and regularly update the variables that affect domestic waste generation. The Community Survey 2007 results released in October 2007 show that the province shrunk both in size and population. This development, viewed in light of the fact that domestic waste generation is directly related to population (Ogbonna et al. [6]), makes it imperative that existing waste management information should be accordingly updated.

1.1 Problem statement

Domestic waste management in the North West municipalities was based on deficient and unreliable information. To solve this problem this study focused on



applying current population data to determining the analytical and total composition of the domestic waste stream of the province.

1.2 Purpose of the study

The purpose of this study was to provide reliable management information for waste management decision-makers in the North West municipalities.

1.3 The objectives of this paper

The objectives of this study were to:

1. Determine the domestic waste load of the province (DWLP) and the domestic waste per capita (DWPC).
2. Project the domestic waste load of the province from 2007 to 2015.
3. Provide baseline information on the fractional composition of domestic waste generated in each municipality in 2007.
4. Provide baseline information on the quantity of recyclable material generated in the municipalities in 2007.
5. Recommend methods of harnessing the entrepreneurial potential inherent in waste.

2 Methodology

In this study, population was applied as the determinant variable of waste generation for the following reasons: According to Adedibu [7], models involving population and socio-economic factors that were used to predict waste generation in developed countries were found to be inappropriate in Ilorin in Nigeria due to cultural factors. Abel [8] also notes that contrary to expectation that waste generated would increase with income and social status, waste per capita in the sub-urban zone of Ogbomoso city did not significantly differ from that recorded in the lower status transitional and traditional core zones of the city while Ogbonna et al. [6] observe that domestic waste is directly related to population. As a result of these observations, this study considered population to be the main variable affecting waste generation and it was assumed that anticipated increments in household incomes would not directly translate into increased waste generation. Therefore improved economic factors would not adversely influence household consumption and as such, their effect was assumed to remain constant in the period of projection.

The data in this study is from a statistical survey of domestic waste generation in the North West province by Kadama [1]. From a population of 21 municipalities a 10% sample (Mafikeng and Rustenburg local municipalities) was randomly selected by the ballot method. In each of these municipalities, the population was stratified into high, middle and low income strata. Each of the strata was demarcated into clusters of 150 households. From each cluster 10% of the households (15) were probabilistically selected for inclusion in the waste

stream analysis following a two stage sampling design. Altogether, 90 households were selected into the sample for waste stream analysis.

2.1 Daily domestic waste load of the province

The daily domestic waste load of the province was computed as follows:

$$DWLP = N_p \times DWPC \quad (1)$$

where:

DWLP = Daily domestic waste load of the province.

N_p = 2007 Population of province (Statssa [4])

Future population projections of the province were computed using an annual growth rate of 0.4% that was obtained by using exponential formula:

$$P_2 = P_1 e^{rn} \quad (2)$$

Source: Cooper and Schindler [9].

Where: P_1 = Population in 2001, P_2 = population in 2007, n = the interval between 2001 and 2007 and r = the population growth rate.

Values of the provincial weekly, monthly and annual waste load were computed by multiplying DWLP by 7, 30 and 365 respectively which are the number of days in a week, month and a year.

Projections of the provincial daily waste load from 2008 to 2015 are computed and the rate at which waste generation increases over the period is computed as follows:

$$R = \frac{\delta y}{\delta x} \quad (3)$$

where:

R = Rate of change in waste generated daily per annum (p.a),

δy = change in y-axis and δx = change in x-axis.

2.2 Domestic waste per capita

Domestic waste per capita was computed as follows:

$$DWPC = \frac{DWLHH}{PHH} \quad (4)$$

where DWPC = domestic waste per capita, DWLHH = domestic waste load per average household and PHH = persons per household.

2.3 Domestic waste load of municipalities

The daily domestic waste load of a given municipality was computed as follows:

$$DWLM_1 = DWPC \times N_{M1} \quad (5)$$

where $DWLM_1$ = domestic waste load of municipality₁, N_{M1} = population of M_1 .

2.4 Fractional composition of domestic waste generated in municipalities

The daily domestic waste load of each municipality was differentiated into the following proportions: 33% bio-waste, 16% garden waste, 12% plastics, 14% dry waste, 4% paper, 11% bottles, 2% metal, 1% textile, 5% cardboard, 1% hazardous waste and 1% others. These being the same proportions as those obtained when waste from an average North West household was fractionally analysed in Kadama [1].

3 Results

3.1 Daily domestic waste load of the province

Formula 1 was applied as follows:

$$DWLP = 3\,271\,911 \times 0.572 = 1871.533T$$

DLWP was applied to compute the following values:

$$WWLP = 13100.731T, MWLP = 56145.99T, AWLP = 683109.545T$$

where WWLP, MWLP and AWLP refer to weekly, monthly and annual waste load respectively.

3.2 Projections of the population and daily domestic waste load

Formula 2 was applied to compute future populations of the province which were then applied to project domestic waste generation. Formula 5 was applied to compute the daily waste load for municipalities and results are presented in Appendix 1. The projected annual increments of the provincial waste load are illustrated in Figure 1.

Results obtained indicate that waste generated will steadily increase during the period of projection at a rate of 7.7T per day per year.

3.3 Fractional analysis of waste generated in the municipalities

The results of the fractional analysis of domestic waste generated on a daily basis in the municipalities are attached as Appendix 1.

4 Discussion

The results obtained indicate that the provincial domestic waste load will steadily increase in the years up to 2015 and beyond. The status quo indicates that the



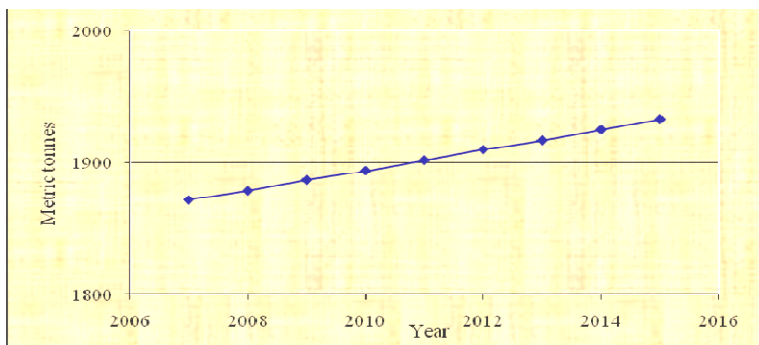


Figure 1: Projections of daily domestic waste.

municipalities are under resourced and are unable to effectively manage the increasing waste burden. Moreover, the municipalities are entrenched in the unsustainable practice of collection and disposal of waste and have not actively viewed domestic waste as a resource inherent with entrepreneurial potential. By entering into contracts with recycling agencies, municipalities would allocate the unnecessary burden to those that have vested interests in waste. Such a measure would improve the constrained municipalities' ability to attain the required levels in waste management service delivery.

As Kadama [1] notes, waste is a resource that can be exploited for:

1. Mining of recyclable items such as plastics, bottle, metals and paper.
2. The provision of electricity and steam as by products of waste incinerations schemes.
3. The provision of electricity from gas recovery wells and gas generators at landfills.
4. The supply of compost which is a soil enriching additive.

Viewing waste as a resource is not a new approach in South Africa for instance; the eThekweni Municipality in Durban secured a R70 million loan in 2006 from the French Development Agency for a project to generate up to 10 megawatts of electricity through the fermentation of household waste (SouthAfrica.info [10]) and, the researcher notes, there are a number of waste recycling enterprises operating in the province. Such enterprises work independently of the municipalities and are not in any way supported by municipalities. Municipalities should consider the option of hiring recycling agencies to collect their choice of waste from the points of generation. It is therefore recommended that:

1. The provincial government undertakes a study to develop a regionally based waste management strategy as operations in individual municipalities may not be economically viable.
2. The provincial Department of Agriculture Conservation and Environment should undertake studies to determine the calorific value

domestic waste and follow it up with further studies aimed at establishing waste to energy ventures in the province.

3. Municipalities should enter into carefully structured and facilitated private sector waste management contracts in order to improve service efficiency and investment in waste management.

5 Conclusion

The paper examined information available to waste management decision-makers and formed the opinion that it was deficient and unreliable. Using the most recent population data the domestic waste load of the province and for each municipality was computed and other values vital for decision-making in waste management were derived. The waste stream for each municipality was fractionally analysed and it showed that in 2007, 1253.9T of recyclable waste was needlessly ferried to landfills all over the province. The objectives of the study were achieved and as such, it can be concluded that this paper provided baseline information for domestic waste management in the province.

References

- [1] Kadama, F. R. K., 'An Analysis of the Generation and Management of Domestic Waste in the North West province of South Africa' PhD thesis, North West University, candidate.
- [2] Hosie, R., (ed). *Readers Digest Illustrated Atlas of the World*. 1st edition. Fabrieken Brepols N.V: Turnhout, Belgium, 1999.
- [3] Statistics South Africa. *Census2001. Census in brief*. Statistics South Africa, Pretoria, 2003.
- [4] Statistics South Africa. *Community Survey 2007. Statistical Release*. Statistics South Africa, Pretoria, 2007.
- [5] Municipal Demarcation Board. *Municipal Demarcation Board of South Africa*, 2006. <http://www.demarcation.org.za>
- [6] Ogbonna, D. N., Amangabara, G. T., & Ekere, T. O., Urban solid waste generation in Port Harcourt metropolis and its implications for waste management. *Management of Environmental Quality: An International Journal*, 18(1), pp. 71–88.
- [7] Adedibu, A. A., Solid waste management and a new environmental edict: a case study from Ilorin, Kwara State, Nigeria. *The Environmentalist*. 6(1), pp. 63–68.
- [8] Abel, A., An analysis of solid waste generation in a traditional African city: the example of Ogbomoso, Nigeria. *Environment and Urbanization*. 19(2). pp. 527–537.
- [9] Cooper, D. & Schindler, P., *Business research methods*. 8th edition. McGraw-Hill College: New York, 2001.
- [10] SouthAfrica.info. Gateway to the nation. <http://www.southafrica.info/about/>



Appendix 1: Fractional analysis of the 2007 daily domestic waste stream of North West municipalities in tonnes.

Municipality	Bio Waste	Garden Waste	Plastics	Dry Waste	Paper	Bottles	Metal	Textile	Card board	Hazard Waste	Other	Total
Ditsobotla	37 780	18 318	13 738	16 028	4 579	12 593	2 290	1 145	5 724	1 145	1 145	114 486
Greater Taung	27 336	13 254	9 940	11 597	3 313	9 112	1 657	0 828	4 142	0 828	0 828	82 837
Kagisano	14 336	6 951	5 213	6 082	1 738	4 779	0 869	0 434	2 172	0 434	0 434	43 441
Kgatlengrivier	7 133	3 459	2 594	3 026	0 865	2 378	0 432	0 216	1 081	0 216	0 216	21 616
Lekwa-Teema	6 194	3 003	2 252	2 628	0 751	2 065	0 375	0 188	0 938	0 188	0 188	18 769
Madibeng	70 065	33 971	25 478	29 724	8 493	23 355	4 246	2 123	10 616	2 123	2 123	212 317

Municipality	Bio Waste	Garden Waste	Plastics	Dry Waste	Paper	Bottles	Metal	Textile	Card board	Hazard Waste	Other	Total
Marikeng	54 783	26 561	19 921	23 241	6 640	18 261	3 320	1 660	8 300	1 660	1 660	166 009
Mamusa	6 897	3 344	2 508	2 926	0 836	2 299	0 418	0 209	1 045	0 209	0 209	20 900
Maquaissi	16 510	8 005	6 004	7 004	2 001	5 503	1 001	0 500	2 501	0 500	0 500	50 030
Matlosana	72 820	35 307	26 480	30 893	8 827	24 273	4 413	2 207	11 033	2 207	2 207	220 666
Merafong	40 746	19 756	14 817	17 286	4 939	13 582	2 469	1 235	6 174	1 235	1 235	123 472
Molopo	1 228	0 596	0 447	0 521	0 149	0 409	0 074	0 037	0 186	0 037	0 037	3 723
Moretele	34 432	16 695	12 521	14 608	4 174	11 477	2 087	1 043	5 217	1 043	1 043	104 341
Moses kotane	42 929	20 814	15 611	18 212	5 204	14 310	2 602	1 301	6 504	1 301	1 301	130 088



Appendix 1: Continued.

	Bio Waste	Garden Waste	Plastics	Dry Waste	Paper	Bottles	Metal	Textile	Card board	Hazard Waste	Other	Total
Municipality												
Naledi	10 935	5 302	3 976	4 639	1 325	3 645	0 663	0 331	1 657	0 331	0 331	33 137
Potchefstroom	23 472	11 380	8 535	9 958	2 845	7 824	1 423	0 711	3 556	0 711	0 711	71 128
Ramotshere	24 407	11 834	8 875	10 354	2 958	8 136	1 479	0 740	3 698	0 740	0 740	73 960
Ratlou	18 518	8 978	6 734	7 856	2 245	6 173	1 122	0 561	2 806	0 561	0 561	56 114
Rustenburg	84 899	41 163	30 872	36 018	10 291	28 300	5 145	2 573	12 863	2 573	2 573	257 269
Tswaing	15 290	7 413	5 560	6 487	1 853	5 097	0 927	0 463	2 317	0 463	0 463	46 334
Ventersdorp	6 896	3 343	2 507	2 925	0 836	2 299	0 418	0 209	1 045	0 209	0 209	20 896
Total	617 606	299 445	224 584	262 015	74 861	205 869	37 431	18 715	93 577	18 715	18 715	1871 533