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Factors Explaining Households' Cash Payment for Solid Waste Disposal and Recycling Behaviors in South Africa

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Received: 28 September 2015; Accepted: 5 November 2015; Published: 30 November 2015
Academic Editor: Giovanni de Feo

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Abstract: Environmental safety is one of the top policy priorities in some developing countries. This study analyzed the factors influencing waste disposal and recycling by households in South Africa. The data were collected by Statistics South Africa in 2012 during the General Household Survey (GHS). Analysis of the data was carried out with the Bivariate Probit model. The results showed that 56.03% and 31.98% of all the households disposed waste through local authority/private companies and own refuse dump sites, respectively. Limpopo and Mpumalanga had the highest usage of own refuse dump sites and dumping of waste anywhere. Littering (34.03%) and land degradation (31.53%) were mostly perceived by the households, while 38.42% were paying for waste disposal and 8.16% would be willing to pay. Only 6.54% and 1.70% of all the households were recycling and selling waste respectively with glass (4.10%) and papers (4.02%) being most recycled. The results of the Bivariate Probit model identified income, access to social grants, Indian origin, and attainment of formal education as significant variables influencing payment for waste disposal and recycling. It was *inter alia* recommended that revision of environmental law, alleviating poverty, and gender sensitive environmental education and awareness creation would enhance environmental conservation behaviors in South Africa.

Keywords: recycling; environmental safety; environmental conservation; South Africa

1. Introduction

Since the turn of 20th century, policy makers in many African countries have pursued two conflicting development goals. These are rapidity in the drive towards urbanized society and the persistent craving for a cleaner environment [1]. The later goal is noteworthy, because promotion of a healthy and safe environment is one of the major hubs of economic growth and development [2]. Prescriptively, this is also a fundamental right of man [3]. Therefore, the quest for a cleaner environment in many developing countries today cannot be overemphasized [4,5]. This justifies some public health concerns already raised by some health professionals in the wake of previous incidences of some water and air borne diseases.

Conventional environmental safety goals are aptly interwoven with several frontline economic development indicators. They have also starkly highlighted the necessity for adequate management of the growing number of cities, which is directly related to the proposed sixth and 11th Sustainable Development Goals (SDGs) [6–8]. Therefore, the prime necessity of ensuring environmental safety in a speedily urbanized society has now come under sheer scrutiny. This is due to the fact that inability to ensure adequate waste management implies that some cities are gradually subsumed inside the end products of their domestic and economic activities [1]. Environmental pollution

is therefore exerting unnecessary pressure on scarce land resources, thereby subjecting them to persistent sub-optimal allocation [9–11].

It should be reemphasized that one of the major development challenges of our time is how to dispose of rapidly increasing spectrums of daily generated domestic and industrial wastes [12,13]. The disequilibrium between waste generation and absorptive capacity of the earth now culminates into environmental pollution [3,14,15]. Waste management challenges in some African cities have formed major environmental concerns that are pleading for prompt attentions from development policy makers [16]. Specifically, spew of solid wastes along major streets and highways in some African cities now constitutes significant embarrassment to our adjudged civilization [2]. In many instances, odious stenches from accumulated and slowly decomposing solid wastes emphasize a significant, though ostensibly peculiar, deficiency in our environmental policies and programs. They also denote some abject notoriousness and impunity of some existing institutional arrangements for enhancing environmental safety in our rapidly urbanized societies [4,17].

Environmental problems are the aftermath of rapid population increases, industrialization, urbanization, and persistent weaknesses in the implementation strategies of promulgated environmental laws, among others [18]. In the wake of recent campaigns for environmental safety, the primary concerns of policy makers are brought to the fore through revision of promulgated environmental guidelines and laws [16]. More specifically, the eccentric nature of urban environment and its associated fragility now require the masterminds of environmentalists, ministries of urban and regional development, and other essential stakeholders in a synergistically linked network of professionals to tactically address the precarious condition of environmental sanitation by reemphasizing our commitments to nature and reechoing the mandates of our environmental stewardship [3,16].

Furthermore, the prescriptive roles of environmental policy in ensuring environmental conservation had been clearly accentuated in several international protocols, although their impacts are sometimes better assumed than felt. In the wake of recent industrialization, globalization, and intermittently pursued environmental conservation, the reality of broken synergies between economic growth and environmental safety is felt more now than before [9,19]. Therefore, the concerns of environmentalists on the need to safeguard the earth from destructive pollutants, which are often induced by our reckless economic activities, can no longer be jettisoned. These concerns obviously underscore the critical state of our environment and the fact that waste management remains "a monster that has aborted most efforts made by city authorities, state and federal governments and professionals alike" [11].

Furthermore, the proportion of developing countries' populations that are living in urban slums and detestable shacks is persistently increasing, thereby creating some serious environmental concerns [10,17]. Such environmental problems are aggravated by persistent urban poverty [20], which mostly concentrates among households with low formal education and low paid jobs or unemployment. Preferential development agendas by provincial and local governments' policy makers often disfavor infrastructural development in rural areas and urban slums [1]. Therefore, in these areas, sanitation facilities, drainage systems, and solid waste collection bins are often inadequate or completely lacking [21]. 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.

The antecedence of an ever growing volume of waste now compels the drive towards reduction, reuse, and recycling [16]. These are notably the ways of achieving stable equilibrium between waste generation and reduction in its associated negative externalities. In South Africa, some definitive constitutional actions have been taken to ensure environmental conservation and safety for every citizen, irrespective of race or socioeconomic status. The dichotomy of social status between the white minority and the black majority often points at the need for more involvement of local municipalities in ensuring safe environment for all [5,13]. Specifically, besides the stance of its panoptic allusion

in the 1994 constitution [14], environmental safety was the hub of the 1998 National Environmental Management Act (NEMA), which emphasized the need for waste avoidance. However, it was noted that where this cannot be ensured, impetus motivations for waste reduction, reusing, and recycling should be adequately provided [15]. Similarly, the Polokwane Declaration on Waste Management emphasized some pragmatic goals of ensuring reduction in generated wastes by 50% in 2012, while targeting 30% growth in the recycling industry [3].

This study seeks to analyze the factors that influence decision to pay for waste disposal and recycling behavior in South Africa. This study can be justified from the fact that illegal disposal of waste is a critical environmental concern that ultimately increases pollution. However, the degree of such pollution will be minimized when there is a regular arrangement to dispose of waste or if members of the household explore some opportunities for recycling. In addition, if the factors influencing payment for waste disposal and recycling behavior are evaluated, our understanding of the policy instruments for communicating waste disposal strategies and ensuring participation of many households will be enhanced [22]. Obviously, promotion of recycling initiatives is becoming top priority among policy makers as a way of reducing accumulation of waste with its cumulative environmental impacts. In addition, there are a few studies on South Africa that had modeled waste disposal and recycling. This study seeks to fill these identified gaps and add to existing literature. Finally, there is the need to understand correlates of waste disposal and recycling in order to enhance proper design of environmental programs and facilitate successful implementation of many pressing environmental policies.

2. Methodology

2.1. Data and Sampling Procedures

The data used in this study were collected by Statistics South Africa during the General Household Survey (GHS) of 2012. Details of the sampling procedures had been explained by Statistics South Africa [23]. However, during the survey, the primary sampling units (PSUs) and dwelling units (DUs) were selected using multi-stage design with probability proportional to size. At the provincial level, the 2001 population census data were used to stratify the allocated samples by geographical and population attributes. The data were collected by enumerators that were trained over a period of four days. A total of 25,330 households were targeted for interview during the survey, although the national response rate was 94.1%. However, for this study, 23,518 with complete information were used. The database includes the sampling weights, thereby enhancing its representativeness.

2.2. Analytical Framework

The choice of waste disposal method, desire for reusing some generated wastes, and willingness to participate in waste recycling are all linked to some socio-demographic and behavioral variables that households and individuals possess. More importantly, De Young [24] noted that if recycling is going to be the ultimate solution to our solid waste management dilemma, it is important for everybody to be involved in it. Therefore, unacceptability of land filling as an option for solid waste disposal, due to several associated ecological and environmental hazards compels the need for promoting sustainable attitudes of recycling in this era of rapid technological development and industrialization [24].

There are several socioeconomic and environmental risk perception factors that would influence households' decision to pay for waste disposal and/or recycling. Gamba and Oskamp [25] submitted that in some previous studies, researchers have included some demographic characteristics, environmental awareness, knowledge, attitudes, and concerns for environmental conservation variables. Some previous studies have therefore hypothesized the role of socio-demographic variables in explaining waste recycling behavior, although many have come up with inconclusive [26]

and contradictory results. In some other studies, some weak correlations were found between recycling and some included socio-demographic variables [25,27–29].

Education of individuals can promote environmental awareness and conservation behaviors. This is as a result of the expectation that educated people would have better values for environmental conservation. Samdahl and Robertson [30] and Guerin *et al.* [26] found positive association between attainment of higher education and waste recycling. Also, Sidique *et al.* [31] found that education had a statistically significant impact on the rate of waste recycling, although that was before controlling for endogeneity of some policy variables in the estimated econometric models. Socio-economic status was found to statistically increase waste recycling by Vining and Ebreo [32]. In some other studies by McGuire [33] and Oskamp *et al.* [25], contradictory results were reported.

Furthermore, contrary to the findings of Buttel [34], Oskamp *et al.* [25], and Derksen and Gartrell [35], some authors [29,36,37] found some correlations between attitudes towards environmental conservation and recycling behaviors. This finding is theoretically rooted in the popular theory of planned behavior that emphasizes the role of awareness in explaining its acceptability [38]. Other socio-demographic variables previously included in waste recycling models are age, racial status, household size, and some norms of perception of environmental pollution.

In order to empirically model decisions of households for disposing solid wastes through cash payment and recycling, the utility maximization framework that was proposed by Kinnaman and Fullerton [39] was modified and adopted. In a related study, Sidique *et al.* [10], previously adopted this framework with some modifications. In the model of Kinnaman and Fullerton [39], it was assumed that the economy comprises of N identical households that possess utility functions represented by

$$U_i = U(z_i, Q_i) \tag{1}$$

where z are the composite goods and services purchased for consumption by ith household, and Q_i is the quantity of environmental quality that is being enjoyed by ith household. Suppose the environmental quality function is expressed as

$$Q_i = f(g_i, r_i, h_i) \tag{2}$$

where g_i is the quantity of solid wastes that was disposed by ith household and r_i is the quantity of solid wastes recycled by ith household. The values of g_i and r_i in the environmental quality model (Q_i) are related to a set of some socio-demographic characteristics (h_i) possessed by the households.

If Equation (2) is directly substituted into Equation (1), the final expression of consumer's utility is derived as Equation (3):

$$U_i = U[z_i, f(g_i, r_i, h_i)] \tag{3}$$

This utility function can be maximized subject to the income constraint faced by the households. The expression of budget constraint is as presented in Equation (4):

$$Y_i = x_i + P_g g_i + P_r r_i \tag{4}$$

It should be noted that in Equation (4), Y_i represents total income of ith household, the price of x_i was normalized to unity, P_g is unit price of waste disposal and P_r is the unit price of recycling.

Solving the utility maximization produces the following waste disposal (Equation (5)) and recycling demand (Equation (6)) functions:

$$g_i = g(P_g, P_r, Y_i, h_i) \tag{5}$$

$$r_i = r(P_g, P_r, Y_i, h_i) \tag{6}$$

2.3. Bivariate Probit Modeling

From available data, payment for waste disposal (G_i) was associated with Equation (5), although the dependent variable is binary (yes = 1 and 0 otherwise). For Equation (6), recycling behavior (R_i) was also captured as a dummy variable (yes = 1 and 0 otherwise). The nature of the dependent variable naturally suggests estimation of Probit regression to determine the factors explaining probability of waste disposal through cash payments and participation in recycling. However, given that Equations (5) and (6) both have binary dependent variables, the choice of the Bivariate Probit model was tested since the errors of the two models are likely going to be correlated. The estimated Bivariate Probit model is as stated below:

$$G_i = \alpha + \pi Y_i + \beta_{ik} \sum_{k=1}^{17} h_i + v_i \tag{7}$$

$$R_i = \omega + \gamma Y_i + \varphi_{ik} \sum_{k=1}^{17} h_i + u_i \tag{8}$$

β_{ik}, φ_{ik}, γ, π, ω and α are the estimated parameters. The independent variables are as specified below: Y_i = households' income (Rand), h_1 = dump refuse anywhere (yes = 1, 0 otherwise), h_2 = irregular or no waste removal (yes = 1, 0 otherwise), h_3 = littering (yes = 1, 0 otherwise), h_3 water pollution (yes = 1, 0 otherwise), h_4 = air pollution (yes = 1, 0 otherwise), h_5 = land degradation (yes = 1, 0 otherwise), h_6 = noise pollution (yes = 1, 0 otherwise), h_7 = Western Cape (yes = 1, 0 otherwise), h_8 = Eastern Cape (yes = 1, 0 otherwise), h_9 = Northern Cape (yes = 1, 0 otherwise), h_{10} = Free State (yes = 1, 0 otherwise), h_{11} = North West (yes = 1, 0 otherwise), h_{12} = Mpumalanga (yes = 1, 0 otherwise), h_{13} = male headship (yes = 1, 0 otherwise), h_{14} = Indian (yes = 1, 0 otherwise), h_{15} = household head's age, h_{16} = formal education (yes = 1, 0 otherwise), h_{17} = access to social grants (yes = 1, 0 otherwise), α_1 and α_2 are the constant terms, v_i and u_i are the error terms.

In Equations (7) and (8), the assumptions are that $E(v_i) = E(u_i) = 0$ and $Var(v_i) = Var(u_i) = 1$. Similarly, $Cov(v_i, u_i) = \rho$, $i = 1, 2, 3, 4, \ldots n$. Estimation of the Bivariate Probit models was carried out with STATA 13 software, where the parameter of correlation between the error terms in the two equations is presented.The Likelihood ratio test evaluates whether the value of ρ is statistically significant ($p < 0.05$). If this is so, it confirms significant correlation between the error terms. This further emphasizes that estimating the models separately using a conventional Probit model would give biased parameters.

3. Results and Discussions

3.1. Socio-Economic Profiles of the Respondents

Table 1 shows the socio-economic characteristics of the respondents across the different provinces in South Africa. It reveals that average age of household heads in the combined data was 46.77 years. Eastern Cape had the highest average age (48.94 years), while Free State reported the lowest (45.57 years). Burger *et al.* [40] emphasized that in contemporary South Africa, there is emergence of households in the middle class due to recently implemented economic reforms although the majority of household heads are quite younger. In addition, understanding the dynamics in marital issues and marriage relationships in South Africa can assist in explaining the results a little further [41]. Persistence of divorce and non-willingness of some marriage eligible men to take up family responsibilities often make young women the heads of households. Prevalence of HIV and AIDS and its associated mortality sometimes subjects young children and women to assume the role of household heads [42].

Table 1. Descriptive statistics of household heads' selected socioeconomic characteristics.

Province	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	All
Age (Years)	46.67	48.94	47.10	45.57	47.01	46.95	45.97	46.06	46.78	46.77
Income (Rands)	7809.82	4358.45	5497.84	5279.86	5399.68	5289.87	8003.05	5929.50	4014.19	6064.52
Social Grants (Rands)	15.33	29.45	23.10	20.53	25.15	21.67	11.00	18.84	24.77	20.00
Formal education (%)	97.06	88.97	87.69	92.05	85.75	86.08	94.40	83.55	81.75	89.38

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

Furthermore, the results reveal that 89.38% of the household heads had formal education. Limpopo province reported the lowest formal education attainment (81.75%), while Western Cape had the highest (97.06%). In a previous study, it was found that the lowest literacy rate was reported among residents from Limpopo [44]. The role of education in defining South African households' socio-economic status and environmental consciousness cannot be overemphasized. Although sometimes considered as deterrent for fulfillment of several socio-economic aspirations, educational attainments are the broad links between today's socio-economic and environmental challenges and ability to properly proffer solutions through definitive behavior change [45,46]. It should be noted that although the literacy rate is very high in South Africa, the quality of attained education for securing high pay jobs had been called to question. Spaull [47] noted that the inability to separate quality from quantity and improper documentation of the rate of school drop outs often inflate assessment scores of South African educational performance.

Average monthly income for all the households was R6064.52. Gauteng and Western Cape had the highest monthly incomes of R8003.05 and R7809.82 respectively, while Limpopo (R4014.19) and Eastern Cape (R4358.45) had the lowest. The notion of strong negative association between poverty (low income) and environmental conservation is well documented in literature [2]. Obviously, this synergy produces a bidirectional reinforcement between poverty and environmental degradation. Fabra [48] noted that "poverty and environmental degradation are often bound together in a mutually reinforcing vicious cycle, and thus human rights abuses related to poverty can be both causes and effects of environmental problems".

The results further show that one out of every five households that were sampled (20.00%) reported access to social grants, although Eastern Cape and KwaZulu Natal had the highest values of 29.45% and 25.15%, respectively. Extension of different form of social grants to black South Africans is the offshoot of major post-1994 economic reforms that were meant to address economic destitutions and inequality [49]. Beneficiaries of this program are considered to be highly marginalized and have more than doubled over the past decade [50]. However, access to social grants will reduce poverty in order to enhance households' notion of environmental conservation and reduce their overdependence on already degraded natural resources [5,51].

3.2. Waste Disposal Methods and Perceived Environmental Problems by the Households

The widely adopted method of waste disposal often tells more about the degree of environmental safety within a society. This is as a result of intricate links between contacts with dangerous pollutants from wastes and the disposal methods. The prime instinct of disposing wastes every week with less or no contacts with people underscores good practice for environmental safety [21]. When this is violated, wastes become elements of pollution and pose substantial threats to human health. In the results presented in Table 2, two methods were largely used for waste disposal by the combined households, these are local authority/private company at least once a week (56.03%) and their own refuse dump (31.98%). Specifically, local authorities/private companies (at least once a week) were responsible for waste disposal among 87.74% and 86.69% of the households in Gauteng and Western Cape, respectively. Limpopo province and Eastern Cape reported the lowest proportions of this

source with 12.59% and 34.17%, respectively. However, households from Limpopo and Mpumalanga had the highest usage of their own refuse dumps with 70.57% and 52.90%, respectively.

According to Makgae [52], in the past, waste management was poorly funded and coordinated in South Africa. Some fundamental problems highlighted by Nahman and Godfrey [53] included inadequacy of waste collection services for majority of the households, dumping of refuse in some illegal places, lack of airspace for implementing landfill obligations, lack of adequate minimization and recycling of wastes and inadequate policy initiatives. In a study conducted by Department of Water Affairs and Forestry (DWAF) [54], the volume of waste generated by households is directly proportional to their income levels. It was estimated that higher income earners generated about 2.7 m^3/per capital/annum compared to low income earners with 0.2 m^3/capital per annum. In another study, Ogola *et al.* [55] reported that the quantity of wastes that was generated in 2001 in South Africa increased due to economic and population growth and persistent adoption of unsustainable lifestyles.

It should also be noted that waste disposal becomes a serious environmental problem when households do not have any safe way of disposal. In such instances, wastes are dumped anywhere thereby constituting some form of negative externalities to other households. In the results in Table 2, 3.28% of South African households dumped refuse anywhere, while provinces with highest percentages are Mpumalanga (5.97%) and Limpopo (5.81%).

Table 3 also shows the types of prevailing environmental problems perceived by household heads in South Africa. It reveals that littering constituted the highest proportion among all the households with 34.03%. In Mpumalanga, 52.10% of the households reported that littering was a major environmental problem. Other provinces with high littering are Free State (42.32%) and Limpopo (36.37%). Irregular or no waste removal was reported by 21.83% of all the households. However, this problem was more pronounced in Mpumalanga (56.46%), while only 5.01% was from Western Cape.

Even though the number of households indulging in the nefarious practice of dumping refuse anywhere was small, many households perceived littering as a critical environmental problem. Dumping of refuse anywhere is illegal based on section 156 of 1996 Constitution of the Republic of South Africa. However, there are some disparities in enforcement of this law across different socio-economic and geographical settings. In its strictest compliance, the person responsible for dumping the waste, the owner of the waste, or owner of the residence where waste had been dumped illegally could be officially mandated to dispose of them within some specified period of time [56].

The South Africa's National Water Act (NWA) of 1998 (Act 36 of 1998) mandated the Department of Water Affairs and Forestry to ensure proper regulation of South Africa's water resources in order to prevent its pollution. Water pollution is a situation when water becomes harmful to use due to alteration of its properties whether deliberately or otherwise [57]. From the results in Table 3, water pollution was reported by 15.49% of the households in South Africa. Specifically, the highest percentages of 21.98% and 21.28% of the households in Eastern Cape and Free State, respectively reported water pollution as a major environmental problem. Pollution of water can result from inappropriate disposal of waste, especially very close to wells, streams, and rivers. Therefore, proper handling of wastes is essential for ensuring access to clean and safe water for domestic uses. Carnie [58] reported that outbreak of diarrhea in Durban had been linked to water pollution, in particular Umgeni River which was considered the dirtiest river in South Africa. Anderson *et al.* [59] also found that among households without access to clean drinking water in South Africa, only 19% treated water before drinking. This emphasizes the fact that if contaminated, drinking of polluted water would result in outbreak of water borne diseases and other infections.

Table 2. Percentage distribution of waste disposal methods among households in South African Provinces.

Province	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	All
Local authority/private company at least once a week	86.69	34.17	69.46	76.79	37.68	46.34	87.74	36.78	12.59	56.03
Local authority/private company less often than once a week	0.12	7.03	1.46	1.34	0.48	2.75	0.53	0.99	0.70	1.56
Community members contracted by the municipalities at least once a week	3.06	0.10	0.18	0.08	7.39	1.27	1.80	1.37	6.22	3.00
Community members contracted by the municipalities less often than once a week	0.07	0.08	0.00	0.00	0.16	2.07	0.00	0.00	0.36	0.23
Community members at least once a week	1.99	0.11	1.21	0.32	0.20	0.15	0.05	0.03	0.42	0.38
Community members at less often than once a week	1.30	0.03	0.00	0.07	0.03	0.00	0.04	0.00	0.09	0.17
Communal refuse dump/container	4.22	0.39	0.50	1.47	0.88	0.84	1.75	0.88	1.19	1.45
Own refuse dump	1.35	51.63	19.03	12.42	48.84	39.52	4.24	52.90	70.57	31.98
Dump or leave rubbish anywhere	0.45	4.03	3.73	4.84	2.25	4.18	2.34	5.97	5.81	3.28
Other places	0.14	0.21	0.54	0.77	0.00	0.12	0.07	0.13	0.40	0.18
Missing responses	0.60	2.23	3.89	1.90	2.10	2.75	1.44	0.96	1.64	1.73

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

Table 3. Percentage distribution of environmental problems identified by the respondents across the Provinces in South Africa.

Province	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	All
Irregular or no waste removal	5.01	23.88	21.25	29.70	21.09	31.05	13.15	56.46	22.28	21.83
Littering	23.53	36.04	26.80	42.32	34.39	34.77	29.14	52.10	36.37	34.03
Water pollution	8.89	21.98	9.07	21.28	18.89	12.95	12.33	16.33	15.21	15.49
Air pollution	7.40	14.03	19.58	29.28	16.15	23.81	19.77	35.43	21.49	19.00
Land degradation	13.41	43.05	29.03	45.21	23.84	45.26	21.99	58.56	36.13	31.53
Noise pollution	17.83	15.98	12.22	19.67	12.38	19.41	16.33	22.39	28.32	17.74

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

In addition, while 19.00% of all the respondents indicated air pollution as an environmental problem, the highest percentages were 35.43% and 29.28% in Mpumalanga and Free State provinces, respectively. The degree of air pollution in South Africa is set to be put under control through sanctions and other regulatory mechanisms. However, some affected industries are seeking for more time before they will fully comply with legislative emission standards. Air pollution poses a significant threat to welfare of households in the world and it is directly linked to some cardiovascular and cancer diseases [60]. Recent estimates from World Health Organization (WHO) indicated that in 2012, 600,000 deaths in Africa could be linked to household air pollution [60]. Outdoor pollution of air results from industrial production, transport, agriculture, cooking with charcoals and fuel wood, among other practices [61]. However, components of air that pose significant threats to human health are nitrogen dioxide, sulphur dioxide, ozone gas, carbon monoxide, and polycyclic aromatic hydrocarbons [61].

Land degradation and noise pollution are the other forms of environmental degradation which the questionnaire probed into. In the combined data, land degradation was reported by 31.53% of all the households, while noise pollution was reported by 17.74%. Mpumalanga (58.56%), North-West (45.26%) and Free State (45.21%) had the highest percentages for land degradation, while Limpopo (28.32%) and Mpumalanga (22.39%) reported the highest exposure to noise pollution. Land degradation in South Africa has different dimensions, although agricultural households are in the best place to perceive the degree to which available farm lands may have degraded [62]. The spate in degradation of land resources is directly linked to other environmental concerns, including waste disposal.

3.3. Paying for Waste Disposal and Recycling Behavior

Table 4 shows the distribution of households that were paying for waste disposal. It reveals that 38.42% of the households in South Africa were paying for waste disposal, although Western Cape and Gauteng provinces reported the highest values of 68.00% and 54.55%, respectively. Similarly, Limpopo and Eastern Cape provinces had lowest proportions of their households paying for waste disposal with 12.92% and 27.18%, respectively. Also, the questionnaire probed into whether those households that were not paying for waste disposal at the time of the interview would be willing to pay in the future. The results show that Gauteng and Free State reported highest willingness to pay with 15.09% and 13.39%, respectively. The lowest percentages, 2.05% and 2.95%, of households would be willing to pay for waste disposal were in Limpopo and KwaZulu Natal, respectively.

These results have significant implications for waste management in South Africa. Kamara [12] emphasized that inability to ensure safe environment for all in South Africa is as a result of deficiency in the institutional arrangements for implementing environmental management policies. Similarly, poverty and income inequality lead to disparities in environmental safety with some residential areas occupied by the rich having little or no waste management problem, while most of the areas occupied by the poor face serious waste disposal issues. In the recently proposed 2015 amendments to the Waste Act, "Polluter Pays" principle which emphasizes that all households and businesses that are responsible for waste generation should bear the cost of its management. Such cost would not only cover waste collection, treatment, and disposal but should also include the externality costs resulting from some health and other environmental consequences of inappropriate waste management [16]. In addition, the constitutional amendments propose "volumetric tariffs" which emphasizes payment for waste disposal in relation to the quantity being generated. In order to cater for disparities in households' income levels, the policy seeks an implementation framework that is based on income levels or some other acceptable ways of defining wealth. The bottom line however is that, every South African household should be prepared to pay for waste disposal in the future as a way of enhancing waste reduction, reusing, and recycling, irrespective of their income levels or socioeconomic status.

Table 4. Percentage distribution of respondents based on paying and willingness to pay for waste disposal across the Provinces in South Africa.

Province	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	All
Paying										
Yes	68.00	27.18	48.69	40.43	25.94	30.93	54.55	29.64	12.92	38.42
No	29.55	14.82	27.75	41.17	22.02	24.51	37.76	10.49	9.14	25.11
Do not know	0.53	0.34	0.00	0.34	0.42	0.47	0.89	0.74	0.64	0.58
Missing	1.93	57.67	23.56	18.06	51.63	44.09	6.80	59.13	77.30	35.89
Willing to pay										
Yes	9.39	4.30	9.60	13.39	2.95	10.27	15.09	4.31	2.05	8.16
No	19.21	9.07	16.82	26.81	17.57	12.96	20.72	5.57	5.82	15.56
Do not know	0.21	0.08	0.00	0.17	0.29	0.11	0.52	0.03	0.00	0.24
Missing	71.19	86.55	73.58	59.63	79.18	76.65	63.66	90.09	92.13	76.05

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

Table 5. Percentage distribution of households recycling or selling wastes and materials recycled across the Provinces in South Africa.

Province	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu-Natal	North West	Gauteng	Mpumalanga	Limpopo	All
Recycling wastes	16.93	6.99	4.05	3.87	5.01	2.57	8.18	2.72	1.69	6.54
Selling wastes	1.40	4.79	2.68	2.18	0.53	1.53	1.26	1.63	1.19	1.70
Materials being recycled										
Paper	14.64	1.25	0.36	1.49	3.95	0.40	5.63	0.20	0.19	4.02
Glass	13.87	4.33	2.24	1.97	1.76	1.36	5.34	1.24	0.54	4.10
Plastics	14.83	2.56	1.77	1.81	1.52	0.50	4.51	0.41	0.23	3.55
Metal	8.69	4.57	1.58	1.20	0.51	1.10	2.18	1.62	1.41	2.59
Oil	0.43	0.09	0.00	0.06	0.05	0.04	0.75	0.00	0.09	0.27

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

Table 5 further shows the distribution of the respondents based on participation in waste recycling and the nature of waste recycled. It reveals that 6.54% of all the households were recycling. However, Western Cape (16.93%) and Gauteng (8.18%) had the highest proportions of their households involved in recycling of wastes. Limpopo, North-West, and Mpumalanga provinces reported the lowest involvement in waste recycling with 1.69%, 2.57%, and 2.72%, respectively. The Waste Act and National Waste Management Strategy of South Africa emphasize waste recycling and primary option for sustainable management of daily generated wastes. Incentives to exchange wastes for cash could facilitate recycling of wastes [63]. In the results, 1.70% of the combined households were selling wastes. Specifically, Eastern Cape and Northern Cape reported the highest proportions selling waste with 4.79% and 2.68%, respectively. The results further show that glass (4.10%) and paper (4.02%) were mostly recycled by all the households.

Although several initiatives to enhance participation of households in waste recycling had been implemented across the globe, they are not without some notable challenges. In Cameroon, for instance, the solid waste minimization and valorization project was initiated to enhance environmental safety in Douala. However, one the biggest challenges was that as households became aware that people collecting recyclable stuffs were selling them, they became more reluctant to give out their waste free of charge [64]. In order to promote involvement of many households in recycling, emphases should be placed on awareness creation, duplication of recyclable waste collection centers, behavioral change, and initiative sustainability [65].

3.4. Factors Explaining Cash Payment for Waste Disposal and Recycling

The results of Bivariate Probit analysis are presented in Table 6. In the modeling, the first step was to test for the presence of multicollinearity among the initially suggested variables. At this stage, some variables failed the test of collinearity and they were excluded. Decision to include a variable was made by examining the level of tolerance. The tolerance levels of included variables are presented in the last column of Table 6, while the average variance inflation factor (VIF) for the model was 1.32. This depicts an overall tolerance of about 75.87% and a very good indication that multicollinearity was not a problem.

Table 6. Bivariate Probit results of factors influencing recycling and payment for waste disposal.

Socio-Demographic Variables	**Recycling Behavior**			**Pay for Waste Disposal**			
Recycling	Coefficient	Std. Error	Prob	Coefficient	Std. Error	Prob	Tolerance
Income	0.00004	0.0000	0.0000	0.0001	0.0000	0.0000	0.7407
Dump refuse anywhere	0.1179	0.0816	0.1480	−6.5908	564.1649	0.9910	0.9514
Irregular or no waste removal	0.0506	0.0418	0.2270	−0.5435	0.0286	0.0000	0.6807
Littering	0.0774	0.0374	0.0380	−0.0360	0.0251	0.1520	0.6366
Water pollution	0.0444	0.0457	0.3310	−0.1987	0.0321	0.0000	0.7587
Air pollution	0.0223	0.0431	0.6050	0.1867	0.0287	0.0000	0.7034
Land degradation	−0.0433	0.0361	0.2300	−0.3709	0.0239	0.0000	0.7254
Noise pollution	0.0390	0.0406	0.3360	0.0228	0.0280	0.4150	0.8180
Western Cape	0.6576	0.0396	0.0000	0.8944	0.0320	0.0000	0.8146
Eastern Cape	0.3163	0.0443	0.0000	0.1272	0.0314	0.0000	0.8472
Northern Cape	0.0361	0.0664	0.5860	0.7389	0.0397	0.0000	0.9079
Free State	0.0095	0.0568	0.8680	0.5906	0.0342	0.0000	0.8756
North West	−0.1355	0.0630	0.0310	0.2255	0.0354	0.0000	0.8822
Mpumalanga	−0.1675	0.0608	0.0060	0.3194	0.0368	0.0000	0.8017
Male headship	0.0285	0.0301	0.3440	0.0478	0.0199	0.0160	0.9252
Indian	0.6081	0.0772	0.0000	1.4646	0.0948	0.0000	0.9469
Household head's age	0.0111	0.0012	0.0000	0.0159	0.0008	0.0000	0.5166
Formal education	0.1383	0.0535	0.0100	0.5904	0.0343	0.0000	0.8045
Access to social grants	−0.2839	0.0461	0.0000	−0.1846	0.0303	0.0000	0.5203
Constant term	−2.6934	0.0876	0.0000	−2.1435	0.0573	0.0000	
Athrho	0.1574	0.0213	7.4000	0.0000	0.1157	0.1991	
Rho	0.1561	0.0208			0.1152	0.1965	
Likelihood-ratio test of rho = 0; chi2(1) = 55.1667,Prob chi^2 = 0.0000							
Number of obs = 23518;Wald chi^2(38) = 6633.13; Prob chi^2 = 0.0000; Log likelihood = −15852.196							Mean VIF = 1.32

Source: Author's computations from South Africa's General Household Survey (GHS) 2012 [43].

The estimated model produced a good fit for the data judging from statistical significance of Wald Chi Square statistics ($p < 0.01$). The computed correlation coefficient between the error terms of the two models was 0.1560. The computed Athrho (0.1574) shows statistical significance ($p < 0.01$). Also, the likelihood ratio test of rho equals to zero rejects the null hypothesis of no correlation ($p < 0.01$). This implies that error terms of the two models are correlated, and estimating the models independently using a conventional Probit model would produce biased parameters. The results further show that those variables that would influence probability of recycling but were excluded would also lead to increase in the probability of paying for waste disposal.

Among the variables that were included, income parameters are statistically significant ($p < 0.01$) in the two models. This implies that if other variables are held constant, probabilities of deciding to recycle and pay for waste disposal significantly increased as households' income increase. Similarly, the parameters of access to social grants in the two models are with negative sign and statistically significant ($p < 0.01$). These indicate that, holding other variables constant, the probabilities of recycling and paying for waste disposal by households that were receiving social grants were lower than those not receiving.

These results go in line with a priori expectation given that prevailing differences in the attitudes of people towards environmental conservation are often borne out of their income and poverty levels. In South Africa, households on social grants are largely poor and unable to independently support their living expenses. In a related study, Guerin *et al.* [26] found that income had a significant relationship with waste recycling behavior. As income increases, there is a higher likelihood that households will reside in locations where environmental safety is not a luxury and would be mandated to pay for environmental services. Similarly, Muzenda *et al.* [66] and Organization for Economic Cooperation and Development (OECD) [67] noted that increase in income resulted in generation of more wastes. However, when disaggregated, OECD [67] found high income households recycling more newspapers and less garbage.

Although statistically insignificant in the recycling model, the irregular or no waste removal variable showed statistical significance ($p < 0.01$) in the pay for waste disposal model and with negative sign. This implies that holding other variables constant, household heads that indicated irregular and no waste removal in their communities had significantly lower probability of paying for waste disposal. This result can also be linked to the level of household's income because erratic disposal of waste often characterizes residential areas occupied by the poor. This may have resulted due to their complete reliance on the municipal authorities for waste collection. Although, constitutionally mandated to ensure adequate management of domestic wastes, the local municipalities often face challenges in providing adequate services of waste collection [4].

In addition, the parameter of littering as a problem perceived by the households is with a positive sign and statistically significant ($p < 0.05$) in the model for recycling wastes, but statistically insignificant ($p > 0.10$) in the pay for waste disposal model. This implies that if other variables are held constant, households that perceived littering as an environmental problem had higher probability of recycling. In the recycling model, perception of the water pollution variable is statistically insignificant ($p > 0.10$). However, the payment for waste disposal model, the parameter is with a negative sign and statistically significant ($p < 0.01$). This implies that if other variables are held constant, households that perceived water pollution had significantly lower probability of paying for waste disposal. The parameters of air pollution in the two models are with a positive sign, although only that of pay for waste disposal shows statistical significance ($p < 0.01$). This implies that if other variables are held constant, households that perceived air pollution have significantly higher probability of paying for waste disposal.

Some of these results go in line with a priori expectation because ability to perceive environmental problem can promote adoption of environmental conservation strategies. Specifically, promotion of awareness on environmental degradation has provided policy makers with a platform for understanding households' responses and behavior pattern on issues environmental

conservation [68]. Similarly, the theories of reasoned action and planned behavior predicted human behavior in respect of some pressing socio-economic challenges [69,70]. There is a clear application of these theories to environmental conservation because they indicate that the consequences of certain actions (positive and negative) would be weighed by individuals in order to generate an attitude which eventually translates into behavior. Whitmarsh [71] and Gooch [72] have also indicated that attitudes towards environmental conservation and perception of individuals on the level of their exposure to environmental hazards will have significant impacts on their environmental attitudes.

The included provincial variables all show statistical significance ($p < 0.01$) and with a positive sign in the model estimated for paying for waste disposal. This implies that taking all other variables constant, households in Western Cape (0.8944), Eastern Cape (0.1272), Northern Cape (0.7389), Free State (0.5908), North West (0.2255), and Mpumalanga (0.3194) would have higher probabilities of paying for waste disposal when compared to those in Gauteng, Limpopo, and KwaZulu Natal. However, in the recycling model, provincial parameters with statistical significance are Western Cape (0.6576), Eastern Cape (0.3163), Mpumalanga (-0.1675), and North West (-0.1355) ($p < 0.05$). The results imply that taking other variables constant, households in Western Cape and Eastern Cape have higher probabilities of recycling when compared to those from Gauteng, Limpopo, and KwaZulu Natal. However, those from Mpumalanga and North West have significantly lower probabilities of recycling (other variables being held constant) when compared to those from Gauteng, Limpopo, and KwaZulu Natal. Several issues are at work in defining people's environmental safety behaviors at a provincial level in South Africa. These include efficiency of environmental service providers whether privately or publicly owned, availability of waste recycling centers, proximity and number of recyclable waste collection centers, and general awareness [3,5,16].

Although gender variable in the recycling model is with a positive sign, it is not statistically significant ($p < 0.10$). However, the estimated parameter in the pay for waste disposal model shows statistical significance ($p < 0.05$). This implies that holding other variables constant, households headed by males have significantly higher probabilities of paying for waste disposal when compared with those headed by females. The issue of gender and positive environmental behavior had been properly documented in literature. Some studies have highlighted positive responses among females [73–75].

Furthermore, the parameters of racial variable (Indian) in the two models show statistical significance ($p < 0.01$) and with a positive sign. These parameters indicate that if other variables are held constant, households of Indian origin have higher probabilities of recycling and paying for waste disposal. This result goes in line with that of Anderson *et al.* [5] who found that racial factor played very crucial role in explaining waste recycling in South Africa.

The parameters of age of household heads in the recycling model and paying for waste disposal show statistical significance ($p < 0.01$). These imply that if age increases by one unit, and holding other variables constant, probabilities of recycling and paying for waste disposal significantly increased. Age of household heads can be associated with proper perception of environmental problems. Although Mohai and Twight [76] reported contrary results, some findings by Guerin *et al.* [26] and Anderson *et al.* [5] indicated higher probability of aged households to be involved in environmental conservation behaviors.

In addition, the parameters of attainment of formal education in the recycling model and paying for waste disposal model both show statistical significance ($p < 0.01$). These indicate that holding other variables constant, households that have heads who attained formal education have significantly higher probabilities of recycling and paying for waste disposal. Education is expected to enhance proper orientation towards environmental conservation. This may be attained through direct relationship with environmental attitudes through access to media and positive influence of high socioeconomic status expected as direct returns of education. In some previous studies, Samdahl and Robertson [31], Guerin *et al.* [26], and Anderson *et al.* [5] found positive relationship between education and good environmental practice.

4. Conclusions

In this study, waste management, which is an aspect of environmental problems facing policy makers in South Africa was studied. The findings point at differences in adopted methods of waste disposal across South African Provinces with a majority of households from Limpopo and Mpumalanga using their own refuse dump and/or dump it anywhere. Also, littering was the major form of environmental problem perceived by the households, although air pollution, land degradation, and noise pollution were also reported. These findings emphasize the need for more integrated efforts to address waste management and environmental degradation by policy makers at provincial level. Sector specific policies that are meant to address environmental problems in South Africa should be reexamined for implementation bottlenecks and efficiency. However, with proper enforcement of environmental regulations and laws, significant improvements would be achieved in compliance for environmental safety.

Only 38.42% of South African households were paying for waste disposal in 2012 and majority were not willing to pay. More awareness and initiatives to promote waste recycling should be provided in South Africa, given that only 6.54% of all the households was recycling. Present barriers to waste recycling should be further evaluated and identified issues should be properly addressed in order to promote a system where generated wastes are turned to glorious wealth.

Behavior change is considered very critical in addressing environmental problems in developing countries. In this study, wealthier households were more involved in paying for waste disposal and recycling. Therefore, addressing poverty in South Africa is very crucial in promoting a safer and cleaner environment for all the citizens. This recommendation can be further amplified from the findings that indicated low probabilities of paying for waste disposal by households that reported irregular or no waste removal in their communities. Amplifying communities' and individuals' responsibility in waste management through some media and sensitization programs would go a long way in enhancing environmental conservation. Such programs should be gender sensitive and targeted at the youths and young household heads. They should also provide basic education on environmental safety and the need to desist from littering and respect the rights of other citizens to safe air, clean water, and a quiet environment.

Acknowledgments: The permission that was granted by Statistics South Africa to use the data set for this study is gratefully acknowledged. I am also very grateful to the North West University for approving funds to go on research visitations to Ghana and Cameroon between 14 June 2015 and 17 July 2015. It was during this time that this paper was conceptualized and written.

Conflicts of Interest: The author declares no conflict of interest.

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