Les Cahiers du CEDIMES

2022, Volume 17, Numéro 3, https://doi.org/10.69611/cahiers17-3-11

ISSN 2110-6045

STANDARD OF LIVING OF HOUSEHOLDS AND MODES OF DISPOSAL OF HOUSEHOLD WASTE IN CAMEROON
NIVEAU DE VIE DES MÉNAGES ET MODES D'ÉVACUATIONS DES DÉCHETS MÉNAGERS AU CAMEROUN

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Abstract:
This paper analyses the modes of household waste disposal according to the standard of living of heads of households in Cameroon. The data for this study were obtained from the Fourth Cameroon Household Survey (ECAM 4) with a sample of 10 303 heads of households. In order to achieve this objective, the simple logistic model was used. The econometric analysis reveals that as the standard of living of the head of household increases, the probability of choosing a garbage bin or waiting for collection trucks or collection agents at the source increases, and as the standard of living of the head of household increases, the probability of disposing of liquid household waste in a yard or in the wilderness decreases; in fact, the probability of being educated increases when the standard of living increases, and also the probability of a head of household living in decent housing increases by 3% and 8% respectively when the standard of living increases.

Keywords*: Standard of living, Household waste disposal, Cameroon.*

Résumé:
Cet article analyse les modes d'évacuations des déchets ménagers en fonction du niveau de vie des chefs de ménages au Cameroun. Les données nécessaires pour réaliser cette étude proviennent de la Quatrième Enquête Camerounaise Auprès des Ménages (ECAM 4) avec un échantillon de 10 303 chefs de ménages. Afin d'atteindre cet objectif, le modèle logistique simple a été retenu. L'analyse économétrique révèle que, plus le niveau de vie du chef de ménage augmente, plus la probabilité de choisir un bac à ordure ou attendre soit les camions ramasseurs soit les agents de collecte à la source augmente, et plus le niveau de vie du chef de ménage augmente moins la probabilité de se débarrasser de ses déchets ménagers liquides dans une cour ou dans la nature augmente; en effet, la probabilité d'être instruit augmente lorsque le niveau de vie augmente, également la probabilité pour qu'un chef de ménage habite dans des logements décents augmente respectivement de 3% et de 8% lorsque le niveau de vie augmente.

Mots-clés *: Niveau de vie, Evacuation des déchets ménagers, Cameroun.*

JEL Classification*: D10.*

Introduction

Developing countries (DCs) are nowadays facing a major challenge, that of household waste management (MWM). Indeed, the demographic growth observed in recent years in most cities of these countries leads to a high production of household waste. Considering the world average of solid waste (SW) production of 0.6 kg/inhabitant/day, Kaza, Yao, Bhada-Tata, & Van Woerden, (2018) They estimate the average production of cities in the world to be 2.1 billion tons of waste per year. Similarly, they projected that by 2050, this volume would increase to 3.4 billion tons per year. The production of waste, which accompanies human activity, is thus bound to increase in considerable proportions in the South as in the North.

It is through the prodigious increase of the population and the evolution of the modes of consumption and production, that the household waste (MW) weighs more and more on the majority of the developing countries like Cameroon. It is true that cities are developing, but they also produce waste in quantity (Redjal & Rouag-Saffidine, 2017). The evolution of the standard of living, consumption and production literally leads to a frantic production of waste, especially household waste. Indeed, the more the district is chic, the more it produces waste, it is the mode of evacuation which differs according to the type of district (Haouaoui and Loukil, 2009). This is why the modernization of the management of this DM remains a real challenge for local development.

Waste management begins with waste disposal; in developing countries, this usually begins with precollection. This is a kind of primary collection of waste from households to designated clusters (Zahrani, 2006). This primary collection, which is carried out partially or unsatisfactorily, literally leads to the proliferation of unauthorized dumps (N'tain, 2010). Thus, in large African cities, there is a proliferation of uncontrolled dumping of household waste on public roads and spaces, along waterways and near homes (Bagalwa et al., 2013; Koné-Bodou Possilétya et al., 2019; Niesel et al., 2008). Good waste disposal therefore has a negative effect on the proliferation of illegal dumps. The method of disposal of household waste also varies between upmarket neighbourhoods and others. (Haouaoui and Loukil, 2009).

Waste disposal can be defined as a method by which a legal or physical person gets rid of its residues (solid or liquid), taking into account or not the externalities that will result from it. DM disposal has depended for some decades on the standard of living of households; indeed, whether one is poor or not would affect one's specific choice of a DM disposal method. The World Bank (WB) defines the absolute poverty line at $1.90 per day (Mondiale, 2018). In Cameroon, the National Institute of Statistics (INS) defines a poor household as one whose standard of living is less than 931 francs per day (INS, 2016). The same study conducted by the INS shows that about 24% of urban households throw their garbage in the nature, Moreover, the statistics reveal that only 23% of urban households in Cameroon use an adequate mode of sewage disposal. The Cameroonian metropolises are the places where the disposal of solid household waste is done in an adequate manner, i.e. over 70%. Concerning liquid household waste, the INS shows that wastewater disposal is done in anarchic and inadequate ways; indeed on average only 5.9% of households dispose of their MSW in an adequate way (by pouring into septic tanks).

With this in mind, it is interesting to consider the effect of household standard of living on the disposal of DM in Cameroon, in other words, what influence does the standard of living of

households have on their DM disposal.

The rest of this paper is organized as follows, the second point is on literature review, the third on methodology, the fourth on results and discussion and the last point is on conclusion and some policy recommendations.

1. Review of the literature

The literature on household behaviour in relation to the choice of DM disposal method is abundant and controversial. Although the study of this behaviour allows for the analysis of DM disposal patterns according to the standard of living of household heads, the results of this analysis remain mixed. Based on social choice theory, several other theories have emerged in relation to this topic.

The objective of this section is to review the different works related to the modes of household waste disposal. To do this, this section allows us to consult the theoretical and empirical literature on the analysis of the modes of disposal of MSW according to the standard of living of the heads of household.

1.1. Theoretical basis for the decision on the choice of disposal methods for household waste

The mobilization of some theories in our article allows us to show the relationships between the standard of living of the heads of households and the choice of different modes of disposal of the DM they produce. Several approaches can explain our research work, but the fundamental one is the theory of revealed preferences of Samuelson (1938) considered as a neoclassical theory.

The economic models of the neoclassical tradition are generally based on the individual preferences of the agents concerned and rarely on social preferences. In 1938, Samuelson proposed that the analysis of individual choices should be based on the observation of the actual choices made by economic agents, rather than on a priori hypotheses concerning preference relations or hypothetical satisfaction functions. The aim of this theory is therefore to understand which preference relations correspond to observed choices and not to deduce from a system of axioms on preferences the choices that can be made.

Samuelson, (1938) proposed that consumers' preferences could be inferred by observing their choices. Rather than asking consumers about their preferences, by offering them several baskets of possible goods, revealed preference theory limits itself to observing their behaviour. Suppose that these consumers are households; in the waste disposal method to be chosen, the household reveals its preferences. Suppose the household chooses to dispose of its solid waste in a garbage bin (A) rather than throwing it away in nature (B). If good A is close to the household or is as close as good B (or is cheaper than good B), then the household reveals that it prefers the use of good A to good B. Assuming that its preferences do not change, the opposite must not occur when it disposes of the waste. In order for his behavior to be consistent, (Samuelson, 1938) proposes the following "weak axiom of revealed preferences": If A is preferred to B then B should not be preferred to A in the same price and

income situation. With this axiom, the preference relationship must be asymmetric, just as he succeeds in deducing the zero-degree homogeneity of the demand function and the negative sign of the substitution effect.

To deal with the case of any number of goods Houthakker (1950) has the natural idea of suggesting an iterative strengthening of Samuelson's axiom. He then proposes the following strong axiom of revealed 4 preferences: let R beD the relation "directly preferred to" and A, B, … … … … , Z different goods. If $A\ R\ D\ B\ R\ D\ C$ … … … . $R\ DZ$then Z is not to be directly preferred to X. With this axiom, the preference relation must be acyclic.

In economic analysis, it is common to summarize consumer behavior and describe preferences by means of a utility function u(.). Consumption choices are classically described by the maximization of a quasi-concave direct utility function ux( ) in a budget set satisfying the income constraint.

In this context, a household makes its household waste disposal choices to simply maximize its utility under income constraints. If the household chooses mode A over mode B, it thus reveals a preference for mode A over mode B. Households face a price for receiving the household waste collection service. Indeed, even if households do not pay directly for this service, they do so indirectly via the household waste collection tax (TEOM). In this context, it is assumed that a price paid by the household for the disposal of its household waste exists, and is unique regardless of the alternative it subsequently chooses. Moreover, if it seems relevant to think that in domestic waste management what influences more the utility of a household is the time or effort to devote to each mode of disposal (disutility, sacrifice, opportunity cost), any analysis that aims at replacing prices by time or effort will lead to analytical difficulties that go beyond the scope of this work.

Thus, according to Varian, (2003) the objective of the rational consumer is the maximization of his utility, under his budget constraint R. Suppose that he discards quantities x and y through two disposal alternatives, his problem can thus be written as:

$$sc\begin{cases}\max U(x,y)\\ p_1(x)+p_2(y)=R\end{cases}$$

With the x amount of waste dumped in the garbage bins, the y amount dumped in the landfills and Q the total amount of household waste to be disposed of. Solving this program allows you to obtain the optimal quantities x* y* that maximize your utility.

Unlike the neoclassical consumer theory where the household gets satisfaction directly from the mode of disposal it chooses, the new consumer theory requires households to integrate other parameters such as the characteristics of the different modes of disposal to make their choices.

1.2. Empirical work on household waste disposal methods

The mobilization of a few empirical works in our article will allow us to show the effective relations between the standard of living of households and the choice of the different modes of disposal of the DM they produce.

Rateau & Tovar, (2019) show that in Latin America, informal waste recovery is a survival activity in cities with few jobs and a literally low standard of living, marked by poverty and a lack of social programmes. Waste is thus seen as an urban resource (Cavé, 2013), the recoverable part of which 5 represents a real resource. And it is the waste pickers who dedicate themselves to the activity of recovering this resource, often working in an informal manner. Indeed, heads of households considered poor and living in towns with few jobs operate without being paid, financed, recognised or formally entrusted with this service by the authorities concerned. Some informal actors specialise in collecting and then disposing of household waste to unauthorised dumps, while others collect organic waste to feed pig farms.

Wenga-Witha & Godé, (2018) in their work whose general objective is to propose solutions for improving the household solid waste management system in Kinshasa, Congo, also seek to understand the factors that encourage the dumping of household waste in the streets, gutters and illegal dumps by the population. Currently in Kinshasa, the majority of the population accepts the abandonment of their solid household waste in the streets, rivers and The majority of the population accepts the abandonment of their solid household waste in the streets, rivers and gutters in search of a good waste management system, probably because of the improvement of their standard of living. Other households prefer landfill and incineration as their treatment method. All these procedures are at the root of the uncontrolled dumps that become favourable environments for the reproduction of pathogens. In fact, 65% of the waste belonging to these households is dumped in unauthorized dumps (public spaces, erosions, streets, markets and rivers...); 15% of the waste is burned, 10% is abandoned in communal markets and 10% is sent to official dumps to be transferred to the Mpasa 2 Technical Waste Disposal Centre.

Mukuku & al., (2018) conducted a study in the Democratic Republic of Congo whose objective was to describe the socio-demographic characteristics of the respondents as well as the management of household waste in the commune of Katuba in Lubumbashi, Democratic Republic of Congo. Indeed, for them, waste management is the organized and systematic channelling of waste through channels to ensure that it is disposed of carefully with acceptable guarantees of public and environmental health. However, proper management cannot be achieved without a well designed waste management plan. According to (Rossel, Jorge, Barrage, & Edelmann, 1999)According to the Canadian Council of Ministers of the Environment (CCME), waste management planning strategies should advocate the avoidance of waste generation, the use of cleaner technologies, the promotion of recycling and waste recovery, the use of appropriate treatment for the waste generated, and the proper disposal of waste. There is a shift from a landfill-based waste management system to a more integrated system. Good solid waste management involves the sequential hierarchy of source reduction, reuse, recycling and safe disposal. One of the greatest difficulties faced by urban authorities is the collection of household waste. These difficulties are reflected in the accumulation of household waste, the creation of numerous illegal dumpsites, the stagnation of wastewater and rainwater in many neighbourhoods, and the lack of strategic awareness among the population.

A cross-sectional descriptive study from April 1 to May 31, 2017 was conducted; It involved households in Katuba commune, where a convenience sample was drawn. A total of 170 households had been interviewed out of which 18 had refused to answer the questionnaires, which corresponds to a response rate of 89.4%. The following variables were retained in this

study: socio-demographic characteristics of the respondents (age, gender, level of education, occupation), parameters related to household waste management (use of storage bins, mode of storage, mode of treatment, mode of transport, rate of disposal, recovery), knowledge of the hazards due to the presence of waste as well as the respondents' proposals concerning waste management (method of payment of waste collection fees, sale of recyclable waste, method of waste separation).

Diawara, (2009) conducted an economic study on household demand for improved municipal solid waste disposal services in Malaysia, with households as the unit of analysis because they are the direct users of solid waste disposal facilities. The results of the study show a strong influence of perception and distance factor on the public choice pattern for waste disposal options.

Diawara (2009) shows in his thesis that, on the whole, people with a high standard of living, living in apartment buildings or in high-standard villas in the primitive nucleus, put their rubbish in bags or bins while waiting for the collection trucks to pass by (80%), tasks that are generally entrusted to domestic servants (90%) or to the security guards responsible for guarding the residences and villas.

Parrot & al (2009) on the other hand, shows that there is a relationship between the standard of living and the daily ratio. Numerous studies have also indicated the importance of the population's lifestyle, type of housing, eating habits and the influence of the seasons on the quantity and quality of waste produced. (Aloueimine, Matejka, Zurbrugg, & Sidi Mohamed, 2006; Thonart, Diabate, Hiligsmann, & Lardinois, 2005).

Manga & al (2008) aim to investigate the factors that explain agricultural household waste management behaviour in Yaoundé. The results indicate that family size and the accessibility of a neighbourhood increase the likelihood of having waste disposal facilities compared to waste recycling and/or disposal in open areas. On the other hand, farm remoteness, low farm income, accessibility of a neighborhood, total amount of waste generated, and agricultural experience of the head of the household are the determinants of organic recycling at the farm household level. Thus, in order to avoid untidy piles of garbage and to encourage the best choice of waste disposal, the distance between households and garbage bins should be reduced.

Ngambi (2015) in his work shows that household income has a significant impact on the use of refuse bins; he also shows that the income of residents, regardless of where they live, provides an indication of the standard of living of households.

Sotamenou (2012) in his study aimed at identifying the explanatory variables that influence the use of compost in Cameroon on the one hand and on the other hand, to determine the effects of these variables on each level of fertilization. Using a logistic model, the researchers found that the key variables that can help in formulating policy implications to improve the use of organic fertilizers in Cameroon are: membership in farmer cooperatives, land ownership rights, cultivation of food crops, and distance between farmers' homes and farms. Transfer stations should therefore be built for the collection and storage of solid waste produced by households living in the lowlands. This will ease the burden of solid waste collection companies in inaccessible areas and promote the extension and promotion of

composting.

The study by Parrot & al., (2008) provide an overview of the state of MSW management in the capital city of Cameroon, Yaoundé, and suggest possible solutions for its improvement. The result revealed that distance and lack of infrastructure have a major impact on waste collection. Therefore, it is recommended to increase the number of waste bins near households. Furthermore, recycling should be encouraged in order to reduce the amount of pure waste and to promote the ecological intensification of agriculture in Yaounde.

The study of Koné-Bodou Possilétya & al., (2019) on Health risks related to household waste on the population of Anyama (Abidjan-Côte d'Ivoire) shows that the level of education of the head of household would be a significant and expressive factor of the living environment of the households, indeed most of the heads who have no level live in the precarious neighborhoods Derrière-Rails (46%) 7 and Michelbougou (41%) on the other hand Those who have the university level live in the neighborhoods of high standing Residential (57%) and medium standing Schneider (32%). As for the standard of living and social integration of the head of household, the population of the commune of Anyama is mostly self-employed (66%) and only 37% of the heads of household manage to save; the average daily expenditure declared by the households is XOF 2,860. Depending on whether the head of household is a woman or a man, the average goes from XOF 2,181.82 to XOF 2,929.63.

Koné-Bodou Possilétya & al., (2019) show that the majority of the population (74%) store solid household waste in a bin (51%) or in a bag (23%). However, there are difficulties in disposing of it: 61% of households dispose of solid waste in streets, gutters, canals and "big holes". As with solid waste disposal, the main places for wastewater disposal in Anyama are streets, gutters, ravines and backyards. Indeed, 48% of households report dumping wastewater in the above places, compared to 37% and 16% who dump wastewater in septic tanks and in the yard respectively.

Kangoy, Ngoyi, & Mudimbiyi, (2016) in their study on household waste management in Bulaska health area in Mbuji-Mayi in the Democratic Republic of Congo shows that 47.6% of the surveys were primary level, 30% were secondary level, 14.1% were no level while higher and university level accounted for only 8.2%. In this study they note that in 83.5% of the cases, the waste was solid and 16.5% was liquid. This study also shows that in the surveys, 50% of the cases threw the waste on the public road, 28.8% of the cases threw it in the garbage pits and 16.4% of the cases proceeded to open burning.

Koné-Bodou Possilétya & al., (2019) in her study which aimed to assess the level of household waste collection and urban growth in the communes of Cocody and Yopougon (district of Abidjan, Cote d'Ivoire) subdivided each commune into three main zones according to habitat: spontaneous habitat (low standard of living), economic habitat (medium standard of living) and residential habitat (high standard of living). This study shows the habitats and households that are most affected by poor waste collection and the areas where insalubrity is gaining ground. It also shows that the absence of a waste collection agency is similar to that of informal settlements with 81.5% for residential housing, 79.6% in informal settlements and 67.4% for economic housing in Cocody; the trends seem similar in the commune of Yopougon. In Côte d'Ivoire, housekeeping is a female activity regardless of the standard of living. In informal settlements, illiteracy affects the female population more than the male

population, which is also not aware of all the rules of hygiene (preparation and sale of food in the vicinity of dumping sites or sewage systems) and potential health risks (typhoid fever, cholera, diarrhoea).

The work of Sotamenou & al (2008) investigated whether urban horticulture in sub-Saharan cities can encourage farmers to use compost. They used a logistic model and found a positive effect of horticulture on farmers' use of compost.

2. Methodology

In order to achieve the objective of this study, it is necessary to use quantitative tools. This section first presents the variables and data sources, then the specification of the model and finally the estimation method.

2.1 Variables and data sources

This section introduces the variables and their data sources.

- Methods of disposal of household waste

Koné-Bodou Possilétya & al., (2019) analyse the health risks associated with household waste in Anyama (Abidjan-Côte d'Ivoire), the analysis of solid waste disposal methods by neighbourhood shows that pre-collection by an agent is chosen only by households in the Schneider (27%) and Résidentiel (72%) neighbourhoods. No household in the precarious neighbourhoods of Michelbougou (0%) and Derrière-Rails (0%) uses an agent to dispose of its solid waste. Kasangye Kangoy & al, (2016) uses solid waste in his study to assess the level of household waste management in the Bulaska health area in Mbuji-Mayi, Democratic Republic of Congo.

- Methods of wastewater disposal

Koné-Bodou Possilétya & al., (2019) In its study on the health risks associated with household waste in Anyama, the study shows that the situation regarding the disposal of wastewater is similar to that of solid waste. Sixty-five per cent, 59 per cent, 17 per cent and 16 per cent of households in Michelbougou, Derrière Rails, Schneider and Résidentiel respectively, dispose of their wastewater in the street. Septic tanks are used by 80% of households in Residential, 74% in Schneider, 23% in Michelbougou and 16% in Derrière-Rails. Kasangye Kangoy & al, (2016) uses liquid waste in his study to assess the level of household waste management in the Bulaska health area in Mbuji-Mayi in the Democratic Republic of Congo.

- Type of accommodation

Koné-Bodou Possilétya & al., (2019) uses the habitat typology of the neighbourhoods, illustrating the spatial and social diversity observed in the district to analyse household waste management, more specifically collection in the communes of Cocody and Yopougon.

- Income status of the head of household

Ngambi (2015) In his work, he shows that the income of inhabitants, regardless of their place of residence, makes it possible to assess the standard of living of households.

- At least one member of the household uses a garbage bin

We hypothesize that if at least one member of a household uses a garbage bin to dispose of solid waste, this would improve the quality of life and general disposal patterns of the

household.

- Is there an undeveloped watercourse near the dwelling?

Here we assume that the presence of an undeveloped watercourse near a dwelling will facilitate the improper disposal of liquid waste.

- Level of education

Kangoy et al., (2016) use the level of education in their study in DRC to try to determine the types of waste and the mode of waste management generated by the households. Indeed, their study confirms the Unicef report on the low rate of schooling in the province of Kasai Oriental as 14.1% of our surveys had no level of education and 47.6% of primary level.

Study data and presentation of selected variables

The secondary data used in this study are from the fourth Cameroon Household Survey (ECAM 4) conducted over 3 months (January - March 2014), the sample size here is 10303 heads of households. 9 These samples are obtained by taking into account about 10% of total non-responses. These sample sizes allow us to have the main significant indicators at the level of the 12 survey regions with good precision. Table 1 shows that the largest areas surveyed are Douala, the Far North and Yaoundé with 11.04%, 10.64% and 10.32% respectively.

Table 1: Distribution of surveyed regions

Survey regions	Freq.	Percent
Douala	1,137	11.04
Yaoundé	1,063	10.32
Adamaoua	732	7.10
Center	820	7.96
East	627	6.09
Far North	1,099	10.67
Coastal	662	6.43
North	967	9.39
Northwest	940	9.12
West	910	8.83
South	547	5.31
Southwest	799	7.76

Source: Authors based on ECAM 4 data.

In this study, we will use variables relating to the variables of interest, controls and techniques. However, we are only interested in the variables that explain the mode of disposal of DM according to the standard of living. Thus, before giving a statistical description of these variables, we will first present them.

The dependent variable of our study is a dichotomous variable. It concerns the standard of living of households which contains the modalities:

$$\begin{cases} Y_i = 1 & Household\ not\ poor \\ Y_i = 0 & sinon \end{cases}$$

With regard to the explanatory variables in the model that can assess the effect of standard of living on the choice of a DM disposal mode, those that can best explain the choice of the DSU management mode are.

Table 2: Description and statistics of selected variables

Name of the variable	Description of the variable	Terms and conditions	Proportions
	Explained variable		
NIVIE	Household standard of living	0= poor	22.05%
		1= not poor	77.95%
	Variables of interest		
MDH (Household Solid Waste)	Method of disposal of household waste	1= truck/trash bin pickup	34.94%
		2= unauthorized dumping	49.31%
		3= buried/ burned	6.51%
		4= recycled	9.24%
MWD (Liquid household waste)	Sewage disposal method	1= Poured into the yard/floor	22.99%
		2= poured into the septic tank	6.45%
		3= Spilled into the wild	38.12%
		4= Poured into the gutter	29.77%
		5= Poured into the river/stream	1.49%
		6= Other	1.17%
	Technical variables		
INCOME	Household income status	1= approximately stable	40.01%
		2= stable	9.79%
		3= very unstable	50.20%
TYPELOGE	Type of accommodation	1= Isolated house	47.06%
		2= Multi-unit house	32.30%
		3= Modern villa/duplex/apartment building	4.10%
		4= Concession/Sare/cabin/hut	16.54%
USEBACS	Does at least one member of your household use a garbage bin	0= no	25.13%
		1= yes	74.87%
COURSDEAUX	Is there an undeveloped watercourse in the vicinity of the dwelling (within 100m)	0= no	62.85%
		1= yes	37.15%
	Control variables		
LEVEL	Level of education of the head of the household	1= No level	20.45%
		2= Primary level	32.47%
		3= Secondary level	36.56%
		4= Upper level	10.53%

Source: Authors based on STATA 14 data

Table 2 shows that 77.95% of heads of households in Cameroon are non-poor; and 79.55% of them have at least one degree. Table 2 also indicates that 49.31% of the heads of households dispose of their MSW in the wild, which is an uncontrolled dumping ground; and 38.12% of them also dispose of their MSW in the wild. Only 50.20% of the heads of households have a very unstable income situation, and 16.54% live in precarious housing. Most heads of households (74.87% of our sample) say that they have at least one member of their household who uses a garbage bin to dispose of their MSW; and 62.85% say that they do not have an undeveloped watercourse in the vicinity of their dwelling (within 100m).

2.2. Model specification

In order to analyse the disposal patterns of household waste according to the standard of living of households, this study uses the model of Sotamenou & al, (2008). Sotamenou & al, (2008) aimed to 11 determine whether urban horticulture in sub-Saharan cities can encourage farmers to use compost. They use a logistic model that is specified as follows:

Estimation technique
The household standard of living question is posed as a dichotomous choice between being non-poor or poor by households, so it is a qualitative choice model (Amemiya & Nold, 1975). The logistic model was used here to measure the effects of the explanatory (dependent) variables on the probability that an individual will choose a mode of evacuation according to his or her standard of living in Cameroon. Moreover, we use the logistic model for its relative simplicity in the mathematical manipulations and its asymptotic characteristics.

The logistic model can be specified as follows:

$$Y = \frac{1}{1+e^{-X\beta}} \quad [1]$$

Where Y= is the dependent variable standard of living of the head of household, its interval is [0,1] (Yes=1 and No=0)

$$\Pr(y_i = 1) = \frac{1}{1+e^{-X\beta}} \quad [2]$$

$$\Pr(Non) = 1 - P_i(y_i = 1) \Rightarrow P_i(y_i = 0) = 1 - P_i(y_i = 1) \quad [3]$$

$$P_i(y_i = 0) = \frac{1}{1+e^{\beta X}} \quad [4]$$

So he comes:

$$\ln\left[\frac{P_i(y_i = 1)}{1 - P_i(y_i = 1)}\right] = \beta X \quad [5]$$

$$TRI_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ...\beta_k X_{ki} + \varepsilon_i \quad [6]$$

Where
β_0= is the constant term
β_1, β_2… β_k= are the parameters associated with the explanatory variables

ε_i = are the error term and $\varepsilon_i : N(0, \sigma_\varepsilon^2)$
X_1, X_2… X_i= are the explanatory variables of the standard of living.
In the end, we obtain the model:

$$Y_i = \beta_0 + \beta_1 DMS + \beta_2 DML + \beta_3 TYPLOGE + \beta_4 REVENU + \beta_5 USEBACS + \beta_6 COURSDEAUX + \beta_7 NIVEAU + \varepsilon_i \quad [7]$$

i= 1, 2, 3…N

Several methods can be used to estimate the parameters of the model thus formalised. These are the Berkson method, the Chi-square minimum method and the Maximum Likelihood

method, which we will use.

The parameter vector β is found by maximizing its logarithm or the likelihood function given by:

$$L(\beta) = \prod_{y=1} \frac{\exp(\beta Z)}{1+\exp(\beta Z)} \prod_{y=0} \frac{1}{1+\exp(\beta Z)}$$

l'estimateur β' (estimé) du maximum de vraisemblance vérifie le système d'équations de vraisemblance donné par : $\left\{\frac{\partial L(\beta)}{\partial \beta}\right\}_{\beta=\beta'} = 0$

The classical methods of numerical solution of the likelihood equations are all based on the Newton method. Its application leads to the Newton-Raphson algorithm which we will use and which provides a solution to the system of likelihood equations in an iterative way.

The numerical values of the Logit coefficients have no direct interpretation, which is why economists are interested in the signs of the relevant variables and the proportional reactions of the explained variable following proportional changes in the level of the explanatory variables, i.e. the elasticities. Since the endogenous variable in our case is a probability, the calculation of marginal effects allows us to assess the impact of the explanatory variables on the probability of adoption. The marginal effects are calculated from the formula [p(1-p) β i], P being the probability for a household to choose a mode of disposal of its DM according to its standard of living.

3. Results and discussion

This section presents the results of the descriptive statistics, the chi-square test and the estimates.

3.1. Descriptive statistics and chi-square test results

This section presents the results of the descriptive statistics for our study.

Table 3: Descriptive statistics and chi-square test

	VARIABLES	Poor	Not poor	Chi-Square
MDH	Truck/trash bin pickup	1.82%	33.13%	Pearson chi2(3) = 932.6087***
	Unauthorized dumping	14.83%	34.48%	
	Buried/ burned	2.06%	4.46%	Pr = 0.000
	Recycled	3.35%	5.89%	
MWD	Poured into the yard/floor	5.70%	17.30%	Pearson chi2(5) = 729.9797***
	poured into the septic tank	0.38%	6.08%	
	Spilled into the wild	12.87%	25.25%	
	Poured into the gutter	2.77%	27.00%	Pr = 0.000

	Poured into the river/stream	0.22%	1.26%	
	Other	0.12%	1.06%	
INCOME	approximately stable	7.24%	32.77%	Pearson chi2(2) = 252.6121***
	Stable	0.81%	8.99%	
	very unstable	14.01%	36.19%	Pr = 0.000
TYPELOGE	Isolated house	9.59%	37.47%	Pearson chi2(3) = 1.0e+03***
	Multi-unit house	4.14%	28.16%	
	Modern villa/duplex/apartment building	0.13%	3.97%	Pr = 0.000
	Concession/Sare/cabin /hut	8.19%	8.35%	
USEBACS	No	6.05%	19.08%	Pearson chi2(1) = 8.1398***
	Yes	16.01%	58.87%	Pr = 0.004
COURSDE AUX	No	14.03%	48.81%	Pearson chi2(1) = 0.7961
	Yes	8.02%	29.14%	Pr = 0.372
NIVEAU	1= No level	9.41%	11.04%	Pearson chi2(3) = 1.3e+03***
	2= Primary level	8.57%	23.90%	
	3= Secondary level	3.90%	32.65%	
	4= Upper level	0.17%	10.37%	Pr = 0.000
	Comments	2272 22.05%	8031 77.95%	

Source: Authors based on STATA 14 data.

Table 3 shows that only 1.82% of the heads of households who dispose of their MDH in a bin or wait for the collection trucks to pass are poor; they dispose of their MSW much more in unauthorized dumps (14.83%). This same table also shows that the heads of non-poor households are undecided as regards their modes of disposal of MSW; in fact, 33.13% dispose of their MSW in bins and 34.48% in an uncontrolled dump. The chi-square test provides us with additional information; indeed, we notice that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) which stipulates the absence of a link between the variables; we can therefore come to the conclusion that the standard of living and the MDH disposal methods are dependent. There is therefore a presumption of an influence of the standard of living of households on the modes of disposal of MDS in Cameroon.

The same table shows that 12.87% of the heads of households who evacuate their MWD in nature are poor; for the non-poor households 25.25% of them also evacuate their wastewater in nature and 27.00% in gullies. The chi-square test provides additional information; indeed, we note that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) that stipulates the absence of a link between the variables; we can therefore reach the conclusion that the standard of living and the modes of disposal of the wastewater are dependent. There is therefore a presumption of an influence of the standard of living of households on the modes of disposal of MWD in Cameroon.

Similarly, it shows that 14.01% of the heads of households with a very unstable income situation are poor; similarly, 26.19% of the heads of non-poor households also have a very unstable income situation. The chi-square test provides us with additional information; indeed, we note that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) that stipulates the absence of a link between the variables; we can therefore reach the conclusion that the standard of living and the income situation of households are dependent. There is therefore a presumption of an influence of the standard of living of households on the income situation of households in Cameroon.

We also note that almost no poor households live in modern villas or duplexes (0.13%) and that nonpoor households clearly prefer to live in isolated houses or multi-unit houses, i.e. 37.47% and 28.16% respectively. The chi-square test provides us with additional information; indeed, we notice that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) which stipulates the absence of a link between the variables; we can therefore reach the conclusion that the standard of living and the type of housing of the heads of households are dependent. There is therefore 14 a presumption of an influence of the standard of living of households on the type of housing of heads of households in Cameroon.

We also note that more than half of the heads of households considered as non-poor say that they have at least one member who uses a garbage bin, i.e. 58.87%; only 16.01% of the heads of households considered as poor also say that they have a member of the household who uses a garbage bin. The chisquare test provides us with additional information; indeed, we note that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) which stipulates the absence of a link between the variables; we can therefore reach the conclusion that the standard of living and the fact of having at least one member of the household who uses a refuse bin are dependent. There is therefore a presumption of an influence of the standard of living of households on the fact that a head of household has at least one member of his household who uses a refuse bin in Cameroon.

Moreover, this table shows that 48.81% of the heads of households who say they do not have an undeveloped watercourse in the vicinity of their dwelling are non-poor and 14.03% are poor. The chisquare test provides us with additional information; indeed, we notice that the Pvalue is not significant (Pr= 0.372), which leads to the acceptance of the null hypothesis (H 0) that stipulates the absence of a link between the variables; we can therefore reach the conclusion that the fact of having an undeveloped or undeveloped watercourse close to the dwelling and the standard of living of the head of household are independent. There is therefore a presumption of a lack of influence of the standard of living on the fact of having or not having an undeveloped watercourse near the dwelling in Cameroon.

Finally, Table 3 shows that 9.41% of the heads of households without level are poor and 11.04 are non-poor. The chi-square test provides us with additional information; indeed, we note that the Pvalues are significant at 1% (Pr= 0.000), which leads to the rejection of the null hypothesis (H 0) which stipulates the absence of a link between the variables; we can therefore reach the conclusion that the standard of living and the level of education of the head of household are dependent. There is therefore a presumption of an influence of the standard of living of households on the level of education of the head of household in Cameroon.

3.2. Results of the estimates

The following table presents the results of the estimations by the Logit model

Table 4: Result of the estimation of the Logit model

	VARIABLES	Coef/ Std. Err.
MDH	uncontrolled landfill	-1.272***
		(0.0907)
	buried/ burned	-1.513***
		(0.125)
	Recycled	-1.697***
		(0.111)
MWD	Poured into the river/stream	-0.0886
		(0.420)
	Poured into the gutter	-0.0853
		(0.343)
	Poured into the wild	-0.755**
	(0.339)	
	Poured into the septic tank	
	0.132	
	(0.376)	
	Poured into the yard/floor	-0.672**
	(0.340)	
INCOME	highly volatile	-0.398***
	(0.0575)	
	Stable	0.421***
	(0.133)	
TYPELOGE	Multi-unit house	0.264***
	(0.0686)	
	Modern villa/duplex/apartment building	0.969***
	(0.292)	
	Concession/Sare/cabin/hut	-0.851***
	(0.0678)	
USEBACS		-0.186***
		(0.0621)
COURSDEAUX		-0.122**
		(0.0573)
NIVEAU	Upper level	2.832***
		(0.252)
	Secondary level	1.338***
		(0.0748)
	Primary level	0.610***
		(0.0648)
	Constant	2.604***
		(0.361)
	Comments	10,303

Note: Dependent variable= household standard of living,
*Log likelihood = -4187.292, Wald chi2 (18) = 1596.77, Prob > chi2= 0.0000, Pseudo R2= 0.2296. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1*

Since the numerical value of the coefficients of the Logit model cannot be interpreted directly, the impact of the variables on the probability of disposing of DM as a function of the standard of living is assessed by calculating the marginal effects and elasticities. Thus, it seems appropriate to calculate them before interpreting the results.

Table 5: Calculation of marginal effects and elasticities in the simple logit model

VARIABLES		dy/dx	ey/ex	X
MDH	Unauthorized dumping	-0.1524964***	-0.0848092***	0.49306
	Buried/ burned	-0.2673653***	-0.0133242***	0.065127
	Recycled	-0.3039482***	-0.0212064***	0.0924
MWD	Poured into the river/stream	-0.0106922	-0.000178	0.01485
	Poured into the gutter	-0.0101028	-0.003434	0.29768
	Poured into the wild	-0.0947406**	-0.0389331**	0.381248
	poured into the septic tank	0.0147632	0.0011491	0.064544
	Poured into the yard/floor	-0.0896288*	-0.0208839**	0.229933
INCOME	highly volatile	-0.0466458***	-0.0270398***	0.50199
	Stable	0.0435277***	0.0055802***	0.097933
TYPELOGE	Multi-unit house	0.0298591***	0.011532***	0.323013
	Modern villa/duplex/apartment building	0.0817973***	0.0053682***	0.040959
	Concession/Sare/cabin/hut	-0.1217905***	-0.0190366***	0.165389
USEBACS		-0.0210256***	-0.0188243***	0.748714
COURSDEAUX		-0.0141573**	-0.0104056**	0.628458
LEVEL	Upper level	0.161791***	0.0403358***	0.105309
	Secondary level	0.1404949***	0.0661414***	0.365525
	Primary level	0.0662339***	0.0267744***	0.324663

Source: Authors based on STATA 14 data.

Validity of the model

The estimated model is globally significant at 1%. In fact, the limiting probability associated with this estimate is less than 1% (Prob Chi2= 0.0000). Moreover, the regression of the model is largely good since the statistic obtained for the Wald is much higher than the value of the theoretical chi-square (1596.77 to 34.81), the R^2 of Mc Fadden (0.2296) is quite satisfactory, especially since and the percentage of good prediction of the model is 81% (see Appendix 4). This percentage indicates that in 81% of cases, this model correctly predicts the behaviour of the head of the household.

The student's T-statistic and the Prob (z) present the variables that have a significant influence in the model. Specifically, these are: the mode of disposal of household waste, the mode of disposal of sewage, the income situation of the head of household, the type of housing of the head of household, at least one member of the household uses a garbage bin, are there undeveloped watercourses near the dwelling, the level of education of the head of household. While the others are not significant.

Interpretation of results

Mode of disposal of household waste (MDH): We observe that the disposal of household waste is strongly dependent on the standard of living of households. In fact, compared to the use of a garbage bin, the use of informal dumping, recycling and burning of MSW by non-poor households is negative and significant at 1%. The marginal effect shows that if the percentage of waste disposal, recycling and burning increases, then the probability of a household being non-poor decreases by 15%, 30% and 26% respectively. We can therefore conclude that as the standard of living of the head of household increases, so does the probability of choosing a garbage bin or waiting for collection trucks or collection agents at the source. This is similar to the work of Parrot & al.,(2008) which shows that the lack of infrastructure has a major impact on waste collection. Therefore, it is recommended to increase the number of bins near households. In addition, recycling should be encouraged in order to reduce the amount of pure waste and promote ecological intensification of agriculture in Yaoundé.

Mode of wastewater disposal (MWD): It is observed that the disposal of MWD according to the standard of living of households is mixed. Indeed, compared to the use of other mode of sewage disposal, the use of nature and yard or pavement by the non-poor household is negative and significant at 5%. The marginal effect gives us the additional information that if the use of nature and yard by a household increases then the probability of that household being non-poor decreases by 9%. In view of this, we can conclude that the higher the standard of living of the head of household, the lower the probability of disposing of household waste in a yard or in nature. This is closely in line with the work of WENGAWITHA & Godé, (2018) which finds that the majority of the population accepts the abandonment of their household waste in the streets, rivers and gutters in search of a good waste management system, this probably because of the improvement of their standard of living. Koné-Bodou Possilétya & al., (2019) The study also shows that the main places of wastewater disposal in Anyama in Côte d'Ivoire are the streets, gutters, ravines and backyards of houses.

Income situation (INCOME): We observe that the "very unstable" and "stable" modalities in relation to heads of household who have a more or less stable income situation, have a significant impact at 1% 18 and respectively a negative and positive impact on the standard of living of the head of household. Indeed, the probability for a household to have a very stable income decreases by 5% and increases by 4% when the standard of living of the head of household increases. This can be explained by the fact that the more your standard of living increases, the more your income level stabilizes. The results found by Ngambi (2015) is close to the one if. Indeed, the Ngambi (2015) shows that household income has a significant impact on the use of refuse bins; it also shows that the income of the inhabitants, whatever their place of residence, makes it possible to appreciate the standard of living of the households.

Type of housing (TYPELOGE): The modalities "Multi-dwelling house", "Modern villa/duplex/apartment building" and "Concession/Sare/cabin/hut" in relation to the head of household who lives in isolated houses influence both positively (0.264 and 0.969) and negatively (-0.851) the standard of living of households. This influence is significant at the 1% level; in fact, the probability of a head of household living in decent housing increases by 3% and 8% respectively when the standard of living increases, and that of precarious housing decreases by 12%. This result is similar to the work of Parrot & al (2009) This result is similar

to the work of the authors of the report on the importance of the type of housing on the quality and quantity of waste produced. Diawara (2009) also shows that globally the populations with a high standard of living, residing in apartment buildings or in the high standing villas of the primitive core, condition their waste in bags or dustbins while waiting for the passage of the dump trucks of collection. The work of(Yao-Kouassi, Gohourou, & Guillaume, 2017) also show that the type of housing is a function of the standard of living of the head of the household: for them, the absence of a waste collection agency is similar to that of spontaneous housing[1];

At least one member of the household uses a garbage bin (USEBACS) and is there an undeveloped watercourse near the dwelling (COURSDEAUX): These two variables have a significant and negative influence on the household standard of living at the 1% and 5% levels respectively. In fact, the probability that at least one member of a household uses a rubbish bin decreases by 2% when the standard of living increases and that of the presence of an undeveloped watercourse near the dwelling also decreases by 1% when the standard of living of the household increases. Indeed, the presence of an undeveloped watercourse will facilitate the poor disposal of household waste.

Level of education (LEVEL): It is observed that compared to heads of households "without level", the education of the head of household affects positively and significantly at 1% the standard of living of the household. Indeed, the more the probability of being educated increases when the standard of living increases. This is close to the results found by de Koné-Bodou Possilétya & al., (2019) in Abidjan-Côte d'Ivoire shows that the level of education of the head of the household is a significant and expressive factor of the living environment of the households, in fact most of the heads who have no education live in the precarious districts of Derrière-Rails and Michelbougou, on the other hand those who have a university education live in the high standard residential and medium standard districts.

4. Conclusion and policy recommendations

The objective of this study was to analyze the modes of household waste disposal according to the standard of living of households in Cameroon. The data used came from the fourth Cameroonian Household Survey. On the one hand, through statistical analysis, we were able to cross-reference thestandard of living of households with a series of variables including variables of interest, technical variables and control variables, which allowed us to have the mixed effects of these variables on the standard of living of households in Cameroon. On the other hand, since statistical analysis does not always allow us to describe the causality between variables, we conducted an econometric analysis using a simple logistic model. The latter enabled us to analyse the modes of DM disposal according to the standard of living of households. It emerges from this study that the modes of evacuation of DM, whether liquid or solid, are strongly linked to the standard of living of the households. Indeed, the use of an

[1] Quonan Christian YAO-KOUASSI & al., (2019) subdivisent les communes de Cocody et Yopougon (district d'Abidjan, Cote d'Ivoire) en trois grandes zones selon l'habitat : habitat spontané (niveau de vie faible), habitat économique (niveau de vie moyen) et habitat résidentiel (niveau de vie élevé).

adequate mode of evacuation of MSW (garbage bin), and the non-use of streets, gutters and rivers (for the evacuation of MSW) is a function of the high standard of living of the head of the household This study also shows that improving the housing typology of the heads of households, the level of education and the income level situation would increase the standard of living of households and de facto facilitate an adequate disposal of MSW in Cameroon.

According to these results, it is recommended to the decentralized territorial authorities, within the framework of the decentralization process initiated in Cameroon, to improve the living environment of the inhabitants of their districts, to reduce the distances between the collection infrastructure and the homes. This study also recommends the development of watercourses close to dwellings to avoid households having to evacuate their waste in the interior, to popularise the problems linked to the poor evacuation of waste at school level and to improve access routes to housing.

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