FACTORS DETERMINING EFFECTIVE HOUSEHOLD SOLID WASTE MANAGEMENT IN ARBA MINCH TOWN: SOUTH WESTERN ETHIOPIA

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Author's Note

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Article Info	Abstract
Accepted on May ,2018 Received in revised from:June,2018 Published on online : August, 2018 ©**Arba Minch University, all**	*Increasing generation of domestic solid waste coupled with ineffective waste management service is the major challenge facing Arba Minch town. The main objective of this study is to examine the factors that determine effective household solid waste management by assessing the current status of household solid waste management practice of the town. A simple random sampling technique was applied for sample size selection of 137 households. The primary data were gathered through questionnaires, interviews, observation, and focus group discussion; whereas secondary data were extracted from different*

published and unpublished materials. The analysis of this study was carried out using both quantitative and qualitative techniques. The findings of the study revealed absence of functional communal waste storage materials, shortage of solid waste transportation vehicles, widespread practice of unauthorized dumping and burning, restriction of the door-to-door waste collection service mainly to the center of the town and the areas close to the main roads. The finding also disclosed that the householder's age, sex, education, income, awareness, willingness to pay, year of stay, household size, and location of the house are the major determining factors of solid waste management at household level. Moreover, institutional factors such as solid waste facilities and equipment, finance, work force, rules and regulations, and accessibility to the private collectors determine the effectiveness of solid waste management among sample households of this study. Generally, household solid waste management of the town is poor and timely measures must be taken.

Keywords: Solid Waste, Waste Management, Household Waste, Arba Minch Town

Introduction

Municipal solid waste generation is an issue of worldwide concern. Rapid growth of population, fast economic development, and rise in community living standards have accelerated the generation rate of municipal solid waste causing its management to be a major worldwide challenge (Seo, et al., 2004). The generators of municipal solid waste are broadly classified as residential, industrial, commercial, institutional, construction and demolition, municipal and agricultural types (Sehker & Beukering, 1998).

Dealing with the environmental costs in rapidly growing economies, urbanization and improving living standards in the cities and towns have led to an increase in the quantity and complexity of generated waste, representing a phenomenal challenge (UNDP, 2004). This is particularly true in the area of solid waste management.

Solid waste management (SWM) is one of the critical concerns facing the developing countries because of the social, economic, and environmental implications once not properly managed. Studies show that only 30-50% of the waste generated in developing countries is collected and managed properly (Dawit & Alebel, 2003). The rest is either burned or left to decompose in open spaces or dumped in unregulated landfills. This is detrimental to the environment. Mungure (2008) indicated that between 0.7 and 1.8 kg

of waste is produced every day in developed countries' urban areas and approximately 0.4 to 0.9 kg of waste is produced in the cities and towns of developing countries per day. Moreover, in recent decades the rapid growth of economic activities and population in the developing countries has caused an increased consumption of natural resources that has led to more waste generation in some areas. This in turn led to unacceptable waste disposal that became a challenge in Africa and other developing countries.

In urban centers of Africa less than half of the solid waste produced is collected and 95% of that amount is either indiscriminately thrown away at various dumping sites on the peripheries of urban areas or at a number of the so-called temporary sites, typically empty lots scattered throughout the cities and towns (Mohammed, 2003). While cities are generating an ever increasing volume of waste, the effectiveness of their solid waste collection and disposal systems are declining. The insufficient handling of solid waste is the cause of land, water and air pollution affecting the urban environment and the health of the people living in the cities and is one of the most critical environmental problems that cities and towns in the continent are facing today. The current capacity of most solid waste management systems in Africa is inadequate and too slow to meet the increasing demand of the solid waste generated (Bjerkli, 2005).

In Ethiopia, like other developing countries, the increase of solid waste generation resulted from rapid urbanization and rapid population growth. In large number of cities and towns of Ethiopia, solid waste management services are either absent or insufficient (UPSBB, 2012). For instance, the collection services are often inefficient and do not cover all areas. In general, the unauthorized and most of the authorized dumping sites are poorly managed causing significant environmental impacts. According to Dawit and Alebel (2003), the amount of solid waste in Addis Ababa and other rapidly growing towns in the country has been increasing overtime.

Arba Minch, being one of the fast growing towns of the country, has ever-increasing solid waste management problems. As per the study by ROSA (2007), the composition, quantity and the amount of the waste generated is alarmingly increasing from time to time mainly due to the fast growth of population and rapid urbanization. This condition is posing a grave challenge on the solid waste management system of the town.

The absence of proper household solid waste management (SWM) is a serious problem in Arba Minch town. Although the town is one of the most significant tourist destination sites of Ethiopia, its natural beauty has not been accompanied by effective solid waste management practice in a standard that it deserves. Despite the Pollution Control Proclamation (2002) which states that all urban

administrations of Ethiopia shall ensure the collection, transportation, recycling, treatment or safe disposal of municipal waste through the institution of an integrated municipal waste management system, it is common to find a heap of solid wastes in places that the law prohibits in Arba Minch town.

As it is evident in other large cities and towns of the country, most of the residents in Arba Minch town dump household solid waste along the roadsides, drainage tunnels, river banks, public places, gorges, backyards of their compound, etc. In addition to that, unauthorized burning of household solid waste is widely practiced in the town. This illegal disposal and dumping of solid waste has become the root cause of environmental, aesthetic and health problems in the town.

In Arba Minch town, the municipal solid waste management practice in general and the household (domestic) solid waste management in particular has so far got little attention from both the local government and other concerned private stakeholders. Therefore, currently the issue of solid waste management has become a source of an actual and potential health and environmental risk in the town. The municipality of Arba Minch town has faced a problem in finding a location for disposing the solid waste (ROSA, 2007). This situation implies that unless immediate and timely intervention was

made by all the concerned stakeholders, the solid waste management related issue of the town will change from bad to worse.

One of the basic things for successful management of municipal solid waste is obtaining reliable information about the existing scenario of solid waste management practice on the ground and identifying the major social, demographic, economic, and institutional factors that determine its effectiveness. Hence, the objective of this is to examine the factors that determine effective household solid waste management in Arba Minch town. More specifically, the study investigates the status of household solid waste management practice, examines demographic, socio-economic, and institutional factors that determine effective household solid waste management, and assesses the condition of solid waste collection service provided by the Micro and Small Enterprises (MSEs) in the town.

Methodology

Description of the Study Area

Arba Minch town is located in the Southern Nations, Nationalities and Peoples Region at about 435 km southwest of Addis Ababa. Arba Minch town is bordered on the east by Lake Abaya and Lake Chamo, which lie on the plain of the rift valley. The area of the

town administered by the municipality extends up to 21.86km^2 of which 10.67km^2 is inhabited by people. The geographical location of the town extends from 50 58'26"N to 6 03'22"N and 37 032'13"E to 37 036'20"E.

Data Collection and Analysis

In this study, both primary and secondary data were used. Instruments used to collect primary data were household survey, interview, field observation, and focus group discussion, while secondary data that were pertinent to the study were gathered from books, journals, and records from governmental and non-governmental institutions. 137 sample households were selected to administer open and close-ended questionnaire. The questionnaire was used to obtain in-depth household information on the existing SWM practice at household level, the attitude of households on solid waste and its collection service, demographic and socio-economic background of the householders, the solid waste collection service delivered by the MSEs and the municipality.

Semi-structured interview was designed in order to obtain relevant data from the staff of the sanitation and beautification unit of the municipality which is formally known as Urban Sanitation, Beautification, and Green Area Development Main Work Process. The interview was used to explore information on the existence and

enforcement of solid waste related rules and regulations, solid waste storage and transportation facilities, budgetary allocation, human and technical factors, and the status of household SWM in the town.

As far as the data from the MSEs were concerned, two focus group discussions were carried out with the private solid waste collectors. Each focus group discussion involved ten individuals. The discussions focused on the establishment and operation of the MSEs, challenges of the MSEs, and attitudes of the households towards the private solid waste collectors.

In addition to descriptive and Chi-square statistics the binary logit (logistic) model was used in order to compute the regression of the dichotomous dependent variable of effective and ineffective solid waste management as a function of multiple independent variables (age, sex, family size, income, education, willingness to pay, and awareness of the householders). As it was indicated in Green (2003) and Gujarati (2006), both logit and probit models are widely applied to analyze the dependent variables which have a binary outcome. However, Green (2003) argues that even though both models resulted in similar outcomes, the logit model is preferable due to its simplicity in estimation.

Specification of Logit Model: Based on the guiding principle of the logit model in Green (2003) and Gujarati (2006), the specification of the model was presented as follows:

1) $P(Y_{1=1}) = \dfrac{1}{1+e^{-(\beta ix_i)}}$

2) $P(Y_i = 1) = \dfrac{1}{1+e^{-Z_i}}$

Where: $(P= Y_i=1)$ is a probability that a household dispose their solid wastes legally.

Z_i is the function of a vector of explanatory variables. *exp* stands for the natural logarithm

While $P(Y_i=1)$ is the probability of choosing to dispose legally, $1-P(Y_i=1)$ represents the probability that the households choose to dispose illegally, and it can be expressed as:

3) $1 - P(Y_i = 1) = 1 - \dfrac{1}{1+exp^{-Z_i}} = \dfrac{1}{1+exp^{Z_i}}$

4) $\dfrac{P(Y_i = 1)}{1-P(Y_i=1)} = \dfrac{1+exp^{Z_i}}{1+exp^{-Z_i}} = exp^{Z_i}$

Equation (4) is the odds ratio in favor of managing the solid waste effectively i.e. the ratio of the probability that a household will dispose the solid waste legally to the probability that it will dispose illegally. Taking natural log of equation (4), it is possible to obtain:

5) $Li = ln\left(\dfrac{P(Y_i=1)}{1-P(Y_i=1)}\right) = Z_i$

Where: Zi is the log of the odds ratio which is not only linear in the explanatory variables but in the parameters also. Thus, introducing the stochastic error term (u_i), the logit model can be written as:

6) $Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \ldots \beta_n X_n + u_i$

Where, X 's are explanatory variables that determine solid waste disposal system at a household level, β_0 is the constant term and ''s are coefficients to be estimated.

Operational Definition of Variables

Dependent variable (Effectiveness). The municipality of the study area classified the residents of the town into two categories with respect to their practice of solid waste management. The households which transfer their solid waste to the private solid waste collectors were regarded as legal disposers. On the other hand, the households which dispose at the place they find, burn, or bury were regarded as illegal disposers. Hence, for this study the operational definition of effective solid waste management by households is delivering their solid waste to the MSEs, whereas the households that do not handover their solid waste to the private collectors are regarded ineffective solid waste managers.

Independent variables. The following are the independent variables assessed in this study.

a) **Age**: It is generally expected that the effective management of solid waste at household level decreases as the age of the householder advances

b) **Sex**: In the context of developing countries, it is expected that women can more effectively manage the solid waste of their household than men.

c) **Income**: It is hypothesized in this study that income had a positive effect to proper solid waste disposal practice.

d) **Years of stay**: It is expected to have a positive relationship between the number of years that the households live and solid waste management.

e) **Family size**: The number of household members is expected to have a negative effect on solid waste management, and the larger the family the higher the chances of ineffective management.

f) **Education**: Educational background of the householder has a positive impact on proper solid waste management at household level.

g) **Distance from the main road**: in this study, it is hypothesized as the distance of the house from the main road increases, the possibility of illegal disposal practice increases.

h) **Willingness to pay**: It is expected that willingness to pay for solid waste collection service has a positive influence on household solid waste management.

i) **Awareness**: As the awareness level of the households enhances regarding solid waste management, the chance of effective management practice also increases.

j) **Access to private waste collectors**: accessibility to the collectors has a positive effect on the effectiveness of solid waste management.

Results and Discussions

Characteristics of Household Solid Waste

Through observation, attempts were made to identify the items that predominantly constitute the household solid wastes of Arba Minch town. The data from observation indicate that household solid waste items such as ash, grasses and leaves, paper and cardboards, plastic products, and food wastes constitute the largest proportion at least in volume. Then sample households were asked to rank the aforementioned solid wastes on the basis of the proportion of generation from the highest to the lowest. The response from the households was not different from the data that had been gathered through observation.

As the questionnaire data collected from the households indicate, paper and cardboards, food wastes, and miscellaneous solid wastes got 8.8%, 5.4% and 0.5% of the respondents' reply respectively. This finding is in line with G/Tsadkan (2002) whose study on domestic solid waste management in Mekele town has concluded that ash, grasses and leaves, food items, plastic and rubber,

papers, glasses and metals are the largest proportion of the domestic solid wastes at least in volume.

Household Solid Waste Storage Materials

These solid waste storage facilities can be classified into two on the basis of their purpose: primary (individual) solid waste storage materials and secondary (communal) solid waste storage materials. In the questionnaire, due attention was paid to investigate the condition and availability of solid waste storage materials that were being used at household and community level.

Primary solid waste storage materials. Before investigating the types of primary (temporary) solid waste storage materials, observation was done to identify whether the sample households possessed these materials or not. About 33.6% of the households have no temporary storage materials. It has been identified that the households have a variety of reasons for not using the primary storage materials. These households resorted to dump the waste they generated into refuse pits or burn it in their compound instead of using the primary storage materials. The others revealed that they throw the solid wastes into ditches, the nearby gorges or any open space outside their compound. On the other hand, 66.4% of the households possess temporary solid waste storage materials such as sacks, baskets, plastic bags, etc.

As it is indicated above, the majorities (66.4%) out of the total households have temporary solid waste storage materials and the rest (33.6%) of the households do not use any type of primary solid waste facilities. Then the households which have temporary containers were asked what type of primary storage materials they use, and the result is revealed that out of 91 households, who had primary storage materials, 19.8% of the respondents used baskets, 64.8% of the respondents had sacks, and the rest 11% and 4.4% households used plastic bags and other types of temporary solid waste storage materials respectively. This finding shows that most of the households i.e. 64.8% of them used polythene sacks that are locally referred as *madaberia*.

This finding from sample households is also in line with the observation data. During the observation, it was identified that the residents were mainly using old polythene sacks, traditional or relatively modern plastic baskets, plastic bags, etc. The households who get the solid waste collectors' service fill the temporary storage materials with the waste they generated and put it at the gate of the house to be picked by the collectors. It was also observed that the households usually stored the solid waste in open primary storage materials which do not meet hygienic standards. Furthermore, this finding is in harmony with that of Solomon (2006) whose study on household solid waste management in Arada sub-city disclosed that

the majority of residents in the study area use sacks as primary solid waste storage materials.

Secondary solid waste storage materials. Regarding the secondary storage materials, sample households were asked whether there are community solid waste containers available in their residential area. From the sample households, 87.6% of the respondents replied that there are no community containers in their area; the remaining 12.4 % confirmed the existence of community containers in their residential area. Then sample households, who responded the existence of the community containers (secondary storage materials), were asked whether they use it to dispose their household solid waste. However, all of the respondents replied that they currently never use it for solid waste disposal.

Furthermore**, t**he households were asked to reflect on whether there is a problem in sitting (placing) of communal solid waste storage containers and all of the respondents unanimously replied 'yes there is a problem'. The response specified by the sample households regarding the community containers supported the findings the researcher identified through observation. All secondary storage facilities in the town were never in use, not uniformly distributed, and are poorly managed.

Household Solid Waste Disposal Options

As it is indicated earlier, a significant number of sample households did not possess and use primary solid waste containers. Moreover, there are only ten second
ary solid waste storage containers in the town which are currently not functional. This led the researcher to enquire about what other options have been used to dispose the solid waste generated from each household. Then the sample households were asked what other alternatives they use to dispose the solid waste of their house.
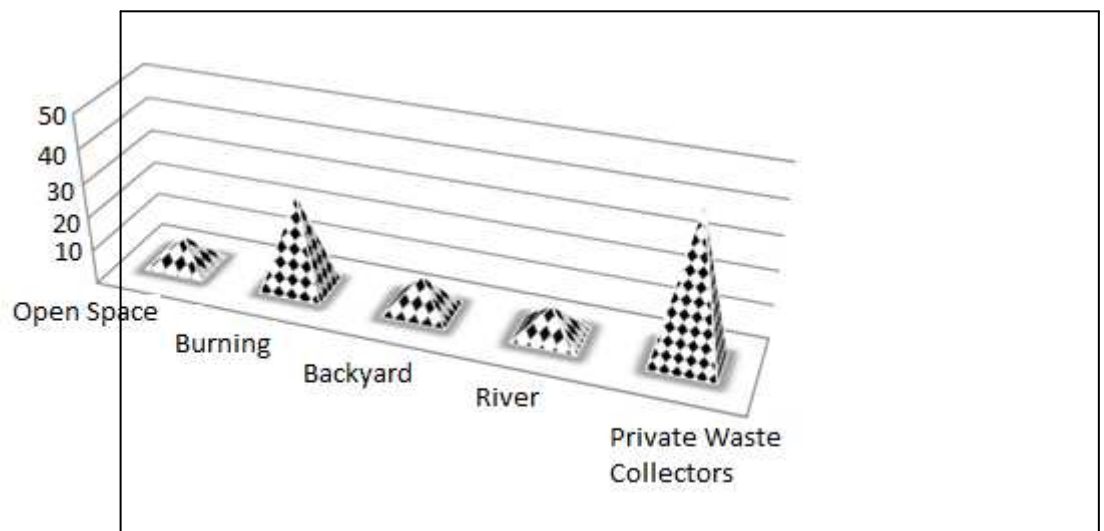

*Figure 1.*Household solid waste disposal options
Source: Field data, Arba Minch, 2016

As it is revealed in Figure 1, out of the total sample households 55.5% of the respondents dispose the solid waste generated from their house either in the backyards of their houses, dump it in the open space they

find, throw it into the nearby rivers and gullies or burn it up in their compound. However, 44.5% of the sample households hand over the solid waste they generated to the private waste collectors paying fee for the provision of the service.

The Service Delivery of the MSEs in Arba Minch Town

It is very difficult to achieve the solid waste management goal only through municipality work plan and activity. Rather it requires an integrated and multidimensional approach from all the concerned parties (stake-holders). One of these stake-holders is the MSEs which are providing solid waste collection service in the town.

Regarding the availability of private solid waste collectors in the studied kebeles, 26.3% of the respondents replied non-existence of the private solid waste collectors (MSEs) in their residential area. On the contrary, 73.7% of the respondents disclosed the existence of MSEs in their area of residence. On the other hand, from the total sample households of the study, 44.5% of the respondents stated that they were getting the MSE's door-to-door waste collection service. On the other hand, 55.5% of the respondents reflected that they were not the beneficiaries of the waste collection service delivered by the MSEs.

This indicates that, the availability (existence) of private solid waste collectors in certain area is not a guarantee for getting the

service unless the residents are the beneficiaries from it. As the questionnaire and observation data reveal, a significant number of households are not the recipients of solid waste collection service even in some places of the town where the MSEs are highly involved.

The households who are not getting the MSE's service have been asked to disclose what reasons keep them away from the service. Low-income families revealed that they had no financial capacity to pay the monthly fee in return for the service provision of the private waste collectors. Moreover, financially well-to-do sample households are not ready to do so despite having the capacity to pay for the service arguing that they have enough space in their compound either to dispose, burn or burn the solid waste they generate. Those who live near the riverbanks and gullies also argue that paying for waste collection service is wastage of money. They replied that there is enough space to dump solid waste in the nearby gully or river.

Frequency of the door-to-door collection service. One crucial issue in the service delivery of the MSEs is the frequency of the private waste collectors in the specified period. Studied households were asked about the frequency of the private waste collectors visit to their houses to collect the waste generated.

Table 1

Frequency private solid waste collectors

	Frequency
Percent	
Twice in a week	2
3.3	
Once in a week	34
55.7	
Once in two weeks	21
34.4	
Once in three weeks	4
6.6	
Total	61
100	

Source: Field data, 2016

Although majority of the respondents (55.7%) of the studied households get the door-to-door solid waste collection service in line with the schedule of both the municipality and the MSEs, 44.3% of the households are not getting the service on the basis of the schedule. That is why the residents of Arba Minch town are dissatisfied by the service provision of the MSEs. Most of the dissatisfaction of households was in the inconsistency and delay of the MSEs in their collection service. The delay of the MSEs extended for several days

and weeks especially in rainy seasons and public holidays like Christmas, Easter, etc. This makes the households to dump their solid waste anywhere.

Determining Factors of Effective Household Solid Waste Management

The sex of the householder is one of the factors that determine effective household solid waste management. Among studied female-headed households, 70.5% manage their household solid waste effectively. On the other hand, 67.7% of male-headed households manage their household solid waste ineffectively. The chi-square test result also verifies that there is a significant relationship between an effective household solid waste management and the householder's sex ($p < 0.05$).

The other important determinant factor of effective solid waste management is the monthly income of the heads of the households. The survey data disclosed that the monthly income of the studied households extend from 150 - 10,000 ETH Birr per month. Among these, 84.4% of those who have monthly income of less than 500 birr managed household waste inefficiently, while it declined to 57 % for households that have income of 2000 birr and above.

Distance of the residential house from the main road is one determinant factor that exerts its own impact on solid waste management either positively or negatively. Observation and the survey data verify the fact that the more the distance of the house from the main road the less opportunity for the households to manage their solid waste effectively (see Ttable 2). Chi square test also reveals that distance of the house from the main road significantly affects the solid waste management (P<0.05).

Table 2

Effective household solid waste management in different distances from the main road

Variable			Effectiveness	
			Effective	Ineffective
		N		Management
management	$\chi2$		p	
Distance				
<250m		110	50.9%	49.1%
9.21	.002			
≥250m		27	18.5%	81.5%

Source: Survey data, 2016

Households Awareness to Solid Waste Related Information

Even though most of the sample households have no any opportunity to get a formal training, attempt was made to identify whether the studied households had exposure to information regarding household solid waste management. Out of the total studied households, 47% had information about household solid waste management that is obtained from a variety of sources such as public meetings, door-to-door information provided by government health extension workers, media and school education. Based on this, the data indicates that 78% of the respondents had awareness about solid waste management.

Awareness to solid waste management has its influence on willingness to pay for collection service, which is one of the most crucial issues in the process of solid waste management at household level. In this regard, 66.4% of the studied households were willing to pay for the service of solid waste collection. This is promising for the future improvement of the solid waste management of Arba Minch town.

Institutional Factors: Enforcement of Rules and Regulations

According to the data from field observation, the solid waste management activities in the town are not practiced according to the provisions of the by-laws of the municipality in particular and the

rules and regulations of the country in general. Household solid wastes were commonly littered along the roads, thrown in the riverbanks, dumped into sewerage tunnels of the highway and feeder roads of the town. Moreover, not only illegal dumping but also unauthorized burning and burying of solid waste is widely practiced in the town even by the households which have high income and live adjacent to the main roads.

Thus, the level of the enforcement of rules and regulations in the town was carefully investigated. Accordingly, out of the total studied households, 71.5% have no any knowledge of either the existence or the enforcement of the rules and regulations about solid waste management in their residential area. This shows that there is huge disparity between the respondents who have awareness about the availability and enforcement of rules and regulations and those who do not have any knowledge of it.

Solid Waste Storage and Transportation Facilities

Regarding the primary storage facilities, the residents of the town mainly use old sacks, baskets, plastic bags, tin and jerry-cans, etc. These materials were mostly employed by the households which were enlisted to receive the service of solid waste collectors. The

households, which did not get the waste collection service of the MSEs, either throw, burn, or bury solid wastes soon after they generate instead of collecting it in the temporary storage materials. Moreover, no difference was observed in the type and condition of the storage materials in all houses. In other words, the households with low and high income use similar types of old and unsanitary primary storage materials.

In addition to primary (individual) solid waste storage facilities, the presence of secondary (communal) solid waste storage facilities is crucial for proper and effective solid waste management in general and household solid waste management in particular. However, as the findings from the observation indicate the conditions regarding the communal storage materials are extremely alarming. During the observation, only ten communal or public solid waste storage containers were available in the town. They have never been used because there were no trucks purchased to carry them.

Financial Resource

Finance is the most crucial factor for the success of any public sector activity. As the data gathered from the sanitation and beautification unit of Arba Minch town indicates, this sector faced a severe financial challenge to achieve its short and long-term goals with respect to waste management at large and household solid waste

management in particular. A meager allocation of finance from the municipality hindered the sector from implementing the planned sanitation and beautification activities including solid waste management. The annual budget assigned to the sanitation and beautification sector from the municipality was insufficient, even though it increases from year to year.

In order to compensate for the shortage of finance, the sector designed additional income generating strategies such as charging the people who send their animals into green areas and taxing the people who pile up construction materials adjacent to main roads. However, that money is not directly paid to the sector due to financial processes. According to the information gathered from the office, the other big problem in addition to inadequacy of budget is the difficulty to obtain and use the allocated budget for the planned purpose in due time because of very complicated financial bureaucracy.

Human and Technical Factors

Solid waste management in general and household solid waste management in particular requires well-qualified and skillful work force. However, finding such human resource expertise in the field of solid waste management is difficult due to many reasons, especially in the least developed countries like Ethiopia. The interview that was made with the head of sanitation and beautification unit of the

municipality verified the presence of acute work force shortage and lack of technical skill in the field of solid waste management.

Currently the office of sanitation and beautification sector faced challenges in its efforts to staff the sector with the adequate work force that has reliable technical expertise and experience. The head of the office revealed that let alone recruiting and employing technically well equipped and experienced work force, the existing employees are going away in search of better payment.

Determining Factors of Effective Solid Waste Management

A logistic regression model was employed mainly to assess and then predict the effectiveness of household solid waste management on the basis of the socio-economic and demographic factors. Prior to applying the model, a due attention was given to the issue of multicollinearity. To avoid this problem, the multicollinearity diagnostics and bivariate correlation test were used. Through multicollinearity diagnostics, it was verified that the variable inflation factor (VIF) value was <10 and the tolerance value was >.10. Moreover, it was confirmed that the bivariate correlation value was <.70.

Secondly, a thorough investigation was made on the 'goodness of fit' test of the model. In order to check this 'goodness of

fit' of the model, two statistical tests namely Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Test were employed. Omnibus Tests of Model Coefficients exhibited the significant p-value of .001 and on the contrary Hosmer and Lemeshow Test reached the p-value of .896 which is greater than .05. Hence, both tests verified that the model had significant explanatory power.

Thirdly, the usefulness of the model for this particular study was also assessed comparing and contrasting the values of Cox & Snell R square and Nagelkerke R square. The values of Cox & Snell R square and Nagelkerke R square were .360 and .482 respectively. The values confirmed that between 36.0% and 48.2% of the amount of variation in the dependent variable is explained by the model.

Lastly an attempt was made to check how well the model was able to predict the correct categories: effectiveness/ineffectiveness of solid waste management for each case. Then the Classification Table without the predictor variables and the Classification Table with the predictor in the output of the model were compared. In this regard, the model correctly classified 78.1% of cases showing a great improvement over 55.5% in Block 0.

Table 3

Results of Logit Model analysis on effective household solid waste management

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Age of householder	-.065	.020	10.240	1	.001	.937	.900	.975
Sex of householder	-1.468	.484	9.212	1	.002	.230	.089	.595
Educational level	-.016	.042	.144	1	.704	.984	.906	1.069
Year of stay	.065	.021	9.402	1	.002	1.068	1.024	1.113
Income	.000	.000	2.570	1	.109	1.000	1.000	1.000
Household size	-.107	.096	1.248	1	.264	.899	.745	1.084
House distance	-.001	.002	.397	1	.529	.999	.996	1.002
Willingness to pay	1.281	.499	6.581	1	.010	3.600	1.353	9.577

Awareness	2.344	.679	11.930	1	.001
10.423	2.756	39.414			
Constant	1.216	1.202	1.024	1	.312
3.375					

Source: Survey data, 2016

The model containing all predictors was statistically significant (p<0.05). As it is indicated in Table 3, each predictor meets the conventional 0.05 standard for statistical significance except for educational level, income of the household, size of the household, and distance of the house. In other words, one can see from the table that age (p=.001), sex (p=.002), year of stay (p=.002), willingness to pay (p=.010), and awareness (p=.001) added significantly to the model, but education (p=.704), income (p=.109), size of the household (p=.264), and distance of the house (p=.529) did not add to the model significantly.

As it was shown in Table 3, as the age of the householder increases by one unit (i.e. one year), it is 0.94 times less likely to manage the solid waste effectively. In case of the sex of the householder, male householders 0.23 times less likely manage the solid waste effectively than the female householders. In other words, female householders 0.23 times more likely manage the solid waste effectively than their male counterparts. As the year of stay increases in one unit (one additional year), the likelihood of effective solid waste management increases in 1.07 times. And also, the

householders who had willingness to pay were 3.60 times more likely to manage the solid waste effectively than the householders who had no willingness to pay. Moreover, the householders who had awareness on solid waste management were 10.42 times more likely to manage the solid waste effectively than the householders who had no awareness.

Private Solid Waste Collectors Service and its Challenges in Arba Minch Town

In Ethiopia, solid waste transport service was primarily the responsibility of the municipalities until recent years. Nowadays, this scenario has been changed and the private stakeholders, non-governmental organizations, community based organizations, and the public were widely involving in the process of solid waste management. One of such organizations is the private solid waste collectors or MSEs of Arba Minch town, which were established in 2004.

With the strong intervention, guidance and assistance of the municipality, there were six solid waste collecting micro and small enterprises at work during field survey of this research. The

municipality, designs the structure following the formal administrative structure of the town. Accordingly, there were two and in some cases more solid waste collectors' micro and small enterprises in each sub-city performing their activity within specified areas of their respective sub-city. During field survey of this research the MSEs operated in all kebeles of Arba Minch town except Gurba and Woze kebeles, which are bounded by peripheral areas of the town where households have no problem to throw their solid waste. Regarding the frequency of collection, the studied small enterprises admitted that they collect the solid wastes generated from the commercial centers like cafeterias, restaurants, and bars in relatively higher frequency than they did for the solid wastes generated from households.

Discussion with MSEs confirmed that they collected the solid waste of commercial centers daily or once in two or three days as per the higher service fee they pay, whereas the household solid waste is collected from residential houses once a week. Regarding the service fee, the households pay 10 to 30 birr per month on the basis of the amount of solid waste they generate, while the commercial centers pay 100 to 600 birr per month based on the amount of solid waste generated.

Nowadays, the MSEs are the only bodies to involve in the process of door-to-door solid waste collection service in Arba Minch

town. This condition keeps them in direct contact with the public more than any other stakeholder engaged in solid waste related tasks. So, they are providing relative solution to the problem. However, there are many challenges listed by these service providers. One of the main challenges raised by all small enterprises was shortage of finance. Since their main source of income is mainly from the service fee collected from households and commercial centers, there income is very small and does not cover their personal expenses.

Another acute problem was a shortage of waste collection facilities and hygienic equipments. Almost all of the MSEs had no adequate solid waste handling facilities. They depended mainly on the donkey-drawn carts. As the data indicates, each of the MSEs owned either one or two donkey-drawn carts. Therefore, it was very difficult for all MSEs to collect all the solid waste generated with the available one or two donkey-drawn carts, which forced the MSEs to hire extra donkey drawn-carts with expensive payment. Moreover, lack of solid waste collection vehicle, shortage of hygienic equipment and safety materials such as gowns, gloves, hats, boots, and masks affected them.

Conclusions

In developing countries, with an ever-increasing population, municipal solid waste management is emerging out to be one of the serious problems. In these countries, household solid waste is a major

source of concern due to lack of appropriate planning, inadequate governance, resource constraint, and ineffective solid waste management. According to UNEP (2005), the generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in the cities and towns of developing countries.

The finding of this study reveals that the current condition of household solid waste management of Arba Minch town is poor. The study discloses the solid wastes generated in high quantity include grasses and leaves, ash, food wastes, paper and cardboards, and plastic materials. Majority of the households have primary solid waste materials in their house. They use a variety of storage materials such as sacks, baskets, and plastic bags in their house to temporarily store the solid waste they generate. With respect to secondary storage facilities, there are only ten storage materials (containers) in the town and four temporary storage sites of 12 by 15 meter wide each. However, these secondary storage containers are not in use currently for their intended purpose. Therefore, it is important for the municipality to work towards ensuring the functioning of these public resources for public use.

With respect to the determining factors of solid waste management, the demographic, socioeconomic, and institutional factors play a key role in influencing effective solid waste

management. As to the demographic factors, female householders manage solid waste effectively compared to their male counterparts. The finding also confirm that the level of effective solid waste management decreases as the age of the household increases. As such, the socio-economic factors exert influence on effectiveness of waste management. The level of educational too has positive association with effective solid waste management. Furthermore, income of the household has the power to build the capacity to pay for solid waste related services and hence it has a positive influence on effectiveness of solid waste management.

The institutional factors also contribute their own part in the process of effective solid waste management. The local government has responsibility to formulate its own local by-laws in line with the federal as well as regional solid waste related laws. The availability of these rules and regulations is not enough without the local legal and moral duty to make the residents aware and enforce the rules and regulations. In line with this, more than 75% of the studied households do not know the existence and enforceability of solid waste related laws in the study area. Moreover, the finding of the study indicates that the sanitation and beautification sector in the town has acute shortage of human, material, and financial resources, which needs immediate solution.

As the finding from the study reveals, the MSEs are the only private sector stakeholders to involve in the door-to-door solid waste collection service in Arba Minch town. However, their financial, material, and human capacity is not promising. And this is evident in almost all of the sanitation and beautification sectors of the town. Although these MSEs created job opportunities for citizens and eased the burden of solid waste for the municipality, they are currently at risk and on the verge of collapse unless timely support is provided from the concerned bodies. The door-to-door solid waste collection service is at its infancy stage in the town and the service is currently provided for a small number of households. Moreover, the service is not given to perieurban residents and should be extended to the residents who live in the outskirts and away from the main roads. Therefore, it is important to strengthen the MSEs as strong partners in the proper management of the waste generated from ever-increasing population of the town.

References

Bizatu Mengistie & Negga Baraki. (2010). *Community based assessment on household Management of waste and hygiene practices in Kersa Woreda, Eastern Ethiopia*. Unpublished MA Thesis. Harar: Haramaya University.

Bjerkli, C.L. (2005). *The cycle of plastic waste: An analysis on the informal plastic recovery*

system in Addis Ababa, Ethiopia. Unpublished MA Thesis. Trondheim, Norway: Norwegian University of Science and Technology. Retrieved from https:// core. ac.uk/ download /pdf/ 52101256.pdf.

Cochran, G. (1977). *Sampling Techniques*. 3rd ed. New York, USA: John Wiley & Sons, Inc.

Central Statistical Agency (CSA). (1984). *Population census of the federal democratic republic of Ethiopia.* Addis Ababa: CSA.

Central Statistical Agency (CSA). (1994). *Population census of the federal democratic republic of Ethiopia.* Addis Ababa: CSA.

Central Statistical Agency (CSA). (2007). *Population census of the federal democratic republic of Ethiopia.* Addis Ababa: CSA.

Dawit Walelign & Alebele Bayrau. (2003). *Improvement of solid waste management in Addis Ababa, a participatory approach (Draft)*. Addis Ababa, Ethiopia.

Fitsum Tsegaye. (2007). *Assessment of management options for domestic solid waste in Addis Ababa: Aase study of French Legasion area, Addis Ababa*. Unpublished MA Thesis. Addis Ababa: Addis Ababa University.

Green, H.W., (2003).*Econometric analysis*. 5th ed. New Jersey: Pearson Education, Inc.

Gujarati, N. D., (2006). *Basic Econometrics*. 3rd ed. New York: McGraw Hill Book Companies Inc.

G/Tsadkan G/Michael. (2002). *Domestic solid waste management in Mekelle city: Tigray region, Ethiopia*. Unpublished MA Thesis. Addis Ababa: Addis Ababa University.

Mohamed N, Elsa Z. (2003). *Waste management programme*. UNIDO View Document, No.3765. Tokyo, Japan.

Mungure, J. (2008). *Governance and community participation in municipal solid waste management, case of Arusha and Dar es Salaam, Tanzania*. Unpublished MA Thesis. Aalborg, Denmark: Aalborg University. Retrieved from http://thesisbank. jhia.ac.ke/213/ 1/2015_06_62.pdf

ROSA. (2007). *Resource-oriented sanitation concepts for peri-urban areas in Africa: Baselines study report of Arba Minch Town, Ethiopia*. Arba Minch, Ethiopia. Retrieved from https:// www.sswm.info/sites/default/files/reference_attachments/RO SA%202006%20Arba%20Minch%20town%20ROSA%20pro ject.pdf.

Sehker, M. & Beukering, P. (1998). *Integrated solid waste management: A perspective Bangalore (India)*, CREED Working Paper Series No. 24, 277-295.

Seo, S., Aramaki, T., Hwang, Y., & Hanaki, K. (2004). Environmental impact of solid waste treatment methods in Korea. *Journal of Environmental Engineering Div. ASCE, 130* (1), 81–89.

Solomon Asrat. (2006). *Solid waste management: A case study of household solid waste management in Arada sub-city, Addis Ababa, Ethiopia*. Unpublished MA Thesis. Addis Ababa: Addis Ababa University.

UNDP. (2004). Urban agriculture: Food, jobs and sustainable Cities. UNDP Urban Harvest Working Paper Series, Paper No. 1. New York: UNDP. Retrieved from http://jacsmit.com/book/Chap02.pdf .

UNEP. (2005). *Solid waste management*. Vol. 1. Training Manual. Osaka/ Shiga, Japan: International Environmental Technology Center

UPSBB. (2012). *Solid waste management manual: With respect to urban plans, sanitary landfill sites and solid waste management planning*. Addis Ababa, Ethiopia: Ministry of Urban Development and Construction Urban Planning, Sanitation and Beautification Bureau.