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Do institutional factors matter for improved solid waste management?

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Abstract

There is non-changing behavior of residents in cooperating and contributing for improved solid waste management in spite of increasing provision of solid waste management services in many urban areas. This paper starts from a hypothesis that institutional factors (interventions) are missing. We considered the case of issuing laws and creating awareness about the health and economic burdens due to improper waste management. We applied a paired-t test to test our hypothesis. We find that institutional factors, creating awareness and introducing rules, significantly increase household's willingness to pay for improved solid waste management services. We find also increasing awareness is more influential than issuing laws. The findings do have important policy implications in reducing not only solid waste management problems but also many other environmental problems in developing countries.

Key Words: Solid waste management, Rules, Awareness, experimental research, t-test.

JEL Classification: Q53

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1. Introduction

Many environmental problems are increasing at alarming rate in many developing countries to the effects of urbanization and industrialization. One of such most important environmental problems increasing with urbanization and industrialization, especially in the third world countries is increasing solid waste. Solid wastes are all the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted (Tadesse, 2004; HPRE, 2007). Solid wastes include different throwaways from dwellers to more homogenous wastes from agricultural, industrial, and mining activities. Solid wastes may be discharged from consumption or production activities. Solid wastes may also be biologically easily degradable (such as piles of fruits) or hardly degradable (such as plastics). Solid wastes can be corrosive (that include acids or bases that are capable of corroding metal containers such as tanks), ignitability (that can create fires under certain condition such as oils and solvents), reactive (which are unstable in nature, they cause explosions, toxic fumes when heated), and toxicity (which are harmful or fatal when ingested or absorb) (Akinbode, undated).

The amount and variety of waste being generated from different economic (agricultural, industrial, and municipal) activities is increasing from time to time. For example, Regassa *et al* (2011) document that solid waste generated in the city of Addis Ababa increased from 482550 m³ (in 1987) to 787305m³ (in 1998). The Public Health Service of the U.S. (PHS, 1967) pinpointed “maintaining the quality of the human environment is the most important challenge of our age”. The report further documented that the challenge will go unresolved as long as efforts to dispose solid wastes continue to cause extensive environmental pollution. The problem, therefore, is not due to the increasing rate of generation of any type of waste *per se*. The problem, however, is related to improper discharge and management of the wastes either due to lack of resources or inefficient institutions and infrastructure.

Unattended solid wastes are threatening the lives of millions in the developing world. It will result in not only an unpleasant and often unsafe environment to live or work in but also piles of refuse can be a fire hazard². Unattended waste lying around attracts flies, rats, and other creatures that in turn spread diseases³ in addition to non-negligible economic burden on the residents (PHS, 1967). Since solid wastes ferment, they create conditions favorable to the

² <http://www.cdc.gov/nceh/ehs/NALBOH/NALBOH-4.pdf>.

³ <http://edugreen.teri.res.in/explore/solwaste/health.htm>.

survival and growth of microbial pathogens which in turn contribute for the creation and spread of variety of diseases.⁴ Especially, solid waste dumped directly into water bodies (rivers, ponds, seas, lakes) causes contamination of the water bodies and result in the accumulation of toxic substances in the food chain through the plants and animals that feed on it (Ibid). To these effects, there are a number of diseases associated with improper waste handling. Among others, skin and blood infections (resulting from direct contact with waste), eye and respiratory infections (resulting from exposure to infected dust), different intestinal diseases that results from the bites and transmitted by of animals feeding on the waste, infections that are transmitted by flies feeding on the waste, and risk of cancer associated with exposure to hazardous dust wastes (PHS, 1967)⁵. Akinbode (undated) adds low birth weight, cancer, congenital malformations, neurological disease, nausea and vomiting, and increase in hospitalization of diabetic residents living near hazard waste sites as some more diseases highly associated with solid wastes.

The health, economic, and environmental impacts of solid wastes are sufficient reasons to dictate concerned urbanities to put an integrated and continuing effort to improve solid waste disposal practices. Therefore, needless to say, preventing excessive solid by taking certain preventive measures is a must. Due to the environmental (loss in aesthetic value of the environment), health, and economic problems arising due to unattended solid wastes may countries (and communities) are thriving to manage solid wastes properly. Improved (or integrated) solid waste management is the term used to refer all activities aimed at handling the community's waste properly. A comprehensive solid waste management includes collecting, storing, and disposing solid wastes. For smaller communities, the wastes may be reused (such as animal manure in rural areas), or can easily be collected by households (such as household wastes). In high-density areas, however, solid waste management scheme can be a large, complex, and expensive enterprise, with many people, materials, and funds required for good operation.⁶ This is especially important for urban areas where millions of people are dwelling. In such cases, communal storage of the waste will be necessary and collection points (or methods) ought to be convenient for the community. The structures should be designed and built so that

⁴ <http://edugreen.teri.res.in/explore/solwaste/health.htm>.

⁵ <http://edugreen.teri.res.in/explore/solwaste/health.htm> and <http://www.cdc.gov/nceh/ehs/NALBOH/NALBOH-4.pdf>.

⁶ <http://www.cdc.gov/nceh/ehs/NALBOH/NALBOH-4.pdf>.

insects, rats, and rainwater are kept out (Ibid). For doing so, the contribution of community, either in kind or cash, is indispensable.

Municipalities in many developing countries are providing integrated solid waste collection services (either through private or public enterprises) to encourage households to cooperate in improved solid waste management (ISWM hereafter). Some developing countries, like Ethiopia, are even taking measures like providing ISWM services, organizing private small scale enterprises to provide the service, establishing a separate authorized organization to do with beautification, cleaning, and greening of cities/towns, and issuing laws against improper waste disposal.

Nonetheless, there is no significant change in the household waste handling behavior in most developing countries. The problem specially is magnificent in sub-Saharan African nations. More than half the solid waste generated in Addis Ababa (Regassa *et al*, 2011) and 40-50% tones of rots in Kampala (Niringiye and Omortor, 2010) are collected. Even though ISWM services have been introduced to the city of Addis Ababa three decades ago, scenes of scattered wastes are most common in the city (Ragassa *et al*, 2011). The question, therefore, is that how can we influence the residents of cities, towns, and peri-urban areas in developing countries so that they can cooperate to fullest possible. Put another way, what increases the willingness to cooperate to or participate in improved solid waste practices in their vicinities.

Many studies in the area (c.f. Amiga, 2002; Yusuf *et al*, 2007; Niringiye and Omortor, 2010; Amfo-Out *et al.*, 2012;) are concentrated to estimate the household willingness to pay (WTP hereafter) and determinants of WTP for improved solid waste management. Such studies, however, will show only the demand for improved solid waste management services. They will not show what exactly affects (changes) the households' behavior to cooperate in solid waste management practices and hence what is expected from concerned government organizations. That is why Niringiye and Omortor (2010) suggested attempts to be made to improve WTP for waste management services in the city of Kampala and of course in any other cities in developing countries.

Motivated by this gap, this paper considered two institutional factors that may influence the household's waste handling behavior through experimental approach. The change in household's behavior (as represented by their maximum WTP for ISWM) was recorded under three conditions from the same sample. First, respondents were asked to state their WTP for

integrated solid waste collection provided by their municipal administration. Second, what if the municipality issues laws and hence poor handling of household waste is subject to fines. Third, ignoring the case of laws, the respondents were taught about the formidable health and economic burdens associated with unattended solid wastes and asked to restate their respective WTP.

The *t* test results of the experiment show that respondents behave differently under different incentives (conditions). Both issuing rules and providing information on health and economic burdens of poor solid waste management results statistically significant change in the household's behavior. Finally, we find that awareness is more potent to affect WTP than rules. The results lend us to conclude that educating residents on health and economic burdens of poor solid waste management is better than making rules and regulation against unattended waste handling in developing countries. The strategy is not preferable only because it affects households' behavior but also it is cost effective (as it has no/little operation costs compared to rules) and reduces the tendency of corruption associated with penalizing those who failed to cooperate.

The rest of the paper is organized as follows. Section 2 describes the data and the methodology. Section 3 analyses the results from the experiment and section 4 concludes the paper.

2. Data and methodology

2.1. Description of the Study Area and the Data

The town of Debre Berhan is located at 09041'N latitude and 39031'E longitude and 130 km North East to Addis Ababa (capital city of Ethiopia). It is located in the central plateau of Ethiopia with an average elevation of between 2800 and 2845 meters above sea level. Debre Berhan is one of the ancient urban centers in Ethiopian history. The town serves as the capital of North Shewa Administrative Zone. As to 2007, the town is organized into nine *kebeles* (sub-towns). It is estimated that about 66, 571 peoples live in the town (CSA, 2007).

In spite of its long recorded history (established in the 15th century) and its geographical nearness to the capital city of Ethiopia, the town had not shown significant change in the last centuries. The town, however, is exhibiting promising movement since the last three to four years. Albeit the town is growing in terms of infrastructure, construction, population, and number of national and regional institutions, the solid waste management system in the

municipality remains too poor. Nor the community is taking its own action on the same. This paper is mainly motivated by this prevailing fact in the town.

2.2. Methodology: Experimental approach

Unlike the most common approaches on the subject matter (i.e. studying the socio-economic determinants of WTP for ISWM service), this paper starts from the hypothesis that institutional intervention, beyond providing the service, significantly affects the residents' behavior on waste management⁷. Among others, the study considered two possible exogenous factors that can affect individual household's WTP: issuing laws against improper waste handling and increasing the residents' awareness about health and economic burdens due lack of solid waste management. To assess whether the suggested incentives are potent (which is influencing more) we applied a field experimental research method on randomly selected 70 households in Debre Berhan town. Experimental research method is a scientific approach in which the experimenter (or the researcher) manipulates one or more variables, and controls and measures any change in other variables. Experimental method involves the deliberate manipulation of one variable, while trying to keep all other variables constant. Therefore, there are two groups in experimental research: treated (experimental) and control groups. The control group is a group where the change is not being made while the treated (experimental group) is the group on which the experiment is being done.

There are many relative advantages of experimental research method over non-experimental methods. First, it enables us to study cause and effect because it involves the deliberate manipulation of one variable, while trying to keep all other variables constant. Second, because experiments generate quantitative data it can also facilitate inferential statistics tests. Third, more importantly, it helps to control for unobservable determinants of our variable of interest. In other words, in experimental methods, other determinants of the outcome can be held constant so that the effect of the treatment can be isolated (Greenstone and Gayer, 2007).

To the end of our objective we established two experimental groups in addition to the control group.

⁷ Willingness to pay is the maximum amount of money an individual is willing to pay to obtain a benefit (Markandya *et al.*, 2001).

Controlled group: the households were asked directly to state their monthly WTP for improved solid waste handling service to be provided by the municipality each week.

Treated group 1: The sample households were told the fact that improper waste handling is subject to regulation and bears fines. We read to them the Solid Waste Management Proclamation No.513/2007 by the government of Ethiopia⁸. Then, they were asked to restate their monthly WTP for improved solid waste handling service to be provided by the municipality each week.

Treated group 2: Thirdly, the sample households were educated about the health and economic impacts poor waste handling practices. They were told the mortality and morbidity risks associated with the unattended solid wastes based on World Health Organization and some specific case studies. They were also told economic loss (due to hospitalization, due to loss in work hours, and loss in tourism inflow) due to solid wastes. Finally, the respondents were told that the health and economic impacts can easily be controlled through proper waste management. The respondents then were asked to restate their monthly WTP for improved solid waste handling service to be provided by the municipality each week.

The experiment helps to answer two important questions which do have policy relevance especially in less developed countries in addition to estimating the WTP for ISWM practices. First, do external interventions affect the residents' behavior in statistically significant and in meaningful sense? Second, which intervention does affect more? The data on households' WTP for improved solid waste management under three scenarios was collected from 70 randomly selected households in Debre Berhan town⁹. To avoid the effects of outliers we predefined the range of WTP from zero to 50 Birr. The range was established based on studies which calculated an average WTP for other Ethiopian cities (c.f. Amiga, 2002; Hagos *et al.*, 2012).

2.3. Methodology: t-test

We used t-test to test our hypothesis posed earlier. T-test “generally determines whether two means are significantly different from each other or the mean of a sample is significantly

⁸ Because the Proclamation gives the mandate to regulate and determine the amount of monetary fines to the municipal cities, we refrain from telling them the exact amount of penalty. But, we acknowledge fact that the amount of fines will also affect the WTP.

⁹ We focused on households because the industrial waste in the town is negligible.

different from that of the population from which it may have been drawn (Cramer and Howitt, 2004). It allows us to determine how likely the difference between two means occurred by chance. Put another way, t-test allows us to check whether the mean difference between the two groups is due to the influence of treatment (incentives or interventions in our case) over the groups rather than by chance.

T-test for related samples (also known as the paired-samples *t*- test) is given by the difference between the two means divided by the standard error of the difference in means. Therefore, it requires three piece of information to compute it manually. These include information on the difference between the means of the two groups, the standard deviation (and hence variance by squaring standard deviation) for each groups, and the sample size in each group.

$$T = \frac{\text{Mean of the treated group} - \text{mean of the control group}}{\text{Standard error of the difference in means}} \dots\dots\dots (1)$$

$$T = \frac{\bar{X}_t - \bar{X}_c}{SE(\bar{X}_t - \bar{X}_c)} \dots\dots\dots (2)$$

$$T = \frac{\bar{X}_t - \bar{X}_c}{\sqrt{\frac{Var_t}{nt} + \frac{Var_c}{nc}}} \dots\dots\dots (3)$$

The equation above tells us that t-test helps to judge the difference between means of two groups relative to the variability within the groups. After calculating the t-value like given above, we cross-check this t-value (T, also known as *t* calculated) with an appropriate degree of freedom and level of significance ($df=n-1$, where *n* is the number of samples) with a critical value in t-table which is given as an appendix in many statistics texts. This helps to determine how likely the difference between the means of the two groups is occurred by chance. If the calculated value (T) is greater than the critical value (from the table) we say the means are statistically significant. Therefore, the treatment (the intervention, the incentive, or the strategy) creates significant difference.

However, this process can be done with computer statistical packages easily like Microsoft Excel, STATA, and SPSS. The packages calculate the means, standard deviations, the mean differences and the *p*-value. Based on the *p*-value we will determine whether the group means are statistically significant. P-value is the probability of the mean difference occurring by

chance. If p -value is less than α significance level, the mean difference is statistically significant and hence the difference in the population from which the sample is drawn didn't occurred by chance. In other words, the mean difference is due to the intervention, incentive, or treatment applied upon the groups. Therefore, there is significant and meaningful difference between the treated and control group of population.

3. Results and discussion

In social science research α is set commonly to be 5%. That is if p -value is less than 5% (0.05), you are 95% confident that the difference in means is due to the treatment. We used STATA 10.0 in this paper. The results and the analysis are discussed below.

Table 1: Summary statistics of the variables

Variable	Observation	Mean	Std. Dev.	Min.	Max.
Controlled	70	13.71429	8.382423	2	40
Treated1	70	23.02857	10.60075	9	50
Treated2	70	27.77143	12.0159	7	50

Source: Survey data

Table 1 gives the summary statistics of the sample under the three groups (controlled, treated 1 (with information on laws and regulations), and treated 2 (with information health and economic impacts of wastes). The summary statistics show that there is clear mean difference among the groups. The mean WTP of the controlled group is 13.71 Birr. However, awareness on the health and economic burdens imposed by wastes and rules and regulation, respectively, increases the mean WTP to 27.77 Birr and 23 Birr. Therefore, we can conclude that institutional intervention (either through laws or awareness) clearly affects the behavior of the households. Looking at the magnitude of the means only, awareness about health problems due to wastes influences people than introducing laws against improper waste management.

The other important information from the table is that from the last two columns of the table: on minimum and maximum values in each group. As we noted before, based on earlier studies, we set the maximum WTP to be 50 Ethiopian Birr to avoid the outlier effects. The six

and awareness on impacts are different. The results in Table 4 shows educating people about health and economic burdens affects more importantly than issuing laws and regulating people who failed to comply with the rules.

Two important policy lessons can be drawn from the results of the experimental research given above. First, institutional intervention to solid waste management is very important. Second and more important is that creating awareness on health and economic impacts of unattended wastes is more important than simply issuing rules. In our experiment, we have given a chance for our respondents to state their WTP along with the question “why?”. Many answered that “the issue is of health”. Some were even stunned while we oriented the variety and severity of health problems with wastes.

Educating or creating awareness about the impacts, however, not increases the WTP and willingness to cooperate ISWM schemes in urban areas. We contend it is also cost effective strategy compared to rules and regulations. First, awareness will make the households to internalize the problem and feel it as a threat for their livelihood and children. Therefore, sustainability is guaranteed with awareness strategy as people are cooperating for the sake of themselves: everyone knows as to why he/she is contributing for ISWM. Second, awareness creation is also advantageous from cost of implementation point of view. The cost is only initial cost of educating people may be through different media. Rules and regulations, on the other hand, bear additional cost of administration. Regulations involve cost of monitoring, evaluating, and bringing to the court those who are not complying with the law. Third, awareness also creates uniformity in ISWM practices. Because waste disposal is a day to day activity it is hardly possible to regulate all households each day. However, if the household are aware of the health and economic problems they are doing from themselves and hence are disposing properly. At last, but not least, compared to regulation, awareness reduces the tendency of corruption. It is well known fact that corruption is rampant in most developing countries. Among other sectors, corruption by bureaucrats in municipalities is severer. Though awareness it is the household managing its waste generation and contributing its waste disposal, there is low venue for bureaucrats to involve.

In addition to this, the study results also substantiate the findings of other similar studies in other Ethiopian/sub-Saharan cities. Regassa *et al* (2011) identified lack of public awareness and illegal dumping are among the most challenging factors for ISWM practice in Addis Ababa

which directly supports our conclusion. Hagos *et al.* (2012), for the case of Mekelle (Ethiopia) also find awareness on environmental quality to determine WTP significantly. Some studies, Amiga (2002), Amfo-otu *et al* (2012), Adepoju and Salimonu (undated) on households' WTP for ISWM in Addis Ababa (Ethiopia), Akuapem (Ghana), and Osun state (Nigeria) found that education (which highly affects level of awareness) significantly affects individual WTP. Our results also go in line with Niringiye and Omortor (2010) which concluded that there is "little chance of success if solid waste collection charges are introduced" for providing improved solid waste collection services and which called for attempts to be made to increase WTP for ISWM in the city of Kampala. Studies also argue, income which conventionally is presumed to affect positively the demand for better environmental quality was not found to be significantly affecting households' WTP for ISWM in some areas (c.f. Niringiye and Omortor, 2010; Amfo-Otu *et al*, 2012). Therefore, the provision of ISWM services (either through government or private enterprises) should be augmented awareness creation campaigns and issuing rules, if necessary.

4. Conclusions

Many environmental problems (e.g. air pollution, water pollution, solid wastes) increase with urbanization and industrialization. Water pollution and solid wastes are the two most common environmental problems in many developing countries. These urban environmental problems results in not only loss in scenic beauty of urban areas but imposes many health and economic burdens on the residents. Nonetheless, there are very limited experiences in improved solid waste management experiences in many developing countries.

This paper was motivated to assess whether institutional factors, beyond providing solid waste management services, are lacking. Among others, we looked at the influence of issuing laws against unattended wastes from households and creating awareness on health and economic impacts of solid wastes on households' willingness to pay for improved solid waste management. We applied a field experiment on seventy randomly selected households in Debre Berhan, a historic but with poor solid waste management experience town in Ethiopia.

The t-test results show that institutional intervention significantly affects households' willingness to pay for improved solid waste management practice in the town. In addition to this, we find that creating awareness was highly influential than issuing laws. We argued also that

awareness is also cost effective strategy compared to rules and regulations for a number of reasons.

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