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Municipal Solid Waste Management in Small Towns

An Economic Analysis Conducted in Yunnan, China

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Abstract

Municipal solid waste management continues to be a major challenge for local governments in both urban and rural areas across the world, and one of the key issues is their financial constraints. Recently an economic analysis was conducted in Eryuan, a poor county located in Yunnan Province of China, where willingness to pay for an improved solid waste collection and treatment service was estimated and compared with the project cost. This study finds that the mean willingness to pay is about 1 percent of household income and the total willingness to pay can basically cover the total cost of the project. The analysis also shows that the poorest households in Eryuan are not only willing to pay more than the rich households in terms of income percentage in general, but also are willing to pay no less than the rich in absolute terms where no solid waste services are available; the poorest households have stronger demand for public solid waste management services while the rich have the capability to take private measures when public services are not available.

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Municipal Solid Waste Management in Small Towns: An Economic Analysis Conducted in Yunnan, China

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1. Introduction

Municipal solid waste management (SWM) continues to be a major challenge for local governments in both urban and rural areas throughout the world. This challenge is particularly important for the developing world. The available statistics show that, although the municipal solid waste generation in the developing countries is still low per-capita level compared to that in the developed world, the developing countries account for a disproportionately high share of the world's solid waste generation relative to their share of world income[2]. Moreover, from a dynamic point of view, the municipal solid waste management in developing countries faces even greater challenges in the future because of their rapid urbanization and economic growth. Empirical analyses using macroeconomic data[3] indicated that the per capita generation of solid waste was at least 0.3-0.4 kilograms per day even for the poorest people. In general, a 1 percent increase in population is associated with a 1.04 percent increase in solid waste generation, and a 1 percent increase in per capita income is associated with a 0.34 percent increase in total solid waste generation. Considering that most of the developing countries are still in the early stage of their urbanization and economic development process, people generally believe that a fast increase in solid waste generation should be unavoidable in the developing world.

The current practice of collecting, processing and disposing municipal solid wastes is also considered to be least efficient in the developing countries. The typical problems are "low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control, the breading of flies and vermin, and the handling and control of informal waste picking or scavenging activities" (Bartone, 1995). Although some cities do spend significant portions of their municipal revenues on waste management (Coitreau, 1984, 1994; Thomas-Hope, 1998; Schübeler, 1996 and Bartone, 2000), they are often unable to keep pace with the scope of the problem. Senkoro (2003) indicated that for many African countries, only less than 30% of the urban population has access to "proper and regular garbage removal".

Poor solid waste management in the developing countries consists of a major threat to public health and environmental quality, and reduces the quality of life, particularly for the poorer residents in both urban and rural areas. One of the principal reasons for the inefficient SWM systems in the developing countries is the financial constraint. As SWM is given low priority in the developing countries, except in capital and large cities, very limited funds are provided to the SWM sector by the government. This is especially true for the small towns and rural areas, where the local taxation system is inadequately developed, and therefore the financial basis for public services, including SWM, is very weak.

From an economic point of view, the "public good" nature of SWM services means that there are important social benefits that need to be taken into account in deciding the level of services to be provided, even though governments may have limited financial capacity. Gomes and Nobrega (2005) show that, if the economic, social and environmental components are all quantified, the benefit-cost ratio for a separate household waste collection in a northeast region of Brazil could "range from 1.27 to 1.77 depending on the economic quantification of the direct and indirect benefits".

[2] See Beede and Bloom (1995).
[3] References: Shafik and Bandyopadhyay, 1992; World Resource Institute, 1993; Beede and Bloom, 1995; Johnstone and Labonne, 2004.

To economically justify the need for better SWM services in the developing countries, good valuation studies on the potential benefits of such services are necessary. Several techniques for assigning economic values to SWM services have been used in the literature, including travel cost (Anex, 1995), hedonic housing price (Arimah, 1996), choice modeling or experiments (Huhtala, 1999; Othman, 2002; Naz and Nazm 2005 and Boyer, 2006 and Jin et al. 2006). But the method that is used the most is the method of contingent valuation or ranking; a non-exhaustive research in the literature gives a list of 19 contingent valuation studies in this area[4]. Evidence from the existing research suggests that the estimates of environmental and public good benefits from well-designed and properly executed contingent valuation surveys appear to be at least as good as estimates obtained with other valuation techniques (OECD, 1994, Mitchell and Carson 1989, Whittington et al., 1990).

Two advantages can further explain the widespread use of the contingent valuation method in environment-related public service valuations. The first is its flexibility. Based on hypothetical markets that can be flexibly defined by researchers according to the specific characteristics of the public services in question, the respondents of valuation surveys are invited to directly state their preferences and to reveal their willingness-to-pay for the specified qualities or quantities of improvement. This is very different from the hedonic price method, whose applicability to a public service valuation depends closely on the existence of compatible real-market data. The second advantage is the capacity of contingent valuation method to measure not only the use value but also other intangible values from the improved public service, such as the non-use value and especially the existence value (Krutilla, 1967). This is very different from the market-based valuation methods, such as the travel cost method, which can only measure (partial) use values of a public service.

Though the contingent valuation method can be a feasible and valid technique to measure the levels of payment for SWM services (Altaf et al. 1994; Altaf and Deshazo, 1996; Whittington et al., 1991), contingent valuation studies for SWM projects in the developing countries have mostly been conducted after 2000[5]. Few such studies have been conducted in China, especially on SWM services in small towns.

This paper reports on a contingent valuation study we conducted in Yunnan, China, on municipal solid waste management based on a real investment project which was intended to improve the solid waste collection and disposal system in county-level and township-level small towns.[6] The project was to be located in Eryuan County of Yunnan Province, and the survey was conducted there in the summer of 2007. Because the survey was conducted for the benefit-cost analysis of a real investment project proposal, the hypothetical nature of a contingent valuation study, which is the single most important criticism of the method for potential biases, can be ameliorated, and therefore the results can be more reliable.

[4] Altaf and Deshazo, 1996; Lake et al., 1996; Tiller et al., 1997; Adaland and Caplan, 1999; Huhtala, 1999; Sterner and Bartelings, 1999; Caplan et al. 2002; Othman, 2002; Bluffstone and DeShazo, 2003; Huang and Ho, 2005; Palatnik et al. 2005, 2008; Basili et al. 2006; Jin et al. 2006; Lal and Takau, 2006; Fonta et al. 2007; Osumanu, 2007; Afroz et al. 2009, and Ichoko et al. 2009.

[5] Examples include Othman (2002) on Malaysia, Bluffstone and Deshazo (2003) on Lithuania, Huang and Ho (2005) on Taiwan, China, Naz and Naz (2005) on Philippines, Jin et al. (2006) on Macao, Lal and Takau (2006) on Kingdom of Tonga, Fonta et al. (2007) and Ichoku et al (2009) on Nigeria, Osumanu (2007) on Ghana, and Afroz et al. (2009) on Bangladesh.

[6] The administrative system in China is composed of 5 levels: nation, province, prefecture/municipality, county, township/xiang, from the highest to the lowest respectively.

The contribution of this study to the literature is threefold. First, to our knowledge, this is the first contingent valuation study conducted in China on the value of a specific SWM project, although one can find research papers on the general situation of China's solid waste management service in the aspects of technology, management and cost-benefit analysis (Yang, 1996; Ward and Li, 1993; World Bank, 2005; Huang et al. 2006; Ye and Qin, 2008; Zhuang et al., 2008). Secondly, instead of focusing on big cities, as most of the previous studies did, our study is conducted to value SWM services in small towns. This is to echo the recent discussions (World Bank, 2005) about the complicated financing aspects for China's SWM. It was pointed out that national government's funding on public services has been mostly allocated to big cities such as Beijing and Shanghai, which may have already had a large industrial and commercial base to support revenue generation for public services and had high capacities to attract private sector investment. It will be in the smaller cities where financing for municipal solid waste management becomes one of the fastest growing budget categories for the local governments. The growing SWM budget requirements are further complicated by the rapidly growing costs to manage special wastes, such as hazardous waste, medical waste, and wastewater treatment sludge. This study is therefore timely in terms of helping better understanding of economic value of financing such a public SWM project in small cities and towns.

Thirdly, this study provides a new practical test on the contingent valuation methodology. The multiple bounded discrete choice (MBDC) value elicitation method is employed in this study. Compared to the traditional single and double bounded dichotomous choice (DC) method, the MBDC format combines two aspects of value elicitation format development. On one hand, the MBDC format allows each respondent to vote repeatedly on an ordered sequence of referendum thresholds, and therefore reduces the impact of the "anchoring" heuristic (Tversky and Kahneman, 1974) which often presents in single or double bounded questions. The repeated referendum thresholds can provide more data to verify the coherence and credibility of the valuation results. On the other hand, in MBDC format, for each referendum threshold, a scale of "polychotomous choice" response options varying from "Definitely No", "Probably Yes", "Not Sure", "Probably No" to "Definitely Yes" is also provided. The polychotomous choices provide the possibility to detect and treat the potential significant uncertainties presented in each response and therefore guaranties more reliable estimations. However, the MBDC format is thought to require more cares in implementation, and confidence in successfully implementing a MBDC CV survey has not been built up, as not many MBDC studies have been conducted. This study is one of the few MBDC studies conducted so far.

This paper is organized as follows. Section 2 gives a short review on the existing valuation studies of municipal SWM project. Section 3 presents the Chinese context and the Eryuan municipal solid waste collection and treatment project. The contingent valuation survey is presented in section 4. The estimation results are reported in Section 5. Section 6 concludes the paper.

2. Previous Valuation Studies on Solid Waste Management

As mentioned above, 19 CV studies have been found which had at least partially used the contingent valuation method to value the benefits of SWM projects. Most of the studies published before 2000 are for projects in the developed countries, but after 2000, more papers are found on projects in the developing world. The study subjects in the developing countries are also very different from those in the developed countries. With the relatively well established public SWM system, the CV studies conducted in the developed countries are

more focused on the benefits of introducing new SWM approaches, such as kerbside/dropoff recycling, composting and incineration, which aim to reduce landfill. But most of the developing-country-based CV studies are focused on the benefits of providing/improving the basic or traditional solid waste disposal methods such as collection, transportation and landfills with better pollution control measures.

With regard to the survey methods used, while in-person, mail and telephone surveys have been used in almost equal frequencies in the developed-country studies, the in-person surveys dominate in the studies conducted in the developing countries. The value elicitation format that is used most frequently is the one/two-step dichotomous choice questions,[7] even though we also find a few studies using open-ended questions (Sterner and Bartelings, 1999; Bluffstone and Deshazo, 2003; Osumanu, 2009) and payment cards (Aadland and Caplan, 1999; Ichoku et al. 2009).

The WTP estimation results of the previous studies provide some interesting and common findings. In general, people in both developed and developing countries are willing to pay for SWM programs, and the requirements for improvement in SWM services are very often placed ahead of other major social concerns such as improvements in water and sewer services, housing, indoor air pollution and insect pests, etc. (Altaf and Deshazo, 1996; Othman, 2002; Osumanu, 2007). The WTP value increases in general with household income (Altaf and Deshazo, 1996; Lake et al., 1996; Aadland and Caplan, 1999; Othman, 2002; Huang and Ho, 2005; Palatnik and al., 2005; Fonta et al., 2007; Osumanu, 2007; Afroz et al., 2009 and Ichoku et al. 2009), respondent's education level (Altaf and Deshazo, 1996; Aadland and Caplan, 1999; Huang and Ho, 2005), conscience about the seriousness of solid-waste-related pollution problems (Huang and Ho, 2005, Ichoku et al., 2009), past positive experience in receiving the SWM services and trust in the proposed project (Afroz et al. 2009). This suggests that SWM service is a normal economic good. Female respondents have a general tendency to be willing to pay more than the male respondents (Aadland and Caplan, 1999; Fonta et al., 2007; Ichoku et al., 2009) Family size seems to affect negatively the WTP (Huang and Ho, 2005) but the families having kids may be ready to pay more (Lake et al. 1997). This finding in fact echoes to the conclusion of Johnstone and labonne (2004). Based on an OECD-country macroeconomic database, they found the family size does not affect significantly the demand for SWM, since the children and adults apparently do not play the same role in the determination.

Several studies, especially those conducted in the developing countries, also reveal an important phenomenon that although people rank improper solid waste disposal as the top environmental problem, the user fee that they are willing to pay can only partially cover the cost of the service. Bluffstone and Deshazo (2003) concluded that the WTP for upgraded landfills covers only about 80-90% of the cost for a project in Lithuania to upgrade their SWM system to European level. Naz and Naz (2005) found the ratio of WTP over the total cost to be only 22-35% in the Philippines. Palatnik et al. (2006) also mentioned the necessity of subsidy to achieve an efficient level of recycling for the case of Israel.

Table 1 lists the WTP values reported in various CV studies. Although the components of the hypothetically proposed projects are different from each other, a general impression is that the WTP for SWM service does not occupy an important share in household income. In general,

[7] Examples include Altaf and Deshazo (1996), Lake et al. (1996), Othman (2002), Tiller et al. (1997), Naz and Naz (2005), Palantnik et al. (2005), Basil et al. (2006), Jin et al. (2006), Lal and Takau (2006), Fonta and al. (2007), and Afroz et al. (2009).

the WTP for a principal SWM service ranges between 1-3% of household income, while the WTP for an SWM service improvement ranges between 0.1-0.9% of household income.

3. The Context

3.1 SWM Service in China

Along with fast economic development, the quantity of municipal solid waste generation is increasing rapidly in China. With an annual average increase rate of 3.7%, the per capital municipal solid waste generation[8] in China has reached 1 kilogram per day per person in 2002 (Huang et al., 2006). World Bank (2005) indicates that China has surpassed the U.S. in 2004 and became the world's largest municipal solid waste (MSW) generator. In 2004, the urban areas of China generated about 190 million tons of MSW. Considering China's relatively low level of per capita GDP and that over 56% of population still live in rural areas, the projected future MSW generation in 2030 for this country will be up to 480 million tons (World Bank, 2005). No country has ever experienced such a large and rapid increase in waste generation.

Along with the rapid increase in municipal solid waste generation is significant improvement in the waste management sector in China. The treatment and disposal of municipal solid waste was only started in the 1980s. By 1990, the total disposal rate of municipal solid waste was lower than 2%, but the quantity of disposed municipal solid waste has increased continuously since then. In 2007, the ratio of the disposed municipal solid waste reached 62% of the total quantity collected and transported.[9] Landfill is the main disposal method for municipal solid waste in China; in 2007, over 80% of the disposed municipal solid waste was land filled, about 15% was incinerated, and about 2.6% was composted (China Statistic Yearbook, 2008).

Even though the pace of China's solid waste management improvement is significant, China has been unable to keep up with the growing demand for waste service coverage, the environmental requirement for safe disposal systems, and the rationalization of cost-effectiveness in service delivery (World Bank, 2005). Most of its landfill sites do not satisfy the national pollution control standard (Huang et al., 2006). There is also obvious regional disparity in municipal solid waste treatment capacities. The municipal solid waste disposal ratio varies significantly between the well-developed eastern coastal provinces, such as Beijing (95.73%), Jiangsu (86.7%) and Zhejiang (87.4%), and those less developed areas located in the inland, such as Heilongjiang (22.97%) and Gansu (26.32%).[10]

There are even more difficulties in providing residential solid waste management service in rural areas in China. Ye and Qin (2008) indicate that "the majority of local authorities at the township and the village level fail to provide the (solid waste treatment) services for their constituencies", and this is "particularly true after the rural tax reform, which resulted in all rural direct taxes and fees being removed in the early 2000s to lower tax burdens on farmers." They estimated that in 2005 alone, 280 million tons of garbage was produced in rural China,

[8] Most Chinese municipal solid waste generation data is presented in three categories; municipal, industrial, and hazardous waste. "Municipal waste" usually includes residential, institutional, commercial, street cleaning, and non-process waste from industries. In some cases, construction and demolition waste is also included and can dramatically skew the generation rate, especially in times of high economic growth and related construction activity. (World Bank 2005)

[9] China's official statistics only account the collected and transported municipal solid waste, but not the total quantity generated. Clearly some municipal solid waste are not collected and transported, therefore are missing from this statistical indicator. (Huang et al., 2006).

[10] The data are calculated by the authors according to the statistics available in China Statistic Yearbook, 2008.

although some rural households try to take care of the collection and disposal of solid wastes generated by their own families, illegal roadside solid waste dumping in rural areas is very pervasive. Without adequate collection and disposal, it will cause wide spread diseases and environmental degradation (surface and ground water contamination, soil contamination and air pollution, etc.).

3.2 The Eryuan Project

In 2007, the Government of Yunnan Province requested World Bank to help finance its new urban environmental enhancement program, which intended to provide critical urban infrastructures and enhance the watershed environments of this less-developed inland south-west province of China. One of the program components is the municipal solid waste management improvement project in Eryuan County.

Eryuan is a small rural county in Yunnan Province. Its total population is under 300,000, most of whom (93%) belong to the rural population, with only 7% possessesing urban residential registration (Hukou) status. Eryuan is a relatively poor county. The per capita GDP in 2005 is only 4600 Yuan (560US$), significantly below that of Kunming city (17000 yuan, or 2075US$)[11], the capital city of Yunnan Province. Located about 70 kilometers away from the famous tourist city, Dali, the capital city of Bai Autonomous Prefecture of Yunnan, Eryuan has a scenic geography and is an important component of Dali's tourist resource.

Figure 2 below indicates the project site in Eryuan County. The project is to build a new sanitary landfill facility, at the site indicated by the black square in Figure 1. With particular considerations given to the location choice and the necessary equipments, the new landfill infrastructure is expected to have no negative impacts on the health of the local residents and the local environment. This new project is also to expand the solid waste collection and disposal service from Cibixiang[12], the capital town of Eryuan County, where a simple service in garbage collection and disposal has been available even though with a very low management quality, to cover three other small towns (Niujiexiang, Sanyingxiang and Fengyuxiang), the geographical locations of which are given by the dotted blue circles in Figure 1.

4. The Survey

4.1 Survey Design and Implementation

In order to estimate the total willingness to pay of the households located in Eryuan for the improved SWM Project, a contingent valuation survey was designed and implemented in the summer of 2007 in the project area. A four stage stratified random sampling approach was used to select a sample of households. At stage 1, according to the distribution of project beneficiaries, a geographical boundary (i.e., towns) was determined so that the sample can cover all the geographical area of the project. At stage 2, the number of households in each town to be surveyed was calculated based on the ratio of sample size to the total number of households in the project area. At stage 3, each town is further divided into a number of communities or villages, and a list of communities is randomly selected to be surveyed, with

[11] The official exchange rate at the end of 2005 : 1USD=8.19 Yuan.

[12] Xiang is a constituency under county in China. In this paper, Xiang refers to a town where the Xiang government is located, which is bigger than a village but is smaller than a county town or a small city.

an average of 20 households in each community. At stage 4, a list of households in each community was obtained with the help of local project management officers and the team randomly picked up the households from the household list. Finally, a total number of 223 households were selected and interviewed and 221 households fully completed the questionnaires. Among the total of 223 households surveyed, 110 households are from where a waste collection and disposal system is available and the county capital is located, and the remaining 113 households are from towns which are proposed to be covered by the project (specifically, 32 from Sanyinxiang, 25 from Niujiexiang and 56 from Fengyuxiang). Among the 110 households which are covered by the existing system, 37 are located near to the existing garbage dumping site.

The survey questionnaire was developed by two authors of this paper with help from the local project team people. The final version of the questionnaire includes four parts: socio-economic characteristics, environmental perceptions and attitudes, questions concerning the current situation of Eryuan residential solid waste collection and disposal and the proposed project, and finally the MBDC contingent valuation questions regarding the WTP to support the project. Repeated pre-tests and focus group discussions are organized to better understand the potential issues associated with the questionnaire presentation and the survey implementation.

Five specifically trained enumerators from Yunnan University, who can understand the local dialect and participated in the focus group studies and the survey pretests, conducted the in-person interviews in July 2007. Cares were specifically taken that only the heads of households selected should be interviewed, who were aware of overall situation of household income and expenditure and could determine the additional expenditures of the households. In the in-person surveys, respondents completed the questionnaires independently but with close guidance of enumerators.[13] Neutrality as well as anonymity of the survey was ensured at the beginning of each survey. Each survey was completed in about 20-30 minutes. At the end of each field day, field coordinators checked the returned questionnaires for completeness and accuracy according to a quality checklist.

The WTP question was presented as follows:

As you may know, along with economic growth and population expansion, residential solid waste has become more and more frequently a social and environmental problem that affects the quality of life. Currently in Eryuan County, the residential solid waste is collected, transported and then simply dumped in a garbage dump site located in Sanyingxiang. The odor of the garbage affects the surrounding neighborhood and the school.

Now, Eryuan county government is considering building a new sanitary landfill in Shanglongmen, which is located in the southwest of Eryuan. With special considerations on location choice and necessary equipments, this new landfill infrastructure will have no negative impacts on the health of the nearby residents, nor on local environment. At the same time, besides continuing the collection of the solid wastes of Eryuan county town, the new project will also expand the solid waste collection and disposal service to cover Sanyingxiang,

[13] The major intention in doing so is to minimize the potential interviewer bias. The interviewers read another copy of identical questionnaire to the respondents, but cannot directly work on the questionnaire that a respondent is working on, and the respondents do not need to speak out their answers to the interviewers. But just like with a mail survey, the final quality of the questionnaire completion cannot be controlled by the enumerators.

Niujiexiang and Fengyuxiang. In these areas, the necessary equipments will be installed to facilitate daily solid waste collection and disposal.

To realize this SWM project, Eryuan government is exploring various financial channels. However, the current situation is that, unless it receives financial support from the local residents like your, the new project will not be implemented. The Eryuan government is considering collecting a monthly fee of solid waste collection and disposal from the local households like yours. This fund will be collected and managed by the related governmental department. It will be solely used for the above-mentioned new project and the fund use will be reported publicly to the local residents periodically.

Now, suppose the local residents like you have an opportunity to vote on whether or not to implement such a SWM project. If most people support the project, the project would be implemented and every household would need to pay a certain solid waste collection and disposal fee to support the construction and daily operation of the facilities. If the majority of local residents were against the project, the project would not be implemented and the residents would not need to make additional payment but the living environment would not be improved and even be further deteriorated.

Now, we want to know the possibility for your household to support this project and make a certain payment each month. Please compare the amount you are willing to pay with the bids shown in the following table and choose a possibility that best describes your willingness to support the project at each of the bids listed below.

	Definitely yes	Probably yes	Not sure	Probably not	Definitely not
Free (0 yuan)					
3 yuans					
5 yuans					
10 yuans					
15 yuans					
20 yuans					
25 yuans					
30 yuans					
40 yuans					
50 yuans					
60 yuans					
70 yuans					
80 yuans					
90 yuans					
100 yuans					
150 yuans					
200 yuans					
250 yuans					
300 yuans					
350 yuans					
400 yuans					
450 yuans					
500 yuans					

Three follow-up questions are also asked. One question concerns the reasons if one refuses to support the project even at the price of zero. The second is to investigate the reasons why one is willing to pay 500 yuans. Another question checks respondents' expectations on the level of easiness of realizing the environmental objective of the project.

4.2 Survey Statistics

The responses to the questions concerning current situation of solid waste collection and disposal service show that people think the solid waste is causing serious problems in this county. Over 85% of the respondents mentioned the solid waste problem in their neighborhood to be one of the most urgent environmental problems. 70% of the respondents mentioned the trash problem to be one of the most urgent social problems. 66% of the respondents believe the residential solid waste to be a serious problem in Eryuan, among which 38% believe the problem to be very serious.

The survey also shows that Eryuan solid waste collection and disposal service lags significantly behind. 53% of the respondents, including all respondents in the three towns to be covered by the project, report that there are no solid waste collection and disposal activities in their neighborhood and another 21%, which are supposed to be covered by the old system, reported only irregular collection and disposal activities. Over 20% of the respondents believe their trash is only simply dumped and 42% do not know how their solid waste is treated.

The obvious lack of solid waste treatment service has caused negative impact on people located around the current solid waste dump site. 88% of the respondents believe the solid waste treatment project to be necessary and 94% of the respondents expressed their willingness to cooperate with the new project.

As shown in Table 2, 218 responses can be used for WTP estimations. Two observations have to be deleted as the respondents gave the same uncertainty responses to all of the proposed bid prices[14], and another observation has to be deleted from the analysis as it did not give a positive ("probably yes" or "definitely yes") answer even at the price of zero[15].

The statistics of the responses to the MBDC WTP question are summarized in Table 3. For each price listed in the questionnaire, the percentage of respondents who choose a specific likelihood answer are provided. In table 3, we can see that the percentage of "definitely yes" answers is decreasing rapidly from 99.54% at the price of zero to 0.97% at the price of 60 yuan. While the percentage of "definitely no" answers increases steadily with the price offered, from 0% at price of zero to about 99.54% when the price increases to 350 yuan. Between the prices of 5 and 30 yuan, 12 to 30% of the respondents chose the "probably yes/no" or "not sure" response options, showing the respondents actually have relatively important uncertainties in their preferences to the bid prices as proposed in the WTP question.

5. WTP Estimation

5.1 Estimation Methodology

Wang and He (2010) developed a new methodology for estimating and analyzing the MBDC valuation data, which is summarized below and will be used in this study. Suppose an individual i's WTP is V_i, which is a random variable with a cumulative distribution function

[14] The answers given by these two respondents for follow-up question shows that, one does not think he should pay extra fee and the other believe his household can handle their own trash. In some sense, these two answers can be regarded as protest response. Therefore we remove them from our following statistical analyses.

[15] From the response to the follow-up question, we find this household located close to the new landfill site. So his no-response can be considered as a protest.

F(t). The mean value of V_i is μ_i and the standard variance is σ_i. The WTP model can be written as,

$$V_i=\mu_i+\varepsilon_i \quad (1)$$

where ε_i is a random term with a mean of zero. Individual i knows his valuation distribution. When given a price t_{ij}, the probability for the person to say "yes" to the offered price, $t_{ij,}$ will be,

$$P_{ij} = Prob(Vi>t_{ij})=1-F(t_{ij}) \quad (2)$$

Once P_{ij}, the probabilities for individual i to agree to the price t_{ij}, is known to a researcher, either by assigning numerical values to the verbal MBDC data or by directly asking individuals of their numerical likelihood information as did with the SPC approach (Wang and Whittington, 2005), equation (2) can be estimated for each individual. The estimation model can be constructed as follows:

$$P_{ij} = 1-F(t_{ij}) + \lambda i \quad (3)$$

where λ_i is an error term with a mean of 0 and a standard variance of δ^2. δ can be constant for a respondent i, but are different for different respondents. P_{ij} is a dependent variable, which is the likelihood answer given by respondent i at price j. P_{ij} takes values between 0 and 1, and can be viewed as a continuous variable. t_{ij} is an independent variable, which corresponds to the bid price proposed in the questionnaire, and t_{ij} is also a continuous variable.

Assume a specific functional form for $F_i(\bullet)$, such as of a normal distribution, with a mean μ_i and a standard variance σ_i , i.e., $F(t_{ij})=\Phi(\frac{t_{ij}-\mu_i}{\sigma_i})$, then the model (3) becomes,

$$P_{ij} = 1-\Phi(\frac{t_{ij}-\mu_i}{\sigma_i}) + \lambda_i \quad (4)$$

The major purpose is to estimate and analyze μ_i, the mean value of V_i for each respondent, which is a function of personal information such as personal characteristics and uncertainties, etc. A two-stage approach proposed by Wang and He (2010) to estimate the equation (4)[16]can be summarized in the following.

<u>Stage 1: Estimate equation (4) for each individual i</u>

Assume λ_i has a normal distribution. Then,

$$\frac{Pij-1+\Phi(\frac{tij-\mu i}{\sigma i})}{\delta} \sim N(0, 1).$$

The log likelihood function then is:

[16] In contrast to the estimation model presented in Wang and Whittington (2005), the equation (4) adds an error term to the probability model, which reflects the consideration that the probability values given by respondents may have deviations from their valuation distributions.

$$\text{Log Li} = \sum_{j=1}^{J} \log \phi\left(\frac{Pij - 1 + \Phi\left(\frac{tij - \mu i}{\sigma i}\right)}{\delta}\right) \quad (5)$$

where $\phi(.)$ is a standard normal distribution probability density function. This is equivalent to a least square nonlinear estimation; δ has no influence on the estimation, as long as it's a normal distribution. With a log likelihood function (5), μ_i can be estimated for each individual i.

Stage 2: Analyze determinants of μ_i

Once μ_i is estimated for each individual, models can be constructed and estimated to analyze their determinants. One simple example is to have the following log linear functional form:

$$\text{Log}(\mu_i) = \beta 0 + xi'\beta + e \quad (6)$$

where x is a vector of personal specific variables such as the personal characteristics and uncertainties, etc. $\beta 0$ and β are coefficients to be estimated; e is a random error which reflects uncertainties that a researcher has and can be homogeneous.

5.2 Estimation Results

In doing the analyses, for each of the 218 valid responses, the redundant answers are first identified and deleted. Redundant answers include those answers to the prices higher than the price where a first "definitely no" answer is given and those answers to the prices lower than the price where a last "definitely yes" answer is given. For each person, there are 2 to 23 answers kept for analyses. Model (4) is first estimated by maximizing the log likelihood function (5) and a mean value estimate of individual WTP distribution is obtained for each respondent. The benchmark verbal likelihood recoding strategy for the analysis is a symmetrical one, with 0.999 for "definitely yes," 0.75 for "probably yes," 0.50 for "not sure," 0.25 for "probably no," and 0.001 for "definitely no". [17]

Table 4 gives the estimation results of mean WTP values. The sample average of the mean WTP is 17.1 yuan and the sample medium value is 12.8 yuan[18]. Table 5 gives more detailed WTP mean and standard errors for respondents of different locations and different income levels. Clearly, the mean value of the estimated WTP depends on both the income level and the location of the respondents. Poor households and those living close to the current trash dumping site have in general lower WTPs in absolute terms but higher WTPs relative to their incomes. The poor households with an annual income lower than 4000 yuan are willing to pay 5.28% of their income for the trash collection and disposal services, while the number for those rich households with an annual income higher than 40000 yuan is only 0.48%.

[17] The values of 1 and 0 cannot be used to recode the answer "definitively yes" and "definitely no" because normal distributions are assumed in the analyses. Wang and He (2010) tried other encoding strategies and found the estimation results were relatively stable if a symmetrical encoding strategy was used.

[18] One respondent gave a "probably yes" answer to the price of zero and the model gives a negative WTP estimate. This should be caused by the assumption of normal distribution, and a zero WTP should be assumed. But this person cannot be included in the final modeling process because of the log transformation.

It is found, surprisingly, that the average WTP of those poor households located in where no trash collection services are provided is higher than that of the mid income group and the rich households, even though the differences may not be statistically significant. See table 5, column "new coverage". This could imply that the poor is really suffering from the trash problems while the rich may have installed some private coping strategies.

WTP determinants are analyzed with the social, economic and demographic characteristics of each respondent. Table 6 gives the definition and the statistics of the major variables used in this analysis. Among the 214 observations finally used in the second-stage estimation, the respondents from the neighborhood of the existing dump site and the new coverage (Sanyingxiang, Niujiexiang and Fengyuxiang) are respectively 17.1% and 51.4% in the total sample. Male respondents take up 60% of the sample.[19] The average age is 37.6 years, with the youngest respondent aging at 17 and the oldest at 78. The average household annual income is about 22,332 yuan and the average family size is 4.6 persons. About 16% of respondents have received university level education. Over 9% of the households expect their household incomes to reduce in the next 5 years. Over 77% of the respondents made donation to social charities in the past. Over 85% of the respondents indicated that the solid waste management problem was one of the three most important environmental problems in Eryuan, and about 13% of the respondents believed that it was solely the responsibility of the government to resolve this problem. 65% of the respondents reported serious solid waste problems in their own neighborhood. Only 43% of the respondents received regular solid waste collection and cleaning services. Most of the respondents showed high confidence in the project proposed in the survey: about 74% of them believed the project can be implemented and only 9% thought they would not be satisfied even if the new project was implemented.

The detailed econometric estimation results are presented in Table 7. Log linear functions are specified for the individual mean WTP value (μ). Five estimation results are presented, where additional independent variables are added into the estimation gradually. Model (1) presents only the correlation between individual mean WTP value and the respondents' demographical, economic and social characteristics. Model (2) includes the environmental attitudes of the respondents as independent variables. Model (3) further includes the variables describing the current trash situation in their neighborhood and the geographical location of the respondent with respect to the trash collection service proposed by the new project. In Model (4), several other variables related to the respondents' attitudes towards the proposed project are also included in the estimation. Finally, in Model (5), we explore the potential differences of certain determinant variables with different income groups.

The results of Model (1) show that the respondents with higher household incomes and expecting no reductions in future income are in general willing to pay more for the project. More precisely, 1% increase in household income can bring an increase of about 0.29% in WTP. Other variables do not have significant correlations with WTP.

The attitudes of the respondents towards the current environmental and social problems in Eryuan (the three variables entering in the estimation in model (2)) seems to have significant impacts on the WTP value. As expected, a respondent who made donation to social charities before is willing to pay more for the project. The respondents who cited the solid waste problem as one of the most serious environmental problems in Eryuan have a tendency to pay

[19] The decrease of the sample size (from 217 to 216) is due to the uncompleted information about family size of one respondent.

more. Those who believe that solving environmental problems in the region is solely the responsibility of the government are willing to pay less.

Model (3) further considers the possible impacts of respondents' current experiences of solid waste management services and their geographical location. The respondents living in the towns where the trash collection service is currently unavailable but will be offered in the new project are willing to pay significantly less. This result is possible and can be explained by their non-experience of such a service. This phenomenon can also find their evidence from the positive and significant coefficient associated to the variable *current cleaning services*: having the experience of regular solid waste collection services seems to increase the WTP. A positive but not significant coefficient is found for the dummy variable "Trash Site", which could imply that people living close to the currently existing trash dumping station are willing to pay more because there would be less trash dumping in the future after the new project is implemented. One counter-intuitive finding with this model is the negative coefficient (non-significant) for the dummy variable *Solid Waste Problem Serious around house*, which seems to suggest that people considering the solid waste problem around their house to be serious are willing to pay less. We will explore on this variable further below.

The results obtained in Model (4) reveal that the attitude that a respondent has towards the proposed new project also affects his/her WTP. We can expect that the respondents who have confidence in the realization of the project are in general willing to pay more, and that those respondents expressing their non-satisfaction with the project are willing to pay less for the project.

Considering the potential differences in the impacts of certain variables on WTP between respondents of different income groups, we further include multiplicative terms of income group dummies (*Rich*, *Mid* and *Poor*) with the seriousness of the solid waste problems around houses, with the access to solid waste cleaning service, and with the geographical location variables. The respondents are considered as rich when their annual household income is over 40 000 yuan and as poor when their annual household income is below 4000 yuan. By this classification, we have about one quarter of the respondents as rich, one quarter as poor, and 50% as middle income respondents with their annual income ranging between 4 000 – 40 000 yuan. The inclusion of the multiplicative terms provides some interesting findings which can not been seen with previous models. Firstly, the counter-intuitive negative coefficient of s*olid waste problem serious around house* can be better understood. Clearly, this negative coefficient principally comes from the rich respondent. While facing a serious solid waste problem around the house, a rich household may be able to take some necessary private measures to protect themselves, and therefore the needs for public intervention will be less for the rich households. A similar reasoning may also be used to explain the results of the interaction of income with *new coverage*, where no public trash services are available. Significant negative coefficients are obtained for both rich and mid-level income respondents, while the poorest 25% of the respondents has a positive coefficient. This implies that in the areas of new coverage, the poor households are willing to pay more for public solid waste management services. This might also be due to the fact that the poorer households, lacking of financial capacity to equip themselves with private trash collection services, may expect more benefits from the proposed project. Statistically insignificant coefficients are found again for the variables of *trash site* interactions with income.

6. Conclusion and Discussion

This paper reports a contingent valuation study on households' willingness to pay (WTP) for improved municipal solid waste management (SWM) services in four small towns located in Eryuan county, Yunnan Province, China. This study is based on an actual investment project proposal, which seeks financial support from the World Bank. A multiple bounded discrete choice (MBDC) contingent valuation survey was developed and implemented in July 2007, to systematically collect households' preference information over the possible SWM services and the associated costs. It is expected that the potential hypothetical bias and uncertainty bias associated with the contingent valuation approach have been kept to the minimum.

This study finds that on average a household in Eryuan is willing to pay about 17 yuan per month for its solid waste collection and disposal, with a median value of 13 yuan. This WTP can barely cover the project cost, if the payments can be properly collected. Assuming the estimated WTP of the households in Eryuan to be the total value of the project benefits, the economic internal rate of return (EIRR) of the project is found to be about 5%, which is low but can still justify for project implementation, especially when considering the fact that the WTP value provided in this study is a conservative estimation[20].

The mean WTP estimated in this study is about 1% of the household income. This result is within the range found in other developing countries, which is higher than the estimations obtained in Pakistan (0.2-0.3%), Malaysia (0.6-0.9%), Lithuania (0.1%), and Bangladesh (0.1%), but lower than the estimations obtained in Tonga (1.6-3.1%) and Nigeria (1.7%). However, the poorest households in Eryuan, which have an annual income lower than 4000 yuan and account for about 25% of the total population, are willing to pay more than 5% of their income for their solid waste disposal. This implies that the poor households in Eryuan have very strong demands for public solid waste management services.

Further analyses of the survey data show that the poor households may have stronger demand for the proposed improved SWM service than rich ones, not only in a relative sense to their incomes but also in absolute WTP values. In the areas of new coverage where no public SWM services are available, the marginal WTP of the poor households is significantly higher than that of the middle income and rich households, according to the econometric analyses, and the average WTP of the poor households is also higher, even though the differences may not be statistically significant. One reason could be that the poor households in those areas were suffering seriously from the solid waste problem, while the rich ones had private coping measures.

A consistent phenomenon is also found about the rich households in Eryuan. If there have been regular solid waste cleaning services in their neighborhood, they are in general willing to pay more for the proposed SWM project. If the solid waste problems around their houses are thought to be serious, they are willing to pay less for the proposed project. This may be understood as if the rich households have already taken some private preventive measures on the solid waste problems around their houses when the problems are thought to be serious, and therefore the potential benefits that they can enjoy from the proposed improved SWM project are reduced.

Among household and individual characteristics, income is found to be a dominant determinant of WTP for SWM services, with an elasticity of 0.22. As expected, those who

[20] The WTP estimated in this study is only the total value of perceived benefits of those households located in the project area. Methodologically, the MBDC design, which starts the bid from the lower end of the payment card, also produces a conservative estimation of WTP.

had provided donations to public charities before or who thought that solid waste was one of the top environmental problems are willing to pay more for the project implementation, and those who thought solving the solid waste problem should be solely the responsibility of the government are willing to pay less. Those who have greater trust that the project will finally be implemented or who are more satisfied with the project outcomes are willing to pay more.

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Table 1. A Review of Contingent Valuation Studies on SWM

Authors	Country / City	Sample / Survey Method	Project valuated	WTP question format	Reported WTP (per household per month)	Annual WTP	Mean annual household income	WTP's % of income	Exchange rate (for 1 US$)
Altaf and Deshazo (1996)	Gujranwala, Pakistan (1990)	In-person questionnaires in 968 households	Municipal waste collection and disposal	Two-step dichotomous choice	8.04 - 11.20 Rs	96.48 - 134.40 Rs	39,600 Rs	0.2-0.3	19.75 Rs
Sterner and Bartelings (1999)	Tvaaker, Sweden (1994)	Questionnaires mailed to nearly 600 households	Municipal Waste Disposal, Recycling, Composting	Open-ended	N/A	420 SEK	280,000 SEK	0.2-0.9	N/A
Othman (2002)	Kajang and Seremban, Malaysia (2001)	In-person survey in two samples of 582 households (582 valid)	Improved waste management	Dichotomous choice	Mandatory separation: 22 MYR; w/o mandatory separation: 30 MYR	264 - 360 MYR	41,112 MYR	0.6-0.9	3.75 MYR
Bluffstone and DeShazo (2003)	Ukmerge, Lithuania	In-person survey in 775 households	Improved landfills	Open-ended	N/A	1.70 Euros	2,184 Euros	0.1	0.91 Euros
Huang and Ho (2005)	Taichung City, Taiwan, China (2004)	Questionnaires mailed to 220 random households (205 valid)	Waste clearance and disposal	N/A	112.97 NT$	1,355.64 NT$	720,000-960,000 NT$	0.14-0.19	About 32 NT$
Jin et al (2006)	Macao, China (2004)	In-person survey in 260 households (252 valid)	Improved solid waste management program	Two-step dichotomous choice	19.20 MOP	799.29 MOP	219,976.20 MOP	0.4	8.00 MOP
Lal and Takau (2006)	Tongatapu, Kingdom of Tonga (2005)	In-person questionnaire	Solid waste collection and disposal system	Two-step dichotomous choice	13.43 $	161.20$	5,200$ - 10,400$	1.6-3.1	N/A
Fonta et al (2007)	Enugu City, Nigeria (2003)	In-person survey in 200 households (182 valid)	Collection of solid waste from residential areas	One-step dichotomous choice followed by open-ended question	230.35 Naira	2,764 Naira	151,320 Naira	1.8	About 130 Naira
Afroz et al (2009)	Dhaka City, Bangladesh (2006)	In-person survey in 480 households:(456 valid)	Improved waste collection and recycling system	Two-step dichotomous choice	13 Taka	156 Taka	144,000 Taka	0.1	70 Taka
Ichoku et al (2009)	Enugu City, Nigeria (2003)	In-person survey in 200 households (197 valid)	Collection of solid waste from residential areas	Payment card	215 Naira	2,580 Naira	151,320 Naira	1.7	About 130 Naira

Table 2. Valid Responses to MBDC Questions

	Obs.	Percents
Total valid responses	218	98.65
Total invalid responses	3	1.35
Always "definitely yes"	0	0
Always "probably yes"	0	0
Always "Not sure"	1	0.45
Always "probably no"	1	0.45
Always "definitely yes"	0	0
Negative answer at price of zero	1	0.45
Positive answer at price of 500 yuan	0	0
Total	**221**	**100.00**

Table 3. Responses to the Likelihood Questions (%)

Price	Definitely Not	Probably Not	Not sure	Probably Yes	Definitely Yes	Total
0	0.000	0.000	0.000	0.459	99.541	100
3	1.835	1.376	0.459	5.046	91.284	100
5	11.927	5.505	4.128	13.761	64.679	100
10	33.028	5.046	7.339	16.972	37.615	100
15	51.835	5.505	12.385	13.761	16.514	100
20	65.596	9.174	5.963	10.092	9.174	100
25	76.606	5.505	7.339	4.587	5.963	100
30	83.028	2.752	7.339	2.752	4.128	100
40	87.615	5.046	2.294	2.752	2.294	100
50	91.284	2.752	3.211	1.376	1.376	100
60	93.119	0.917	4.128	0.917	0.917	100
70	94.037	0.917	4.128	0.000	0.917	100
80	94.495	0.917	3.670	0.000	0.917	100
90	94.495	1.835	2.752	0.000	0.917	100
100	96.789	0.917	1.376	0.000	0.917	100
150	98.165	1.376	0.459	0.000	0.000	100
200	98.165	1.376	0.459	0.000	0.000	100
250	98.624	0.917	0.459	0.000	0.000	100
300	99.083	0.917	0.000	0.000	0.000	100
350	99.541	0.459	0.000	0.000	0.000	100
400	99.541	0.459	0.000	0.000	0.000	100
450	99.541	0.459	0.000	0.000	0.000	100
500	99.541	0.459	0.000	0.000	0.000	100
Total	**76.865**	**2.373**	**2.952**	**3.151**	**14.659**	**100**

Table 4. WTP Estimation

Variable	Obs	Percentile	Centile	[95% Conf.	Interval]
Mean WTP	217	0	1.49	1.49	1.49
		10	4.40	4.40	4.64
		20	5.00	4.64	6.07
		30	8.25	5.56	8.33
		40	9.48	8.25	10.90
Mean :	17.1 yuan	50	12.84	10.15	13.96
Stand. Err.	20.9 yuan	60	14.32	13.63	15.59
		70	16.01	15.00	18.98
		80	20.95	18.04	25.42
		90	32.814	25.97	40.92
		100	200.00	200.00	200.00

Table 5. WTP by Income and Location

Income (yuan)	Location:	Currently Served (Cibixiang)	Current Trash Site	New Coverage	Total
Poor :	WTP	17.44	12.40	13.81	14.17
<4000	STD. Err.	21.78	7.85	17.07	16.31
	Num. obs	10	12	31	53
% of household income		6.6	4.32	5.28	5.28
Mid Income:	WTP	17.79	12.43	11.58	13.47
4000-40000	STD. Err.	16.38	5.52	8.33	11.06
	Num. obs	32	22	61	115
% of household income		1.68	1.20	1.08	1.20
Rich :	WTP	39.96	16.29	13.28	27.92
> 40000	STD. Err.	42.53	7.85	9.57	34.26
	Num. obs	26	3	19	48
% of household income		0.60	0.48	0.24	0.48
Total :	WTP	26.21	12.73	12.50	16.86
	STD. Err.	31.33	6.24	11.55	20.52
	Num. obs	68	37	111	216
% of household income		0.84	1.32	0.84	0.96

Table 6. Major Variables Used in WTP Analyses

Variable	Explanation	Mean	Std. Dev.	Min	Max
Individual mean WTP (estimated)	Estimated individual mean WTP by the first-stage maximum likelihood estimation	16.88	20.60	1.49	200
Education	university diploma, yes=1, no=0	0.16	0.37	0	1
Male	sex: male=1 female=0	0.60	0.49	0	1
Age	age (years)	37.57	11.39	17	78
Farmer	Houshold head's profession : farmer=1, other=0	0.44	0.50	0	1
Married	marital situation (married=1, other=0)	0.88	0.32	0	1
Houshold income	Household income (yuan) in 2006	22332.36	33749.19	500	200000
Family Size	Family size (person)	4.59	1.74	1	15
Income decrease	Do you expect your household income to decrease in future 5 years ? Yes=1, no=0	0.09	0.29	0	1
Donation in the past	Donation for social charity before? (yes=1, no=0)	0.77	0.42	0	1
Important	Solid waste considered as one of the three most important environmental problem: yes=1, no=0	0.85	0.36	0	1
Government responsability	Do you think environmental problems should only be resolved by government? yes=1, no=0	0.13	0.33	0	1
Serious around house	Is the trash problem around your house serious? (yes=1 no=0)	0.65	0.48	0	1
Current cleaning services	Is there regular trash cleaning activities in your neighbourhood? (yes=1, no=0)	0.43	0.50	0	1
Not satisfied	Are you satisfied with the results of the proejct? (no=1; 0=yes)	0.09	0.29	0	1
Project implement	Do you think the project will finally be implemented? (yes=1, no=0)	0.74	0.44	0	1
Trash site	1= respondents living close to the existing trash dumping station; 0=otherwise	0.17	0.38	0	1
New coverage	1= households which were not covered by the existing system but will be covered by the new project; 0=otherwise	0.51	0.50	0	1
Rich	1= income equal or over 40 000 yuan per year; 0=otherwise	0.22	0.41	0	1
Midincome	1= income between 4000 and 40 000 yuan per year; 0=otherwise	0.54	0.50	0	1
Poor	1= income under or equal to 4000 yuan per year; 0=otherwise	0.24	0.43	0	1

Table 7. WTP Analyses

	Log (mean WTP)				
	(1)	(2)	(3)	(4)	(5)
Education	0.167	0.063	0.015	0.008	0.102
	(0.94)	(0.35)	(0.09)	(0.04)	(0.56)
Male	0.143	0.112	0.159	0.156	0.121
	(1.18)	(0.95)	(1.36)	(1.36)	(1.02)
Age	-0.004	-0.002	-0.004	-0.004	-0.005
	(0.77)	(0.41)	(0.68)	(0.81)	(1.01)
Farmer	0.010	-0.013	-0.011	-0.003	-0.131
	(0.09)	(0.11)	(0.08)	(0.02)	(0.97)
Married	-0.125	-0.169	-0.068	-0.064	-0.075
	(0.61)	(0.85)	(0.36)	(0.34)	(0.40)
Log (Household income)	0.290	0.247	0.230	0.219	0.238
	(11.45)***	(8.97)***	(7.78)***	(6.99)***	(6.94)***
Family size	-0.022	-0.030	-0.005	0.000	0.001
	(0.70)	(1.02)	(0.17)	(0.02)	(0.05)
Income decrease	-0.362	-0.428	-0.311	-0.231	-0.361
	(1.94)	(2.34)**	(1.63)	(1.19)	(1.90)*
Donation in the past		0.254	0.302	0.280	0.211
		(1.96)*	(2.37)**	(2.15)**	(1.57)
Important		0.373	0.388	0.374	0.332
		(2.63)***	(2.67)***	(2.63)***	(2.30)**
Government responsibility		-0.380	-0.335	-0.345	-0.321
		(3.04)***	(2.53)**	(2.54)**	(2.69)***
Serious around house			-0.092	-0.096	
			(0.80)	(0.84)	
Current cleaning services			0.260	0.244	
			(1.99)**	(1.90)*	
Trash site			0.061	0.053	
			(0.38)	(0.32)	
New coverage			-0.288	-0.332	
			(2.14)**	(2.44)**	
Not satisfied				-0.226	-0.272
				(1.48)	(1.78)*
Project implement				0.234	0.170
				(1.80)*	(1.32)
Rich×Serious around house					-0.753
					(3.82)***
Mid× Serious around house					0.054
					(0.35)
Poor× Serious around house					-0.132
					(0.64)
Rich×Current cleaning services					0.672
					(3.40)***
Mid×Current cleaning services					0.067
					(0.46)
Poor× Current cleaning services					0.337
					(1.09)
Rich×trash site					-0.311
					(1.11)
Mid×trash site					0.093
					(0.53)
Poor×trash site					0.388
					(1.36)
Rich×new coverage					-0.355
					(1.91)*
Mid×new coverage					-0.386
					(2.27)**
Poor×new coverage					0.200
					(1.03)
R-Squared	0.91	0.92	0.92	0.92	0.94
F statistics	270.80	213.65	197.72	177.65	178.63
Robust t statistics in parentheses. * significant at 10%;** significant at 5%; ***significant at 1%.					

Figure 1. The Geographical Location of the Project