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RESEARCH REPORT

No. 2004-RR4

Impacts of Units Pricing of Solid Waste Collection and Disposal in Olongapo City, Philippines

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This report provides information on the impact of a unit pricing scheme for domestic solid waste collection and disposal in Olongapo City, the Philippines. It investigates how the amount of waste households produce changes if they are charged a collection rate dependent on the number of bags of garbage they produce. It investigates how such a scheme would affect both the overall volume of waste produced in the city and the overall cost of managing this waste.

Shifting from the current flat rate to unit pricing of solid waste in Olongapo City would increase waste recycling and create welfare gains. The amount of waste that would have to be disposed of by burning or landfill would go down, as would the size of most household's waste bills. The report recommends that the city should be adopted in similar metropolitan areas across the country.

Published by the Economy and Environment Program for Southeast Asia (EEPSEA)
Tanglin PO Box 101, Singapore 912404 (www.eepsea.org)
tel: +65-6235-1344, fax: +65-6235-1849, email: eepsea@idrc.org.sg

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National Library of Canada cataloguing in publication

Bennagen, Ma. Eugenia C. (Maria Eugenia C.)

Impacts of unit pricing of solid waste collection and disposal in
Olongapo City, Philippines

(Research report, ISSN 1608-5434; 2004-RR4)
Co-published by the International Development Research Centre.
ISBN 1-55250-122-1

1. Integrated solid waste management – Economic aspects -- Philippines –
Olongapo.
2. Waste minimization – Economic aspects -- Philippines – Olongapo.
- I. Altez, Vincent.
- II. Economy and Environment Program for Southeast Asia.
- III. International Development Research Centre (Canada)
- IV. Title.
- V. Series: Research report (Economy and Environment Program for Southeast
Asia) ; 2004-RR4.

TD789.P6B36 2004

363.72'856'09599

C2004-980221-6

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**IMPACTS OF UNIT PRICING OF SOLID WASTE COLLECTION
AND DISPOSAL IN OLONGAPO CITY , PHILIPPINES**

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March 2004

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EEPSEA is supported by the International Development Research Centre (IDRC); the Swedish International Development Cooperation Agency (Sida); and the Canadian International Development Agency (CIDA).

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ACKNOWLEDGEMENT

This study was made possible through a research grant from EEPSEA to the Resources, Environment and Economics Center for Studies, Inc. (REECS) which the authors gratefully acknowledge.

The authors also acknowledge with much appreciation the guidance and support throughout the project of Dr. Benoit Laplante, EEPSEA resource person, and to the following for their valuable support and comments on the various drafts: Dr. David Glover, Dr. Hermi Francisco, and Dr. Aleta Domdom.

Our sincerest appreciation to Mayor Kate Gordon of Olongapo City for the support and cooperation provided to this project through her following staff: Mr. Dante Ramos, head, of the Environmental Sanitation and Management Office and his technical staff, Wency, Lorie and Ernie; Ms. Elizabeth Zavalla, the City Planning Administrator and her staff; and the staff of the budget and accounting office.

We also wish to gratefully acknowledge the cooperation of our household respondents who provided us with most of the information and data used in this study.

As in the past EEPSEA researches of the principal author, special thanks to Mr. Jose Logarta Jr. whose inputs throughout the project were very much appreciated.

Finally, but not the least, to the people at REECS for their support and friendship.

Table of Contents

Executive Summary.	1
1.0 INTRODUCTION.....	1
2.0 CONCEPTUAL FRAMEWORK.....	3
3.0 REVIEW OF LITERATURE	5
3.1 External Costs of Solid Waste Management	5
3.2 Impact of Unit Pricing on Quantity of Waste Discarded	5
3.3 Welfare Gains from Unit Pricing	6
4.0 CURRENT SWM SYSTEM IN OLONGAPO CITY: FOCUS ON COST STRUCTURE.....	7
4.1 Brief Description of SWM	7
4.2 Private Costs of SWM	7
4.3 SWM Unit Costs	8
4.4 External Costs of SWM.....	8
5.0 THE SOCIO-ECONOMIC SURVEY.	9
5.1 Sampling Design and Survey Questionnaire	9
5.2 Socio-economic Characteristics and Solid Waste Management Practices of Sampled Households	9
6.0 THE EXPERIMENT.....	14
6.1 Experiment Design.....	14
6.2 Results of the Experiment	16
6.2.1 Overall results of waste measurements	16
6.2.2 Disaggregating the reduction in non-recyclable wastes	18
6.2.3 Estimating the household response to the incentive	20
6.2.4 Estimating the impact on waste diversion and on disposal costs	22
6.2.5 Estimating the welfare gains and effects of changes in unit price	24
7.0 PROPOSED UNIT PRICING SYSTEM FOR OLONGAPO CITY.....	25
7.1 Basic Elements of a Unit Pricing System.....	25
7.2 Basic Design of a Unit Pricing System for Olongapo City.....	26
8.0 SUMMARY OF RESULTS	28
9.0 POLICY RECOMMENDATIONS.....	30

List of Tables

Table 1	Cost Structure of SWM Collect and Dump System and Waste Generation, Olongapo City, 1997 and 2001 (in million Php).
Table 2	SWM Unit Costs, Olongapo City, 2001 (in Php).
Table 3	Household Socio-Economic Characteristics by Population Density, Olongapo City.
Table 4	Solid Waste Management Practices by Population Density, Olongapo City.
Table 5	Household Response to Different Aspects of Solid Waste. Management by Population Density, Olongapo City.
Table 6	Comparison of Waste Generation during Baseline and SUP Periods.
Table 7	Household Waste Composition during Baseline vs. Simulated Unit Pricing (SUP), Olongapo City, 2003.
Table 8	Comparison of Non-recyclable Waste Reduction by Group.
Table 9	Post-experiment Evaluation Results.
Table 10	Description of Variables Used in Regression.
Table 11	Regression Results with Non-recyclable Waste as Dependent Variable.
Table 12	Expected Direction of Costs, Revenues and Waste Tonnage Under Unit Pricing System.

List of Figures

Figure 1	The Demand Curve for Residential Solid Waste Services.
Figure 2	Experiment Design.
Figure 3	Waste Generation by Waste Type during Baseline vs. SUP, Olongapo City.

List of Appendix Tables

Appendix Table 1	SW Collection and Disposal Service Cost based on Full Cost Accounting, Olongapo City, 1997-2001
Appendix Table 2	Computation of SWM service cost per bag, Olongapo City, 2001.
Appendix Table 3	Olongapo City Demographic Profile and Survey Sample Size.
Appendix Table 4	Double Log Regression Results.

IMPACTS OF UNIT PRICING OF SOLID WASTE COLLECTION AND DISPOSAL IN OLONGAPO CITY, PHILIPPINES ¹

Ma. Eugenia C. Bennagen and Vincent Altez

EXECUTIVE SUMMARY

This study examines the potential impacts of the unit pricing of solid waste collection and disposal on the solid waste management system of Olongapo City. Currently, the city is under a flat garbage fee regime that has been implemented by the local government since 1989.

Under unit-based or quantity-based pricing systems, waste generators are charged based on the quantity of wastes they dispose of. The system, in principle, provides incentives for waste reduction and diversion since waste generators who dispose of more garbage have to pay more, and those who dispose of less garbage, pay proportionally less. Moreover, when the unit price reflects the marginal social cost of waste collection and disposal, there are potential welfare benefits to be gained from shifting to such a pricing program.

A unit pricing system was tested in Olongapo City in order to examine how households respond to incentives to reduce the quantity of wastes they dispose of and to estimate the welfare gains it would produce. The system tested resulted in a 24 percent reduction in the household production of non-recyclable wastes and generated an annual disposal cost saving of PHP3.1 million. The potential welfare gains for the city associated with such a unit pricing system were estimated to be almost Php 10.0 million annually.

The report recommends that the city should implement such a scheme and makes suggestions for how it should be organized and structured. It also recommends that such a system may be adopted subsequently in similar metropolitan areas across the rest of the country.

1.0 INTRODUCTION

Unit pricing of solid waste collection and disposal, more popularly known as pay-as-you-throw or pay-per-bag, is a solid waste management approach that aims to reduce the amount of wastes discarded by people. In principle, this approach provides incentives for waste reduction and diversion since the less garbage people discard, the less they have to pay. Empirical studies in the U.S.A., where such a system is implemented in over 4,000

¹ This research was funded by the Environment and Economy Program for Southeast Asia (EEPSEA). Unit pricing of solid wastes in this study refers to the pricing of solid waste collection and disposal services in terms of volume or weight. The terms “non-recyclable wastes”, non-recyclables” and “garbage” are used interchangeably to refer to the wastes that a household disposes for collection, after separating wastes that can be reused such as food and yard wastes, plastics, paper, and others. These reusable wastes are referred to in the report as recyclables. The terms “dispose” and “discard” are also used interchangeably.

communities, indicate that unit pricing programs have resulted in waste diversion and welfare gains (Kinnaman & Fullerton 2000).

In the Philippines, and in most developing countries, the pricing of garbage collection and disposal is not widely practiced. In the areas where it is implemented, local governments, who traditionally have responsibility over solid waste management, apply it exclusively to the commercial or business sector. Yet, domestic or household garbage accounts for 60-70 percent of the total amount of garbage produced in these countries. There are very few local governments that charge households for the solid waste collection and disposal services they provide. Those that do, charge the fee as part of an annual property tax or collect a flat monthly fee. Such a system discourages the efficient disposal of waste products since households pay the same fee regardless of the amount of garbage they throw out. Their marginal or incremental waste disposal cost is therefore zero.

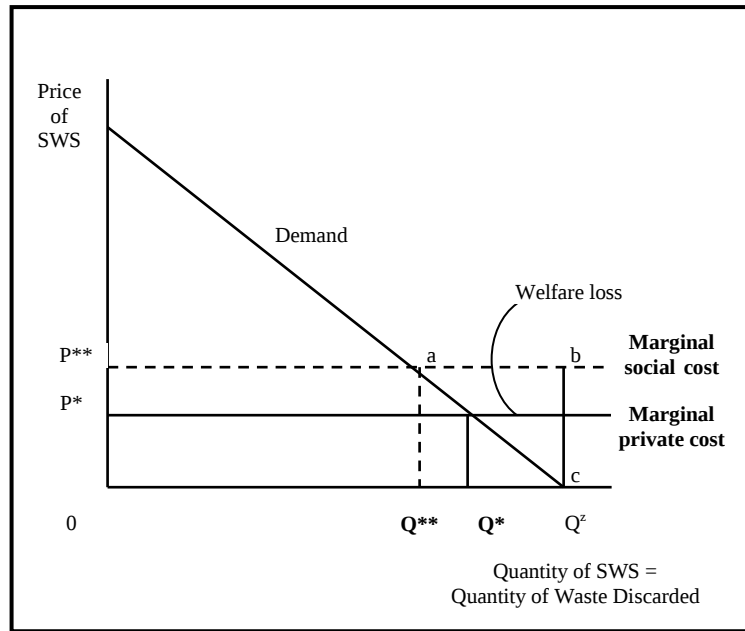
The almost total absence of unit pricing programs in developing countries may be largely due to the lack of information on their benefits. This research aimed to fill this information gap and to demonstrate the potential waste diversion and welfare gains such systems could bring to developing countries. To do this, an experiment was conducted in Olongapo City, an urbanizing area north of Metro Manila. The experiment tested a unit pricing system to see how households respond to incentives designed to encourage them to reduce the amount of garbage they discard. The main hypothesis of the research was that the introduction of unit pricing brings aggregate social benefits to a community.

The report is organized as follows: Section II briefly discusses the conceptual framework of the research. This is followed by a review of relevant literature in Section III. Section IV contains a discussion of the solid waste management system of Olongapo City. Section V discusses the methodology and results of the socio-economic survey that was used to collect household baseline information. Section VI discusses the main experiment design and analyzes its results. A brief proposal for a two-tiered unit pricing system in Olongapo City is discussed in Section VII. The last two sections contain a summary of the major findings of the study and some policy recommendations.

2.0 CONCEPTUAL FRAMEWORK

Figure 1 shows a downward sloping demand curve for solid waste collection services (SWS). Demand for SWS, measured in terms of quantity of waste discarded, increases as price decreases. In most cases in the developing world, and also in developed countries in the recent past, households pay a flat fee and therefore face a zero marginal or incremental cost of SWS. Under a flat-fee pricing scheme, households will generate inefficiently high levels of garbage. This is shown in Figure 1 where households paying a flat fee face a zero price for increments in collection services, thus, demand for SWS or quantity of waste discarded will be at Q^z .

Figure 1. The Demand Curve for Residential Solid Waste Services (SWS).



Source: Jenkins, R. R. (1993), with modifications.

With the introduction of marginal or incremental pricing of SWS, households will now be charged a price per unit of SWS, say, P^* . Note that with marginal pricing, the demand for SWS shifts to the left and is now at Q^* . The demand for SWS, as measured by the quantity of household waste discarded, declines with a price increase in SWS.

For economic efficiency, it is not sufficient that only the private cost of SWS is reflected in the price or marginal cost function. There are a number of externalities related to SWS, such as public health risks, groundwater pollution and foul odors. When these are considered, there is a divergence between the private cost of providing the services and the cost that these services impose on society at large.

The price, P^* , should therefore incorporate not only the private cost of SWS, but also the external cost. In Figure 1, when the marginal external cost of SWS is reflected in the pricing of SWS, at P^{**} , the SWS demand shifts further to the left, at Q^{**} . This results in a further decline in the quantity of wastes discarded. Thus, for efficiency or optimality, the price per unit charged to households should reflect the social cost of SWS. This includes both the private and the external cost.

At Q^z , the quantity of waste discarded is beyond the optimal level. The cost to society of disposing of that quantity of waste is therefore greater than the benefit that households gain from having it discarded. The triangle ***abc*** represents the welfare loss to society under a zero marginal pricing regime. There is good evidence that the marginal social cost of SWS is significant.

3.0 REVIEW OF LITERATURE

3.1 External Costs of Solid Waste Management

There is limited information available on the external costs of solid waste collection and disposal. Using environmental life cycle and economic valuation methodologies, a European Commission study reported that the average net environmental cost of land filling (with no gas recovery) ranged from ECU 4/ton in the United Kingdom to ECU 20/ton in Greece. These estimated external costs increased total waste disposal costs in the UK by 15 percent and by 100 percent in Greece (Brisson 1997).

In order to estimate the user fee for solid waste collection and disposal in the U.S.A., Repetto et al. used the results of two studies that estimated the social costs of waste disposal (1992).² These costs included the risks of air and water pollution, along with noise, and other disamenities. Both studies found that, in the states they covered, the social costs of waste disposal into a lined landfill with leachate collection were of the same approximate magnitude as the private costs. Using these studies, the Repetto research assumed that non-market solid waste disposal costs are of the same magnitude as market disposal costs in all North American states.

3.2 Impact of Unit Pricing on Quantity of Waste Discarded

The field of market-based incentives for waste reduction has been extensively researched by economists and other specialists over the past decade (Fullerton and Kinnaman 1996; Reschovsky & Stone 1994; Jenkins 1993; Repetto et al. 1992; among others).

All of these studies argue that the flat fee pricing of waste disposal is inefficient and does not encourage waste reduction since the marginal cost of waste disposal is zero. Unit pricing as an alternative instrument has been shown empirically to be effective in reducing waste generation by U.S. households. For instance, an analysis of survey data from ten U.S. communities with pay-by-the-bag systems show that an increase in the collection fee per 15-kilogram bag from zero to \$1.50 results in an 18-percent reduction in the volume of solid wastes disposed of to landfill. The same increase results in a 30-percent reduction when accompanied by a community curbside recycling program (Repetto et al. 1992).

A quantity-based pricing scheme in High Bridge, New Jersey, which charged communities \$2.69 for the first tag and \$1.25 per additional tag reported a 25 percent decline in trash volume (Reschovsky and Stone 1994). In Charlottesville, Virginia, a pay-per-bag pricing scheme prompted the average person to reduce the weight and volume of their garbage by 14 and 37 percent respectively and to increase the weight of their recyclables by 16 percent (Fullerton and Kinnaman 1996). Data from 21 communities with unit pricing schemes, show that these schemes reduced garbage by between 17 and 74 percent and increased recycling by 128 percent (Miranda et al. 1994). Survey data

² R. F. Stone and N.A. Ashford, "Package Deal: The Economic Impacts of Recycling Standards for Packaging in Massachusetts," Massachusetts Institute of Technology, March 1991; and Tellus Institute, "Disposal Cost Fee Study: Final Report", prepared for California Integrated Waste Management Board, Boston: Tellus Institute, February 1991. Unfortunately, the researcher is not able to discuss the methodology used in these two studies as she was not able to access copies of these reports.

from Portland, Oregon (Hong et al. 1993) on the other hand show that while the adoption of a user fee increases the probability that a household recycles, it does not appreciably reduce the quantity of garbage produced at the curb.

In a unit-pricing demonstration project in 1995 in Marietta, Georgia, residents participated in two different programs requiring the payment of user fees. Half of the residents participated in a bag program in which each household paid a fixed price of \$0.75 for each bag set out for collection. The other half participated in a subscription can program in which they set up agreements for a maximum number of cans of waste to be collected on any given collection day. The results indicated that the bag program reduced mixed waste by as much as 51 percent, while the can program by approximately 20 percent. In both programs the probability of households recycling increased by 18 percent (Van Houtven and Morris 1999).

In Cedar Rapids, Iowa, the city implemented a 12-week pilot project in April 1997 that combined curbside recycling pick up with a pay-as-you-throw program. The program reported that diversion and recycling rates rose to encouraging levels and projected that if implemented city-wide, the program could possibly extend the life of the city's landfill for an extra four years (Block 1997).

3.3 Welfare Gains from Unit Pricing

Using panel data covering 12 U.S. cities, Jenkins (1993) estimated welfare gains from pricing garbage according to its social marginal cost. He found that this would improve social welfare by as much as US\$650 million per year or roughly US\$3 per person per year. Fullerton and Kinnaman (1996) calculated approximately the same estimate. In the Georgia demonstration project, the net savings in explicit costs per day were estimated at \$215 for the bag program and \$72 for the can program. When avoided external costs were included, net benefits were \$586 for the bag program and \$234 for the can program (Van Houtven and Morris 1999). Finally, Repetto et al estimated the annual net savings from a pay-per-bag pricing system, based on both market and non-market waste disposal costs, at US\$2.2 million for moderate-cost communities and US\$7.0 million for high-cost communities (1992).

A number of these researchers, however, caution readers about the magnitude of the estimates particularly in cases where illicit or illegal dumping of wastes is a disposal option. For instance, the Fullerman & Kinnaman study (1996) estimates that about 28 percent of the reduction in garbage may have been due to illegal dumping. According to Jenkins (1993), municipal waste authorities have suggested that illegal dumping does occur immediately following the implementation of a user charge.

4.0 CURRENT SOLID WASTE MANAGEMENT SYSTEM (SWM) IN OLONGAPO CITY: FOCUS ON COST STRUCTURE

4.1 Brief Description of SWM in Olongapo City

Olongapo City is located 127 km north of Metro Manila. It has a population of 194,260 (Census 2000) that generates about 66 tons of garbage daily.³ The city government is directly responsible for solid waste management. This consists principally of a traditional collect and dump system. Households and commercial establishments pay monthly garbage fees for a twice-weekly waste collection service. Waste collection for recycling is done under permit by ambulant collectors. Recyclables are sold to junkshops that in turn sell on to recycling establishments.

Households are charged a flat household monthly fee of PhP30-40 (depending on lot size) and commercial establishments a fee of PhP 50-500 (depending on the nature of business and other factors).⁴ The garbage fees collected fund the activities of the Environmental Sanitation and Management Office (ESMO) that handles SWM. In addition to waste collection and disposal, ESMO also handles other city services such as sanitation and beautification.

During recent years, the City has been incurring deficits as garbage fees collected have not covered expenditures. This deficit is charged to the City Government's budget. In turn, the City government has resorted to periodic fee increases to cover its losses. Three fee increases have been imposed since the fee system was implemented in 1989, with the most recent one taking effect in September 2002.⁵

4.2 Private Costs of SWM

Table 1 below shows that there has been a significant increase in SWM costs in Olongapo City. These have grown by 17 percent annually since 1997. Waste tonnages, on the other hand, have increased by only about 5 percent annually over the same period.⁶ Wages, salaries and benefits were responsible for a significant percentage of the increase in SWM costs. ESMO had only 52 permanent personnel in 1997 and this increased to 141 in 2001.⁷ Gas and oil costs were also significant since expenditure on fuel for SWM has increased considerably since 1997, mainly due to fuel price increases. (see **Appendix Table 1** for a more detailed version of the FCA).⁸

³ Site of former US military bases in Subic. Metropolitan Manila generates about 6,000 tons/day.

⁴ At the time the research was conducted, households with lot sizes less than 100 sq m were charged P30/month; those with lots larger than 100 sq m. were charged P40/month. The exchange rate at the time of the study was US\$1:PhP 50.

⁵ The September 2002 increase is not considered in this study.

⁶ The study implemented full cost accounting (FCA) to examine the cost structure of the City's SWM system. It adopted that US Environmental Protection Agency FCA framework (USEPA 1997 & 1998).

⁷ This law resulted in substantial increases both in number and salaries of government personnel in Olongapo City.

⁸ Fuel prices (premium gasoline) increased by 70% between 1997 and 2001 (The Philippine Inquirer website, October 2002).

Table 1. Cost Structure of SWM Collect and Dump System and Waste Generation, Olongapo City, 1997 and 2001 (in million Php).

Cost Component	1997	2001	Growth rate (annual)
Personal services (labor)	7.93	14.35	20.2
Operating expenses	2.17	4.94	32.0
Up-front costs	1.39	1.26	(2.3)
Back-end costs	1.51	1.51	na
Total (excludes external costs)	13.0	22.06	17.4
Total (includes external costs)	26.0	44.12	17.4
Non-recyclable wastes disposed (tons)	20,075	23,748	4.6

na – not applicable; assumes constant back-end costs.

4.3 SWM Unit Costs

Full cost accounting allows the estimation of important SWM indicators such as those unit costs shown in **Table 2**. Based on the FCA accounts and waste generation data from Olongapo City, the average cost per unit of waste collected and disposed of in 2001, without accounting for external costs, was P929 per ton.

It is also possible to estimate the cost of servicing the household sector using FCA. Since the residential sector accounts for 80 percent of total wastes disposed of in Olongapo City, the analysis assumes it also accounts for 80 percent of total service cost. With a service household sector of 34,742 households in 2001, the monthly service cost during this year was P42 per household for waste collected and disposed.⁹

4.4 External Costs of SWM

The external costs of solid waste collection and disposal consist of the environmental damages and human health problems that arise from improper waste collection and disposal. More specifically, the potential impacts of waste collection include: risk of injury to the public by large and poorly maintained garbage trucks; road congestion that causes air and noise pollution and road destruction; and litter escaping from the trucks. The potential external costs from waste disposal include: threats to public health from the pollution of ground and surface water; methane gas release and explosions; and aesthetic problems caused by noises and odors.

In developing countries such as the Philippines, the environmental impact of waste disposal sites is expected to be larger than in the United States, since most sites in the Philippines are open dumps while the majority of those in the States are covered. However, the monetary valuation per unit of environmental impact (using willingness-to-

⁹ The monthly service cost of P42 per household was computed as follows: 80 percent of total service cost / number of households served / 12 months (see Appendix Table 2).

pay valuation or WTP) is likely to be lower in developing countries. This is because the WTP to avoid the impacts of waste disposal is lower in developing countries where incomes are lower.

Given the very poor disposal facilities in the Philippines, it may thus be reasonable to assume that the environmental costs per unit are greater than the private costs (Bennagen et al. 2002). This study however adopts a conservative estimate for the environmental cost of waste disposal used and assumes that the environmental cost per ton of waste disposed of in Olongapo City approximates that of private cost (see column 3 of Table 2).

Table 2. SWM Unit Costs, Olongapo City, 2001 (in Php).

Cost Item	Private	Social *
Service cost per ton (all sources)	929	1,858
Service cost per household (annual)	508.	1,016
Service cost per household (monthly)	42	84

* Social cost is equal to private cost + external cost. Assumes external cost approximates private cost.

5.0 THE SOCIO-ECONOMIC SURVEY

5.1 Sampling Design and Survey Questionnaire

A socio-economic survey of a citywide sample of 360 households was conducted. This sample was proportionally allocated to the 17 barangays of the city using household population as weight. Four puroks (districts) in each barangay were randomly drawn and the allocated sample for the relevant barangay was equally allocated among them (no information on purok population was available). Finally, every tenth household in each purok was systematically selected as the sample household. The survey was conducted in June and July 2002.

Population density has been shown to affect household waste management behavior (Jenkins 1993). On the one hand, households in densely populated communities have less storage space and therefore discard and replace items more often. However, they also have better access to shops, so goods are purchased more often and in smaller quantities. This results in more packaging for disposal. On the other hand, households in less dense communities with large backyards generate large quantities of yard waste and therefore have a greater need for solid waste services.

To get more information about the impact of population density on waste management behavior and to help delineate the sample for the experiment, the 17 barangays of Olongapo City were classified as high and low density. One hundred persons per hectare was used as the threshold for the high/low density classification. Ten barangays were found to belong to the high density classification, the rest were low density barangays. Over all, 62 percent of households reside in the low density barangays, while 38 percent are from the high density areas (see **Appendix Table 3**).

The main purpose of the survey was to collect baseline information on the economic and demographic characteristics of the sampled households as well as their waste management practices and attitudes. In addition to its use in the current research, this baseline information can be useful in the future for an impact assessment, if or when the local government decides to implement a unit pricing system.

The survey questionnaire included questions on waste generation in which households were asked to estimate the weight of all the different types of wastes they generated. The waste quantity data reported in this section are therefore self-reported estimates of the households.

5.2 Socio-economic Characteristics and SWM Practices of Sampled Households

The average monthly income of the sampled households was PhP12,843 and the average household expenditure was PhP 11,791/month. Food comprised 48 percent of total expenditures (**Table 3**).¹⁰ Households in high-density communities, clustered around the town (poblacion), had higher incomes than those in low-density communities since the town offered more work opportunities.

¹⁰ Official income estimates, based on the 2000 Family Income and Expenditure Survey (FIES), reported an average monthly income in Olongapo City of PhP 16,411 and an average monthly expenditure of PhP 13,393. (National Statistics Office-FIES 2000). Based on 2000 FIES, food expenditures account for 43.7 percent of total expenditures. At the national level, monthly income based on 2000 FIES was PhP 12,003.

Each household head had been to school for an average of ten years. This implies that they had completed only secondary or high school education. Thirty percent of the sampled household had working mothers.

In low-density areas 73 percent of households had backyards, while this figure was only 44 percent for households in high-density areas. Over all, 61 percent of households had backyards.

These two household characteristics (i.e. the mother's employment status and the presence of a backyard) were found to be significant in explaining household waste management practices such as waste separation and composting (Bennagen et al 2002). Based on self-reported waste generation, the average total amount of waste disposed of by the sampled households was 1.49 kg/day.¹¹

Table 3. Household Socio-economic Characteristics by Population Density, Olongapo City

Variables	Unit	High Density		Low Density		All	
		mean	s.d.	mean	s.d.	mean	s.d.
Annual income	PhP	13936	10715	12115	10583	12843	10658
Annual expenditure	Php	12287	7371	11461	7068	11791	7192
Household size	# persons	5.4	2.6	5.6	2.3	5.5	2.4
Education of household head	# years	10	3	10	3	10	3
Age of the household head	# years	51	14	47	13	48	14
Revenue from selling recyclables	PhP/mo	11	16	14	31	13	26
Self reported total waste disposed	Kg/day/hh	1.35	1.02	1.59	1.11	1.49	1.02
Mother employed	% reporting yes	30		31		30	
Presence of yard	% reporting yes	44		73		61	
House owned	% reporting yes	44		70		60	

In terms of waste management practices, less than half of the sampled households (43 percent) practiced waste segregation and only 16 percent engaged in composting (Table 4). About 25 percent of those who engaged in waste separation reported that they only started this year as a result of the waste segregation program set up by the local government. Composting of biodegradables is not widely practiced in the city. As expected, there were more households in high-density areas that segregated waste, while there were more households in the low-density areas that burnt waste.

Almost all of the sampled households reported that there were people who visited their communities to buy or collect recyclables. Most of the households sold or gave away recyclables to these collectors, while a much smaller percentage returned used bottles to get back the deposit. In the low-density communities, where incomes were lower, a greater percentage sold their recyclables than in the high-density areas.

The buyers and collectors of recyclables serve as an alternative to municipal waste disposal. They are therefore an important consideration in the implementation of any incentive-based solid waste management policy that aims to divert wastes from disposal

¹¹ This estimate when translated into per capita terms result in 0.28 per capita and is comparable to that estimated by GHK/MRM study cited in Bennagen et al. (2002) for Olongapo City of 0.30 per capita.

sites. In the absence of alternatives, the imposition of unit pricing may result in significant illegal dumping.

On average, only a small percentage (12 percent) of households bought trash bags to dispose of their wastes; most households made use of plastic shopping bags they got from markets and commercial stores. However, there were significantly more households in the high-density communities that bought trash bags. Higher income is one explanation for this, however the fact that the shops selling trash bags are more accessible to these communities is probably also a factor. This issue is important since a pay-as-you-throw system will require households to purchase garbage bags.

Table 4. Household Solid Waste Management Practices by Population Density, Olongapo City (percentage of households reporting “yes”)

Variables	High Density	Low Density	All
Segregating *	51	37	43
Composting	14	18	16
Managing food wastes as hogfood			
Recycling			
<i>Return bottles</i>	25	28	27
<i>Sell *</i>	71	87	80
<i>Give away</i>	92	91	91
<i>Reuse</i>	93	97	95
Burning			
<i>Mixed dry waste *</i>	15	33	25
<i>Yard waste*</i>	26	63	48
<i>Mixed dry and yard waste *</i>	32	71	55
Purchasing of trash bags *	17	9	12

* Comparison of means test yielded significant results at 5% level.

Eighty-eight percent of households reported that they were aware of the city’s waste management program (**Table 5**). The program was featured on local television and radio which explains this finding. At the local level, each barangay conducts an information and education campaign on the program. However, the survey indicated that awareness of these local programs is very low: only 23 percent reported that they were aware of their respective barangay programs. This awareness was significantly lower in low-density communities with only 15 percent of the households reporting awareness of their local program. It is clear that local efforts to promote waste management programs are lacking.

The garbage fee collected by the City is P30-40 per month. About 55 percent indicated that this is reasonable (neither too high nor low), with high-density communities more satisfied than low-density communities. This is also true with respect to levels of satisfaction with the city’s collection services. About 20 percent indicated there should be no garbage fee, most of these were in the low-density barangays.

The sampled households were also asked whether they found the idea of volume-based pricing of garbage acceptable. More than half of the respondents (62 percent) agreed with the idea. It is interesting to note that there was no significant difference in the responses of households in the two density groups on this issue.

Households were asked whether they see any illegal dumping of wastes in their surroundings. Only 26 percent said “yes”. It is important to note that 32 percent of households in low-density communities reported that they had seen illegal dumping compared to only 17 percent in high-density barangays. This result was expected since the monitoring of illegal dumping is more difficult in these areas. Moreover, about 25 percent of the households in these areas are located in the hilly parts that are not serviced by garbage trucks.

Table 5. Household Response to Different Aspects of Solid Waste Management by Population Density, Olongapo City (percentage of households reporting “yes”).

Variables	High Density	Low Density	All
Awareness of City Govt. waste segregation program	88	88	88
Awareness of Barangay waste segregation program *	35	15	23
Reasonableness of amount of garbage fee collected *	68	47	55
Satisfaction with collection services *	87	76	81
Acceptability of idea of a volume-based pricing system	56	66	62
Garbage collection as a responsibility of government	34	45	40
Observation of unauthorized dumping *	17	32	26

*Comparison of means test yielded significant results at 5 percent level.

6.0 THE EXPERIMENT

6.1 Experiment Design

The sample for the experiment was drawn exclusively from the high-density barangays. This decision was made to minimize the likelihood of illegal dumping taking place. It was taken in light of the socio-economic survey results which indicated that illegal dumping is higher in low-density barangays.

For the experiment, a sub-sample of 72 households was randomly drawn from the list of households in high-density barangays that had participated in the socio-economic survey. The 72-household sample size represented 50 percent of the sampled households in the high-density barangay.¹² There were four drop-outs during the course of the experiment.

The households were provided with a cash incentive for their participation in the experiment and a separate 'per-bag' cash incentive for reducing waste. Their waste generation and disposal behavior was monitored over an eight-week period during February and March 2003. During this time their garbage was collected and weighed twice each week.¹³ The participating households were provided with color-coded plastic bags and trash cans, one color for each type of waste. The following waste types were collected and weighed: food and kitchen wastes, recyclables, garden wastes and non-recyclable wastes (please refer to glossary at the end of the report for definition of these wastes).

The eight-week waste monitoring period was broken down into four sub-periods: pre-baseline, baseline, SUP-1 and SUP-2 (SUP=simulated unit pricing). This was done to observe how household waste disposal behavior changed in response to price incentives. Other concerns relating to unit pricing were also examined during the eight-week experiment. These were: household's response to the provision of trash bags and cans and illegal dumping behavior.

The following activities were undertaken in each sub-period:

- 1) Pre-baseline (first two weeks) – Each household's wastes were weighed twice a week. No plastic bags or trash cans were provided.
- 2) Baseline (second two weeks) – Each household was provided with color-coded plastic bags and trash cans and their wastes were weighed twice a week. The bags were distributed to ensure uniformity in waste measurements. The data collected during this period were used as the basis for bag allocation in the two simulated unit pricing periods.
- 3) Simulated unit pricing 1 or SUP-1 (third two weeks) – Each household was provided with a number of bags based on the baseline waste measurement data and was offered a cash incentive per bag that was unused. In this period, the participants were divided into two groups: Group A and Group B. Each group was further subdivided into

¹² The sample includes the 11 households covered during the trial experiment that was implemented in October-November 2002 to pilot test the waste measurement procedures. The measurement data collected in the trial experiment was included in the statistical analysis conducted thereafter in as much as the procedural refinements implemented resulting from the pilot test were minor.

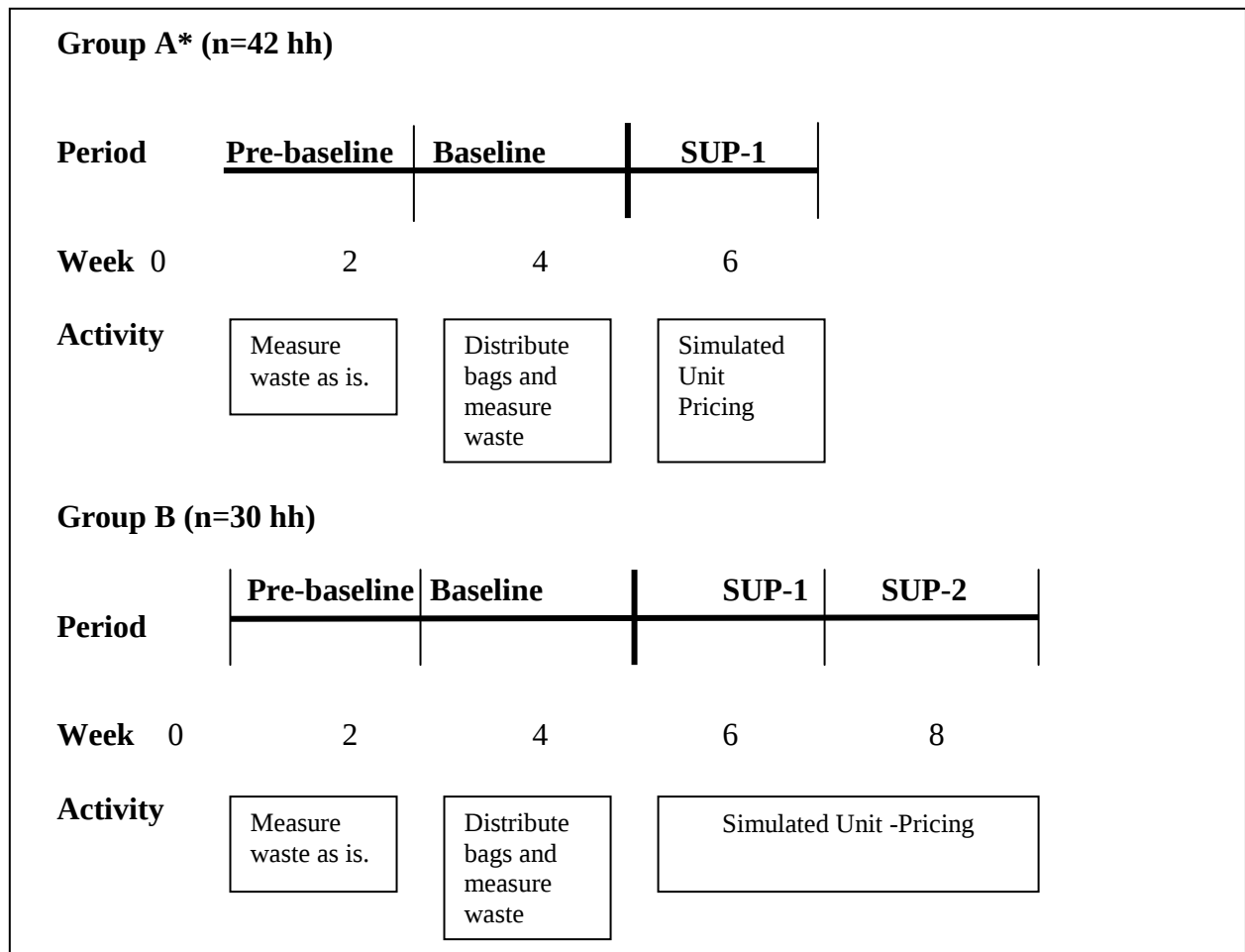
¹³ Recyclables were weighed only once each week since their quantities were not substantial based on the trial experiment.

two groups: Group A-1 and A-2 and Group B-1 and B-2. The participants in Group A were told that the experiment would end in two weeks and those in Group B were told it would end in four weeks. The objective of the A-B grouping was to observe any illegal dumping behavior. The objective of the sub-grouping (A-1 & A-2 and B-1 & B-2) was to increase the price variation across the experiment. The household wastes in all groups were weighed also twice a week.

4) Simulated unit pricing or SUP-2 (last two weeks) – The participating households in Group B continued on with the experiment and their wastes were weighed twice a week. As mentioned above, the objective of extending the participation of Group B households was to observe any difference in the waste disposal behavior of the participants in terms of illegal dumping.

The discussion above is summarized in **Figure 2**.

Figure 2. Experiment design of simulated unit pricing.



Each subgroup of groups A and B faced different cash incentives (Php3 and Php6) during the SUP-1 period. In SUP-2, the incentives faced by the two subgroups of group B were increased from Php3 to Php 4.5 for subgroup B-1 and from Php6 to Php9 for subgroup B-2. The reference unit price was P6.00 per bag. This is the estimated user fee (including external costs) based on the full cost accounts of the ESMO (see Appendix Table 2).

The changes in the cash incentive per bag are summarized below (in Php):

Period	Group A		Group B	
	Subgrp A-1 (n=15)	Subgrp A-2 (n=27)	Subgrp B-1 (n=15)	Subgrp B-2 (n=15)
Baseline (<i>week 3-4</i>)	0	0	0	0
SUP-1 (<i>weeks 5-6</i>)	3.00	6.00	3.00	6.00
SUP-2 (<i>week 7-8</i>)	--	--	4.50	9.00

Note: P6 is the estimated unit price per bag (see Appendix **Table 2** for calculation).

*Group A includes data of 11 households of Bry. Banicain from the trial experiment.

It would have been ideal if the city government had agreed to suspend the fixed garbage collection fee and replace it, for the duration of the experiment, with a unit fee for the households covered by the experiment. However, offering a cash incentive (unit price) for each unit reduction in garbage, simulated the imposition of a unit charge in the following fashion. Conceptually, a household moves up from the x-intercept (the point where marginal utility of MU is zero) of its demand curve to the point where MU equals the unit cash incentive. If an actual unit price were charged, the household moves down the demand curve up to the unit price. (Please refer to **Figure 1** for the demand curve for solid waste services.)

6.2 Results of the Experiment

6.2.1 Overall Results of Waste Measurements

Table 6 summarizes the results of the waste measurements for the different types of household wastes collected and weighed (see also **Figure 3**). Column two shows the waste measurements collected during the baseline period of the experiment.¹⁴ The measurements indicate that, on the average, an urban household of Olongapo generated 2.01 kg/day of total wastes. Of this, non-recyclable wastes accounted for about 43 percent, food/kitchen wastes for 40 percent, recyclables 10 percent and yard wastes 7 percent. Based on these measurements, the total annual waste generated by the residential sector city-wide was 32,255 tons and per capita waste generated was 0.34 kg/day.¹⁵ Based on volume, the average bag (small size) consumption per day was 0.49 bags.

¹⁴ The bags weighed during the pre-baseline averaged 1.37 kg/day.

¹⁵ Existing per capita waste generation estimates for Olongapo City range from 0.30 kg/day for the residential sector and 0.39 for all waste sources (reported in Table 2, Bennagen et al. 2002).

Table 6. Comparison of Waste Generation during Baseline and SUP Periods.

Waste type	Baseline	SUP	Change	
			kg/day	%
Weight (kg/day)				
Non-recyclable	0.86	0.65	-0.21*	-24
Recyclable	1.15	1.27	0.12	
Food /kitchen	0.81	0.88	0.07	9
Reusable	0.21	0.25	0.04	19
Yard	0.13	0.14	0.01	8
Total waste generated (kg/day)	2.01	1.92	-0.09 *	- 5
Volume (bags/day)				
Non-recyclable	0.49	0.34	-0.15*	-31
Recyclable	0.34	0.33	-0.01	- 3
Food/kitchen	0.12	0.11	-0.01	- 8
Reusable	0.14	0.16	0.02	14
Yard	0.08	0.06	-0.02*	-25
Total waste generated (bags/day)	0.83	0.67	-0.16	- 19

* Significant at 5 percent level.

The baseline information on waste composition suggests that households in Olongapo City were already diverting almost half of their total wastes away from the disposal site. They were doing this by managing their food/kitchen wastes as hog food and by selling or giving away their reusables such as old newspapers, plastic containers, etc. Most of the households (76 percent) set aside their food and kitchen wastes as hog food to be collected daily by neighbors with backyard piggeries. No payments were made for these wastes. Some recyclables were sold to ambulant buyers, but most of it was given away for free. The households with backyards either included their yard wastes in the non-recyclable waste bags collected by the garbage trucks or burnt them.

Column three of **Table 6** gives the waste measurements during the simulated unit pricing period (SUP). Households reduced the weight and volume of their non-recyclable wastes by 0.21 kg/day and 0.15 bags/day, respectively, in response to the price incentive. Percentage-wise, the response in terms of volume is higher compared to the response in terms of weight (31 vs. 24 percent). This is expected since the incentive was pegged on the number of bags saved or unused.

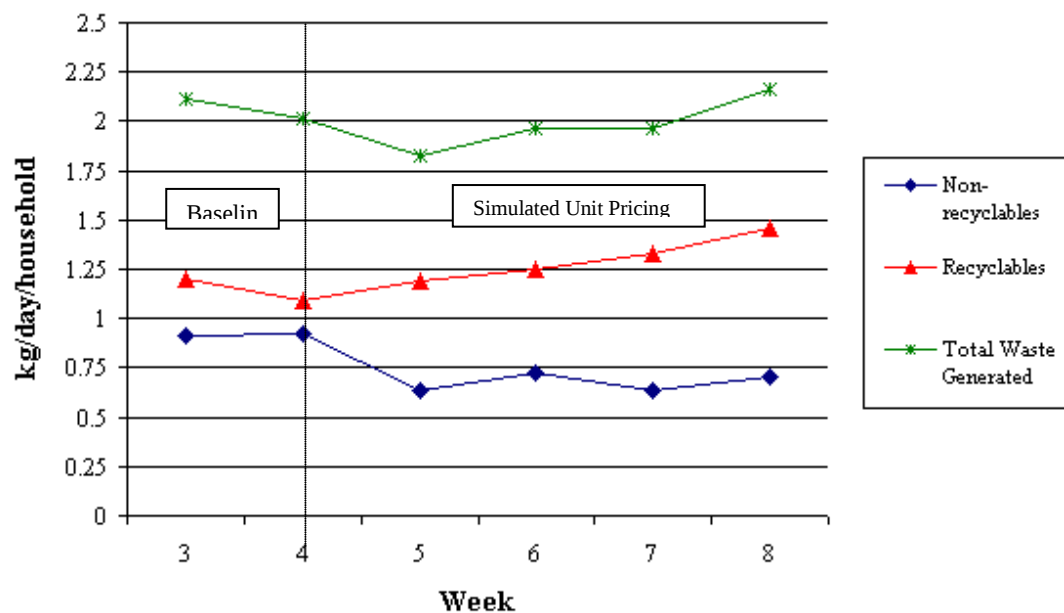
At the same time, households increased their food wastes, reusables and yard wastes. This increase was, however, not as proportionately large as the reduction in non-recyclables. These changes resulted in changes in the overall composition of household's

waste: non-recyclables now accounted for 34 percent (down from 43 percent) of total wastes (Table 7). Figure 3 shows these changes graphically.

Table 7. Household Waste Composition During Baseline vs. Simulated Unit Pricing (SUP), Olongapo City, 2003.

Waste Type	Under flat fee		Under SUP	
	Tons/yr	% of TW	Tons/yr	% of TW
Non-recyclable	13,531	43	10,227	34
Recyclable	18,094	57	19,510	66
Total waste (TW)	31,625	100	29,737	100

Figure 3. Waste Generation by Waste Type During Baseline vs. Simulated Unit Pricing (SUP) Olongapo City, 2003.



6.2.2 Disaggregating the Reduction in Non-recyclable Wastes

The reduction in non-recyclable wastes of 0.21 kg/day can be explained in the following way: food/kitchen wastes increased by 0.07 kg/day, reusables by 0.04 kg/day, and yard wastes by 0.01 kg/day (Table 8). The remainder of .09 kg/day can be considered unexplained reductions. This unaccounted portion may be due to household practices that the experiment could not monitor or quantify, e.g. changes in consumption patterns, or, perhaps more importantly, illegal disposal.

As several households shared the location where waste containers were left for collection by city trucks, it was difficult to quantitatively assess the extent of illegal disposal by the participating households.

It was suggested that any “illegal” waste disposal behavior might be affected by the length of time the experiment lasted. This is because, the longer the experiment, the more costly it would be for households to ‘hide’ waste or to transport it to places where they could illegally dump it. As explained, this was the reason why the experiment was conducted for two weeks with one group and four weeks with the other.

The results of the statistical analysis using T-test shown in **Table 8** imply that the behavior of the two groups during the SUP is the same. Therefore, it is difficult to infer if any strategic behavior occurred in either of the two groups in response to the price incentive.

Table 8. Comparison of Non-recyclable Waste Reduction by Group.

	Group A* (n=31)	Group B (n=30)	t-stat
Average reduction in weight (kg/day)	0.23	0.13	1.104
Average reduction in volume (bag/day)	0.12	0.13	-0.027

*Group A excludes Bry. Banicaian data

A post-survey interview was conducted to further investigate illegal disposal. Ten households were randomly drawn from each group. They were asked how they had responded to the price incentive. They were also asked whether the idea of unit pricing was acceptable.

Table 9 indicates that 20 percent of the sampled households either increased their non-recyclable wastes or that their wastes changed minimally during the experiment. Thus, 80 percent of the sampled households reduced their non-recyclable wastes in response to the incentive. These households were asked about the waste reduction practices, legitimate or otherwise, they had adopted during the experiment.

In particular, the households were asked whether they unintentionally gave their plastic bags to the city trucks on some days during the experiment. Eight of the 20 households (four in each group) admitted they did. They were also asked whether they tried to save on the use of plastic bags by stomping on their wastes. Four households in each group said “yes”. Two households in each group admitted to burning their wastes. When asked whether it was the cash incentive that motivated them to reduce wastes, many of the households, especially in the two-week SUP group, indicated the incentive did not influence their behavior.

Table 9. Post-experiment Evaluation Results.

Item	Group A (# of hhs)	Group B (# of hhs)
Response to incentive (n=10 per group)		
Reduced non-recyclable waste	8	8
Increased non-recyclable waste	2	1
Unchanged	0	1
Practices to reduce waste (n=8 per group)		
Increased recyclables	8	8
Diverted more food wastes	5	6
Compressed (stomped) bags	4	8
Increased reuse	4	6
Purchases with less packaging	4	2
Burned dry wastes	2	2
Burned yard wastes	2 *	3 **
Composted food waste	0	1
Reduced purchases	0	0
Incentive motivated waste reduction (n=10 per group)	3	6
Garbage was given to truck unintentionally (n=10 per gr)***	4	4
Acceptance of unit pricing as alternative to fixed fee (n=10/gr)	9	8

*n=3.

**n=6

***maximum of 2 times

In qualitative terms, therefore, it can be concluded that there was no illegal disposal behavior in the two groups in response to the cash incentive.

6.2.3 Estimating the Household Response to the Incentive

Two functional forms of the demand curve were estimated to examine the household response to unit pricing: linear and double log. Unit price, household income and other socio-economic household characteristics were independent variables. In the double log equation, the baseline observations of zero price were discarded as the functional form cannot have an x-intercept. In the regression, it was assumed that monthly household income was constant for the duration of the experiment. The study hypothesizes that there are welfare gains in the aggregate with the introduction of a unit pricing scheme.

In order to test the hypothesis that unit pricing of garbage reduces the quantity of household non-recyclable wastes, regression analysis using ordinary least squares (OLS) was conducted with price and some socio-economic household characteristics. Income, household size and education have all been found to influence demand for solid waste services and these were therefore included as explanatory variables. Moreover, the value of time measured by the wage rate is also an influential variable in household waste

management. This variable was proxied in the model by a dummy variable relating to the employment of the mother of the household (who has an important role in household waste management). Finally, a dummy variable to reflect how households manage their food and kitchen wastes was included in the regression model. The main focus of the exercise was, however, the coefficient of the price incentive since that gave an estimate of the price elasticity of demand for solid waste services.

It has been shown in a previous study that unit pricing has a more substantial effect on the volume of garbage produced than on its weight (Fullerton and Kinnaman 1996). The volume of non-recyclable wastes was therefore also regressed on the same explanatory variables. The variables are defined in **Table 10** and the results of the regression analysis using ordinary least squares are given in **Table 11**.

Table 10. Description of Variables Used in Regression

Variables	Mean	Std. dev.	Description
WEIGHT_NRW	0.743	0.609	Weight of non-recyclable waste (kg/day/hh)
VOLUME_NRW	0.396	0.210	Volume of non-recyclable waste (bags/day)
PRICE	3.129	3.034	Price incentive per bag unused
INCOME	12728	9713	Monthly household income (Php)
HH_SIZE	5.9	2.7	Household size (# person)
EDUC	10.2	2.8	Education of the HH head (# years)
Percentage			
D_MANAGEFW	74		Dummy for food waste management 1- FW collected by neighbors for hogfood 0- otherwise
D_MOTHER	28		Dummy for employment of mother 1- Mother of household is employed 0 – otherwise

In both equations the price coefficient (PRICE) was found to be significant at the 5 percent level. The demand elasticity estimates computed at sample means were -0.15 and -0.21 for the weight and volume equations, respectively. These estimates imply an inelastic demand (as predicted by the empirical literature) and are within the range of the existing price elasticities mentioned earlier. Household size (HH_SIZE) was also significant in both equations and has the expected positive sign.¹⁶ The dummy variable D_MANAGEFW was significant and negative which implies that when the mother of the

¹⁶ The equations were regressed with per capita waste as dependent variable and the same explanatory variables. The household size coefficient is negative and significant at 5 percent level. The negative sign indicates the existence of economies of scale in waste generation, i.e., as the household increases in size, per capita waste generation declines (see Jenkins 1993).

household was employed, the quantity of non-recyclable wastes was higher than otherwise. The results of the double log regression were generally not significant and are shown in **Appendix Table 4**.

Table 11. Regression Results with Non-recyclable Waste as Dependent Variable.

Independent variables	Dependent variable: Non-recyclable Waste	
	Weight	Volume
	(kg/day)	(#bags/day)
Constant	0.642** (2.620)	0.356** (5.211)
PRICE	-0.035** (-2.474)	-0.026** (-5.594)
INCOME	3.48E-07 (-0.078)	1.37E-06 (0.884)
HH_SIZE	0.080** (5.256)	0.030** (5.651)
EDUC	-9.81E-04 (-0.054)	-0.001 (-0.237)
D_MANAGEFW	-0.297** (-2.543)	-0.064* (-2.010)
D_MOTHER	-0.149 (-1.541)	-0.045 (-1.433)
Elasticity estimate (at sample means)	-0.15	-0.21
Adjusted R ²	0.15	0.24
F-Statistics	6.011**	10.123**
N	174	174

* significant at 10 percent level

** significant at 5 percent level

6.2.4 Estimating the Impact on Waste Diversion and Disposal costs

Anually, the measurement results reveal that Olongapo City residents already divert at least 10,000 tons of their garbage away from the dumpsite by recycling and by managing their food wastes for hog food. This amount represents 30 percent of their total wastes. Based on the results of the experiment and under the assumption of no illegal disposal, unit pricing in the city will result in an incremental reduction of about 3,305 tons annually.

One of the benefits of a unit pricing program are the collection and disposal costs that are avoided. In the short run, only variable costs, which accounts for 25-30 percent of total costs, would be avoided with a shift from the traditional collection and disposal system to a unit pricing system.

Olongapo City's collection and disposal costs of Php 929 per ton include both fixed and variable costs but exclude external costs. This means that unit pricing in the city would translate into avoided costs (excluding external costs) of about Php 920,000 annually in the first three years. Subsequently, the city could save as much as Php 3.1 million annually in saved SWM costs. When external costs are incorporated, the savings would at least double.

The costs of implementing a unit pricing program, including the costs of any recycling programs, would have to be deducted from the avoided cost estimated above to derive the net benefit of the program. These costs will depend on the type of unit pricing system that is adopted. However, they would include start-up costs, such as personnel training and public education and outreach, and running costs, such as enforcement and monitoring.

Currently, the City government spends about Php3.0 million in monitoring and enforcement, three-fourths of which is made up of labor costs. The enforcement costs of a unit pricing program will probably be higher to begin with, since it will initially encourage some illegal waste disposal. However, given the findings of this study, local residents should adopt the new pricing scheme with little resistance. Moreover, the ESMO has indicated that illegal dumping of waste in the city is minimal. Therefore, the increase in enforcement costs under a unit pricing program may be expected to be moderate. **Table 12** summarizes the above discussion.

Table 12. Expected Direction of Costs, Revenues and Waste Tonnage Under Unit Pricing System.

	Status quo (fixed fee) * (2001)	Expected direction of change under unit pricing
Total revenue (Php/yr)	16.4 million **	Increase initially, then will stabilize as households respond to incentive
Total cost (Php/yr)	22.1 million	Enforcement and information campaign costs will increase initially. Total cost (both fixed and variable) will decline subsequently as total waste diverted increases in response to incentive resulting in avoided costs
Net revenue (Php/yr)	- 5.7 million	Positive
Total waste disposed (t/yr)	23,748	Decline
Total waste diverted (t/yr)	10,000	Increase
Total welfare gain (Php/yr)	Not applicable	Positive and substantial

* Based on 2001 ESMO cost data.

** Revenues have increased substantially since last quarter of 2002 with the 30% percent increase in SWM fixed fees. Therefore, net revenue in 2003 is expected to be positive if there are no major increases in program costs.

6.2.5 Estimating the Welfare Gains and Effects of Changes in Unit Price

In estimating the welfare gain from unit pricing (or the triangle *abc* in **Figure 1**), the following assumptions are made: (1) the behavior of households in a real program will be the same as their behavior in the simulated unit pricing experiment; (2) the experiment data generated is applicable to the whole of Olongapo City; (3) all households will participate in the program; and (4) the elasticities generated in the simulated unit pricing are applicable to a real program.

To estimate the welfare gains from unit pricing, the coefficient of the price variable in **Table 11** was used. The estimated welfare gain from unit pricing is Php 0.63 per household per day or Php 9.91 million per year in the whole city.¹⁷ This welfare gain estimate represents about 40 percent of the total operating expenditures of Olongapo City in 2001. This implies that shifting to a unit pricing scheme would bring substantial social benefits for the city's residents.

The estimate of the price elasticity of demand for solid waste services obtained from the regression analysis (-0.15) implies that a 10 percent increase in the unit price will reduce non-recyclable wastes by 270 tons per year.

As in any policy reform, there will be winners and losers in the short term from the implementation of unit pricing in Olongapo City. Some households will end up paying more since they will lose some of the consumer surplus they enjoyed under the flat fee pricing regime. Other households will pay less than the flat fee and will gain additional consumer surplus. The experimental data generated by this research indicates that there would be more winners than losers. The ratio between them would be 6:4.

¹⁷ The formula used in estimating welfare gain per household per day is: $\beta/2 (\frac{1}{p^2})$, where β is the slope or the coefficient of the price variable in the OLS regression and p is the unit price. Note that β is the inverse of the slope in **Figure 1**.

7.0 PROPOSED UNIT PRICING SYSTEM FOR OLONGAPO CITY

7.1 Basic Elements of a Unit Pricing System¹⁸

The design of a unit pricing system involves the following processes or decisions (EPA 2000): (1) choosing a volume- or weight-based system; (2) selecting containers; (3) examining pricing structures; (4) considering billing and payment procedures; (5) determining service options and complementary programs. Each of these processes needs to be considered in the design of a unit pricing system for Olongapo City.

The first issue is how wastes will be measured: Weight-based programs tend to be more expensive to implement but offer more incentives for waste reduction than volume-based programs. Volume-based programs are easier to implement and are therefore considered below.

There are three container options for a volume-based system: a can system (small or large); a bag system; and a tag or sticker system. In the can system, the program implementer usually provides the container to ensure uniformity. The bag and the tag or sticker systems involve the purchase of bags or stickers from designated outlets. The cost of these items normally includes the cost of waste collection. These schemes are therefore referred to as pre-paid volume-based systems. Tag and sticker systems have been found to be easier and less expensive to implement (compared to can systems) but there is greater revenue uncertainty.

There are four types of rate or pricing structure for unit pricing schemes: (1) a proportional (linear) rate system; (2) a variable container rate system; (3) a two-tiered rate system; and (4) a multi-tiered rate system.

The proportional rate system charges households a flat price for each uniform sized-container of waste they place out for collection, while the variable container rate system charges different rates for different sized containers. Two-tiered rate systems charge households both a fixed fee and a separate per-container charge, while the multi-tiered rate system charges households a fixed fee plus variable fees for different container sizes.

Each system has advantages and disadvantages and the choice depends on various factors such as: the objective of the unit pricing program, the revenue goals of the community, and the administrative capability of the local government that will implement the program. The proportional rate system is the simplest rate structure and provides a strong incentive to reduce wastes, however it does not ensure a stable revenue stream. The two-tiered rate system provides a more stable revenue flow but offers less waste reduction incentives since households will not have the incentive to reduce wastes below the minimum service level. Variable container and multi-tiered rate systems create strong incentives to reduce waste but can be complicated to administer.

With respect to billing and payment systems there are again, a number of options: the direct payment system allows residents to pay for waste collection services by purchasing bags or stickers from the local government outlets. Subscription systems allow

¹⁸ The reader interested in this topic, particularly the advantages and disadvantages of the different unit pricing systems, is referred to the Environmental Protection Agency website, www.epa.gov/payt

residents to be billed on a regular basis. An actual set-out system bills residents based on the actual number of containers set out for collection. This system can be impractical since the hauler has to count the number of bags, tags or cans set out and then record the information for billing purposes.

Finally, the unit pricing program can be designed in such a way that it is accompanied by complementary services such as recycling and composting. The provision of these services ensures that residents have ways of reducing their wastes in response to the incentives offered by the pricing program.

7.2 Basic Design of a Unit Pricing System for Olongapo City

This study proposes a two-phased, volume-based unit pricing program for Olongapo City: a two-tiered, volume-based pricing system in the first phase (short term), followed by a proportional rate structure in the second phase (long term).¹⁹ The first phase will allow the local government to get a feel for how a unit pricing program works and at the same time maintain, or even increase, its revenues. Residents will be introduced to unit pricing in a gradual manner and at the same time will have an incentive to reduce their waste.

After the third or fourth year, it is expected that both the local officials and residents will be ready for a unit pricing system with a proportionate rate structure in which the incentive to reduce will be higher. Only the first phase of the program is discussed below since the implementation details of the second phase will depend on the outcome of the first.

Under the proposed two-tiered, volume-based system, the ESMO can either implement a bag or tag system. The fixed fee portion of the system will entail households paying the current flat fee of P40-50 per month for the collection of not more than two small bags of waste per collection day.²⁰ The billing and payment system for this portion of the program will continue as at present, that is, through their monthly electricity bill.

The variable portion of the proposed unit pricing system will entail households who put out more than two bags per collection paying for each additional bag. The price per bag will be P6.00. This reflects the marginal social costs of waste collection and disposal.²¹ Bags or stickers will be sold at the City Hall and other recognized commercial outlets. The bags will have a unique mark or logo and bags (in excess of the minimum two bags) without the mark will not be collected. Strict monitoring of illegal disposal should accompany the program.

Under this proposed system, the current monthly revenue of ESMO of P 1.5 million will be maintained.²² The variable portion of the proposed system has the potential to generate about P140,000 from those residents who exceed the two-bag

¹⁹ During a meeting with the Olongapo City officials, they expressed preference for the two-tiered pricing structure to allow for stable revenues and at the same time penalize residents who generate too much waste.

²⁰ The average weekly usage of bags during the experiment was three bags per household. Since garbage collection is done twice a week, an allocation of two bags per collection per household is being proposed for practical purposes.

²¹ The P6.00/bag assumes average cost is equal to marginal cost. This price should be updated as required since this was estimated using 2001 cost figures of ESMO.

²² As of year 2001. As indicated earlier, ESMO revenues have increased substantially since the last quarter of 2002.

minimum service level. This amount can be expected to decrease over time as these households respond to the incentive to reduce waste, although this decrease will be relatively small in view of the inelastic demand for solid waste services discussed earlier. This extra revenue can be used to strengthen enforcement and monitoring programs.

There may be no need for ESMO to provide recycling collection services to complement the unit pricing scheme, since household recycling collection is already being done effectively by the informal sector. The ESMO can enhance resource recovery by providing information to the public regarding which recyclables have market value. For instance, during the experiment, most of the households did not know that soft aluminum wrappers from shampoo and candies are being collected by the pushcart boys. On the other hand, there is as yet no market for empty tin cans of soft drinks and beer. ESMO should conduct research to identify markets for these recyclables.

It may be useful for ESMO to encourage or support community composting programs to reduce the amount of food and kitchen waste that is disposed of as non-recyclable waste. There is a lot of room to divert more of these wastes since about 50 percent of them are still disposed of into the dumpsite.

8.0 SUMMARY OF RESULTS

Waste Generation and Practices

- 1) Forty-three percent of households practice waste segregation; 16 percent engage in composting; the majority set aside their food/kitchen wastes for hog food, while almost all households engage in some kind of recycling (i.e., they reuse, sell or give away recyclables, or return bottles for their deposit). About 25 percent engage in some waste burning (mixed dry and yard wastes).
- 2) Most households make use of used plastic bags to dispose of their garbage. Only 12 percent purchase commercial garbage bags .
- 3) Based on actual waste measurements, the average household in Olongapo City generates 2.01 kgs/day of garbage. This gives a total of 32,255 tons per year.
- 4) Non-recyclable wastes account for 43 percent of total wastes generated; food/kitchen wastes, 40 percent; reusables 10 percent, and yard wastes 7 percent.
- 5) The household sector diverts at least 30 percent of their garbage away from dumpsite through: (1) the management of food/kitchen wastes as hog food; and (2) selling or giving away recyclables to the informal recycling sector.
- 6) The informal sector, consisting of junkshops and ambulant waste collectors, is in charge of waste collection for recycling.

Attitudes to SWM Program

- 7) Awareness of the city government SWM program is high (88 percent) but awareness of the barangay SWM program is low (23 percent).
- 8) Eigthy-one percent expressed satisfaction with collection services (this was higher in high-density areas).
- 9) Regarding garbage fees: 55 percent felt they were reasonable, 25 percent indicated there should be no fees, and the rest said that the fees should be lower.
- 10) Twenty-six percent said that they observed unauthorized dumping of garbage in their surroundings (this was higher in low-density areas)
- 11) More than 50 percent of the households found the idea of unit-based pricing acceptable.

SWM Collection and Disposal Costs

- 12) The cost of collecting and disposing of one ton of household garbage in Olongapo City was P 929 (year 2001 values). Personel services accounted for 70 percent. This cost doubles when external costs are considered.
- 13) A monthly fee of P42 to collect and dispose of household garbage would recover collection and disposal costs.

Impacts of Unit Pricing

- 14) Non-recyclable wastes declined by 0.21 kg/day/household or by 24 percent in response to unit pricing, while recyclables increased by 0.12 kg/day. There is a portion of the decline in non-recyclables that is unaccounted for. There is, however, no strong indication that households engaged in large-scale illegal disposal.
- 15) The price elasticity of demand for solid waste services is -0.15 . This suggests that the demand is inelastic, i.e., an increase in the unit price will elicit a smaller change in waste reduction.
- 16) The cost of waste collection and disposal that can be avoided thanks to unit pricing can be as much as Php 3.1million annually. Recycling costs on the part of government would be minimum because the informal sector is already actively and effectively involved.
- 17) Welfare gains of Php 9.9 million annually can be enjoyed by society if unit pricing replaces a fixed-rate system. If implemented by the City government, the policy reform would result in more winners than losers at a ratio of 58:42 in the short term.

9.0 POLICY RECOMMENDATIONS

The overall findings of the study suggest that shifting from the existing flat fee structure to unit pricing of solid waste in Olongapo City has the potential to enhance waste diversion and create welfare gains. The waste measurements conducted by the study indicate that the residential sector is already diverting at least 30 percent of their garbage through various alternative waste management practices such as household recycling and managing food wastes. Thus, while the City is already in compliance with the requirement of Republic Act 9003 requiring local governments to divert 25 percent of their garbage within the next five years, the implementation of unit pricing would further increase this rate of waste diversion and at the same time generate social gains. The study thus recommends that the City shift from its present flat fee garbage pricing to a unit pricing program to increase social welfare.

Although the idea of a unit pricing system of garbage appears to be acceptable to the majority of the City residents, its acceptability as a new pricing scheme remains to be seen in practice. Residents will have to be convinced that the new program will be fair and that the City government will be able to monitor and check whatever illegal disposal may result. An aggressive information campaign would be necessary to gain public support for the new pricing system. The winners of this policy reform can be harnessed by the City government as the natural constituency of this campaign.

Finally, the results of this study can be used by the Department of Environment and Natural Resources (DENR) to promote unit pricing of solid waste services among local government units (LGUs) that are as progressive as Olongapo City in their solid waste management programs. As demonstrated by the study, these LGUs can use this policy instrument as a tool to meet their waste diversion targets, promote recycling, and achieve other solid waste-related environmental goals.

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Appendix Table 1. SW Collection and Disposal Service Cost based on Full Cost Accounting, Olongapo City, 1997-2001.

Cost Component	1997	1998	1999	2000	2001
Personal Services ¹	7,928,412	8,154,318	9,586,112	12,000,036	14,351,827
Salaries and Wages	2,409,845	2,409,845	3,378,878	5,216,085	5,943,260
Insurance and other benefits	2,059,415	2,059,415	2,522,176	3,098,893	3,643,362
Oversight and Support Services ⁵	3,459,152	3,685,058	3,685,058	3,685,058	4,765,205
Maintenance and Other Operating Expenses	2,170,284	2,604,527	2,444,781	4,148,733	4,940,995
Travel and transportation	65,584	83,886	78,194	89,239	112,760
Communications and other utilities ³	12,746	17,240	18,885	36,880	54,122
Repair of Furniture and Equipment	-	1,820	-	752	3,760
Vehicle Maintenance and Rental ⁴	496,167	560,328	749,172	1,446,718	1,122,682
Supplies and Materials	74,477	113,887	98,629	133,824	150,400
Gas and Oil	1,407,743	1,713,800	1,386,333	2,327,753	3,383,703
Office Rental ⁶	113,568	113,568	113,568	113,568	113,568
Subtotal (Personal services and MOE)	10,098,696	10,758,846	12,030,893	16,148,770	19,292,822
Up-Front Costs					
Depreciation (1)	1,385,604	1,607,527	1,438,421	1,467,764	1,264,772
Vehicles ⁷	897,173	1,053,173	875,449	911,418	715,273
Equipment and Office Furniture ⁸	26,667	92,589	101,208	94,581	87,734
Landfill ⁹	461,765	461,765	461,765	461,765	461,765
Back-End Costs					
Amortized Closure and Post-closure Care ¹⁰	n.e.	n.e.	n.e.	1,471,917	1,507,908
Total Cost (without back-end costs)	11,484,301	12,366,372	13,469,314	17,616,533	20,557,594
Total Cost (with back-end costs)	n.e.	n.e.	n.e.	19,088,451	22,065,502
Estimated # of tons of solid waste collected	20,075	20,805	20,130	21,900	23,748
SWM service cost/ton w/out back-end costs(PhP/yr)	572	594	669	804	866
SWM service cost/ton w/ back-end costs(PhP/yr)	n.e.	n.e.	n.e.	872	929
# of households served	32,032	32,693	33,367	34,055	34,742
# of tons of household waste collected and disposed¹¹	16,060	16,644	16,104	17,520	18,998
SWM service cost of household sector (000 PhP)	n.e.	n.e.	n.e.	n.e.	17,,652
SWM service cost per household per month (PhP)¹²	n.e.	n.e.	n.e.	37	42
SWM service cost per bag ¹³	n.e.	n.e.	n.e.	n.e.	2.73

Notes:

1. Personnel Costs include only salaries 1 Public Service Foreman, 1 Laborer, 1 Public Utility Worker and those under Waste Disposal and Waste Collection Services (drivers and metro aides)
2. Includes (1) 60 percent of Representation and Transportation Allowance based on Department Head's estimate of proportion for SWM activities and (2) 75.20 percent of Travel and Transportation Expense based on personnel share.
3. Includes 75.20 percent of Telephone and Power and Illumination expenses. Other overhead expenses, namely Repair of Furniture and Equipment, Supplies and Materials, and Office Rental are allocated in the same manner.
4. Includes Repair and Servicing of MVSPL, Vehicle and Equipment Rental, Vehicle Insurance Premiums and Registration Fees. The figures that appear here are based on share of vehicles. Expenses for Gas and Oil is treated in the same manner.
5. Based on the following estimates of proportion of time spent by non-SWM personnel on SWM activities: Dept. Head and Asst. Dept. Head- 60 percent, Research- 3 days per month, Admin and Support- 1 week per month and Accounting/Budget/Government Office - 11 days per month
6. ESMO estimated cost of office rental (102 sq.m.) is PhP 13,000 per month. Assumed no increase in rental cost from 1996 to 2002.
7. Depreciation cost of vehicles is computed as : acquisition cost ÷ useful life. If information on the month the asset was acquired is available, depreciation on the year of acquisition includes only the number of months it was used in that year and the rest is credited on the last year of its useful life. Otherwise, 6 months is credited on the year of acquisition and 6 months on the last year of useful life.
8. Useful life of office furniture is assumed to be 4 years, computers- three years, while for other equipment it is assumed to be five years.

Some assets were not included due to lack of data in either acquisition cost or date of acquisition. Allocation is again based on personnel share.

9. Depreciation cost of landfill is based on its market value and its remaining useful life in 1996. Estimated useful life is 50 years, which starts in 1980 when the landfill was acquired.

10. Based on ESMO current estimate of total closure and post-closure cost of PhP 80M. This amount was adjusted to 2000 prices, yielding a figure of PhP 73.65 M. This was computed using the following formula: (Estimated cost of Closure and Post closure plans x Capacity of Landfill used for household garbage) ÷ Estimated total capacity of landfill (see worksheet "backend cost")

11. Assumes a ratio of 80:20 for residential to commercial and other wastes

12. 80% of total service cost/number of household served/12 months.

13. Refer to **Appendix Table 2** for calculation.

Appendix Table 2. Computation of SWM service cost per bag, Olongapo City, 2001.

	Unit	Initial value	Data source/remarks
Waste information			
Total waste collected	Tons	23,748	ESMO
Total waste disposed	Tons	20,186	ESMO; assumes 15 percent is recovered at dumpsite
Household waste collected	Tons	18,998	ESMO; 80 percent of total wastes collected
Average # of small bags used for household non-recyclables per month	# bag/mo	15.50	Based on baseline waste measurement data of Brgy Banicain
Average # of small bags used for household non-recyclables per year	# bag/yr	186.00	Based on baseline waste measurement data of Brgy Banicain
Household information			
No. of households served by ESMO	# hh	34,742	ESMO; 85 percent of total households
Cost Accounting			
Total cost of SW collection and disposal (w/ back-end costs)	Php	22,065,502	Obtained from FCA
Total household cost of collecting non-recyclable waste	Php	17,652,402	80 percent of total cost is household service cost
Total service cost per household per year	Php	508.10	Total household cost divided by total number of households served
Household service cost per month	Php	42	Total service cost per household divided by 12 months
Service cost per bag (private costs only)	Php	2.73	Service cost divided by adjusted average # of bags used
Service cost per bag (private costs+external costs)	Php	5.46	Assumes external cost of waste collection and disposal is equal to private cost.
Cost Accounting			
Total cost of SW collection and disposal (w/ back-end costs)	Php	22,065,502	Obtained from FCA
Total household cost of collecting non-recyclable waste	Php	17,652,402	80 percent of total cost is household service cost
Total service cost per household per year	Php	508.10	Total household cost divided by total number of households served
Household service cost per month	Php	42	Total service cost per household divided by 12 months
Service cost per bag (private costs only)	Php	2.73	Service cost divided by adjusted average # of bags used
Service cost per bag (private costs+external costs)	Php	5.46	Assumes external cost of waste collection and disposal is equal to private cost.

Appendix Table 3. Olongapo City Demographic Profile* and Survey Sample Size

	Population	No. of Household	Land Area (ha)	Density (pph)	No. of Puroks (districts)	Sample Size
<i>Olongapo City</i>	<i>194,260</i>	<i>43,107</i>	<i>7,391</i>	<i>2,772</i>	<i>203</i>	<i>360</i>
High density barangays						
Banicaín	6,654	1,609	13	504	10	14
West Tapinac	7,420	1,770	15	493	10	15
New Kalalake	8,718	1,899	26	330	8	16
East Tapinac	10,058	2,317	43	235	12	20
Pag-asa	5,716	1,300	27	215	6	11
East Bajac-Bajac	18,725	4,202	94	200	27	36
New Ilalim	1,484	362	8	193	5	3
New Kababae	2,092	467	11	188	4	4
Asinan	3,389	843	24	141	9	7
West Bajac-Bajac	8,015	1,822	65	124	7	16
<i>Subtotal</i>	<i>72,271</i>	<i>16,591</i>	<i>325</i>	<i>2,622</i>	<i>98</i>	<i>144</i>
Low density barangays						
Mabayuan	10,305	2,250	273	38	7	18
Barretto	15,816	3,434	496	32	18	28
Gordon Heights	21,536	4,676	862	25	25	38
Sta. Rita	33,477	7,407	1529	22	24	60
Kalaklan	10,340	2,276	750	14	11	19
Old Cabalan	12,348	2,727	1200	10	13	22
New Cabalan	18,167	3,746	1956	9	7	31
<i>Subtotal</i>	<i>121,989</i>	<i>26,516</i>	<i>7,066</i>	<i>150</i>	<i>105</i>	<i>216</i>

Source: National Statistics Office Census 2000

Appendix Table 4. Double Log Regression Result.

Independent variables	Dependent variable: Log of Non-recyclable Waste	
	Weight	Volume
	(kg/day)	(#bags/day)
Constant	-0.533 (-0.961)	0.654** (-2.124)
LOG_PRICE	-0.159 (-0.603)	-0.199 (-1.362)
LOG_INC	-3.81E-02 (-0.268)	3.39E-02 (0.430)
LOG_HSIZE	0.820** (3.622)	0.528** (4.204)
LOG_EDUC	-0.067 (-0.226)	-0.205 (-1.252)
D_MANAGEFW	-0.125 (-1.321)	-0.084 (-1.586)
D_MOTHER	8.95E-02 (-0.940)	-5.12E-02 (-0.968)
Elasticity estimate (at sample means)	-0.16	-0.20
Adjusted R ²	0.09	0.15
F-Statistics	2.590**	3.925**
N	102	102

** significant at 5 percent level

Appendix 5. Glossary

Barangay	The basic political unit in the Philippines with a population of at least 5,000 inhabitants in very major cities and municipalities and 2,000 inhabitants in less urbanized areas.
External costs	Unintended effects of an action of an agent on others and for which the agent does not bear the consequences.
FCA	Full Cost Accounting is a framework for examining the actual costs of SWM and serves as a useful tool for local governments to become aware of the environmental impacts of waste management through the identification and quantification, whenever feasible, of the external costs of improper waste management practices.
Food wastes	Left-over household wastes after cooking and eating
RA 9003	Republic act or law entitled “The Ecological Solid Waste Management of 2000” enacted in January 2001.
Recyclables	Waste that can be reused by the household or other individuals such as plastics, used paper, etc.
Non-recyclables	Household wastes that are disposed for collection and disposal by service trucks.
SUP	Simulated Unit Pricing
SWM	Solid Waste Management
SWS	Solid Waste Services
Unit pricing	Pricing of solid waste collection and disposal services based on the level of service, either in volume, weight or bulk.
WTP	Willingness to pay