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solution to household waste management.

A case study in Da Nang city, Vietnam”

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Hai Anh Nguyen

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1. Introduction

1.1. Urbanization and the landfill conflicts

Vietnam is located on the Indochina Peninsula in Southeastern Asia (Wikipedia). The neighbor countries of Vietnam are China to the north, Laos to the northwest, and Cambodia to the southwest. To the east, Vietnam is border by Gulf of Thailand, the Gulf of Tonkin and the South China Sea (CIA The World Factbook). The population of Vietnam in 2011 was approximately 87.84 million people and Vietnam ranked the 13th in the most populous countries in the world (General Statistics Office Vietnam). Vietnam is the 66th largest nation in the world with the area of 325,360 km² (General Statistics Office Vietnam). The pressure of population and economy has exerted a number of significant influences on the natural resources of Vietnam (Le at al., 2009; JICA, 2010).

Vietnam is now facing many environmental conflicts as many developing countries, which are in the process of urbanization. One of the most serious conflicts is the environment pollution in residential areas near landfill sites where big urban areas dump their waste. Many current projects on landfill sites building especially in big cities like Hanoi, Ho Chi Minh, Da Nang are confronted with strong opposition from the residential communities living nearby. The authorities (central and local governments), enterprises and local communities in many cases hardly reach an agreement or a solution which is beneficial to all parties (Dang et al., 2007).

The average agricultural land area per head in Vietnam is 0.3 hectares (World Bank 2011, p.34) and is therefore a country with land resources scarcity (Le, 2008). When the land resources for agriculture, forest and aquaculture cultivating could not be extended, Vietnam had to convert a number of agricultural land areas into building sites for industrial zones and urban infrastructure (Le, 2008). It is estimated that the areas for urban and industrial zones took almost half a million hectares of agricultural land form the period of 1993 to 2008 (World Bank, 2011, p.35).

Landfills account for only a small part of the agricultural land taken and in comparison with the total area of a city (for example Da Nang city with 1.283,42 km^2, Khanh Son Landfill 0.483 km^2, reported by Vietnam General Statistics Office), however, their

associated issues are not of minor importance. With the rapid urbanization, the demand for new landfill is increasing. There could be at least three reasons to explain this. Firstly, as the rule, the new urban area needs its new landfill. Secondly, the already existed urban area is expanded leading to an increasing amount of municipal waste which makes the already existed landfills reach its capacity faster than designed. Lastly, the old open landfills must be replaced by the sanitary landfill in an attempt of the government to improve the waste management situation in Vietnam. Besides, the old landfills after being closed cannot be reused for any purpose except for a deserted green place but not a public park. There are efforts to produce green electricity from greenhouse gas from the old landfills in Vietnam. However, the green electricity receives little interest from the distributors and consumers due to its high price, which does not receive any subsidy from the government. When the usable land area stays the same, those old landfills are such an enormous waste for land resource.

This industrialization and urbanization process has caused many conflicts among authorities (central and local governments), enterprises and local communities in Vietnam. The “physical, economic and social impacts of landfills” were the main concern of the local community (Nguyen and Maclaren, 2005, p.811). According to this study, physical impacts included contamination of ground and surface water, landfill gases, dust, noise and odor caused by landfills despite many new waste processing technologies claimed to be used. The community concerns resulted also from social impacts such as community perception of health risks (Nguyen and Maclaren, 2005). The community where waste facilities located was separated from the rest of society by waste and pollution; leading to a major loss to the community image (Zeiss and Atwater, 1987). The local insecurity is also an important issue of the social impacts from the landfill. The number of unemployed young people in the local community near landfills increases as the consequence of the fact that their land on which they used to cultivate to earn their living was taken for the landfills. Lastly, the economic impacts such as the reduction of their property values, rising infrastructure costs and slow development caused a number of concerns in the local community (Zeiss, 1996). Another reason for those concerns is the government compensation system. In many cases the farmers found the compensation package unreasonable, leading to tense conflicts (Nguyen and Maclaren, 2005).

There were a great number of public oppositions to landfills around Vietnam, especially in big cities like Hanoi, Ho Chi Minh and Da Nang. The number of complaints about landfills and civil disobedience related to landfill pollution is increasing unceasingly. They were “generally tolerated by authorities (unless accompanied by violence or threats) as legitimate protest” (Nguyen and Maclaren, 2005, p.816). As the latest on 15 July, 2011, hundreds of households in 4 communes of Son Tay in Hanoi blocked the roads by setting up living tents preventing the garbage collecting trucks entering the landfill. The protest lasted for almost two weeks, causing waste chaos for the city. On 22 January 2008, many waste collecting trucks were stopped by households in Hoa Nam Khanh commune, Lien Chieu district, Da Nang. Those public oppositions are increasing unceasingly and widely both in frequency and tenseness since the first time in 1992 in Hanoi.

1.2. Municipal solid waste management in Vietnam

In order to have a deep perspective on the above mentioned landfill conflicts, it is necessary to understand the municipal solid waste management system. This part provides an overview of the municipal solid waste management in Vietnam in which the institutional framework and the solid waste management in Vietnam are addressed.

The following paragraphs in this part (1.2.) including tables and figures are quoted, composed and summarized based on data from the Study on Urban Environmental Management in Vietnam, Volume 06, Study Report on Solid Waste Management in Target Cities, in October 2010 implemented by Ministry of Natural Resources and Environment (MONRE) with the cooperation and sponsor of Japan International Corporation Agency (JICA) unless otherwise cited (JICA, 2010).

1.2.1. Institutional framework

In this part, the institutional framework of Vietnam due to its own guideline is summarized from the above mentioned report by JICA (JICA, 2010) and the policy paper “Legal and institutional framework for solid waste management in Vietnam” by Le, H. V., Nguyen, V. C. N., Nguyen, X. H., Do, N. Q., Warinthorn, S., Catalin, S., Commins, T., in 2009 (Le et al., 2009), unless otherwise cited.

There are two levels of the institutional framework in Vietnam: national level and local level. At the national level, the main state authority is the Ministry of Natural Resources and Environment (MONRE). This ministry has three administrative units which are responsible for the waste management. The Ministry of Construction is in charge of municipal solid waste (MSW) management. Beside the two ministries, other waste management issues are under the instruction, control and conduct of different ministries and provincial People´s Committees (JICA, 2010, p.11).

At local levels, The People´s Council which is elected by local residents is the highest state unit. The Council is in charge of (i) approving the waste treatment projects in the city or province, (ii) supporting in financing the landfill construction, (iii) giving instruction to the Department of Natural Resources and Environment (DONRE) and Department of Construction **(**DOC) in waste treatment projects implementation and (iv) directing the Urban Environment Company (URENCO) in waste collection, transport and treatment, and waste fee scheme application (JICA 2010, p.14).

People's Committees is responsible for (i) implementing the environmental protection regulations (ii) coordinating with their agencies to develop waste management plans and (iii) supporting their agencies in environmental hygiene (JICA 2010, p.15).

Department of Construction (DOC): is a provincial level agency. It works under the instruction of People´s Committee, People´s Council and Ministry of Construction (MOC). The Department is in charge of (i) "supervising the implementation of urban master plans of the city or province", (ii) "organizing the design and construction of landfill projects according to environmental and construction standards", (iii) "supporting PPCs in making decisions on waste treatment facility projects", and (iv) "reporting and proposing appropriate landfill sites to PPCs for approval in coordination with DONRE" (Le et al., 2009, p.269).

Department of Natural Resources and Environment (DONRE) functions under the instruction of MONRE and People´s Committee. Its tasks are (i) to monitor the environmental quality, (ii) to manage and implement waste management policies and regulations issued by MONRE (JICA 2010, p.15).

Urban Environment Company (URENCO) due to its functions, the name could be changed in some cities or provinces. URENCO is responsible for collecting, transporting and treating waste for the whole city or province. URENCO is also in

charge of landfills. The company conducts the management and operation activities of the landfill (JICA 2010, p.16).

Depending on the characteristics and organization of each city or province, the solid waste management system could have some difference in its own structure. Agencies in charge of MSW and leading company for waste management in each city are shown in Table 1 below.

Table 1: Agencies in charge of MSW in target cities

City / Items	Hanoi	Hai Phong	Hue	Da Nang	HCMC
Management Agency	DOC	DOC	DOC	DONRE	DONRE
Leading collection company	URENCO Hanoi	URENCO Hai Phong	Hue Env. and Public Works Company	URENCO Da Nang	City Env. Company

(Source: JICA 2010, p.15)

1.2.2. Solid waste management conditions in Vietnam

The waste in Vietnam was categorized under ordinary solid waste and hazardous solid waste according to Decree 59/2007/ND-CP dated on April 9, 2007 by the Government. Municipal Solid Waste (MSW), Industrial Waste (IW) and Medical Waste (MW) were three types of solid waste (JICA, 2010). During the last ten years, there had been an unceasingly increase in the solid waste volume in Vietnam. From 1996 to 2004, the average amount of municipal waste had been doubled, from 5.9 million tons per year to 12.8 million tons, respectively (Nguyen, 2005; World Bank, 2004).

The Table 2 below shows the general situation of solid waste management in Vietnam.

Table 2. Solid waste management in Vietnam at a glance

Municipal solid waste generation (tons/yr) • National • Urban areas • Rural areas	 12,800,000 6,400,000 6,400,000
Hazardous waste generation by industries (tons/yr)	128,400
Non hazardous waste generation by industries (tons/yr)	2,510,000
Hazardous healthcare waste generation (tons/yr)	21,000
Hazardous waste from agriculture (tons/yr)	8,600
Amount of stockpiled agricultural chemicals (tons)	37,000
Municipal waste generation (kg/pers/day) • National • Urban areas • Rural areas	 0.4 0.7 0.3
Collection of waste (% of waste generated) • Urban areas • Rural areas • Among urban poor	 71% <20 % 10-20%
No. of solid waste disposal facilities • Dumps and poorly operated landfills • Sanitary landfills	 74 17
Capacity for hazardous healthcare waste treatment (% of total).	50%

(Source: World Bank, Vietnam Environment Monitor 2004)

From the table, the average volume of municipal solid waste per head per day in urban areas is almost the double of that in rural areas. Even though this rate in Vietnam is not high in the region, it is estimated to increase dramatically in the next ten years (Nguyen, 2005). Appendix 1 provides further information of the five largest cities of Vietnam.

1.2.2.1. Collection and Transportation

In almost all cities in Vietnam, the Urban Environment Company (URENCO) conducts the collection, transportation and disposal of domestic waste under the contract with local People´s Committee (Le at al., 2009).

The amount of waste collected in urban areas in comparison with rural areas and even with poor urban areas, which could be seen from the Table 2 above, is of great difference. Whereas more than 70% of the waste in urban areas is collected, only less than 20% of the waste in rural and poor urban areas is collected. The consequence is relative obvious. People in rural areas and poor urban areas have no choice but to dispose their waste on their own. Waste is directly either disposed to the surrounding environment, which could be ponds, rivers, abandoned ground, or burned at their own plot of land (World Bank, 2004, p.23).

A door-to-door system is mostly applied among the cities in Vietnam. Collection workers push handcart to each residential area to collect waste. The handcarts could have capacity from 0.4 m^3 to 1m^3. At the loading point, those handcarts are emptied by a truck. The waste will then be taken to the dumpsite or landfill nearby in the region (Nguyen, 2005).

Besides, many cities in Vietnam have applied the container system. The containers have volume from 90m^3 to 660m^3. They are located in designated places near residential areas, which are convenient for residents to dispose waste. Those containers become more and more popular in many cities nowadays (JICA, 2010, p.19).

Source separation test projects were introduced in the five target cities (Ha Noi, Hai Phong, Hue, Da Nang, and Ho Chi Minh). Some projects were successful; however, most of them could not be maintained as expected. One of the main reasons for those unsuccessful cases was that the project was not thoroughly and detailed planned (JICA, 2010, p.19).

The waste transportation system in Vietnam is mostly based on direct transfer. Transfer station is introduced recently. Da Nang and Ho Chi Minh city are reported to use transfer station efficiently. However, there are still a number of problem related to those station, which will be addressed in the parts about Da Nang (JICA, 2010, p.19).

1.2.2.2. Treatment

As in many other developing countries, landfill is the solution to the municipal waste. However, out of total 72 landfills scattered over the country, Vietnam has only 17 sanitary landfills (World Bank, 2004, p.21). In Vietnam, composting has become more popular in waste treatment. 30 composting projects are reported to be implemented recently (JICA, 2010).

(1) Unit generation rates of waste

Table 3 shows the unit generation rate of waste for households.

Table 3. Unit generation rate of waste at households (*Unit: kg/person/day)*

City / Income	Hanoi			Hai Phong	Hue			Da Nang			Ho Chi Minh		
	R	W	T	W	R	W	T	R	W	T	R	W	T
High	0.04	0.40	0.44	0.52	0.01	0.38	0.39	0.01	0.43	0.44	0.01	0.53	0.55
Medium	0.03	0.44	0.47	0.51	0.01	0.31	0.32	0.01	0.27	0.28	0.01	0.37	0.38
Low	0.03	0.47	0.50	0.13	0.01	0.27	0.28	0.01	0.24	0.25	0.02	0.29	031
Average	0.03	0.44	0.47	0.46	0.01	0.32	0.33	0.01	0.31	0.32	0.01	0.42	0.43

(Notes: R – Recyclables; W – Discharged waste; T – Total)

(Source: JICA 2010, p.61)

From the table, the recyclables is obviously low in comparison with discharged waste. There is also a big difference in the average waste generation rate among households. The higher the family income is, the more waste it produces. Only Hanoi, where household with high income produces less waste than household with medium and low income, is the exception to this.

In Table 4 statistics on the unit generation rate of waste for commercial establishments is presented in detail. The waste from commercial establishments is categorized under 5 groups which are shop, office, hotel, restaurant and market.

Table 4. Unit generation rate of waste from commercial establishments

City / Group	Hanoi ($kg/m^2/day$)	Hai Phong	Hue ($kg/m^2/day$)	Da Nang ($kg/m^2/day$)	Ho Chi Minh ($kg/m^2/day$)
Shop	-	-	0.04	0.06	0.09
Office	0.03	-	0.01	0.01	0.02
Hotel	0.03	-	0.01	0.01	0.02
Restaurant	0.19	-	0.02	0.06	0.12
Market	-	-	0.02	0.30	0.68

(Source: JICA 2010, p.61)

Hanoi and Ho Chi Minh city has much higher commercial establishment waste generation rate than that of other cities, especially from restaurant and market. Data for each type of commercial entity is shown in Appendix 3.

Table 5 provides the total MSW from each city. The average MSW generation unit of Da Nang is surprisingly much higher than that of Ha Noi or Hai Phong, which have larger population and area.

Table 5. Municipal Solid Waste generation in target areas

No	Items	Hanoi	Hai Phong	Hue	Da Nang	HCMC
1	MSW Collection amount (tons/day)	3,971	1,024	202	662	6,343
2	MSW Collection ratio (%)	83.2	80	90	90	90
3	MSW Generation amount (kg/day)	4,772,837	1,280,000	224,444	735,556	7,047,778
4	Population (persons)	6,451,909	1,837,173	337,169	887,437	7,162,864
5	MSW Generation Unit (kg/person/day)	***0.74***	***0.70***	***0.67***	***0.83***	***0.98***

(Source: JICA 2010, p.62)

(2) Composition of waste

The collected waste from household was categorized under 14 types. Table 6 provides the household waste composition in detail.

Table 6. Waste composition of household waste (*Unit: %)*

No	Types of waste	Hanoi	Hai Phong	Hue	Da Nang	HCMC
1	Kitchen waste	70.9	55.51	77.25	63.92	65.40
2	Paper	3.8	3.45	2.30	1.97	6.77
3	Textile	1.6	0.95	1.21	2.40	1.78
4	Wood	1.3	12.85	1.70	2.57	3.96
5	Plastic	9.0	6.10	13.99	13.82	16.07
6	Leather and Rubber	0.7	0.29	0.40	1.68	0.81
7	Metal	0.4	0.44	0.49	0.77	0.68
8	Glasses	1.3	0.29	0.48	1.84	0.51
9	Ceramic	-	-	0.25	2.15	0.18
10	Stone and sand	-	4.66	0.01	3.18	0.35
11	Briquette coal	6.8	-	0.00	2.46	0.69
12	Dangerous	0.5	-	0.01	0.50	0.11
13	Diaper	3.3	-	1.87	2.17	2.55
14	Others	0.28	15.46	0.05	0.58	0.14
Total		100	100	100	100	100

(Source: JICA 2010, p.63)

Table 7 shows the amount of waste coming to landfill and composting plant. It is clear that the waste of 2 big cities Hanoi and Ho Chi Minh is much higher than that of the other 3 cities.

Table 7. Amount of incoming waste in target cities (*Unit: Tons/day)*

City / Plant	Hanoi	Hai Phong	Hue	Da Nang	HCMC
Landfill(s)	3,814	874	61	662	5,971
Composting plant (s)	158	150	141	-	372
Total	3,971	1,024	202	662	6,343

(Source: JICA 2010, p.64)

1.3. Da Nang municipal solid waste management system

The following paragraphs in this part (1.3.) including tables and figures are quoted, composed and summarized based on the Study on Urban Environmental Management in Vietnam, Volume 06, Study Report on Solid Waste Management in Target Cities, October 2010 implemented by Ministry of Natural Resources and Environment (MONRE) with the cooperation and sponsor of Japan International Corporation Agency (JICA) unless otherwise cited (JICA, 2010).

1.3.1. Overview

Da Nang located in in the central part of Vietnam. It is the fourth biggest city and is the center for commerce and education in the central part of Vietnam. Da Nang is 764 km from the south of Hanoi and 946km from the north of Ho Chi Minh City with the area of 1,283.42 km^2 and population of 822,178 people (General Statistic of Vietnam 2008). Da Nang was separated from Quang Nam province in 1996. It is now one of five cities directly responsible to the central government (Da Nang People´s Committee 2005). The detail geographical location can be seen in Appendix 2, Figure 1.

There are 6 urban districts, which are Hai Chau, Thanh Khe, Lien Chieu, Son Tra, Ngu Hanh Son, Cam Le, 1 rural district, which is Hoa Vang and 1 island district, which is Hoang Sa, in Da Nang. The following socioeconomic statistics are based on Da Nang DONRE reported to Vietnam Environment Administration. Structure of GDP is industry and construction 45.76%; agriculture, forestry and marine 4.15%; service 50.09%. GDP growing ratio in 2008 is 10.05%; GDP per head in 2008: 25,321,000 VND. GDP in 2008 is 20,819 billion VND.

1.3.2. Institution framework

DONRE is responsible of solid waste management in Da Nang whereas in Hue or Hanoi, this responsibility belongs to DOC. The organization chart of DONRE Da Nang could be found in Apendix 2, Figure 2.

1.3.3. Municipal solid waste management

The collection ratio of MSW increases slowly in comparison with the increase in the amount of waste each year.

Table 8. Generation of waste in Da Nang

Year	Collection (tons/day)	Collection ratio
2007	497	85 – 86
2008	532	86 – 87
2009	574	88 – 90

(Source: JICA 2010, p.41)

The composition of MSW in Da Nang is of no difference to the other big cities like Ha Noi, or Hue. Organic waste always has the largest volume on the total waste of the city.

Table 9. Composition of MSW in Da Nang

No	Items	Ratio (%)
1	Organic	53.35
2	Wood, branch	3.5
3	Paper	2.55
4	Plastic	2.58
5	Textile	4.38
6	Rubber and leather	3.55
7	Born, shell	1.64
8	Nylon	8.4
9	Soil	8.28
10	Metal	2.08
11	Other	9.69

(Source: JICA 2010, p.42)

1.3.3.1. Collection and Transportation

Da Nang URENCO is in charge of MSW collection and transportation in Da Nang. Approximately 90% of MSW in Da Nang was collected by this company.

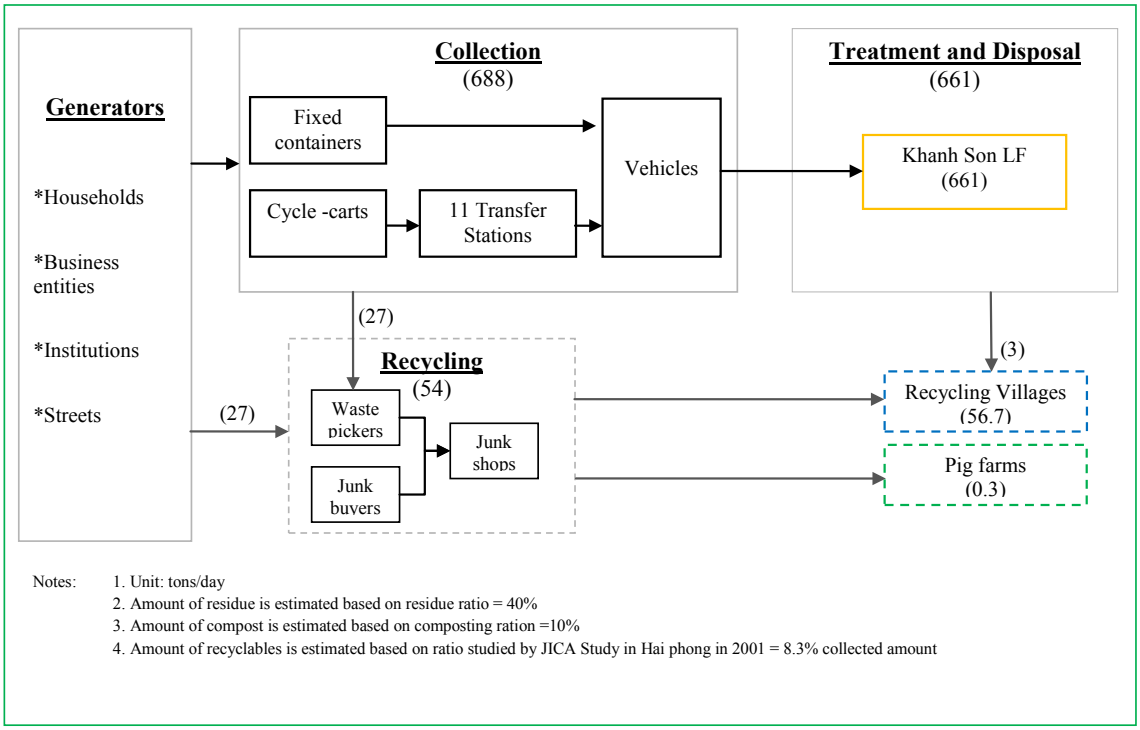

Figure 1. Waste flow in Da Nang

(Source: JICA 2010, p.78)

Approximately 95% of the waste generated in 6 urban districts is collected. However, due to the collection ratio in Hoa Vang rural district is much lower.

As in other cities in Vietnam, there are two most popular waste collection methods used in Da Nang: collection at the containers and collection directly to the vehicles. Table 10 provides their collection ratios.

Table 10. Ratio of collection by each method

No	Collection method	Collected amount (tons/day)	Ratio(%)	Notes
I	*Collecting by 240l, 660l containers*			
I.1	Collecting at transfer station	97	17	10 transfer stations
I.2	Collecting to vehicles from container	392	68	
II	*Collecting directly to vehicles*	85	15	Rural areas
Total		574	100	88% of generated amount

(Source: JICA 2010, p.42)

1.3.3.2. Treatment

Khanh Son is the only sanitary landfill in Da Nang where all the MSW of the city is disposed. Table 11 provides information on this landfill.

Table 11. Information on Khanh Son landfill

	Location	Area	Capacity	Technology	Note
Old Khanh Son	Lien Chieu District	9,8 ha	15 years	Landfill	Started in 1992 and closed in the end of 2006
New Khanh Son	1 km far from the old one	48,3 ha	15 - 20 years	Sanitary landfill	Started in 2007

(Source: JICA 2010, p.43)

1.3.4. Household waste situation

The waste generated by household with high income is much higher than that by household with middle or low income. There is almost no difference between the waste generated by low income and middle income household. The amount of household waste is given by Table 12.

Table 12. Amount of waste from household in Da Nang

Kind of income	High income			Midle income			Low income			Total of household		
	R	W	Total	R	W	Total	R	W	Total	R	W	Total
Average (kg/household/day)	0.0048	2.1640	2.1687	0.0014	1.0803	1.0817	0.0017	1.3631	1.3648	0.0026	1.5358	1.5384
Average (kg/person/day)	0.0010	0.4386	0.4396	0.0004	0.2701	0.2704	0.0003	0.2420	0.2423	0.0005	0.3163	0.3168
Density (kg/l)	0.0667	0.1291	0.1288	0.0429	0.1367	0.1363	0.0500	0.1551	0.1553	0.0532	0.1403	0.1401

(Source: JICA 2010, p.57)

Recyclables (R) included: metal, paper, box, carton, can, plastic (excluded nylon bag), old electric devices, etc. Other wastes (W) include organic waste such as kitchen waste.

Table 13. The difference in amount of waste between weekdays and weekends in Da Nang

Amount of waste	Weekdays	Weekends
Average (kg/households/day)	1.47	1.71
Average (kg/person/day)	0.303	0.352

(Source: JICA 2010, p.57)

From this table, it is rather obvious that waste generated by households in Da Nang was higher in weekends.

Table 14 describes the composition of incoming wastes to Khanh Son landfill. The kitchen waste amounts up to 68.47% of total wastes. Kitchen waste treatment is therefore a crucial factor to improve the waste treatment in the landfill.

Table 14. The composition of incoming wastes to Khanh Son landfill (*Unit:%)*

No	Types of waste	Khanh Son LF
1	Kitchen waste	68.47
2	Paper	5.07
3	Textile	1.55
4	Wood	2.79
5	Plastic	11.36
6	Leather and Rubber	0.23
7	Metal	1.45
8	Glasses	0.14
9	Ceramic	0.79
10	Stone and sand	6.75
11	Briquette coal	0.00
12	Dangerous	0.02
13	Diaper	1.35
14	Others	0.03
Total		100

(Source: JICA 2010, p.77)

1.4. Study issues and objectives

As in many developing countries, landfill is considered the most suitable waste disposal method in Vietnam. The existence of landfill for urban area is inevitable. However, landfill and its related issues have caused a number of serious environmental conflicts. It is a challenging question of how to manage the municipal waste disposed to landfill properly and effectively in order to minimize the associated pollutions and prolong the duration of landfill.

Reducing the household waste, therefore, should be considered as prerequisite to this. Out of different economic tools, household waste unit pricing is proved in many countries to be an effective measure in reducing the household waste and improving people´s awareness of household waste management.

In this thesis, an empirical research through a survey in communities of all 6 urban districts of Da Nang city in Vietnam is conducted. Khanh Son landfill is the only landfill of the city and situated in Lien Chieu district. The survey focuses on (i) general awareness of household waste of the local people, (ii) local current situation of household waste management and (iii) the introduction of the household unit pricing in Da Nang, Vietnam.

The logistic regression and correlations methods are used in the thesis. The logistic regression is used to determine which factors mostly influence on the decision to use the household waste unit pricing of the local people. The Spearman correlation is used in order to examine the correlations among the factors which could influence the perception of residents of unit pricing and household waste.

The objectives of this thesis are firstly to understand the current situation and identify the main problems of household waste management with special regard to landfill in urban area of Vietnam (Khanh Son landfill, Da Nang city, Vietnam). Secondly, the awareness and attitude of local communities about the household waste management are also addressed. The findings of the survey should identify the factors contributing to the effectiveness of household waste unit pricing application, and the obstacles when applying household waste unit pricing and measures to deal with them. Finally, it could contribute to the improvement of institutional responses to issues of environmental protection in Vietnam, especially in the field of the household waste management.

This thesis consists of four parts. In the first part, the relation between urbanization and landfill conflicts is addressed. The overview of Vietnam municipal waste, in general, and Da Nang household waste, in particular, are presented. The second part focuses on literature review, in which unit pricing concept is introduced and illustrated by cases in the United States, Taiwan and several Asian developing countries. The empirical research is the content of the third part in which the methodology with logistic regression and correlations are explained in detail. Recommendations and conclusion compose the final part of the thesis.

2. Literature review

2.1. Household waste unit pricing model

2.1.1. Unit pricing concept

Skumaz & Green (2002) defined “Pay as you throw (PAYT) systems, also known as variable rates programs or user pay, ask households to pay more if they put out more garbage for collection” (p.3). The definitions by Hannequart & Radermaker (2003), Miranda et al. (1996), Barterling & Sterner (1999), was summarized by Pickin (2008) (p.508) as `Unit pricing is a system under which households pay for municipal waste management services per unit of waste based on weight, volume, collection frequency or a combination of these rather than through a fixed fee`.

In many countries the payment for waste management is included in “property taxes or through an annual fee charged to each household” (US EPA Handbook 2006, p.2). Despite the differences in the amount of waste, the cost per each household, due to the flat tax, remains constant (US EPA Handbook 2006).

The traditional flat waste services were considered to have negative effect on quantities of waste as it discouraged people to reduce and to recycle their waste (Pickin 2008).

2.1.2. Types of unit pricing

Unit pricing can be applied in different programs. “Can programs, bin programs, bag programs, tag or sticker programs, and hybrid programs” are most used types whereas the weight based rates programs are less popular (Skumatz & Freeman 2006, p.2). The following types of unit pricing programs were summarized from this study.

Variable can or subscribed can: the number or size of containers for the weekly disposal amount was chosen by customers. The larger the number or size of containers were, the higher the service fee customers had to pay (Skumatz & Freeman 2006, p.3).

Bag program: Instead of paying waste fee, customers bought bags with the logo of city or hauler company. Only waste that were put in those bags are collected. Bags were available in supermarkets, convenience stores, grocery. Normally the all costs "collection, transportation, and disposal of the waste" were included in bag price (Skumatz & Freeman 2006, p.3).

Tag or Sticker Programs: Instead of the bag as in the bag program, a special logo sticker or tag was used to put on the waste containers. Only bags, cans with the visible tag or sticker were collected. The tag or sticker programs applied the same pricing and distribution system in bag programs (Skumatz & Freeman 2006, p.3).

Hybrid System: This system was a hybrid of the current collection system and a new incentive-based system. Only a limited volume of service was free of charge (one or two cans or bags). The additional volume was charged based on the bag or sticker programs. The advantage of this system was that the waste collection system did not have to be changed. This system could be easily applied to every community (Skumatz & Freeman 2006, p.3).

Weight-based System: the waste containers were weighed by the truck-based scales. The weights were recorded by on-board computers. The waste collection service fee was accordingly charged to each household. Container of household participated in the system was identified by the radio frequency tags attached on it (Skumatz & Freeman 2006, p.3).

Other Variations: customers could choose among UP and other waste service system (Skumatz & Freeman 2006, p.3).

2.1.3. Unit pricing and the quantity of household waste reduction

Unit pricing was found to have positive effect on recycling and waste quantities through many researches and studies (Pickin, 2008). The probability that households would participate more often in recycling was found increased when unit pricing was applied (Hong et al, 1993). The recycling rate was increased by the presence of unit

pricing (Callan and Thomas 1997). Hong and Adams (1999) (p.513) indicated that a unit price had a significant positive effect on the recycling rate.

In the study by Repetto et al 1992, in the scale of ten U.S. communities where UP was applied, 18 percent reduction in the volume of solid wastes disposed to landfill was reported after the waste unit pricing collection fee was introduced. This study also found that the reduction was up to 30 percent in a combination with a community curbside recycling program (Repetto et al 1992, p.16).

In another research by Reschovsky and Stone (1994) in High Bridge, New Jersey, 25 percent decrease in the waste quantity was achieved when the waste unit pricing was applied.

Fullerton and Kinnaman (1996) conducted a survey in Charlottesville, Virginia, USA in which 75 households were observed twice of a period of 2 weeks. The data was collected at two periods of time. The first period was 3 months after implementation. The results were 14 percent reduction in the waste weight, 37 percent reduction in waste volume and 16 percent increase in recyclables weight (Fullerton and Kinnaman 1996, p.971).

Hong et al (1993) found in the survey data of 2,298 households in Portland, Oregon, USA, that by applying the unit pricing, the probability of waste recycles could be increased whereas the waste quantity stayed the same.

Van Houtven and Morris (1999) conducted a research on unit pricing demonstration in Marietta, Georgia. The residents were divided into two groups. The first group took part in the bag programs. The subscription can program was applied for the other group in which the maximum number of waste cans were fixed. 51 percent waste reduction was reported in the fisrt group in comparison with approximately 20 percent in the other group; 18 percent increase in the household recycling probability was achieved by the both groups (Van Houtven and Morris 1999, p.517).

Block (1997) did a research on a pilot project in Cedar Rapids, Iowa, USA in April 1997 in the period of 12 weeks. In this project the curbside recycling pick up was combined with an unit pricing program. Based on the results of this research, if the

program could be implemented all over the city, the landfill of the city could possibly be used for extra three or four years (Block 1997, p.46).

Those empirical studies focused on the correlation between consumer´s behavior and the household waste. There was another field of research on unit pricing, in which the behavior of governments, firms and consumers were analyzed simultaneously (Linderhof et al., 2001). According to this study, unit pricing alone may not have the expected effect if not in combination with other factors. Linderhof et al. (2001) also stressed on the welfare maximization through charging the marginal social cost.

Beside the two waste disposal options with garbage and recycling, burning and dumping was the third option introduced in the model by Fullerton and Kinnaman (1995). Due to the study, a deposit refund system was considered the optimal fee structure with this option. Customers had to pay taxes for all wastes and received a rebate for their proper disposal (p.78). A subsidiary should be applied for the household waste collection so that the illegal waste disposal could be prevented (Fullerton and Kinnaman, 1995, p.88). According to Choe and Fraser (1999), the optimal policy should combine an environmental tax, a household waste collection charge and monitoring and fining illegal waste disposal.

Van Houtven and Morris (1999) (p.531, p.532) concluded that the presence of unit pricing could have positive influences on the probability that a household would participate in the recycling but had almost no effect on the quantity of recyclables.

Unit pricing was examined through a case study on unit pricing in Melbourne, Australia, using longitudinal data by Pickin 2008. This study found that the number of service properties had more influences on the management costs than the waste quantity. The author indicated that only when the “economic principles” were not to be considered; unit pricing could be very helpful in order to encourage recycling and to reduce waste (Pickin 2008, p.511).

Jenkins et al 2003 showed that waste reduction rather than economic efficiency was the targeted by the unit pricing guidance. Unit pricing was “set too high to produce an economically inefficient outcome” (Pickin 2008, p.508).

There were also studies in which the actual weight of the household waste was put into consideration. The number of bags could decrease but it did not mean that the waste volume and the illegal dumping were reduced. For instance, Jenkins (1993) indicated that right after the unit pricing was implemented; illegal dumping took place and tended to increase. In a study by Fullerman & Kinnaman (1996), illegal dumping was reported to cover up from 28 percent to 43 percent of the waste reduction (p.971).

The combination of pay-as-you-throw program, total recycling for kitchen garbage program, restricted use on plastic tableware program, producer responsibility program and recycling fund management programs in Taiwan has achieved great success. Chang et al (2008) found the mandatory sorting schemes, in which people had to separate recyclables from their waste, effective in the waste reduction.

Allers and Hoeben (2010) used a unique 10 year dataset of all 458 Dutch municipalities to estimate the effect of unit based pricing on household waste quantities and recycling applying a differences-in-differences approach. This study showed that unit pricing increased recycling, especially of paper. However, the quantity of waste reduction was unclear. The evidence of waste tourism and illegal dumping was not found. Based on the estimations by the authors, it was uncertain whether unit based pricing yields any net welfare gained (Allers and Hoeben 2010, p.425).

To my understanding, from those empirical researches, it is rather clear that the household unit pricing in those countries where people have good “tradition” of the environment protection, or in other word, high environment awareness such as the Netherlands and Australia has less effect on the household waste reduction than in countries where people´s awareness on environment, in general, and on household waste management, in particular, is somewhat limited such as the U.S., Taiwan.

2.2. Case studies in the United States, Taiwan, and Asian developing countries

These countries are chosen to be addressed due to some reasons. Firstly, they have applied unit pricing for household waste officially (USA and Taiwan) or on trial in

some projects (Philippines). Out of these countries, USA can be considered as the most interesting example of unit pricing application thanks to its different and flexible forms in unit pricing introduction. Secondly, due to the household waste composition characteristics, of which kitchen waste or biodegradable waste plays an important part, Taiwan, and other Asian countries may have the same experiences as Vietnam. Besides, Taiwan is recognized as one of the most successful countries in managing the municipal solid waste and household garbage. It might be a good example for Vietnam to adapt. Finally, the Asian developing countries like the Philippines, Malaysia and Bangladesh have the most resemblances in economic and social characteristics which may affect people´s behaviors on household waste management and unit pricing, in particular.

2.2.1. Case studies in the United States

Unit pricing (UP) has a long history. The first unit pricing program was launched in Richmond, California in 1916 (US EPA, 2004).

A number of empirical studies have been conducted in the U.S. during the past three decades which were mentioned previously in 2.1.3. Therefore, this part only focuses on the study “Pay as you Throw (PAYT) in the US: 2006 Update and Analyses” by Skumatz, L. A. and Freeman, D. J., which was prepared for US EPA and SERA, by Skumatz Economic Research Associates (Skumatz & Freeman, 2006). The study was conducted was conducted in more than 500 UP and non-UP communities under the sponsor of U.S. Environment Agency in 2006. To date, it is one of the largest researches in this field in the U.S. The following paragraphs in this part (2.2.1) follow this report unless otherwise cited.

In the study by Skumatz & Freeman 2006, unit pricing (UP) programs in the U.S. grew rapidly from about 100 in the late 1980s to approximately 1000 in 1993, 4150 in 1997, and to a total of 7100 UP in 2006. These programs are currently available to residents in almost jurisdictions across the U.S. These programs are now available in about a quarter of communities in the U.S., thus to approximately 25% of the U.S. population (Skumatz & Freeman 2006, p.3).

The study of Skumatz & Freeman (2006) (p.11) found that UP communities had

higher diversion rates. UP increased recycling based on the fact that recycling rates in UP communities were 4.3 percentage points higher than that in non-UP communities. The yard waste diversion rates in UP were 3.5 percentage points higher than that in non-UP communities. Overall diversion rates were 5.8 percentage points higher in UP communities than in non-UP communities.

It was predicted that only UP alone cannot push the US to the ambitious goal of 40% waste diversion. UP only make a decrease of about 16-17% of the residential materials delivered to the landfills in the US. However, if UP was combined with other tools of household waste management strategies, it could contribute positively to this goal (Skumatz & Freeman 2006, p.13).

UP programs were also found to have the significant advantages beyond recycling and equity. The main advantages of UP programs were explained by these authors Skumatz & Freeman (2006) (p.14) in detail below.

Fairness: obviously the UP programs brought about the equity. The more waste a household disposed, the more waste service fee it had to pay (Skumatz & Freeman, 2006, p.14).

Economic signal: in comparison with flat tax on waste service fee, UP could create an economic signal to the customer. The waste disposal "behavior" of customers could influence the waste service fee they had to pay (Skumatz & Freeman 2006, p.14). However, this signal may also have the negative effect in the sense that customers can use illegal dumping to reduce the waste service fee they have to pay.

No restrictions: Customers in the UP program were free to make their choice of waste disposal volume. The more waste they generated the more they had to pay (Skumatz & Freeman, 2006, p.14).

Efficiency: UP programs were efficient in the sense that the implementation cost was not high. The programs could be tailored to fit every community. The waste services would also be more efficient and cost saving as customers tended to use these services sparingly (Skumatz & Freeman, 2006, p.14).

Source Reduction: waste reduction at source played the decisive role in the waste management goals. The UP programs could actively contribute to those goals as these programs encourage customers to recycle, composte and reduce waste at source (Skumatz & Freeman, 2006, p.14).

Flexibility: thanks to a number of different subprograms and implementation forms, UP programs could easily adapt to almost every community despite of the community´s own characteristics (Skumatz & Freeman, 2006, p.14).

Speed of implementation: the flexibility character of UP programs should be considered as the main reason reducing the time in UP programs implementation process (Skumatz & Freeman, 2006, p.14).

Environmental benefits: UP programs contributed effectively to waste recycling and waste reducing, that brought undoubtedly benefits to the environment (Skumatz & Freeman, 2006, p.14).

Despite above mentioned significant advantages, there are also concerns about UP programs. The following paragraphs follow Skumatz & Freeman (2006) (p.14, p.15), in which the most frequently concerns were mentioned.

Illegal dumping: it was found in the research by Skumatz & Freeman (2006) that approximately 20% of the communities have illegal dumping. Only about 15% of the illegal dumping waste originated from household waste. Bulky items were the largest components in household waste. Thus, it was very important that the instruction to dispose occasional bulky waste through different type of UP programs were provided (Skumatz & Freeman, 2006, p.14).

Revenue uncertainties: it was very important for the communities and haulers in which UP was applied to have a suitable and prompt adaptation to the new output of bags or cans after UP implementation. Customers were found to reduce their waste bags or cans quickly, which could lead to an unstable income of the service providers. However, there were not any fixed numbers of those output changes. The UP communities and haulers had to consider this problem thoroughly (Skumatz &

Freeman, 2006, p.14).

Administrative burdens and workload: In the first period of the UP implementation process, a number of workloads accelerated were added leading to an increase in personal needs. In the next period of this process when everything was worked out, the workloads could even reduce to more than a half (Skumatz & Freeman, 2006, p.14).

Multifamily buildings: UP should be tested in the multifamily buildings because there had not been many researches on this category (Skumatz & Freeman, 2006, p.15). However, it is questionable that the multifamily buildings should not be considered as disadvantages of the UP program. The reason is that they cover only a minor part in the communities

Concerns about large families: The volume of waste from those families was certainly more than that from families with fewer members, and the opportunity to reduce waste was also higher. UP programs could be very effective for those larges families. The subsidiary for those large families should, therefore, not be necessary due to the equity effect of UP (Skumatz & Freeman, 2006, p.15).

Concerns about the poor: in a number of communities, families with low income received subsidiaries in some services. Those subsidiaries could also be applied for waste services fee in form of discount rates or some free bags or cans depending on the social welfare budget and strategy of the community (Skumatz & Freeman, 2006, p.15).

2.2.2. Case studies in Taiwan

Taiwan has the serious problem with waste management since the early 1990s. A number of measures have been introduced with an effort to improve the waste management. Initially, instead of traditional tipping systems, they applied the incineration and charged a waste fee proportional to water usage (Yang and Innes, 2007). This method, however, did not turn out to be successful. In 1997 they began to promote recycling by setting up recycling sites for residents to dispose recyclable

materials (Yang and Innes, 2007). However, the waste management situation was not significantly improved.

In different regions of Taiwan the local authorities introduced their own waste management policies. Taipei city introduced per-bag garbage charge (unit pricing) in July 2000 which required households to purchase official garbage bags with official stamps for their household waste (Yang and Innes, 2007). According to this report, people could buy official bags from 5 to 92l in all convenience stores and supermarkets; 5 Taiwan dollars (NT$) (approximately 10 Euro cents) was charged for every 10 liters (Yang and Innes 2007, p.494). The regulation of Taipei City Council stated the fine between NT$30,000 (€600) and NT$100,000 (€2000) was imposed for residents counterfeiting or selling fakes waste bags (Taipei Times, 2001).

A plastic bag regulation was introduced by the central government in January 2003 (Yang and Innes 2007, p.494). According to this regulation, customers had to pay 1 to 2 NT$ (approximately 2 to 4 Euro cents) for a plastic bag and restaurants and street vendors were prohibited to use polystyrene dishes.

A number of studies found that Taiwan had been very successful in managing their municipal waste. The following chart shows the result that Taiwan achieved during the time from 1995 to 2005 (Chang et al., 2008).

Table 15. Disposal method for MSW in Taiwan from 1995 to 2005

Table 1
Disposal methods for MSW in Taiwan from 1995 to 2005

Year	Quantity for various disposal methods (ton)											Ratio of recovered food waste (%) (9)	Rate of complete disposal (%) (10)
	Total (1)	Incineration (2)	Sanitary landfill (3)	General landfill (4)	Dumping (5)	Regulated recovery (6)	Others (7)	Recovered food waste (8)	Utilization of food waste				
									Fertilizer	Pig feed	Other utilization		
1995	9,529,687	1,301,036	4,362,789	2,537,556	776,863	45,128	500,033	6282	6282	0	0	0.07	86.60
1996	9,582,643	1,364,639	4,823,997	2,090,514	790,099	56,124	454,750	2520	2520	0	0	0.03	87.01
1997	9,628,644	1,691,626	5,129,676	1,536,415	649,544	98,325	508,885	14,173	14,173	0	0	0.15	87.97
1998	8,992,239	1,741,095	5,597,979	1,088,934	296,545	111,753	155,405	528	528	0	0	0.006	94.97
1999	8,715,575	2,020,634	5,366,936	857,267	245,183	149,876	56,186	19,493	19,242	251	0	0.22	96.54
2000	8,353,368	3,229,750	3,822,124	697,050	119,116	477,856	4690	2782	2659	123	0	0.033	98.52
2001	7,839,175	3,736,891	2,996,805	433,330	73,040	584,333	14,560	216	216	0	0	0.003	98.88
2002	7,601,960	4,316,049	2,116,375	224,477	55,076	878,319	7958	3706	3506	150	50	0.05	99.17
2003	7,555,372	4,304,574	1,900,438	113,115	20,190	1,048,981	734	167,304	22,290	139,614	5400	2.21	99.72
2004	7,522,263	4,305,822	1,458,234	59,792	15,004	1,387,371	1201	294,799	64,950	221,559	8290	3.92	99.78
2005	7,505,419	4,153,760	1,105,224	36,332	2585	1,749,952	104	460,137	95,820	357,473	6844	6.13	99.96

Remark: (1) = (2) + (3) + (4) + (5) + (6) + (7) + (8) (9) = (8)/(1) (10) = [(2) + (3) + (4) + (6) + (8)]/(1).

(Source: Chang et al 2008, p.2444)

As we can see from the chart, the total MSW in Taiwan reduced suprisingly from 9.5 million tons in 1995 to 7.5 million tons in 2005. The rate of complete disposal is almost 100% in 2005 in comparison with 86.6% in 1995.

In an empirical research about the impacts of the waste management policies in different regions of Taiwan over the 1997-2004 period, Yang and Innes (2007) found that the per-bag policy had positive impact on recycling volumes that was statistically and quantitatively significant three out of four categories (paper, plastic and metal). Kuo and Perrings (2010) (p.427) confirmed this in their study with an example of Taipei. This study stated that in two years applying unit pricing, the waste disposal decreased by 32.79% and recycling increased by 98.87%.

Taipei with its unit pricing program has received number of awards for its admirable achievements in waste management like Metropolis Award presented by the Spain-based Metropolis Association in November 25, 2011 in the Brazilian city of Porto Alegre. According to the study of this association, 'Pay as you throw' (UP) garbage collection system had significantly reduced the amount of trash in the city with the example of the significant drop in waste volume from 2,501 tons per day in 1994 to 59 tons per day in 2009 at the Shanchuku landfill in Nangang District (Taipei Times, 2011). The city government said the goal of eventually achieving zero landfill was achievable.

This city also won global recognition for its recycling program with the above average position in waste management in the Asian Green City Index – a study commissioned by Siemens and performed by the independent Economist Intelligence Unit (EIU). In this study, which was carried out over the past few months, the EIU analyzed the aims and achievements of 22 major Asian cities with respect to environmental and climate protection. Pay as you throw (or UP) was considered as the great green initiatives of the city. Over the last ten years, the avarage daily waste of the city was reduced almost 33%; the waste recycling waste achieved 45% which was doubled in comparison with the last decade (Siemens Asian Green City Index 2011, p.109).

The interesting point in the unit pricing program of Taipei (and a number of other cities) is that the program is intergrated with other national regulations and policies on waste management. The effective coordination and interlocked effects of those programs could be the answers for the success in their program.

After unit program was introduced in 2000 in Taipei, the volume of kitchen waste was found to be the main component of the total waste composition in landfills (Chang et al. 2008). According to this study, the total recycling for kitchen garbage was launched in Taipei in April 2002. This program encouraged people to separate food waste from kitchen garbage before discharge. Food from kitchen waste could be used as pig food and the rest were turned into fertilizer by composting, thus helped reducing the need for landfills. In recent years, the local government level decided that food waste was the focused recycling program which Taipei set a good example (Chang et al. 2008, p.2445).

The study by Kuo and Perrings 2010 (p.427) showed that the success in waste disposal reduction and recycle implied a “highly elastic response to price signal”. Together with a number of collection reforms, charging exerted positive influences on Taipei residents in the sense that they recognized the benefits of this strategy in comparison with other disposal methods. The policy of no waste on the street and high collection frequency were some of those reforms which contributed actively to the success story of Taipei (Kuo and Perrings, 2010).

The restricted use of plastic shopping bags and plastic table ware in 2003 had also positive effect on the overall success of waste reduction. Yang and Innes (2007) stated that by reducing the demand for bulky packaging, customers could have a better perception in the use and wear of plastic carrying bags. Through this, the overall garbage generation could be reduced thanks to plastic bag charges. They found some evidences that Taiwan´s plastic bag policy had this effect (Yang and Innes 2007, p.517).

Chang et al. (2008) (p.2450) stated in their study that the combination of household garbage unit pricing and the adjustment program of total kitchen garbage recycling could reduce the percentage of high-moisture food waste in MSW and lead to a decrease in moisture content. Accordingly, after program was implemented, the

heating value of MSW generated in Taiwan increased gradually by about 5% annually (p.2455). The chlorine content in MSW changed, for which the reduction in food waste and salt content due to total kitchen garbage recycle program was one of the main reasons. This achievement would lead to reduced dioxin emissions from MSW incineration (Chang et al 2008, p.2455).

After unit pricing was adopted, illegal dumping did not increase whereas the recycling ratio increased significantly (Kuo and Perrings, 2010). The study by Yang and Innes 2007 stated that unit pricing could have an unremarkable effect on illegal dumping. However there had not been any serious problem in illegal disposal in Taipei. In detail, government reported that, only approximately 0.02% of the total household waste was illegal disposed (Yang and Innes 2007, p.501).

Kuo and Perrings (2010) indicated that the time cost involved in alternative disposal options shoud be considered as the critical factor in determining household recycling strategies. The recycling decisions and willingness were not only made under the effect of the bags programs or waste disposal fining system but also under the effect of time cost factor. “People dislike wasting time in recycling. Moreover, the wealthier a community is, the larger the time cost looms” (Kuo and Perrings 2010, p.436). According to this study, another factor should also be considered was the living characteristics of Taiwan where most of the residents lived in small, high rise apartments, the cost of waste storage were also high.

More attention should be paid to this time-cost factor. In the study by Yang and Innes (2007), the residents had to bring their household waste (both waste and recycles) to regulated places and times. It took them also a lot of time waiting for “local environmental management workers to collect the garbage in their presence” (Yang and Innes 2007, p.494). It was found somewhat cumbersome and time wasting.

2.2.3. Case studies in several Asian developing countries

Most of Asian developing countries do not apply unit pricing on household waste management. Bennagen and Altez (2004) tested unit pricing system in Olongapo City, the Philippines in order to examine in order to examine the household´s response to the waste reduction and the welfare gains that unit pricing could bring

about. Due to findings in the survey, the illegal dumping was found to be higher in low-density barangays. The following two paragraphs were summarized from this research.

The 72-household sample size received color coded plastic bags and trash cans for their waste. Food and kitchen wastes, recyclables, garden wastes and non-recyclable wastes were collected and weighed. In a period of eight week, the waste generation and disposal behavior were observed (Bennagen and Altez, 2004, p.10).

24 percent reduction of non-recyclable household wastes was achieved in the tested system, leading to an annual disposal cost saving of Php (Philippine Peso) 3.1 million. It was estimated that the welfare gains with the application of unit pricing could be up to Php 10.0 million every year (Bennagen and Altez, 2004, p.1).

C. Naz and N. Naz (2008) conducted a study in Tuba, a radiation area of Baguio City, Philippines with 7,391 households. Due to the lack of a waste collection and disposal system in Tuba, solid waste from household and business was disposed without state regulation.

Their survey, in which different options of garbage fee were provided, was made in forms of interview and questionnaire with households and businesses. Most of households and establishments found waste fees necessary. Almost half of the households and more than half of the business establishments agreed that the waste fees should be charged on the volume generated by household (C. Naz and N. Naz, 2008, p.5).

They preferred the option in which they would separate the garbage and pay a small fix fee per month, and no separation – no collection. This was a modified form of unit pricing and pick up. The businesses most agreed with the unit pricing form (8 Php per bag). Both households and businesses were even willing to pay more when the frequency of collection was higher. Those fees were estimated to cover up to 25 percent of the ecological solid waste management cost, which was a solution to the financial problem of the local authority in applying the collection service (C. Naz and N. Naz, 2008, p.1).

Another study by Othman (2003) (p.3-4) was conducted with a sample size of 600 people in Kajang and Seremban municipalities, Malaysia. It was estimated that only 3 percent of the total solid wastes generated nationwide were being recycled. The municipal solid waste management was under the privatization process which was initiated in 1996. In the privatized areas, the waste bags would be collected by the private collectors twice or three times a week. The collection services fee was charged “indirectly through house assessment” every year (Othman, 2003, p.4).

The study found that the households placed a high value on improvements in solid waste management plan. Specifically, the households were willing to pay a premium for the improvements in collection frequency. The results from the models were not in consent with each other. Although customers were provided the free recycling facilities and did percepted the positive influences of this on waste management situation, they did not want to pay any other fee for the compulsory kerbside recycling (Othman, 2003, p.41).

In a study by Afroz et al (2011) in Dhaka city, Bangladesh 402 households were interviewed. Although 61.94 percent of surveyed households stated that they had knowledge about solid waste minimization, only 103 out of 402 households (25.6 percent) regular practised recycling activities. 30.1 percent of the households in this study were willing to minimise their household waste. The dominants factors that might influence the waste generation and household´s willingness to minimise solid waste were identified through the regessions. Those factors were “environmental consciousness, income groups, particularly the middle-income earners, young adults mainly those aged between 25 to 35 years and storage facility” (Afroz et al 2011, p.711). They suggested a question of what discourage people from their willingess to separate waste. As a result, measure to encourage recycling both voluntary and mandatory could be identified in order to have an efficient strategy on solid waste management.

3. Methodology and findings

3.1. Methodology

3.1.1. Communities in surveyed areas

The survey was conducted in all 6 urban districts of Da Nang city: Cam Le, Hai Chau, Lien Chieu, Ngu Hanh Son, Son Tra, Thanh Khe.

Figure 2. The map of Da Nang city

(Source: JICA, 2010)

The number of questionnaire was decided on the general data of each district such as natural area, population and population density. Accordingly, these are the number of questionnaire per each district: Son Tra (43), Hai Chau (41), Cam Le (32), Thanh Khe (31), Ngu Hanh Son (30) and Lien Chieu (15). Lien Chieu district where Khanh Son landfill situated (Figure 3), has the least natural area and lowest population density.

Table 16. The urban districts in Da Nang city

Districts	Subdivisions	Area (km²)	Population	Pop.Density (persons/km²)
Hai Chau	13	24.08	208,281	8,650
Thanh Khe	10	9.3	159,272	17,126
Son Tra	7	60.78	109,978	1,809
Ngu Hanh Son	4	36.52	49,180	1,347
Lien Chieu	5	82.37	70,441	855
Cam Le	6	33.3	71,429	2,145

(Source: http://www.danang.gov.vn/)

3.1.2. The survey questionnaire

The survey questionnaire consists of three parts. In the first part, there are general questions about gender, education background, incomes, number of household members, and organization participation. The second part focuses on household waste management and household waste separation. The third part is about unit pricing.

Target audience of the survey is ordinary people in Da Nang city. Survey was conducted in the form of personal interview with multiple choice questions in April 2011. There were 192 people participated in the survey.

3.2. Findings from the empirical analysis

3.2.1. Descriptive results

In the first part of the survey, there are questions about general information. 58% of the participants are women and 42% are men. The most popular household size is 3, 4 and 5 members with the proportion of 10%, 30% and 23%, respectively, of the total number of households. People with high school education make up the largest proportion of 37%, then graduates, 29%, and people with secondary school education, 27%, respectively. Most of the audience has the income from 2 to 8 million VND (70 to 270 Euro) per month, in which the group of 2 to 4 million VND per month is up to 36%.

About source separation and household waste management, although 66% people asked assume that source separation is a good solution to deal with household waste, the ratio between households separate waste and households do not separate is 50% to 50%. About 8% of the household used to separate their waste.

Regarding household waste management habit, 80% empty their waste once a day, 89% bring their waste to waste collecting vehicles.

41% find the environment condition in their living area is acceptable, 30% find it good and only 28% find it bad. The main reasons for the bad environment condition are believed to be air pollution and water resource pollution.

About the perceptions of present waste collecting fees, 70% are content with the fees, 18% find it somewhat high. 53% agree that the waste collecting service is good, 37% find it acceptable.

Related to Khanh Son landfill, 24% never hear about it. With the rest who know about it, 65% believe it caused serious pollution to the environment surrounded;

only 4% think it is acceptable. All people (100%) in Lien Chieu district, where Khanh Son located, believe serious pollution to the environment surrounded is caused by this landfill.

Regarding the question whether unit pricing should be applied or not, 61% believe that unit pricing should be applied. 42% assume that improvement of the awareness about environment protection especially source separation is the most efficient way to bring unit pricing into practice. 20% count on the control measures such as waste fine, and warning in community.

3.2.2. Logistic regression results

EViews (Econometric Views), a statistical package for Windows used mainly for time-series oriented econometric analysis was used for all the analysis in this thesis.

The logistic regression was used to determine which factors mostly influence on the decision to use the unit pricing of the local people. 7 questions, that in my opinion, may have direct correlation and could have influenced on the decision of the local people were chosen. The logistic regression model was estimated using Maximum Likelihood – Binary Logit (Quadratic hill climbing) method.

The variables used in the model are:

Y (dependant variable): decision of "yes" or "no" to unit pricing

D: How do you think of the environment in your living area?
D1 Acceptable / D2 Good

K: Do you separate waste at your household?

L: How do you think about this collecting fee?
L1 Reasonable / L2 High

M: How is the waste collecting service at your community?

M1 Acceptable /M2 Good

P: Monthly income

P1 6-10 million VND/P2 up 10 million VND

Q: Education

Q1 secondary school/Q2 high school/ Q3 graduate and post graduate

X: How much do you pay for waste collecting fee?

The results obtained after the first time running the model are given in the Table 17 below:

Table 17. Logistic regression – the first time

Variable	Coefficient	Std. Error	z-Statistic	Prob.
D1	0.050066	0.414175	0.120881	0.9038
D2	-0.082061	0.466877	-0.175767	0.8605
K	0.251899	0.322126	0.781987	0.4342
L1	-0.352088	0.529183	-0.665342	0.5058
L2	0.824427	0.666321	1.237281	0.2160
M1	-0.524255	0.586137	-0.894425	0.3711
M2	0.201708	0.601839	0.335152	0.7375
P1	-0.041110	0.408643	-0.100601	0.9199
P2	0.420845	0.512831	0.820631	0.4119
Q1	1.213620	0.500497	2.424829	0.0153

Q2	0.754214	0.461390	1.634656	0.1021
Q3	1.015385	0.502377	2.021162	0.0433
X	-1.08E-05	2.61E-05	-0.412726	0.6798

McFadden R-squared	0.076732	Mean dependent var	0.536458
S.D. dependent var	0.499973	S.E. of regression	0.490506
Akaike info criterion	1.420841	Sum squared resid	42.82606
Schwarz criterion	1.658367	Log likelihood	-122.4008
Hannan-Quinn criter.	1.517041	Restr. log likelihood	-132.5734
LR statistic	20.34521	Avg. log likelihood	-0.637504
Prob(LR statistic)	0.086931		

Obs with Dep=0	89	Total obs	192
Obs with Dep=1	103		

Subsequently, the values obtained for the variables are examined.

A positive value of D1, means that the number of responses to “yes” to unit pricing from group “acceptable” to the living environment condition is higher than that from group “bad”. A negative value of D2 explains that the number of responses to “yes” to unit pricing from group “good” is lower than that from group “bad”.

K has a positive value and it proves a higher probability of the households with waste separating habit compared to households that do not have this habit.

The value of L1and L2 show that the number of responses to “yes” to unit pricing from group “reasonable” to waste collecting fee is higher than that from group “low”. However, the number of responses to “yes” to unit pricing from group “high” is higher than from group “bad”. This could be explained that the group with a

“high” perception to collecting fee is not content with the collecting service. They have to pay high fee, in their opinions, but the service is not equal to that fee.

According to the values of M1 and M2, the number of responses to “yes” to unit pricing from group “good” to waste collecting service is higher than that from group “low”. However, the number of responses to “yes” to unit pricing from group “acceptable” is lower than from group “bad”. It is expected that the number of responses to “yes” to unit pricing from groups “good” and “acceptable” to waste collecting service should be higher compared to that from group “low”.

Regarding the values of P1 and P2, the number of responses to “yes” to unit pricing from group with monthly income “up 10 million VND” is higher than that from group “under 6 million VND”. However, this number of responses to “yes” to unit pricing from group with monthly income ”6-10 million VND” is lower than from the other two groups. It is expected that the number of responses to “yes” to unit pricing from groups “up 10 million VND” and ”6-10 million VND” is higher than from group “under 6 million VND”.

Q1, Q2 and Q3 show that the number of responses to “yes” to unit pricing from groups with education levels of “secondary school”, “high school”, “graduate and post graduate” is higher than that from group of “primary school”.

According to X value, it is found that if the waste collecting fee is 1000 VND higher, the ratio with “yes” to unit pricing will decrease. People expect the new form of unit pricing will provide good service at a better price.

Only variables Q1and Q3 are statistically significant with p value < 5%, all others are not. The model is therefore repeated in order to omit the variables without statistically significance.

P1; D1, D2; M2; X; K, L1, P2 are respectively omitted.

The results obtained after 6th time running the model on EView are shown in Table 18.

Table 18. Logistic regression – the sixth time

Variable	Coefficient	Std. Error	z-Statistic	Prob.
L2	1.080991	0.428920	2.520261	0.0117
M1	-0.606836	0.315365	-1.924232	0.0543
Q1	1.142788	0.475005	2.405846	0.0161
Q2	0.756540	0.440647	1.716883	0.0860
Q3	0.998416	0.465648	2.144143	0.0320

McFadden R-squared	0.067264	Mean dependent var	0.536458
S.D. dependent var	0.499973	S.E. of regression	0.483135
Akaike info criterion	1.350583	Sum squared resid	43.41600
Schwarz criterion	1.452380	Log likelihood	-123.6560
Hannan-Quinn criter.	1.391811	Restr. log likelihood	-132.5734
LR statistic	17.83486	Avg. log likelihood	-0.644041
Prob(LR statistic)	0.003161		

Obs with Dep=0	89	Total obs	192
Obs with Dep=1	103		

In comparison with the previously obtained models, the sixth model has all the variables with statistically significance. Other standards like Log likelihood, Schwarz, are at their lowest values. The Probability (LR statistic) gets also the lowest value.

The logistic regression model is:

$$\ln\left(\frac{p}{1-p}\right) = -0.57063 + 1,081L2 - 0.60684M1 + 1.14279Q1 + 0.75654Q2 + 0.99842Q3$$

Based on the above obtained model, the following conclusions can be drawn:

1. Opinion about the waste collecting fee, opinion about the waste collecting service and education level are the most influenced factors on the decision "yes" or "no" to unit pricing.

2. - L1 (in the question about waste collecting fee) does not exist in the model, thus it can be explained that the "Yes" rate to unit pricing from the group with "High" waste collecting fee is $e^{1.081} = 2.9476$ times HIGHER than that from the group with "Reasonable" and "Low" waste collecting fee.

- M2 (in the question about waste collecting service) does not exist in model, thus it can be explained that the "Yes" rate to unit pricing from the group with "Acceptable" waste collecting service is $e^{1.081} = 2.9476$ times LOWER than that from the group with "Good" and "Bad" waste collecting fee.

- The "Yes" rate to unit pricing from the group with "Secondary school", "High school", "Graduate or higher education levels" is $e^{1.14279} = 3.1355; e^{0.75654} = 2.1309; e^{0.99842} = 2.714$ times, respectively, HIGHER than that from the group with "Primary school education".

3.2.3. Influence of the correlations among the factors on people's attitude

In order to examine the correlations among the factors which could influence the perception of residents of unit pricing and household waste, the Spearman correlation is applied. The sample size n is 192. The formula of Spearman as follows:

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Unit pricing in this thesis is assumed to reduce the waste in household scale. Therefore, it is very important to understand the habits, perceptions of the local residents of waste separation. It explains why the questions related to source separation (3 questions a, b and c) are chosen. The last correlation between the waste collecting fee and monthly income (d) is an “examined” question in order to obtain viewpoint of local people on the collecting fee, which could be a good reference for the future fee of bag or can in the unit pricing program.

The perception of source separation is examined through four coupling correlations:

a) the quality of the present living area environment (D) and the decision to separate waste at each family (K);

D: How do you think of the environment in your living area?
D1 Acceptable /D2 Good

K: Do you separate waste at your household?

b) the decision to separate waste in each family (K) and education level (Q)

K: Do you separate waste at your household?

Q: Education
Q1 secondary school/Q2 high school/Q3 graduate and post graduate

c) waste separation on mass media (R) and reason to separate waste at home (S).

R: In the last year through the mass media have you heard about waste separation and reduction?

S: Do you know why you should separate waste at your household?

d) waste collecting fee and monthly income

L: How do you think about this collecting fee?
L1 Reasonable/L2 High

P: Monthly income
P1 6 -10 million VND/P2 up 10 million VND

The results of Spearman correlation are given below:

a) D and K: r = 0.154962

b) K and Q: r = 0.27589

c) R and S: r = 0.36345

d) L and P: r = 0.25507

The Student's t distribution with $n - 2$ degrees of freedom, T = $\frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$, is used to test for significance.

Because the sample size is rather large (n=192), T equal to the standard normal distribution N (0,1). The results are:

a) D and K: T = 2.1621

b) K and Q: T = 3.9564

c) R and S: T = 5.37756

d) L and P: T = 3.6362

Due to the standard normal distribution N(0,1), the significance levels of 0.05; 0.01; 0.002 of the above cases are 1.96; 2.576; 3.09, respectively.

According to this, the correlation of b) K and Q; c) R and S; d) L and P have the significance of 0.2% level. The correlation of a) D and K is at level of 5% and there is no correlation at the significance of 1% and 0.2%.

Therefore, the conclusions for the correlations could be drawn as follows:

a) The quality of the present living area environment (D) has no correlation with the decision to separate waste at each family (K).

b) The decision to separate waste at each family (K) and education level (Q) has a correlation with each other. The higher the education level people have, the more probability they will separate their waste.

c) The waste separation awareness rising programs on mass media (R) has correlated to the waste separation at each household. The mass media has a positive influence on the perception of people on source separation.

d) The opinions on waste collecting fee (L) and monthly income (P) have a correlation with each other; however, it is a weak correlation. The explanation for this could be that the waste collecting fee is still relatively low in comparison with the monthly income, and therefore has not created any incentive to the local residents.

4. Conclusion and Recommendations

Da Nang is an young urban area. The development in this city was very fast in the past decade leading to a lot of problems of legislation and planning. In other words, the master plan was not able to catch up with the development rate. The issue of waste management is in the same situation. The volume of municipal waste that increases unceasingly each year has been a challenge to the city authorities.

Khanh Son is the only sanitary landfill in Da Nang, which has been built under a project funded by World Bank for Da Nang City. By the end of 2007, a new landfill was opened to replace the old one which was over capacity (JICA 2010). However, the operation of this new landfill did not meet the expectation of the project. There have been a number of problems in design, operation and maintenance process causing serious pollution to the air and water resources.

The collection system in Da Nang is also a problem, of which the transfer stations are the main issues. JICA 2010 reported 11 small scale transfer stations scattered over the city. However, all of them were all located in residential areas, which made negative impact especially the odor from those transfer station to the residents living in the surrounding areas. Due to technical breakage or limited financial source, a number of the odor treatment systems which were installed for those stations could not be maintained (JICA 2010).

According to JICA 2010, a pilot scale on source separation in Nam Duong Ward with approximately 2,000 households involved was conducted. The supportive attitude of local residents for this project was reported. However, this model could not be continued for the two reasons. Firstly, finance source to maintain and improve the model could not be found. Secondly, and organic waste and recycles after separation could not be treated properly due to the lack of treatment facility. The waste after separation could not be treated because a composting plant does not exist. The city authorities now plan to support a CDM project with the aim to use biogas from the organic wastes instead of building a composting plant (JICA 2010).

In the framework of this thesis, the issues on general municipal waste management on the macro scale are not discussed but the recommendations on the introduction of unit pricing with focus on source separation based on the findings from the survey are to be emphasized.

4. 1. Technical issues

4.1.1. Source separation and mass media

Source separation plays a decisive role in the unit pricing program. As mentioned above source separation was once introduced in a pilot project without success due to lacking of financial support and measures to deal with the organic waste. Having no composting plant or a CDM project dealing with the organic waste is an enormous disadvantage in the waste management.

The mass media programs to improve waste separation awareness have a correlation to the decision to separate waste at each family based on Spearman correlation analyses. In this study, it is found that the higher the education level people have, the more probability they will separate their waste. 66% people asked assume that source separation is a good solution to the pollution situation and is an effective way deal with household waste.

However, the ratio between the households, which separate, and the household, which do not separate their waste, is 50% to 50%. There are some main reasons for not separating waste. These households only have a limited volume of household waste which is disposed almost every day; and separating waste every day is very cumbersome for them; or people do not know how to deal with the recyclable waste; or there is no place to dispose the recyclable waste, and if there is any, then the containers are very difficult to be accessed.

Therefore, beside technical measures in managing household wastes, for example building an organic composting plant and installation of more recyclable dispose places, the mass media programs on environmental issues especially on waste

separation awareness should be improved. The more often the people can access to this information, the better the source separation will be, and in this case, the people who have higher education usually have more access to the information sources. The residents in each living area should be well informed about the methods to separate household wastes and the places to dispose their separated waste.

4.1.2. Kitchen waste

Looking back to Table 14 (The composition of incoming waste to Khanh Son landfill), 68.47% of the total waste coming to this landfill is kitchen waste. In the composition of household wastes in Da Nang, kitchen waste make up 63.92%, whereas other recyclable waste types such as paper are only 1.97 %, plastic 13.82%, metal 0.77% and glasses 1.84%, (Appendix 2, Table A2-1). Clearly, kitchen waste is the most determining factor in the process of reducing the waste volume to landfill.

The system for the separation of kitchen waste from the rest of the household garbage outlets should be implemented. The implementation of kitchen waste separation will require the improvement of waste transfer stations in order to prevent the odor and other associated problems to the residents and their living environment. The decision either to support a CDM project with the aim to use biogas from the organic waste or to build a composting plant has to be made as soon as possible. The sooner the decision is made, the better the household waste management, in general, and unit pricing program, in particular, will be.

4.1.3. Bag program

Out of different programs with unit pricing concept, the bag program is the good choice for the city of Da Nang. The frequency of household garbage disposal, places for waste dumping and types of waste containers are the main reasons for this choice.

80% people asked dump their household waste once a day, 11% do it once every second day, which is not because of the garbage volume, but more than that it is

their habit. This habit is an obstacle for the recycling program. Due to large amount of kitchen waste and the hot and moisture climate, they have to dump their waste every day in order to prevent the odor from their waste. Another reason for that is the storage place. Most of the residents in the city live in small building apartments or small houses. They do not have a separate space to place their household waste.

The introduction of bag program may create the incentive to dump their waste not so often but, for example, once in two days due to the price of bags they have to pay. Eventually, their habit of storing the kitchen waste and recyclable waste could be somewhat changed into a more friendly way to the environment.

The can program with large volume is not suitable due to the above mentioned habits in waste disposal frequency and storage. 55% people asked use their small PVC can (10 to 15 liter) to contain the waste, 30% use plastic bags, the others use those two alternatively. The small can could also be a choice but it will be very complicated to implement. The questions of how to design a reasonable unit price per can and more difficulty, how to control the “legal” can, are very challenging.

Another factor should be considered is the place where people dump their waste. 89% people asked bring their household garbage to the garbage collector handcart. This handcart is manually controlled by one or two environmental workers. Normally there is one handcart coming to each resident area every day at fixed time. Those handcarts then will be driven manually to the waste transfer stations. People are used to this system, and do not want to go too far from their residence to dump their garbage. The bag program, therefore, match the expectation of those residents.

31% people asked use only plastic bags to contain the waste, of which 12% buy their own plastic bags and 19% use the free plastic bags they received from their goods purchasing. Bag program can reduce the need of plastic bags from the group who use free plastic bags to contain their waste.

The “legal” plastic bag in the bag program of unit pricing therefore must be environmental friendly. Using those legal bags instead of the normal and sometimes even toxic plastic bags can help reduce the toxic plastic waste composition landing to

the landfill. It is also the answer to the question whether stickers should be used or not.

4.1.4. Waste collecting fee and waste collecting service

The logistic regression model shows that the waste collecting fee and waste collecting service beside the factor of education level discussed above are the factors, which have most influenced on the decision of whether or not unit pricing should be applied. In the survey, 73% people asked will separate their waste once unit pricing is applied, 22% will not do that mostly due to the reasons mentioned previously in 4.1.1. How to keep those 73% people to fulfill their will and eventually make the others persuaded about the program is again a great challenge.

The waste collecting fee is put into consideration by looking at the empirical findings from the survey. The group of people, who think that the current collecting fee is high, have a higher tendency to support unit pricing based on the regression model. However, this group counts for only 18% of the total people asked in the survey whereas 70% people satisfy with this collecting fee.

The waste collecting service has slightly different results. According to the regression model, the group of people, who think that the current collecting fee is acceptable, have a lower tendency to support unit pricing. Those people are to some extent indifferent about unit pricing. This group counts for 37% of the total people taken part in the survey. 53% people asked, whereas, agree that waste collecting service is good and the rest finds it bad.

Regarding unit pricing, interestingly, 61% of the people questioned agree that unit pricing should be applied. In the Spearman correlation, the perception of waste collecting fee and monthly income has a weak correlation with each other. Therefore in general, the waste collecting fee is largely accepted by the residents. The price for legal bags, or stickers or can once applied should be considered in lieu with the current fee. In Da Nang there is a very small group of people which was exempted from this fee due to their extreme poverty. It is also an issue that should be addressed.

The waste collecting service should be improved in order to persuade the group, which finds the service acceptable, to join the unit pricing program. It is essential to improve the situation at the transfer stations so that the residents living close to these stations do not have to suffer from waste odor. Public recyclable waste containers are also very important for the program. They should be installed in each street and hamlet and should be accessible for all the local residents.

4.2. Institutional issues

4.2.1. Mandatory recycling policies

In the survey, there are the questions aiming at the general awareness of environment and it is found that many people do not receive enough and thoroughly information. In the first question about Khanh Son landfill, there is 24% people do not know about this landfill even though it is located in one urban district of the city and it is the only landfill in the whole city. The second question is about environment police, which requires more specific information, 73% people asked do not know if they even exist. The quality of the environment in the living area has no correlation to the decision whether or not to separate household waste even though only 30% people find their living environment is good. A concept of source separation is not thoroughly introduced to make them aware if its benefit, thus an environment education program should be considered.

Moreover, with regard to the volume of waste coming daily to the landfill and its associated problems, the implementation of mandatory recycling policies in a combination with unit pricing could be a good choice. 54% people believed that rising awareness about environment, in general, and source separation is the most important factor leading to the success of unit pricing program. A pilot mandatory recycling program could prove this prediction.

In addition, unit pricing with its advantages could provide an incentive to improve the household waste generation and management. It is showed that only financial

incentive by purchasing the legal bags is not enough. The effectiveness of the policies based on a combination of mandatory recycling and the unit pricing of waste collection in Taipei is a valuable example for Da Nang.

Kitchen waste separation is recommended to be used as the first mandatory recycling method. As discussed above, kitchen waste recycling is one of the most determining factors to reduce the waste coming to landfill. It can be also understood as the adjustment in unit pricing program. However, it should be applied after a certain period of time implementing unit pricing. People need time to get used to the new regulations, to understand the benefits of unit pricing and also to change their habit.

4.2.2. Control measures

As mentioned above, people´s awareness of source separation is improved recently. However, there is a big gap between the awareness and the voluntary action to conduct waste separation in daily life. Therefore, the control measures in unit pricing programs and mandatory recycling programs are of great importance. Without the control measures, those programs cannot be implemented. This control could compose of both technical and legal measures.

Transparent “legal” bags could be very effective in many ways in controlling the waste. The waste content is visible, which provides very useful information on the waste generation habits of each particular household or living area. In a pilot project implementing unit pricing, it is very valuable. Once the mandatory recycling policies are used, it is the most effective to control the waste. People will recycle more because hiding their recyclable waste in these bags is not possible.

39% of people participated in the survey believe that an official warning of the local authority in the living community about a person who violates the unit pricing regulations is necessary. 18% believe that financial fines at different scales should be applied. The fining scale, in my opinion, should be considered in a compliance with the social and the economic situations of each city or regions.

Illegal dumping of household waste based on the results of the survey appeared to be not a problem. In the survey question about the manners to dispose the household waste, all normal legal manners are mentioned. The illegal dumping is covered under the category “other”. There is no questionnaire with this category crossed. Therefore, this should be examined by a more-in-depth research. The fine scheme for illegal dumping is still necessary and should be carefully studied.

The control personal force is also a difficult question. 37% people asked think that the ward authority officers should be responsible for the waste disposal violation control, 28% think the waste collecting workers should do this and 13% believe that the environmental officers have to do the controlling. Each community has its own characteristic. Therefore, the forms of authority participation should be carefully researched in order to get along with the community features (Skumatz et al 2006).

The combination of different authority forces is a good suggestion for having an effective control in the unit pricing program. The environment police in Vietnam was firstly introduced in 2007. Together with the environment inspectors they focus mostly on the environmental violations in business sector. Once the mandatory recycling policies are implemented, their cooperation with other local forces will be more effective in monitoring the control measures.

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APPENDIX 1: GENERAL INFORMATION OF VIETNAM

Table A1-1. MSW in five largest cities

No	City / Item	Ha Noi	Hai Phong	Hue	Da Nang	HCMC
I	**General Info.**					
1	Area (km^2)	3,344.7	1,507.57	83.3	1,283.42	2,095
2	Population (people)	6,500,000	1,884,685	333,004	822,178	7,123,340
3	Number of Districts/ Wards	29 districts	15 districts	27 wards	8 districts	24 districts
4	Density (people/ km^2)	1,943	1,207	3,997	640	3,401
II	**MSWM system**					
1	Management agency	DOC	DOC	DOC	DONRE	DONRE
2	Legislation system					
	Master plan	Under construction	Direction documents: 1/ Resolution No.04/2005/NQ-HDND on innovation on MSW management in Hai Phong, period 2005-2010 2/ Plan No.6444/2005/UBND-GT on implementation the resolution No.04/2005/NQ-HDND	Plan on system of Solid waste collection and treatment of Thua Thien Hue until 2010 vision to 2020.	Direction documents: 1/ Decision No.41/2008/QD-UBND on promulgating the program: "Developing Da Nang- the Environmental City"	(It has been started to prepared since 2004 but have not been approved yet)
3	Generation amount	~4,000 tons	~980 tons	~202 tons	~660	~6,300 tons
4	Collection ratio	83.2% (100% in urban area)	80% (100% in urban area)	90%	95%	90%
5	Leading collection company	URENCO Hanoi	URENCO Hai Phong	HEPCO	URENCO Da Nang	CITENCO
6	Transfer station	0	0	0	11 small ones for containers transfer	2 big ones for vehicles transfer
7	Waste treatment facilities					
	Landfill	3 operating +1 temporary closing	6	1	1	2
	Composting plant	3	1	1	0	1

(Source: JICA 2010)

Table A1-2. GDP and Population of target cities

City	Items \ Year	2000	2005	2006	2007	2008	2010	2020
Hanoi	Population (1000 ppl)	2,739.2	3,149.8	3,236.4	3,289.3	6,350.2	6,588.9	7,943.4
	GDP (Billion VND)	31,513	76,006	90,929	107,744	178,533	240,600	971,888
Hai Phong	Population (1000 ppl)	1,694.4	1,790.3	1,807.5	1,827.7	-	1,897.8	2,138.5
	GDP (Billion VND)	10,487.1	213,71.5	255,48.8	312,65.1	-	Growth ratio 12%-13%	
Hue	Population (1000 ppl)	1,663.5	1,134.4	1,137.9	1,150.9	-	-	1,356.6
	GDP (Billion VND)	3,460.8	7,131.2	8,518.8	10,261.6	-	-	22,198
Da Nang	Population (1000 ppl)	703.5	777	789.8	805.4	-	865	1,369
	GDP (Billion VND)	4,946.9	11,690.8	12,865	15,284	-	28,771	161,356
HCMC	Population (1000 ppl)	5,226.1	5,911.6	6,107.8	6,347	-	7,200	10,800
	GDP (Billion VND)	75,863	165,297	190,561	228,795	-	296,788	-

(Source: JICA 2010)

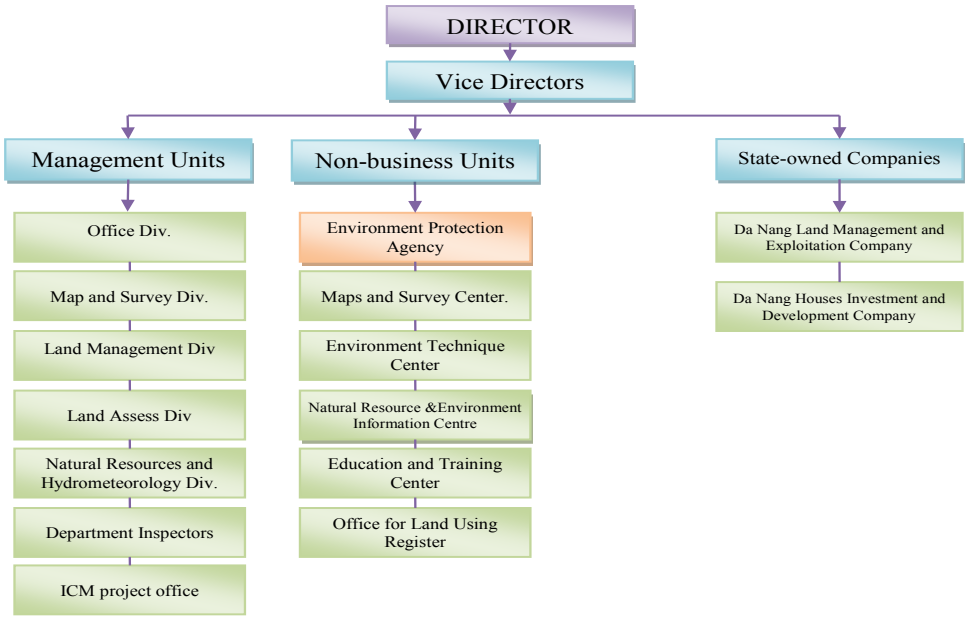
APPENDIX 2: DA NANG SOLID WASTE MANAGEMENT

Figure A2-1. Da Nang

Area: 1.283,42 km^2
Districts: 8 districts, in which - Urban district: 6 - Rural: 1 - Island: 1
Population (2008): 822.178 ppl

(Source: JICA 2010, p.40)

Figure A2-2. Organization chart of Da Nang DONRE



(Source: JICA 2010, p.41)

Table A2-1. Composition of household waste in Da Nang

No	Types of waste	High income (%)	Midle income (%)	Low income (%)	Average (%)
1	Kitchen waste	62.71	64.76	64.30	63.92
2	Paper	2.89	1.89	1.13	1.97
3	Textile	2.11	2.58	2.50	2.40
4	Wood	3.42	1.68	2.59	2.57
5	Plastic	15.13	13.23	13.11	13.82
6	Leather and Rubber	1.68	1.60	1.75	1.68
7	Metal	0.60	0.97	0.74	0.77
8	Glasses	2.31	1.61	1.61	1.84
9	Ceramic	2.34	2.25	1.87	2.15
10	Stone and sand	2.15	3.07	4.32	3.18
11	Briquette coal	0.79	2.69	3.89	2.46
12	Dangerous subtance	0.81	0.28	0.42	0.50
13	Other 1: Diaper	2.89	2.80	0.82	2.17
	Other 2: Cigarette	0.16	0.07	0.03	0.09
	Other 3: Mouse	0.00	0.00	0.00	0.00
	Other 4: Hair	0.00	0.50	0.00	0.17
	Other 5: Injection needle	0.00	0.00	0.00	0.00
	Other 6: Printing Ink	0.00	0.03	0.00	0.01
	Other 7: Soap	0.00	0.00	0.00	0.00
	Other 8: Silver paper	0.00	0.00	0.92	0.31
	Other 9: Wax	0.00	0.00	0.00	0.00
	Other 10: Candle	0.00	0.00	0.00	0.00
	Other 11: Polish paper	0.00	0.00	0.00	0.00

(Source: JICA 2010, p.58)

Abstract in English

As in many developing countries, landfill is considered to be the most suitable waste disposal method in Vietnam. However, landfill and its related issues have caused a number of serious environmental conflicts. To manage the municipal waste disposed to landfill properly and effectively in order to minimize the associated pollutions and prolong the duration of landfill, it requires a comprehensive and challenging solution to those conflicts. Reducing the household waste, therefore, should be considered as prerequisite in solving these conflicts. Household waste unit pricing is proved in many countries to be an effective measure in reducing the household waste and improving people´s awareness of household waste management. In this thesis, an empirical research through a survey in the communities of all 6 urban districts of Da Nang city in Vietnam, where Khanh Son landfill located, is conducted. The survey focuses on general awareness of household waste of the people in these communities, as well as on the local current situation of household waste management, and on the introduction of the household unit pricing in Da Nang. The logistic regression model and Spearman correlation are presented in the thesis to identify the factors determining the effective implementation of household waste unit pricing. The obstacles occurred when introducing household waste unit pricing and the measures to deal with them are also addressed. The findings of this study could contribute to the improvement of the institutional responses to waste management issues in Vietnam, especially in the field of the household waste management.

Abstract in German

Wie in vielen Entwicklungsländern wird auch in Vietnam das Entsorgen des Haushaltsmülls in den Mülldeponien als die geeignetste Methode für die Abfallentsorgung gesehen. Allerdings verursachen die Mülldeponien eine Reihe von Umweltprobleme und Interessenkonflikte. Deswegen ist – neben den Deponien selbst - eine effektive Verwaltung des in den Deponien zu lagernden Abfalls unabdingbar. Eine effektive Abfallverwaltung hilft nicht nur bei der Minimierung der Umwelt-Verunreinigungen durch Deponien, sondern erhöht somit indirekt auch die Lebensdauer dieser Deponien.

Die Reduzierung des Haushaltsmülls wird in diesem Zusammenhang als die zentrale Lösung betrachtet. In vielen Ländern erwies sich die Einführung des Preises pro Einheit des Haushaltsmülls (Household waste unit pricing) als wirksame Maßnahme zur Verstärkung des Bewusstseins der Bevölkerung für die Notwendigkeit zu Reduzierung des Haushaltsmülls. Die Methodologie dieser Diplomarbeit ist empirische Forschung durch Umfrage. Die Umfrage wurde in einigen ausgewählten Gemeinden der 6 Bezirke der Stadt Da Nang in Vietnam, wo sich die Khanh Son Mülldeponie befindet, durchgeführt. Die Studie befasst sich zunächst mit der Einstellung der Bevölkerung zur Verwaltung und Reduzierung des Haushaltsmülls. In weiterer Folge wird die aktuelle Situation der Haushaltmüll-Verwaltung in den betroffenen Gemeinden untersucht. Schließlich wird Auswirkung der Einführung des Preises pro Einheit des Haushaltsmülls in Vietnam näher betrachtet.

Diese Diplomarbeit wendet die Methoden der logistischen Regression sowie der Spearman Korrelation an und zeigt die Wirksamkeit sowie die Probleme des vorgestellten Konzepts “Preise pro Einheit des Haushaltsmülls“. Maßnahmen zur Lösung der angezeigten Probleme werden ebenso identifiziert. Diese Arbeit könnte somit zu einer Verbesserung der institutionellen Reaktionen zu Fragen der Müllentsorgung, insbesondere im Bereich der Hausmüllentsorgung in Vietnam, beitragen.

Survey questionnaire on the environmental awareness with a focus on household waste management in Da Nang City

This questionnaire is designed to provide information for a study of household unit pricing in Vietnam. All your information you provide will not be shared to a third party. Thank you very much for your cooperation.

Interviewee

Ward:

Occupation:

Interviewer

Name:

Date: Duration:

Part 1: General information

1. Gender

□ Male □ Female

2. Education background

□ Post graduate □ Graduate
□ High school □ Lower

3. Number of your family members in your household?

4. Your household income estimated per month? (VND: Vietnamese dong, 1 Euro equal to 29.000 VND)

□ Below 2 million VND □ 10 to 15 million VND
□ 2 to 4 million VND □ 15 to 20 million VND
□ 4 to 6 million VND □ 20 to 30 million VND
□ 6 to 8 million VND □ 30 to 50 million VND
□ 8 to 10 million VND □ More than 50 million VND

5. Is there any of your family members participated in a community or social organization?

□ No
□ Yes (please name it)

Part 2: Household waste management and waste separation

1. How do you think about the environment in your living area?

   □ Good □ Acceptable □ Bad

2. What could be the reasons for the pollution (if any)?

   □ Solid waste
   □ Wastewater
   □ Polluted air
   □ Other (please illustrate)

3. What of the following methods could help to reduce the waste to the environment?

   □ Waste separating at source (household/schools/firms…)
   □ Reuse at source
   □ Recycling
   □ Producing Bio-organic fertilizers from organic waste
   □ Making full use of Greenhouse gas emissions from landfill

4. Have you ever heard of the importance of waste reduction and waste management via mass media?

   □ Yes □ No

   If yes, which from the followings?

   □ Newspapers, internet □ Local television and radio programs
   □ Local commune □ Other sources

5. Do you know Khanh Son landfill?

   □ Yes, I have been there □ Yes, but never been there □ No

6. How do you think about the pollution caused by the landfill?

   □ Serious □ Acceptable □ Somewhat

7. How do you manage your household waste?

   □ Bring to waste collecting vehicles
   □ Bring to waste collecting area nearby
   □ Burn at my own premise
   □ Dump in my own premise
   □ Other

8. How often do you empty your household waste?

 More than once a day (right after having waste)
 Once a day
 Once in two days
 Twice in one week
 Once in one week

9. What kind of waste container/bag do you use? And from which source?

 Plastic waste container
 Plastic bag received from shopping
 Paper bag received from shopping
 Plastic bag bought on my own
 Paper bag bought on my own

10. Do you separate your household waste?

 Yes
 No
 Used to (please explain why you do it no longer)

11. When separating, what kind of waste do you separate?

 Bio waste (food, fruits, vegetables, gardening waste)
 Reusable or recyclable waste (plastic, glass, metal, paper)
 Other

12. When separating, do you have any difficulties?

 No
 Yes (please name it)

13. Why do you not separate your household waste?

 Have no time
 Have no place to keep the waste
 Do not remember
 Other (please mention)

14. Do you know why you should separate your household waste?

 I do not know
 To control the waste better
 To recycle the waste
 To protect the environment
 Our leaders want us to do so
 Other (please mention)

15. How much is your household garbage collecting fee monthly?

16. How do you think about this fee?

□ High □ Reasonable □ Low

17. How do you think about the household garbage collecting service?

□ Good □ Acceptable □ Bad

Part 3: Unit pricing

Assuming that instead of the household waste collecting fee per head, the unit pricing is applied. You can drop your household waste that could be recycled such as paper, glass, metal, bio waste in public waste containers for free. The rest of household waste will be put into an environment friendly nylon bag distributed by environment management agencies. Only household waste put in this bag will be collected. Instead of paying monthly waste collecting fee per head as present you only have to buy these bags. Therefore the estimated cost for your family will be lower on average.

1. How is your opinion about this new measure?

□ Should be applied
□ Should not be applied
□ Do not care

If it should not be applied, what could be the reason for that?

2. If the household waste unit pricing (in form of buying waste bags) is applied, what could be your reaction to this?

□ Separate waste to reduce the waste volume, through that reduce the household waste collecting fee
□ Do not separate
□ Other

If not to separate waste, what could be reasons for you?

3. In your opinion what should be paid attention to implement the household waste unit pricing efficiently?

   □ More recyclable containers to be put into use
   □ Household waste disposal to be controlled (only waste in officially distributed bags is collected)
   □ Environment awareness to be educated (waste separating)

   Your suggestion:

4. In order to stimulate people to separate and put recyclable waste into public recyclable waste containers, what do you think should be the most efficient way?

   □ People who dispose household waste against the regulation will be warned over the commune
   □ People who dispose household waste against the regulation will be financially fined
   □ People who dispose household waste as regulated can receive bio-fertilizer for free

5. Which of the following forces can help to control the household waste disposal as regulated?

   □ Worker from waste collecting company
   □ Staff from environment management agencies
   □ Civil defense force
   □ Commune staff
   □ Environmental police

6. Have you ever heard about environmental police?
   □ Yes, I have heard about them
   □ No, never heard about
   □ If yes, can you tell more about them.

Curriculum Vitae

Personal Information

Name: Hai Anh NGUYEN
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Education

09/1986 - 06/1993	Elementary School in Hanoi, Vietnam
09/1993 - 06/1996	High School in Hanoi, Vietnam. High School Graduation with Distinction
09/1996 - 07/2000	Faculty of English, Hanoi University of Foreign Languages
7/2000	**Graduation as Bachelor of Art**
07/2001 - 08/2001	Summer Course of International Relations at Utrecht University, The Netherland
10/2001 - 07/2002	German Preparation Course of Vienna University
10/2004 – now	Faculty of Business, Economics and Statistics, Vienna University 1. Major: International Energy and Environment Management, 2. Major: International Management

Employment History

02/2011 – 6/2011	Collaborator Independent Research Group of the project "Assessing Impact of Green House Gas Emissions from Solid Waste in Da Nang, Viet Nam" funded by Australian Scholarships for Development in Vietnam, Alumni Program Small Grant
7/2010 – 9/2010	Temporary Administration Officer of the Project "Provincial Governance and Public Administration Performance Index (PAPI) in Vietnam" conducted by Centre for Community Support and Development Studies Vietnam (CECODES) and United Nations Development Program (UNDP)

7/2009 – 9/2009	Field Study Assistant of the Project "Anti-corruption law implementation in Vietnam: Current situation assessment and CSOs Anti-corruption capacity building" sponsored by Fund for Local Corporation, The Embassy of Finland in Vietnam and conducted by Centre for Community Support-Development Studies Vietnam (CECODES)
7/2008 – 9/2008	Field Study Assistant of the Project "Conflict Resolution in urbanized areas: The participation of Civil Society Organizations (CSOs) - A focus on land revoking and environment pollution" sponsored by Fund for Local Corporation, The Embassy of Finland in Vietnam and conducted by Centre for Community Support-Development Studies Vietnam (CECODES)
7/2006– 9/2006	Administrative Assistant of the Project "Community-Driven Regulation as a tool for Environmental Conflict Resolution" sponsored by Vietnam-Sweden Research Corporation Program, The Embassy of Sweden in Vietnam and conducted by Vietnam Institute of Development Studies (VIDS)
7/2000 – 7/2001	Officer at International Relations Office, Hanoi University of Technology

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Languages	Fluent in English and German
	Basic spoken Chinese, Spanish
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