MASS FLOW ANALYSIS AND FACTOR INFLUENCING HOUSEHOLD HAZARDOUS WASTE GENERATION IN BANGKOK

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Environmental Management
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การวิเคราะห์ กระแสการไหลและปัจจัยที่ส่งผลต่ออัตราการเกิดของขยะมูลฝอยอันตราย จากชุมชนในกรุงเทพมหานคร

นางสาวปิญานุช สืบ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ปิญานุช สืบ : การวิเคราะห์ กระแสการไหลและปัจจัยที่ส่งผลต่ออัตราการเกิดของขยะมูลฝอยอันตราย จากชุมชนในกรุงเทพมหานคร. (MASS FLOW ANALYSIS AND FACTOR INFLUENCING HOUSEHOLD HAZARDOUS WASTE GENERATION IN BANGKOK) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. ชนาธิป ผาริโน, 124 หน้า.

การจัดการปัญหาการเพิ่มขึ้นของปริมาณขยะมูลฝอยอันตรายจากชุมชนในกรุงเทพมหานครปัจจุบันยังไม่มีนโยบายการแก้ปัญหาเฉพาะไว้รองรับ ภาพรวมของการจัดการขยะมูลฝอยอันตรายจากชุมชนที่เป็นอยู่ในปัจจุบันสามารถใช้เป็นความรู้พื้นฐานสำหรับการวางแผนการจัดการที่มีประสิทธิภาพในอนาคต การศึกษานี้มีวัตถุประสงค์เพื่อพัฒนาแผนภาพการวิเคราะห์กระแสการไหลของขยะมูลฝอยอันตรายจากชุมชนในกรุงเทพมหานคร และ ศึกษาปัจจัยที่มีผลต่ออัตราการเกิดขยะมูลฝอยอันตรายเหล่านี้ รวมทั้งวิเคราะห์และเสนอแนะนโยบายสำหรับจัดการขยะอันตรายจากชุมชนในอนาคต การดำเนินงานวิจัยในใช้แบบสอบถามและการสัมภาษณ์ผู้ที่มีส่วนเกี่ยวข้องกับระบบการจัดการขยะต่างๆ ในเกรุงเทพมหานคร จากการวิเคราะห์และรวบรวมข้อมูลพบว่าอัตราการเกิดของขยะมูลฝอยอันตรายในกรุงเทพมหานครคิดเป็น 0.26% ของปริมาณขยะทั้งหมด ในปี 2556 พบว่ามีปริมาณขยะมูลฝอยอันตรายจากชุมชนทั้งหมดเป็น 9,374.88 ตันหรือคิดเฉลี่ยเป็น 1.033 ±0.82 กิโลกรับ/คน/ปี จากการศึกษายังพบอีกว่าขยะมูลฝอยอันตรายจากชุมชนในกรุงเทพมหานครซึ่งเป็นสังคมเมืองสามารถแบ่งออกได้เป็น 7 ชนิด ได้แก่ บรรจุภัณฑ์ของผลิตภัณฑ์ทีมีส่วนประกอบเป็นสารเคมี เช่นน้ำยาล้างห้องน้ำ น้ำยาถูพื้น เป็นต้น (25.8%) บรรจุบรรณของผลิตภัณฑ์บำรุงร่างกาย (29.83%) หลอดไฟ (29.21%) แบตเตอรี่ (10.48%) เครื่องสำอาง (1.63%) ยาหมดอายุ (0.71%) และขยะที่เป็นอุปกรณ์สำนักงานเช่น ปากกา น้ำยาลบคำผิด แผ่นซีดี เป็นต้น (2.34%)

จากการวิเคราะห์กระแสการไหลของขยะมูลฝอยอันตรายจากชุมชนพบว่าจากจำนวนขยะอันตรายทั้งหมด มีส่วนที่ได้รับการบำบัดอย่างถูกต้องคิดเป็นประมาณ 6.23% หรือ 584 ตันจากปริมาณขยะมูลฝอยอันตรายจากชุมชน ซึ่งถือว่าเป็นปริมาณที่น้อยมาก ส่วนขยะอันตรายจากชุมชนที่เหลือ 8,790.88 ตันหรือคิดเป็น 93.77% ถูกส่งไปยังหลุมฝังกลบรวมกับขยะอื่นๆ จุดที่ควรปรับปรุงแก้ไขของระบบการจัดการขยะมูลฝอยอันตรายในกรุงเทพมหานครคือควรมีการแยกขยะมาจากแหล่งกำเนิดซึ่งจะทำให้มีการจัดเก็บรวมรวมขยะอันตรายได้มากขึ้น ผลการวิเคราะห์ปัจจัยที่มีผลต่ออัตราการเกิดของขยะมูลฝอยอันตรายจากชุมชน พบว่า รายได้มีผลต่อปริมาณการเกิดขยะมูลฝอยอันตรายโดยกลุ่มที่มีรายได้มากที่สุดเป็นกลุ่มที่มีอัตราการบริโภคและอัตราการเกิดขยะมูลฝอยอันตรายมากที่สุด ชนิดของที่พักอาศัยพบว่ามีผลต่ออัตราการเกิดขยะเช่นกัน ส่วนระดับการศึกษาไม่มีผลต่ออัตราการเกิดขยะมูลฝอยอันตรายจากชุมชน จากผลที่ได้รับจากการวิจัยสามารถใช้เป็นข้อมูลในประกอบการวิเคราะห์นโยบายที่เหมาะสมการจัดการขยะมูลฝอยอันตรายจากชุมชนในอนาคต นโยบายที่ควรเริ่มเป็นอันดับแรกคือการรณรงค์ให้มีการแยกขยะมูลฝอยอันตรายจากชุมชนออกจากขยะทั่วไป ควรเพิ่มหลักสูตรสิ่งแวดล้อมในบทเรียนเพื่อปลูกฝังให้เยาวชนตระหนักถึงปัญหาสิ่งแวดล้อมรวมถึงปัญหาการจัดการขยะเพื่อเตรียมพร้อมสำหรับระบบการจัดการขยะที่จะเปลี่ยนแปลงในอนาคต นอกจากนี้แต่ละชุมชนควรมีศูนย์รับทิ้งขยะมูลฝอยอันตราย และควรมีถังขยะอันตรายแยกออกจากถังขยะชนิดอื่นๆ ซึ่งควรมีการจัดเก็บสัปดาห์ละครั้งโดยนำไปเก็บไว้ที่สถานีขนถ่ายขยะก่อนการนำไปจัดการอย่างถูกวิธี

สาขาวิชา การจัดการสิ่งแวดล้อม ลายมือชื่อนิสิต .....

ปีการศึกษา 2556 ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก .....

5587575820 : MAJOR ENVIRONMENTAL MANAGEMENT
KEYWORDS: HOUSEHOLD HAZARDOUS WASTE / MASS FLOW ANALYSIS / QUESTIONNAIRE SURVEY / GENERATION RATE

PIYANUCH SUEB: MASS FLOW ANALYSIS AND FACTOR INFLUENCING HOUSEHOLD HAZARDOUS WASTE GENERATION IN BANGKOK. ADVISOR: ASST. PROF. CHANATHIP PHARINO, Ph.D., 124 pp.

An increase in the amount of household hazardous waste (HHW) is one of the waste management problems in Bangkok. Currently there is no specific policy to address this concern. The amount and characteristic as well as understanding the overview for current management flow of household hazardous waste are fundamental data required planning an effective waste management strategy. The objective of this study is to develop mass flow analysis (MFA) of household hazardous waste management in Bangkok, to investigate whether income, residential type and education level have any influence to amount of household hazardous waste generation rate and to suggest recommendation for future improvement. Research methodology for this research used questionnaires and interviews those involved in waste management systems. From questionnaire analysis indicated that in 2013 approximately 0.26% of total waste stream consists of HHW. The total amount of household hazardous waste generated was 9,374.88 tons or 1.033±0.82 Kg/capita/year. Fraction composition of household hazardous waste was classified in seven different categories. Percentage of each fraction is following; chemical container (25.8%), self-care product (29.83%), light bulb (29.21%), and battery (10.48%), expired cosmetic (1.63%), expired medicine (0.71%), and office supplies (2.34%).

From the MFA diagram total amount of household hazardous waste generation is about 584 tons (6.23%) of household hazardous waste was sent to incineration and recycle while, other 8,790.88 tons (93.77%) still mixed together with municipal solid waste to landfill. The weak point of management system is waste segregation. The result of analyzed the influence of HHW generation rate found that different income range give an influence to generation rate. High income range is the largest generator per capita. Different type of residential is influence to amount of household hazardous waste generation rate while, level of education do not have effects. The results obtained from this research can be used as a policy analyst in the appropriate household hazardous waste management in the future. Improving HHW segregation behavior should be prioritized as first concern. Environmental program should be established in school to enhance children awareness about environmental problem including waste management problem preparing for changes HHW management system in the future. Drop off center should be provided for every community. HHW separated bin should be provided in other area outside community. The collection process should be done once a week. HHW should be keeping in storage building in transfer station before sending of proper treatment.

Field of Study: Environmental Management Student's Signature .....

Academic Year: 2013 Advisor's Signature .....

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LIST OF ABBREATIONS

ANOVA	Analysis of Variance
BKK	Bangkok
BMA	Bangkok Metropolitan Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	Environmental protection agency
F	Flow
HHW	Household hazardous waste
I	Incineration
L	Landfill
MD	Mean different
MFA	Mass flow analysis
MSW	Municipal solid waste
RCRA	Resource Conservation and Recovery Act Ministry
SIG	Significant level
SPSS	Statistical Package for Social Science
TWARC	Television, washing machine, air condition, refrigerator and personal computer

CHAPTER I

INTRODUCTION

1.1 Rationale for the study

Today, a number of populations are continuing to increase. A number of waste generation rates also increases rapidly. Bangkok is one of growing city that is facing the problem on municipal solid waste management. Municipal solid wastes include solid waste, hazardous waste and infected waste. Comparing with solid waste, hazardous wastes show very small amount and proportion; however these wastes can adversely affect to human health and environmental quality.

According to Thailand state of pollution report in 2011, 0.89 million tons of hazardous waste was generated in Bangkok. Around 69.6 % (0.62 million tons) of hazardous waste were industrial hazardous waste, 29.21 % (0.26 million tons) were household hazardous waste, and 1.78% (0.016 million tons) was infectious waste. Even, the amount of industrial hazardous waste is very high but due to the regulation requirement for proper treatment; indicated that the situation of industrial hazardous waste was not in a serious concern as much as household hazardous waste. Household hazardous waste generation is mainly from residential and commercial areas such as household, shop, hotel, gas station and school. In 2011, 719,500 tons of household hazardous wastes were generated. Wastes from Electrical and Electronic Equipment (WEEE) were around 52% (374,140 tons) while household hazardous wastes such as batteries, light bulbs and chemical containers were approximately 48% (345,360 tons).

In Mexico, comparative analyses of household hazardous waste characteristic in two Mexican regions were done in northern and central regions. In northern region (Mexicali city), household hazardous waste comprised 3.7% of municipal solid waste, the largest categories in this fraction were home care products (29.2%), cleaning products (19.5%) and batteries and electronic equipment (15.7%). In the central region, HHW comprised 1.03% of municipal solid waste; the main categories in this fraction were represented by cleaning products (39%), self-care products (27.3%), and insecticides (14.4%) (Otoniel., Benıtez., & . 2007)

Currently in Thailand, household hazardous wastes mostly are discarded together with other solid wastes or sold to buyers to extract some parts and discard other parts to open dumping. There is still no household hazardous wastes treatment facility that properly manages the household hazardous waste. According to steadily increasing of household hazardous wastes and lack of appropriate management, this may affect to human health and the environment such as heavy metals poisoning, soil and water contamination.

Evidently, Bangkok is a good candidate to select as a case study for analyzing HHW flow. Since Bangkok has the highest household hazardous waste generation rate and the highest population density.

This study aims to analyze the current status and management system of household hazardous waste in Bangkok by using material flow analysis (MFA) method to develop the flow of household hazardous from source of generation to final disposal. The result of this study will be helpful for developing waste management information and recommendation for establishing effective household hazardous waste management plan in the future.

1.2 Research questions

1. What types and how much HHW are generated in Bangkok annually?
2. Where is the influence of HHW generation rate in Bangkok?
3. How to better improve the HHW management system in Bangkok?

1.3 Research objective

From introduction, many problems on household hazardous waste management have to be considered. This is main objective of the study;

1. To develop mass flow analysis (MFA) diagram of household hazardous wastes (HHW) in Bangkok
2. To identify the influence of HHW generation, HHW segregation behavior and attitude of willingness to pay

3. To suggest household hazardous waste management plan and policy for improving HHW management

1.4 Expected outcomes

1. Better understanding an overview on current status of household hazardous waste management in Bangkok in term of material flow.

2. Suggestions on management strategies and policy for better improvement of household hazardous waste management in the future.

1.5 Scope of study

Material flow analysis of household hazardous was carried out in Bangkok, the capital city of Thailand. Present populations are 5,674,843 with 2,459,689 apartments and houses in 1,568.737 m^2.

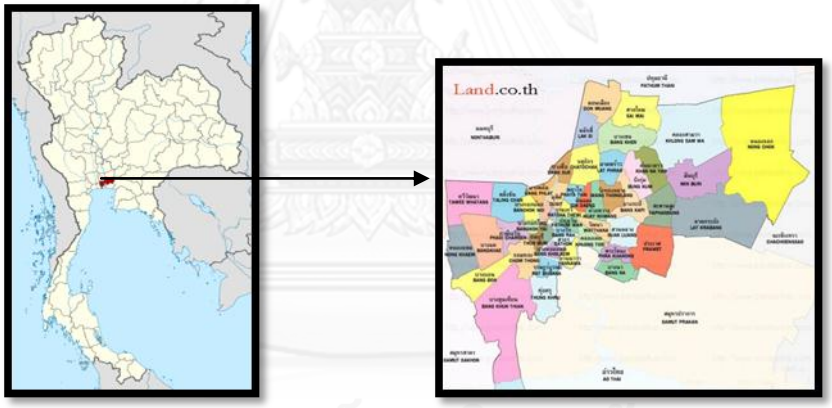


Figure 1-1: Study area in Bangkok, Thailand

Bangkok divided into 50 districts (**figure** 1-1), the recorded of total amount of household hazardous waste collection were collected from each district (Provided by Bangkok Metropolitan Administrative). The research period was during October, 2012 to September, 2013. The scope of this study considers household hazardous wastes from residential source only while, electronic wastes was not included. This study assumed that HHWs have no value and there is no waste separation for reuse or recycle of the wastes from the collection and management steps. Therefore, we assumed that all HHW eventually entered to the waste collection system; there was no HHW stream extraction from scavengers.

CHAPTER II

LITERATURE REVIEW

This study aims to develop MFA of HHW in Bangkok and suggested suitable policy for improving HHW management. In order to accomplish the study following related work were studied.

2.1 What is household hazardous waste?

2.2 Situation of household hazardous waste in Thailand and international

2.3 Household hazardous waste generation

2.4 Treatment technology

2.5 HHW's regulation

2.6 HHW's impact

2.7 Material flow analysis

2.8 Related article

2.1 What is household hazardous waste?

2.1.1 Definition/ Type of household hazardous waste

North Dakota Solid Waste and Recycling Association have given the definition of household hazardous waste**.** Household hazardous waste defines as any waste, produced in the home, which contains hazardous substances, which may pose threat to the environment, wildlife, and human health (NDSWRA., 2014).

United State of Environmental Protection Agency also has given the definition as leftover household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be household hazardous waste (EPA, 2013).

In Thailand, Pollution Control Department defined household hazardous waste as any household products containing hazardous substance. **"Hazardous substances" under the Hazardous Substance Act, B.E. 2535** were defined as

incendiary materials, flammable materials, oxidizers and peroxide substances, toxics, substances causing diseases, radioactive materials, genetic modification, corrosives, irritants and other materials such as chemicals or other substances that might cause danger to individuals, animals, plants, properties and the environment.

From the definition of hazardous waste and household hazardous waste can be conclude that "**Household hazardous waste (HHW) is hazardous waste that generated from activities in community and household but not include industrial hazardous waste and infectious waste**"

The term hazardous waste can be categorized following;

1. **Ignitability** - Ignitable wastes, such as wastes oils and solvents, can create fires under certain conditions.

2. **Corrosively** - Corrosive wastes, such as battery acid, are acids or bases (pH less than or equal to 2, or greater than or equal to 12.5) that are capable of corroding metal containers, such as storage tanks, drums, and barrels.

3. **Reactivity** - Reactive wastes, such as lithium-sulfur batteries and explosives, are unstable under "normal" conditions. They can cause explosions, toxic fumes, gases, or vapors when heated, compressed, or mixed with water.

4. **Toxicity** - Toxic wastes are harmful or fatal when ingested or absorbed (e.g., containing mercury, lead, etc.). When toxic wastes are land disposed, contaminated liquid may leach from the waste and pollute ground water

Table 2-1 shows examples of potentially hazardous chemical found in household, hazardous properties and ingredient of each product was given. Some products contain only one hazardous property such as household bleach, but mostly each product contain more than one hazardous property.

2.1.2 Source of household hazardous waste generation

Household hazardous waste were generated from households and businesses such as shops, hotels, laundry shops, gas stations, etc (PCD, 2011). Common items

considered as major sources of household hazardous waste are as following **(North Central Texas Community Recycling Information, 2014);**

1. Household Cleaning Products: aerosols, air fresheners, bleach, ammonia, drain cleaners, oven cleaners, aluminum cleaner, spot remover, dyes, furniture polish, rug cleaners, wood preservatives
2. Automotive products: lead-acid batteries, anti-freeze, automatic transmission fluid, brake fluid, fuel additives, gasoline
3. Paints and Solvents: acetone, wood preservatives, varnishes and lacquers, paints, paint and varnish removers, paint thinner
4. Pesticides: insecticides, herbicides, rodenticides, fungicides, germicides, matricides, insect repellents
5. Other Products: Pool chemical, ammunition, dry cell and disc batteries, airplane glue, photography chemicals, septic tank cleaners, some glues and adhesives

Table 2- 1: Examples of Potentially Hazardous Chemical Found in Household

Product	Ingredient	Hazardous property
Oven and cleaners	Sodium hydroxide and/or ammonium hydroxide, and possible methylene chloride	Very corrosive and can cause death if ingested, burns skin and eyes
Drain cleaners	Concentrated sodium hydroxide (can be solid or in aqueous solution of 50% m/m) or hydrochloric acid or sulphuric acid (up to 70% m/m)	Very corrosive and can cause death if ingested, burns skin and eyes
Household bleach	Sodium or calcium hyperchloride in concentrations up to 10% m/m, or hydrogen peroxide	Can burn skin and eyes
Toilet bowl cleaners	Hydrochloric acid or sodium hyperchloride and if colure blue can contain chromium compounds	Very corrosive and can cause death if ingested, burns skin and eyes
Mould and mildew cleaners	Sodium hyperchloride and formaldehyde	Very corrosive and can cause death if ingested, burn skin and eyes
Other cleaning products	Ammonium hydroxide and ethanol, chlorinated phenols and complex phosphates	Harmful if ingested and can cause burns to the skin and eyes

Source: Adopted from R.Slack and T.M.Letcher, (1991)

2.2 Situation of household hazardous waste

2.2.1 International situation

From reviewed on international situation of household hazardous waste management, in 2001 the population of the Karnataka state, India is about 60 million. By considering per-capita generation rate of about 5 g/capita/day of household hazardous waste, approximated total amount of hazardous waste generated across the state will be 300 tons/day (H**. Lakshmikantha and N. Lakshminarasimaiah, 2007**). In Vietnam, generation rate of household hazardous waste were study in 2008, the result per-capita generation of household hazardous waste was about 0.554 g /capita/ day with similar to Karnataka state in India (**Thanh, Nguyen.P et al., 2010**).

European commission reported amount of household hazardous waste generation in each country in European Union in 2010 (**Table 2-2**). Among the waste generated in the EU-27 in 2010, around 101.3 million tons (4.0 % of the total) were classified as hazardous waste. Germany shows the highest amount of hazardous waste generation following by Bulgaria and France respectively. The amounts of hazardous waste generation are directly proportional to the total amount of municipal solid waste. Considering on household waste, each inhabitants in the EU-27 generated on average about 5 ton/year of which 202 kg were hazardous waste(Eisted & Christensen, 2011; Kahhata & William, (2012))

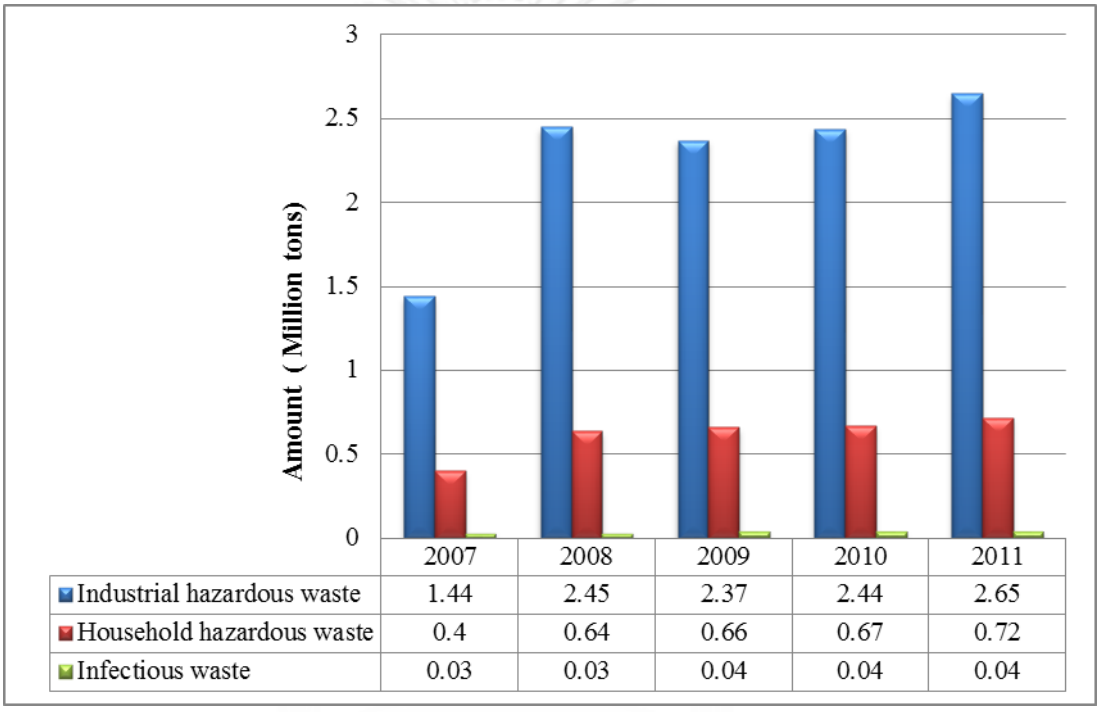
Table 2- 2: Waste Generation Rate in Europe (Ton/year)

No.	Country	Waste from economic activities and household	
		Total	of which hazardous
1	Belgium	62,537	4,479
2	Bulgaria	167,203	13,542
3	Czech Republic	23,758	1,363
4	Denmark	20,965	1,784
5	Germany	363,545	19,931
6	Estonia	19,000	8,962
7	Ireland	19,808	1,972
8	Greece	70,433	292
9	Spain	137,519	2,991
10	France	355,081	11,538
11	Croatia	3,158	73
12	Italy	158,628	8,543
13	Cyprus	2,373	37
14	Latvia	1,498	68
15	Lithuania	5,583	110
16	Luxembourg	10,440	379
17	Hungary	15,735	541
18	Malta	1,288	17
19	Netherlands	119,255	4,421
20	Austria	34,883	1,473
21	Poland	159,458	1,492
22	Portugal	38,347	1,625
23	Romania	219,310	666
24	Slovenia	5,159	120
25	Slovakia	9,384	415
26	Finland	104,337	2,559
27	Sweden	117,645	2,528
28	UK	259,068	9,447
29	Liechtenatein	312	8
30	Norway	9,433	1,763

Source of data: (Eurostat., 2013)

2.2.2 Thailand situation

Due to increases in number of population cause higher in production and consumption rate. As showed in 5 year record, a trend of amount household hazardous waste generation is increasing. **Figure 2-1** shows the significant increase of household hazardous waste from 2007 to 2011 in Thailand from 0.40 Mtons to 0.72 Mtons. In 2007, shows the lowest amount of household hazardous waste generation probably due to economic crisis in that year (PCD, 2011).



	2007	2008	2009	2010	2011
Industrial hazardous waste	1.44	2.45	2.37	2.44	2.65
Household hazardous waste	0.4	0.64	0.66	0.67	0.72
Infectious waste	0.03	0.03	0.04	0.04	0.04

Figure 2- 1: Amount of Hazardous Waste generate in Thailand during 2007 – 2011

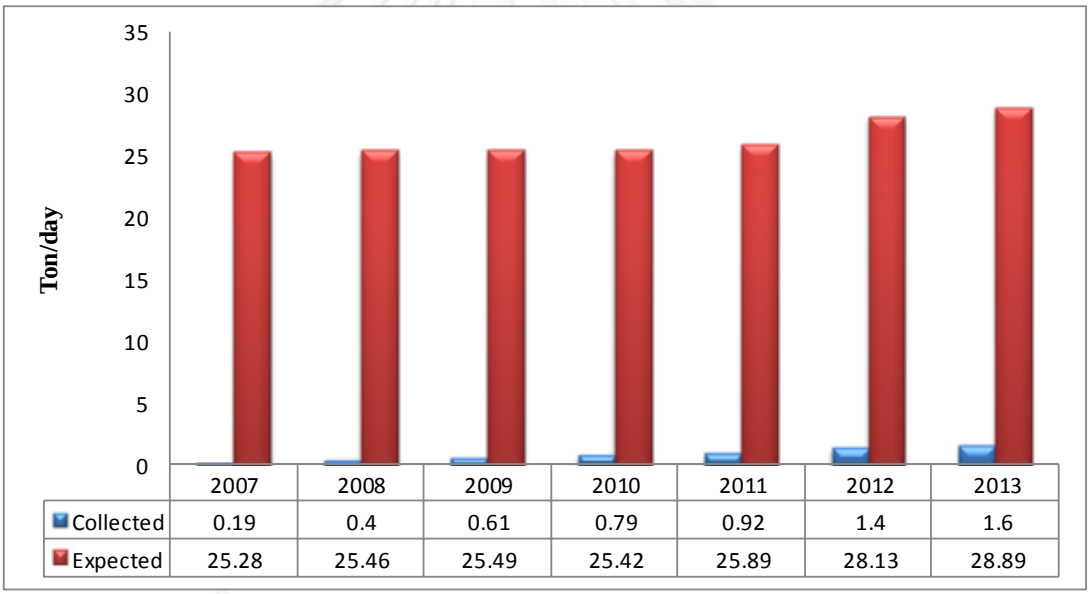
Source: Department of Pollution Control (2011)

In 2011, 719,500 tons of household hazardous wastes were generated, increasing from 2010 by 7.26% or 48,700 tons. Approximately 707,000 tons were generated during normal period and 12,500 tons were generated during flooding period. The generation rate is 1,971 tons/day or 0.03 Kg/capita/day (PCD, 2011).

Presently, household hazardous waste is discarded together with other general waste. The main reason is because citizens lack of essential knowledge about impact of household hazardous waste. In addition, the Government does not provide

proper collection and management system specifically for household hazardous waste. There is no household hazardous waste treatment facility. Most of the HHW are still managed improperly.

In Bangkok, BMA started aggregate household hazardous waste from other waste since 1998. In 2009, Bangkok cooperated with Spain government on "Feasibility Study for the Household Hazardous Waste Management in BMA". The result found that HHW contain 0.68% of total waste. **Figure 2-2** shows amount of household hazardous waste collected and expected amount in Bangkok during 2007-2012. Amount of HHW is slightly increasing very year as same as expected amount. Only 5.53% of expected household hazardous in Bangkok were collected.



	2007	2008	2009	2010	2011	2012	2013
Collected	0.19	0.4	0.61	0.79	0.92	1.4	1.6
Expected	25.28	25.46	25.49	25.42	25.89	28.13	28.89

Figure 2- 2: Amount of Household hazardous collected and expected in Bangkok

Source: Bangkok metropolitan administration (2013)

2.3 Generation of household hazardous waste

2.3.1 Fraction and composition of household hazardous waste

Currently, fraction of household hazardous waste is similar in each country. Only percentages of the composition are different. **Table2-3** shows categories of household hazardous waste including home cleaning, automotive, batteries,

medicines, biological infection, gardening, self-care and others (**B.T.Otoniel et al., 2006**) and (Aretha Apriliaa, 2013).

Table 2- 3: Household Hazardous Waste Categories

Categories	Examples of HHW
Home Cleaning	Laundry detergent, Powder of liquid, Laundry aids, Bleach, Fabric, oven cleaner, Soap bars, All propose cleaner, Wood protection, Drain opener
Automotive	Oli, Antifreeze, Agents, Brake fluid, Lubricansts, Windshield, Wiper solution, Transmission fluid
Batteries	Car batteries, Other batteries
Medicines	Oral, Injections, Syrup, Lotion, Supposition, Food supplement
Biological- Infectious	Dialysis, Syringes, Condoms, Gauze bandages
Gardening	Insecticides, Pesticide, Soil fertilizers
Self care	Cosmetics and beauty product, Hair care, Lotion, Perfume, Deodorant, Soap bar, Talcum powder, Ketone, Toothpaste, Acrylic nails
Other	Oil base, Water base, Solvent, Shoe, Polish, Printer toner, CD, Glue

Source: Adopted from B.T.Otoniel et al., (2006)

Averaged composition of household hazardous waste in America are approximately 40% paint-related, 30% dry cell batteries and 30% other HHW (MSW Management Magazine, 1994). In Mexico, the household hazardous waste composition was studied in two different regions. In northern region (Mexicali city), household hazardous waste comprised 3.7% of municipal solid waste, the largest categories in this fraction were home care products (29.2%), cleaning products (19.5%) and batteries and electronic equipment (15.7%). In the central region, HHW comprised 1.03% of municipal solid waste; the main categories in this fraction were represented by cleaning products (39%), self-care products (27.3%), and insecticides (14.4%) (O. B. Delgado et al., 2006). In 2011, household hazardous waste composition in Thailand can be categorized in 3 fractions. Waste from Electrical and Electronic Equipment (WEEE) taken place 52% (374,140 tons) and waste from household hazardous waste such as batteries, light bulbs and chemical containers taken 48% (345,360 tons)

2.3.2 Generation rate estimation

Due to household hazardous comprise only small amount of total wastes from household, the generation rate estimation rate is also various. From the review on HHW **Management Study** by Gene (Anchor engineering services, 1996), the important sources of generation rate estimation are suggested from:

1. EPA's Generation Rate Estimate

USEPA has estimated that approximately 0.1% of all municipal solid waste is hazardous. The works were done by Bob Palmer of the Housatonic Regional Recovery Authority.

2. Palm Beach Country's HHW Generation Rate

This is one of the most study that use for comparison of HHW generation rate with other study with published by USEPA. Based on the studies, 700,000 tons of MSW were collected during 1993-1994 and 883 tons of HHW were separated. Hence, household hazardous waste generation rate in Palm Beach Country during 1993-1994 is approximately 0.13% of total MSW.

Other studies were showed different value of household hazardous waste generation rate for example 1.0% of the total MSW in Argentina (Altolaguirre, 2004), ranking between 0-1.0% of the total MSW in United Kingdom (Slack et al.,2004). However, in Thailand two value of HHW generation rate was reported from different institutes. In 1992, institute of public health estimated that amount of HHW comprise 0.29% of total waste and in 2008 Thai government cooperated with Spanish government on the project of "Feasibility study for the household hazardous waste management in BMA". The estimated amount of total HHW is about 0.68% of total wastes.

2.3.3 Influence of household hazardous waste generation rate

1. Consumption pattern

Consumption pattern also can be influence to the generation rate of HHW. Low strata will have lower HHW generation rate than high strata. This is due to many reasons such as income, life style, location and behavior (B.T.Otoniel et al., 2007).

2. Location

Location area of household also influence to the generation. In Mexico, two regions of different lifestyle were study for comparison on urban and rural area. In the Cuitzeo Basin (rural), hazardous waste from residential sources averaged 1.03% of the total solid waste generation stream. However, percentages of HHW in each municipality are highly variable, ranging from 0.23% to 1.66%. HHW generation in Mexicali (urban) was 3.72% of the solid waste stream, 2.2 times of that obtained in the Cuitzeo Basin. Hence, rural areas have lower household hazardous waste generation rate than urban areas do, due to different in their lifestyles (B.T.Otoniel et al., 2007).

2.4 Treatment technology

There are a number of treatment technologies for HHW. Each method has different in the advantages and disadvantages. In **Table 2-4** presents lists of common HHW disposal methods with widely available for specific waste stream (Amy D.Cabaniss, 2008). Five treatment technologies used for HHW are following;

2.4.1 Recycle

Recycling of material has become much more common as Americans' environmental consciousness has risen. There are different forms of recycling. A particular product is refined of cleaned and return it to original use such as motor oil and latex paint. Other of recycle form is breaking down of product to take useable part such as light bulbs and electronic waste. HHW item that commonly recycled include latex paint, propane cylinder, rechargeable batteries, mercury, antifreeze, motor oil and oil filters.

2.4.2 Alternative Fuel

Fuels blending or alternative fuel management is the process of combining high BTU-value materials, such as oil-based paint, solvents, and gasoline to use as an energy source alternative of fuel cement kilns.

Table 2- 4: Common Disposal Methods

Waste stem	Available disposal method				
	Recycle	Alternative Fuel	Treatment	Incineration	Landfill
Aerosols	X			X	X
Propane cylinder	X			X	X
Fire extinguisher	X			X	X
Flammable liquids		X		X	X
Oil-based paint		X	X	X	X
Flammable solids		X	X	X	X
Air reactive			X	X	X
Water reactive				X	X
Oxidizing, acid				X	X
Oxidizing, alkaline				X	X
Oxidizing, neutral			X	X	X
Organic peroxide			X	X	X
Toxic				X	X
Corrosive, acidic				X	X
Corrosive, alkaline				X	X
Mercury	X			X	
Asbestos				X	X
PCB ballasts	X			X	X
PCB-containing materials	X			X	X
Antifreeze	X				X
Car batteries	X				X
Fluorescent light tubes	X			X	X
Latex paint	X			X	X
Motor oil	X			X	X
Oil filters	X				X
Electronic waste	X			X	X
Sharps	X			X	X
Household batteries	X			X	X

Source: Adopted from (Cabaniss., 2008)

2.4.3 Treatment

Treatment is widely available for corrosive and oxidizing wastes. There is variety of specific treatment methods available such as chemical oxidation and reduction, neutralization, metal precipitation, flocculation, filtration, and carbon adsorption. HHW items commonly sent for treatment include cleaner and pool chemical.

2.4.4 Destructive Incineration

In this method, hazardous waste heats to extremely high temperature (over 1,800-2,200 F). The process converts the solid and liquid waste into gases. Byproduct of this method in hazardous ash, the ash residue is treated to meet regulatory specifications and then sent to a hazardous waste landfill. HHW items commonly incinerated include pesticides and organic peroxides.

2.4.5 Secured Landfill

Hazardous waste landfills are required to meet stringent federal and state standards regarding their location, design, construction, operation, and final closure. The advantage of landfill over other method is low cost option. HHW items commonly sent to landfill including alkaline batteries and asbestos.

2.5 Household hazardous waste regulation

2.5.1 International regulation

Regulations in the US

The Resource Conservation and Recovery Act (RCRA)

Household waste, including HHW, is exempt from federal hazardous waste regulations and liability under RCRA Subtitle C. Therefore, HHW is not regulated under RCRA as a hazardous waste. Programs that collect HHW do not need a Subtitle C (Appendix A) permit or EPA identification number and HHW can be transported without following hazardous waste transportation regulations (e.g., people can bring HHW to a collection facility in their cars). No quantity of HHW or length of time of accumulation triggers the Subtitle C requirements. To be defined as “household”

waste and thus be exempt from federal hazardous waste regulations, the waste must be:

1) Generated by individuals on the premises of a residence for individuals (a household).

2) Composed primarily of materials found in the wastes generated by consumers in their homes.

Even if waste generated by a commercial or industrial establishment looks like household waste, it is not exempt from federal hazardous waste regulations. The household waste exemption applies to HHW through its entire management cycle. The waste collected through a HHW collection program does not lose its exemption by being consolidated with other household waste. In summary, if a program accepts only waste from households, there are no applicable federal hazardous waste regulations (USEPA., 2013).

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund)

CERCLA does not exclude HHW from liability, nor does it allow any exemption based on the amount of waste generated. If HHW contains a substance defined as hazardous under CERCLA, potential liability exists. The Agency, however, will generally not notify generators or transporters of municipal solid waste including HHW collection programs that they are considered PRPs, unless EPA has information indicating that the waste came from an industrial, institutional, or commercial process or activity. This includes, but is not limited to small quantity generator (SQG) waste from commercial or industrial processes or activities, and used or spent solvents from private or municipally owned maintenance shops. EPA makes decisions about notifying PRPs on a case-by-case basis, and May, in exceptional situations, notify parties who generated or transported only household waste to a site. PRPs may sue other parties that they believe share liability. Citizen suits are unrestricted (USEPA., 2013).

State Regulations in the US

While households do not have to separate household hazardous waste from trash under federal law, some states have special requirements. Call local or state solid waste officials (USEPA., 2013).

European Union's Hazardous Waste Directive (European Council, 1991a)

Hazardous Waste Directive (91/689/EEC)

Article 1 (5) – 'Domestic waste shall be exempted from the provisions of this Directive. The Council shall establish, upon a proposal from the Commission, specific rules taking into consideration the particular nature of domestic waste not later than the end of 1992.'

Article 2 (2) – '.do not mix different categories of hazardous waste or mix hazardous waste with nonhazardous waste.'

Annex IA – 'Wastes displaying any of the properties listed in Annex III and which consist of:

1. Pharmaceuticals, medicines and veterinary compounds;
2. Wood preservatives;
3. Biocides and phyto-pharmaceutical substances (e.g.pesticides, etc.);
4. Residue from substances employed as solvents;
5. Mineral oils and oily substances;
6. Oil/water, hydrocarbon/water mixtures, emulsions;
7. Inks, dyes, pigments, paints, lacquers, varnishes;
8. Resins, latex, plasticizers, glues/adhesives;
9. Photographic chemicals and processing materials' may be classified as hazardous.

Annex I B (39) – ‘materials resulting from selective waste collections from households and which exhibit any of the characteristics listed in Annex III’ can be considered hazardous.

Annex I B (40) – ‘any other wastes which contain any of the constituents listed in Annex II and any of the properties listed in Annex III.

Annex II – ‘Constituents of the wastes in Annex I B, which render them hazardous. C5 nickel compounds; C6 copper compounds; C7 zinc compounds; C8 arsenic compounds; C11 cadmium, cadmium compounds; C16 mercury, mercury compounds; C18 lead, lead compounds; C21 inorganic cyanides; C23 acidic solutions/solid form; C24 basic solutions/solid form; C33 pharmaceutical or veterinary compounds; C34 biocides and phyto-pharmaceutical substances; C36 creosotes; C39 phenols, phenol compounds; C40 halogenated solvents; C41 other organic solvents; C42 organohalogen compounds; C43 aromatic, polycyclic, heterocyclic compounds; C44/45 aliphatic/aromatics amines; C51 hydrocarbons.’

Annex III – Properties of wastes which render them hazardous: H1 Explosive; H2 Oxidizing; H3A Highly flammable; H3B Flammable; H4 Irritant; H5 Harmful;

H6 Toxic; H7 Carcinogenic; H8 Corrosive; H9 Infectious; H10 Teratogenic; H11 Mutagenic; H12 Substances/ preparations which release toxic gases; H13 Substances/preparations yielding hazardous substances after disposal; H14 Ecotoxic (Slack, Gronow, & Voulvoulis, 2009).

2.5.2 Regulation in Thailand

Currently, there is no specific regulation for household hazardous waste management in Thailand. Government is on first step of HHW management. Some program has been applied for household hazardous waste management such as taking back expire medicine, household hazardous bank.

Current practice on HHW management in Thailand

The practice on HHW management was started since 2007 but due to no continues program, no regulation. The efficiency of the practices still did not

improve. **Figure 2-3** shows the current practices diagram of HHW management in Thailand by pollution control department. The processes are following **Table 2-5**:

Figure 2- 3: HHW Management Scheme in Thailand

Sources: Waste and Hazardous Substances Management Bureau, Pollution Control Department (2011)

Table 2- 5: HHW Management Scheme in Thailand

Approach	Detail
Awareness raising	There are many campaigns for awareness rising in the community such as poster campaign and people's manual/brochure. All the activities aim to give knowledge about household hazardous waste and rising awareness on HHW's impact.
Separation method	Government has setting drop off center for hazardous waste in the community. The pilot district was Laskrabung district.
Collection	Hazardous waste will be collect from drop off center on 1st

	and 15th of every month
Storage	Hazardous waste will be store in each district (hazardous waste storage building) until reach target amount and transport to transfer station.
Transportation to recycling or disposal facility	The transportation can be done by permitted agencies only
Recycling	Currently, only light bulbs and electronic waste can be recycled. Two important companies on waste recycling are courtesy of Thoshiba lighting and courtesy of Wongpanit group
Treatment or disposal	Current treatment technology takes place for household hazardous waste is stabilization and solidification by private company. Then the solidity of waste will send for secure landfill

The BMA operates a service such as HHW drop off center for handling household hazardous waste such as batteries, fluorescent lamps, oil paint, drain cleaners, cosmetics, motor oil, pesticides, cleaning chemicals, etc. The BMA has a campaign to encourage people to separate household hazardous waste. On the 1st and 5th of the month (or any other days agreed to by District Offices) garbage collectors collect and transport waste to the disposal sites in Nongkhame, Saimai and On-nut. The waste is stored there and a contracted private company authorized by The Department of Industrial Works disposes of the waste properly. Currently, the BMA has contracted Akkee Prakan, PLC to dispose of this kind of waste by incineration treatment method.

From the operation, the BMA found that the amount of household hazardous waste collected was less than expected. In 2554, it was expected that the amount of household hazardous waste collected was 249 tons/day, but the exact amount of the waste collected was only 1 ton/day due to no HHW segregation from other waste as well as no specific program for HHW management. The collected waste was

analyzed, and it was shown that canisters were the most common form of waste (71%), followed by fluorescent lamps (24%) and batteries (5%) (BMA., 2012)

2.6 Impact of HHW

2.6.1 Impact to health

There are various impacts from HHW because of many toxic substances. **Table 2-6** shows the major toxic substances of each fraction and health impact of each substance. If HHW get improper management, their hazardous substances may contaminated environment and get harmful to other organization. For example, if fluorescent lamp were mix together with general waste. It may get broken during transportation and the Mercury directly exposes to worker. The worker may cause Irritating to skin, hyperplasia, inflammatory bleeding, abdominal pain and severe diarrhea**.**

Table 2- 6: Impact from HHW's Substances to Health

Material fraction	Major hazardous substance	Health impact
Light bulbs	Mercury	– Irritating to skin, hyperplasia, – Inflammatory, Severe diarrhea – Bleeding, abdominal pain,
Batteries	Lead	– Headache, weary, pale – Abdominal pain – Muscle aches – Amnesia, twitch, senseless
Chemical containers **(Depend on type of chemical)**	Mercury, Lead Manganese	– Similarly to battery – Headache ,Sleepy ,Weary – Dreary ,Emotions ,Mental unrest

-insecticide **-paint cans**		– Hallucination , Cramps – Confused brain ,Encephalitis
WEEE	Lead Mercury Chlorine Cadmium Bromine	– Destroy nervous system, endocrine system, blood, kidneys and brain development of children – Destroy brain and medulla result in loss of self-control – Carcinogenic – Acute effect to respiratory system – Carcinogenic
Other such as cosmetic, cleaning product, Self-care product	Specific on type of substances	– Skins irritating – Allergic

Source: Environmental Control Department (2006)

2.6.2 Impact to environment

If environment contaminated by HHW due to improper management. It will cause damage to ecology such as land pollution, inland water pollution, marine pollution, air pollution, ozone layer depletion and greenhouse gases emission.

2.7 Material flow analysis

2.7.1 Concept

Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time (Brunner & Rechberger, 2005). The similar definition also given by German commission of inquiry as material flow analysis is a systematic reconstruction of the way a chemical element, a compound or a material takes through the natural and/or the economic cycle which generally based on the principle of physical balance. (German commission of inquiry

“Schutz des Menschen under Umwelt” Protection of human life and the environment of the Deutsche Bundestag, 1993)

2.7.2 MFA terms and definitions

Substance is a physical matter or material specific of the thing that consists or consider in the flow of the system. Substances are important especially for environmental, resources and hazardous management. Many MFAs are carried out to determine flows of potentially hazardous substances to the environment and to find out more about the fate of these substances in environmental compartments such as water bodies and soils. Other MFA studies are commenced to understand better the flows and stocks of a resource in a system. Often these are substances such as heavy metals (Cu, Zn) or nutrients (N, P) **(Brunner & Rechberger, 2005).**

Material is similar to substance. Comparatively, substance is sub-group of material with smaller and particularly. For example, wood is considered as material but it composed of many differences such as cellulose, hydrogen, oxygen, and many others. Consider from an example substance consists of identical units only.

Process is defined as connection of the flow such as transportation, transformation and storage of material.

Flow and flux, flow is flow rate in unit of mass per time but flux defined as flow per cross section. Generally, in MFA flow is normally uses.

System and system boundary, a system is defined by a group of elements, the interaction between these elements, and the boundaries between these and other elements in space and time.

2.7.3 Application

MFA is tool applied to many fields of study and work such as Industrial Ecology, Environmental Management and Engineering, Resource and Waste Management and Human Metabolism**.** MFA can be applied for waste management in Modeling elemental compositions of wastes and evaluating material management

performance in recycling/treatment facilities. Example of MFA in waste management is regional material balances and single material system analysis (J. Gregory, 2000).

Industrial ecology

Recently, MFA applied to industrial ecology to handle the selection of the material, economy goods or nutrients enter to the industrial metabolism. For example, industry is planning to use alternative fluid for their incinerator. MFA can be applying to each alternative fluid and see which one is cause smaller impact to environment.

Environmental management and engineering

MFA has applied to variety filed of environmental management and engineering such as remediation of hazardous waste site, environmental impact statement and pollution control strategies. MFA has become important tool this is because those filed required understanding on flow of the pollution or substance in system to create effective and low cost management plan (Andersen, Helge, & et al., 2007).

Resources management

Natural resources and manmade resource (Anthropogenic) are two main types of resource. MFA is helpful in identifying the accumulation and depletion of materials in natural and anthropogenic environments. Without it, it is impossible to identify the shift of material stocks from “natural” reserves to “anthropogenic” accumulations **(**Brunner and Rechberger, 2005**).**

Waste management

MFA is a very important tool for waste management since MFA can contribute to the design of better products that are more easily recycled or treated once they become obsolete and turn into “waste.” These practices are known as design for recycling, design for disposal, or design for environment **(**Brunner and Rechberger, 2005**).**

2.8 Literature review on MFA of waste management

Misuzu Asari, Kazuki Fukui, and Shin-ichi Sakai (Asari, Fukui, & Sakai, 2008) did the research about life-cycle flow of mercury and recycling scenario of fluorescent lamps in Japan. The study shows the mercury flow of mercury-containing products from their manufacture to their disposal in Japan and discussed the current management of mercury-containing hazardous household waste (HHW). Fluorescent lamps were the major mercury-containing products in Japan. The mercury flow for end-of-life fluorescent lamps (excluding backlights) was analyzed under three scenarios for Kyoto, Japan in 2003: the present condition scenario, the improved recycling scenario, and the complete recycling scenario. Under the present condition scenario, mercury flow was calculated to be 34 kg Hg for incineration, 17 kg Hg for crushing, 21 kg Hg for landfill, and only 4 kg Hg for recycling as shown in **Figure 2-4** Incinerated and landfill mercury from end-of-life fluorescent lamps contributed to residential waste, and crushed lamps contributed to commercial and industrial waste.

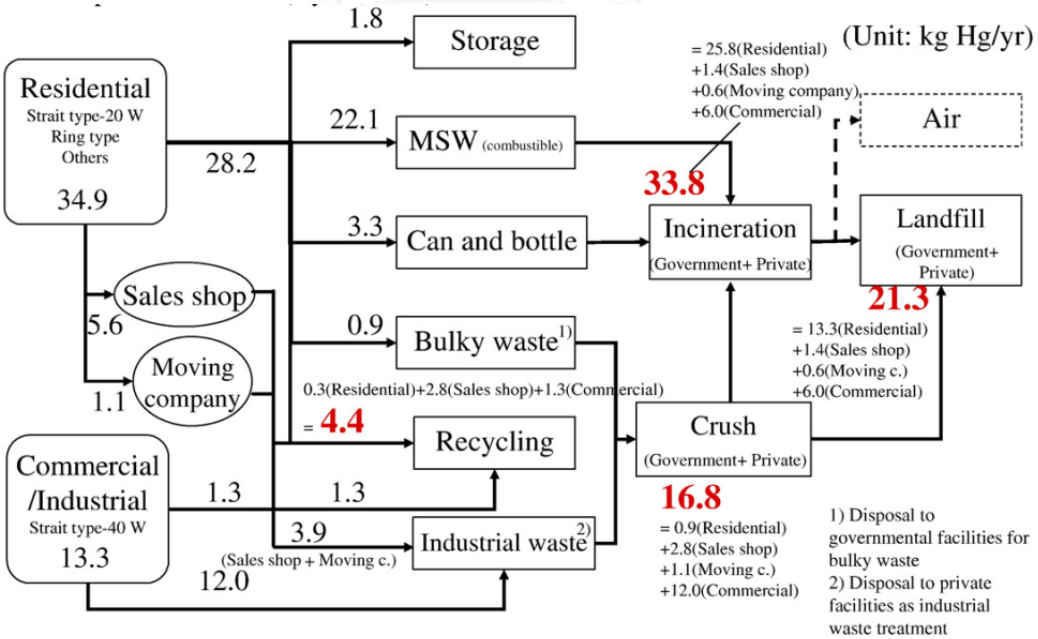


Figure 2- 4: Estimated Flow of Mercury for One Scenario for End-of-life Fluorescent Lamps in Kyoto (2003) under the Present Condition Scenario

Ramzy Kahhata and Eric Williamsb (2012) were studied about material flow analysis of domestic flows and exports of used computers from the United States. The result showed in **figure 2-5** that 40 million used and scrap computers, including laptops and desktops, were discarded from the residential and business/public sector in 2010 (calendar year), from which 2–12 million used computers were exported, 7–9 placed in domestic landfills and 8–19 were sent to domestic recycling activities. Moreover, 12 million computers were reused domestically, 16% of the total computer acquisitions in 2010 for both sectors. In the residential sector, 50% of the reuse occurred within low- middle-income households (annual household income of less than US$ 35,000).

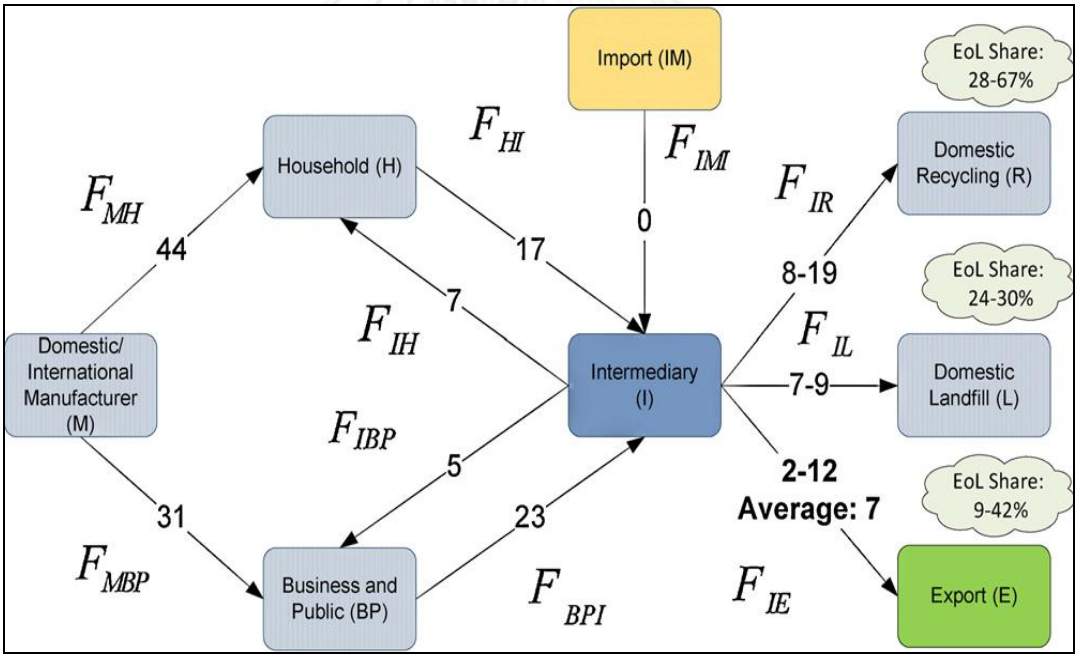


Figure 2- 5: Computer material flow analysis for the United States, 2010 (million units)

The result also found that 6–29% of the used and scrap computers at the EoU, or computers entering the “intermediary” sector were exported, 20–47% recycled domestically or initiated recycling activities domestically, 17–21% placed in American landfills and 30% reused within the United States. Not considering

domestic reuse, on average 24%, 47% and 28% were exported, entered a domestic recycling facility or landfill in domestic sites, respectively.

(**Winifred, Shan-Shan, & Zhang, 2013**) studies about a material flow analysis on current electrical and electronic waste disposal from Hong Kong households. Five types of household electrical and electronic equipment, namely television, washing machine, air conditioner, refrigerator and personal computer (TWARC) were conducted to assist the Government of Hong Kong to establish an e-waste take-back system. MFA of this research (**Figure 5**) can be concluding that the majority of TWARC waste disposal from households was handled by e-waste collectors with a throughput of 41,900 tons/yr. Most of the households TWARC waste was sold to the e-waste collectors while some may have been removed without any redemption value. In addition to direct collection from households, 23.4% of households requested building cleaners or delivery workers to dispose of TWARC. Approximately 75% of TWARC collected from repair shops would be resold in the second-hand market while the remaining 25%, and most of the TWARC collected by scrap metal dealers, were eventually be exported. The research also found that each year, 7220 tons of household TWARC waste or 1.0 kg/capita reach the public waste disposal facilities

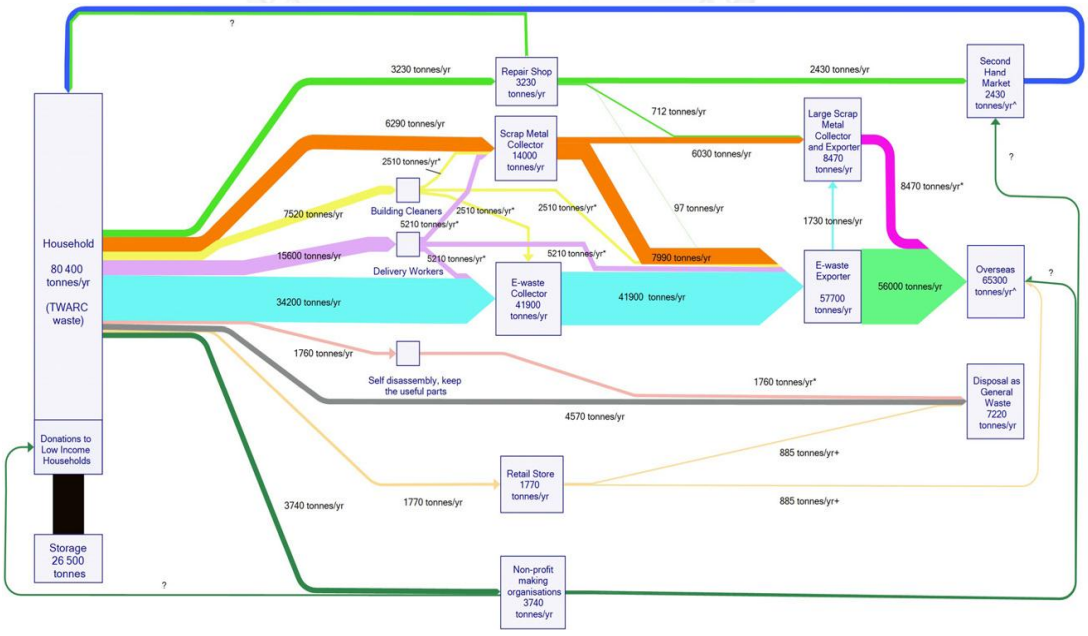


Figure 2- 6: Material flow of TWARC Waste from Hong Kong Households

(Binder & Mosler, 2007), the research investigated waste-resource flows of short-lived goods in households of Santiago de Cuba. The research applied the method of material flow analysis to analyze the consumption and waste mass flows of short-lived goods and understand the waste management behavior of households in Santiago de Cuba. The analyzed goods were glasses, aluminum, organic materials and PET. The necessary data were gathered in personal interviews with 1,171 households using a standardized questionnaire. The households were asked how many PET bottles, Aluminum, and glass containers which they consumed per month, and how they disposed of the different kinds of garbage. The results showed the material flows for glass, PET and aluminum, respectively (in kg/household and year). Regarding weight, glasses were the most widely used packaging material with a yearly consumption of 22 kg/household as shown in Figure 2-7 and followed by PET with 3.3 kg/household and aluminum with 1.3 kg/household.

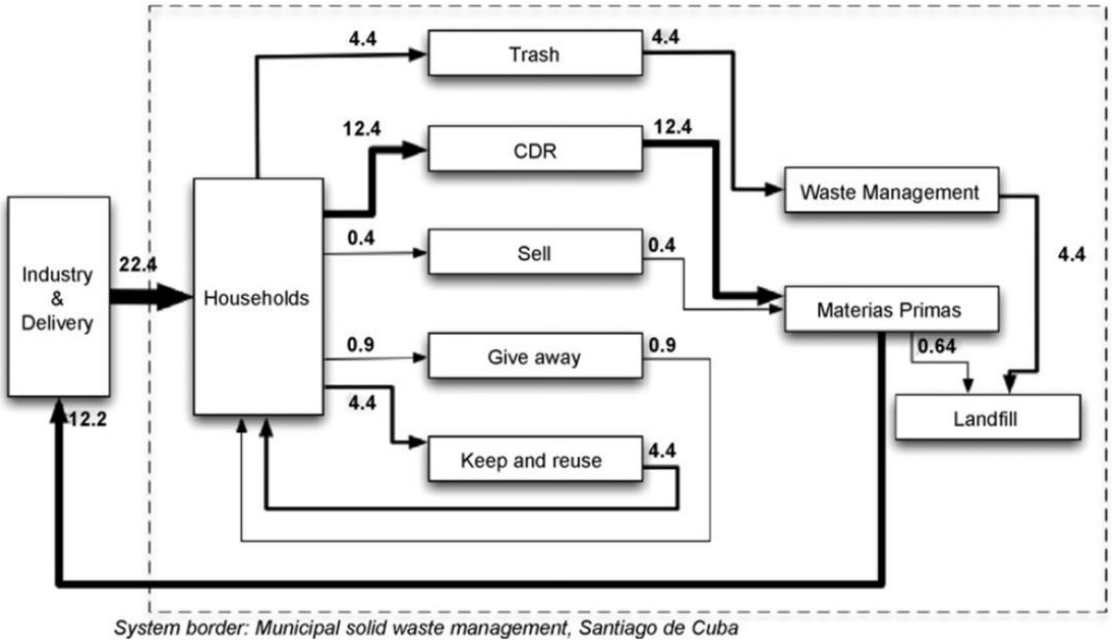


Figure 2-7: MFA of glass in kg/capita and year for 2004 in Santiago De Cuba

CHAPTER III

METHOD AND METERIAL

There are 6 steps in research methodology.

a) Review on related topic of HHW

b) Develop experimental plan and questionnaire for data collection

c) Selected sampling size and sampling area

d) Data collection

e) Questionnaire analysis

f) Evaluate HHW flow in Bangkok and material flow analysis diagram of HHW in Bangkok

g) Analyze management strategies for HHW management in the future

3.1 Review on related topic of household hazardous waste

To understand the overview of household hazardous waste characterization, current policy and HHW management system in Thailand the following topic were studied.

- What is household hazardous waste?
- Situation of household hazardous waste in Thailand and international
- Household hazardous waste generation
- Treatment technology
- HHW's regulation
- HHW's impact
- Material flow analysis
- Related article

3.2 Develop experimental plan and questionnaire for data collection

In order to measure household hazardous waste generation rate, household hazardous waste composition and direction for developing recommend of household hazardous waste management strategies in Bangkok, questionnaire was develop to collect all primary data of this study. The process of developing questionnaire was taking 1 month. Each draft of questionnaire has to be tested and revised for several time. The final questionnaire format consists of 5 sections in 6 pages (**Appendix B**). The five section of questionnaire consist of following;

Part 1: General information of respondent

Demographic detail in this study was used for analyzed factors influencing HHW generation rate, HHW segregation behavior and attitude of willingness to pay for better HHW management. The hypothesis of this section was following;

Dose income level affect to amount of HHW waste generated, waste segregation behavior and attitude of willingness to pay? In questionnaire, income level was analyzed in two different unites. Amount of income range per capita used for studied the influence of income to HHW generation rate while, income range per household used for studied the influence of income to waste segregation behavior and attitude of willingness to pay. Income range per capita divided in 5 different ranges; lower than 5,000, between 5,001-15,000, between 15,001-25,000, between 25,001-35,000 and higher than 35,001 Baht. Income range per household divided in 6 different ranges; lower than 10,000, between 10,001 to 20,000, between 20,001 to 30,000, between 30,001 to 40,000, between 40,001 to 50,000 and higher than 50,000 Baht.The reason to divide income into 6 ranges is because Bangkok has various types of population with different income level. The assumption of different income rage is people who have more income will consume more goods and generate more waste, moreover people who have more income will do better waste segregation as well as have positive attitude of willingness to pay for improving HHW management system.

Does residential type affect to amount of HHW generated, waste segregation behavior and attitude of willingness to pay? Residential type was divided into 5 different types due to their utility space. The standard of utility space of each residential type was given by ***Thai appraisal foundation (2014)*** shown in **table 3-1.** The hypothesis of this section is whether people who live in residential type with large utility space will consume more goods and generate more waste. These people may have better waste segregation behavior and positive attitude of willingness to pay.

Table 3- 1: different residential type with utility space (http://www.thaiappraisal.org/)

Residential type	Utility space (Sq.m)
Single house	105-280
Townhouse/condominium	55-120
Row house	48-60
Room rental	21-45
Other such as dormitory	16-25

Does education level affect to amount of HHW generated, waste segregation behavior as well as attitude of willingness to pay? Due to our assumption, higher education level must generate lower amount of HHW and always do better in waste segregation behavior as well as have positive attitude of willingness to pay. This study divided education levels in 4 categories; elementary school, high school, bachelor degree, and higher than bachelor degree.

Part 2: General knowledge about household hazardous waste

The general knowledge test was investigated to identify whether or not the citizen have knowledge about HHW or have sufficient knowledge about HHW but lack of incentive for better HHW management. What should be next step for arising awareness concern about HHW problem?

Part 3: Amount of household hazardous waste generation

In this part HHW was categorized in 7 different fractions from the definition for HHW as following "***Household hazardous waste define as any waste, produced in the home, which contains hazardous substances, which may pose threat to the environment, wildlife, and human health*** (NDSWRA, 2010-2014)" as well as the waste category was also referred from B.D Otoniel work (Buenrostro Delgado Otoniel, 2008**).** The reason of dividing in different fraction is facilitate the data collection process to identify specific types and estimate amount of waste from questionnaire respondents.

Table 3- 2: Seven groups of household hazardous wastes (B.D. Otoniel, 2008)

Chemical container	Self care products	Light bulb	Battery	Expire cosmetic	Expire medicine	Office supplies
Insecticide Air fragrances All propose cleaner	Beauty product Hair care Lotion Perfume	Fluorescent lamp	Battery	Talcum powder Acrylic nails Nail remover	Oral Injection Syrup Food supplement	Ink Glue CD Oil base paint Printer toner

The 7 fractions Of HHW are shown in table 3-2. ***Chemical container*** **are** included wastes from containers of products such as spay, insecticide, air fragrances and all-purpose cleaner products**.** ***Self-care products*** are included of beauty product, hair care, lotion and perfume. ***Light bulb*** are included of fluorescent lamp as well as battery consists of only battery. ***Expire cosmetic*** are included of talcum powder, ketone, acrylic nails and nail remover**.** ***Expired medicine*** included all oral, injection, syrup and food supplementary. The last fraction is ***office supplies*****;** including ink, glue, CD, oil base paint, and printer toner. According to hazardous material identification system (HMIS), has identified risk level each type of HHW. Some type was surprised to consider as HHW such as lotion, shampoo and other self-care

product but in HMIS standard guideline classifies self-care product as HHW in level 1 of flammability property.

Table 3- 3: Risk values for typical household products according to the HMIS

Product	Health rating	Flammability	Reactivity
House maintenance	2	4	1
Insecticides	4*	4	4
Self care	0	1	0
Cleaning products	3	1	1

HMIS 0- minimal; 1-slight; 2-moderate; 3-serious; 4-severe

*Cancer risk

Source: (HMIS, 2013)

Part 4 and 5: Household hazardous waste disposal behavior of the respondent and possible policy on household hazardous waste management in the future

This part asked about personal opinions of respondents for developing suggestion plan for HHW management in the future.

Each part of questionnaire was developed for different purpose however, all data was used for developed mass flow analysis of household hazardous waste in Bangkok, influence factor analysis and policy recommendation.

3.3 Selected sample size and sampling area

The sample size of this study was conducted with 500 respondents in Bangkok. Following Yamane (1972), this sample size is 95% reliability with ± 5% error possibility in infinite number of population the sampling size should be higher than 400 samples (**Table 3-4**). 50 districts in Bangkok were divided in 10 ranges of population density (**Table 3-5**) one district was choosing randomly from each range. 12 selected districts distributed by 500 copies of questionnaire. The sampling group of this study is the districts office and the citizen who come for do their work as the

district office. Two types of methodology were done for collecting data and questionnaires. One approach is to interview face to face with the respondent; another is to request municipality officers to distribute the questionnaire to the public and the questionnaire will be collected back later.

Table 3- 4: Sample size by Yamane with 95% Reliability and other Error level

Population	Sample size in different error level (e)					
	± 1%	± 2%	± 3%	± 4%	± 5%	± 10%
500	*	*	*	*	222	83
1,000	*	*	*	385	286	91
1,500	*	*	638	441	316	94
2,000	*	*	714	476	333	95
2,500	*	1,250	769	500	345	96
3,000	*	1,364	811	517	353	97
3,500	*	1,458	843	530	359	97
4,000	*	1,538	870	541	364	98
4,500	*	1,607	891	549	367	98
5,000	*	1,667	909	556	370	98
6,000	*	1,765	938	566	375	98
7,000	*	1,842	959	574	378	99
8,000	*	1,905	976	580	381	99
9,000	*	1,957	989	584	383	99
10,000	5,000	2,000	1,000	588	385	99
15,000	6,000	2,143	1,034	600	390	99
20,000	6,667	2,222	1,053	606	392	100
25,000	7,143	2,273	1,064	610	394	100
50,000	8,333	2,381	1,087	617	397	100
100,000	9,091	2,439	1,099	621	398	100
∞	10,000	2,500	1,111	625	400	100

Source: T, Yamane (1972)

Table 3- 5: Selected sampling area

* Population density (No. of population/m2)	Districts	Selected district
>500-2,000	Nong Chok, Don Mueang, Bang Khun Thian, Chatuchak, Thawi Watthana	Chatuchuk
>2,000-3,500	Chom Thong, Min Buri, Bang Bon, Saphan Sung, Rat Burana	Rat Burana
>3,500-5,000	Bang Khae, Bang Khen, Sai Mai, Khlong Sam Wa, Lat Krabang, Bang Kapi, Thung Khru, Suan Luang, Lak Si, Taling Chan, Watthana	Min Buri
>5,000-6,500	Prawet, Nong Khaem, Bueng Kum, Lat Phrao, Wang Thonglang, Bang Na, Khan Na Yao, Yan Nawa, Huai Khwang	LatPhrao
>6,500-8,000	Phasi Charoen, Phra Khanong	Phra Khanong
>>8,000-9,500	Khlong Toei, Bang Phlat, Bang Kho Laem, Sathon, Bang Rak	Sathon
>>9,500-11,500	Bangkok Noi, Dusit, Bangkok Yai, Phra Nakhon	Dusit, Bangkok Yai
>>11,500-13,000	Bang Sue, Khlong San, Ratchathewi	Ratchathewi
>13,000-14,500	Thon Buri District, Din Daeng	Din Daeng
>14,500	Pom Prap Sattru Phai, Samphanthawong	Pom Prap Sattru Phai, Samphanthawong

* Office of Register, department of the Interior, Ministry of Interior

3.4 Questionnaire Analysis

There are two types of questionnaire analysis with using different tool for analyzed**.** First, quantity analysis used **Microsoft Excel** program for getting result. Second, quality analysis used **SPSS (Statistical Package for Social Science)** version 17 for study the relationship of each function.

3.4.1 One way ANOVA

One-way ANOVA or one-way analysis of variance in statistic is a technique used to compare means of two or more sample by using F-distribution. Numerical data can be applied for this technique. The ANOVA tests the null hypothesis that sample in two or more groups are drawn from population with the same mean values. For doing this, two estimates are made of the population variance. The estimation relies on several of assumptions. F-statistic produced from ANOVA giving the ratio of variance calculated among the mean to the variance within sample. If the group means are drawn from populations with the same mean values, the variance between the group means should be lower than the variance of the samples, following the central limit theorem. A higher ratio therefore implies that the samples were drawn from populations with different mean values (Wikipedia, 2014).

3.4.2 Scheffe's method

Scheffe's procedure is perhaps the most popular of the post hoc procedures, the most flexible, and the most conservative. It is a method for adjusting significance levels in a linear regression analysis to account for multiple comparisons. It is particularly useful in analysis of variance (ANOVA), and in constructing simultaneous confidence bands for regressions involving basis functions. Complex comparisons involve contrasts of more than two means at a time. As a result, Scheffe's is also the least statistically powerful procedure (Stevens, 1999).

3.5 Data collection

To build MFA diagram of household hazardous waste in Bangkok, data were collected from different sources. Sources, type and data collected show in **Table 3-6.** Primary data measured and analyzed from questionnaire survey. The survey has been done in two different methodologies. First, the respondents complete questionnaire by interview face to face. Second, questionnaires were sent to office of selected district by self-delivery. The work got cooperated from section of administrative from each district. The target sampling group is divided in two groups. Half of questionnaires have done by the officers and other half has done by the person who comes to do their work in the district's office. Secondary data were

collected from interview waste collectors, officer in Bangkok metropolitan administration and literature review.

3.5.1 Household hazardous waste generation rate

This primary data come from questionnaire analysis in part one and part three. From each respondent, a total number of HHW will be writing in a unit of item in separate fraction. A number of items from each fraction will be multiply by their average weight. After that, total weight of household hazardous calculated the in unit of kg/year. After getting total amount of household hazardous waste in one year, the total amount will be divided by total family member then; the amount of household hazardous waste generation rate will measure in unit of Kg/Capita/Year and other amount can be estimate as following formula;

Total amount of HHW (Ton/year) = Total population (registered + non-registered) x HHW generation

Percentage of HHW from total waste = (Total HHW/Total MSW) x 100

3.5.2 Fraction composition of household hazardous waste

From part 3 in questionnaire, total amount of each fraction of household hazardous waste can be measure. Questionnaire from every respondents recorded by using Microsoft Excel. The total amount of HHW in each fraction in 2013 from residential source in Bangkok was compared in term of percentage.

3.5.3 Management strategies' recommend

This part of data also used primary data from questionnaire survey. This management strategies' recommend come from three sections in part 2, 4 and 5. Part 2 was testing about general knowledge whether they know or does not know. Part 4 used for study waste management behavior. The last part is about how to change negative behavior in part 4.

Table 3- 6: Data collection/Type/Source

Data collection	Type	Source
HHW generation rate	Primary data	Questionnaire survey
HHW composition	Primary data	Questionnaire survey
HHW management strategies' recommend	Primary data	Questionnaire survey
Total amount of MSW in Bangkok	Secondary data	BMA
Total collected amount of HHW in Bangkok	Secondary data	BMA

*BMA (Bangkok metropolitan administration)

3.6 Evaluate HHW flow in Bangkok and material flow analysis diagram of HHW in Bangkok

From reviewed on current practice of HHW management in Bangkok, the flow of HHW represent in **figure 3-1.** The flow shows the beginning state of HHW management practice in Bangkok. HHW is collect twice a month, storage at transfer station and send to private company for proper treatment. This diagram used as a model for developing MFA of household hazardous waste in this study.

Figure 3- 1: Diagram of HHW flow in Bangkok

3.7 Develop material flow analysis diagram

Material flow analysis is consisting of many steps. The definition of the problem is the first thing to be analyzed before starting conducts the flow. In this

study the objective is to develop mass flow analysis (MFA) diagram of household hazardous waste in Bangkok.

3.7.1 Selection of the substance/material

There are three approach for choosing substance or material in MFA 1). Legislation such as Hazardous substance Act and clean air Act. This type of approach is mostly done by authority. 2) The relevance of substances/material is in the important flow of the system that has to be evaluated and 3) to determine a system's metabolism of one or several substances for resource and/or environmental impact aspects. In this study, the selection of the material were followed the third approach. Household hazardous waste is selected material in this study.

3.7.2 System definition in space and time

Usually system definition in space and time is referring to the scope of the study. In this study the space (location) is taking place in Bangkok, the capital city of Thailand and time duration is 1 year (October, 2012 - September, 2013).

3.7.3 Determination of Mass Flows, Stocks, and Amount

This sector is normally focused on sources of database collection such as statistic institution, government sector and literature or journal. In this study, data were collected from government section (**Bangkok Metropolitan Administration**) and questionnaire survey.

3.7.4 Determination of Key Processes, Flows, and Stocks

To develop MAF diagram of HHW, source, destination and concentration of HHW was conducted following MFA developing methodology. The pathway is conducted from interviewed waste collection workers, questionnaire and literature review. Table 3-7 show flow, description, unit and data source. The flow was started from first source (household) with three ended destination. One is started from household and ended at incineration. Another is also started at household but ended at recycle. The last pathway start at household and ended at normal landfill

together with municipal waste. The unit of the flow is ton per year and data source is used both from primary data and secondary data.

Table 3- 7: Flow, Description, Unit and Data source of HHW

Flow	Description	Unit	Source
HW	HHW generated from household	Ton/year	Primary data: this work
HC	Flow of HHW (H) from household to collection (C)	Ton/year	Primary data: this work
CS	Flow from collection (C) to storage area (S)	Ton/year	Secondary data: from BMA
SI	Flow from storage(S) to incineration(I)	Ton/year	Secondary data: from BMA
SR	Flow from storage (S) to recycle (R)	Ton/year	Secondary data: from BMA
CT	Flow from collection (C) to transportation (T)	Ton/year	Primary data: this work
TN	Flow from transportation (T) to Nong Khame waste transfer station (N)	Ton/year	Secondary data: Estimated from maximum capacity of the station
TS	Flow from transportation (T) to Saimai waste transfer station (S)	Ton/year	Secondary data: Estimated from maximum capacity of the station
TO	Flow from transfortation (T) to On-nut waste transfer starion (O)	Ton/year	Secondary data: Estimated from maximum capacity of the station
NL	Flow from Nonge Khame waste transfer station (N) to Landfill (L)	Ton/year	Primary data + secondary data
SL	Flow from Saimai waste transfer station (S) to landfill (L)	Ton/year	Primary data + secondary data
OL	Flow from On-nut waste transfer station (O) to landfill (L)	Ton/year	Primary data + secondary data

3.7.5 System analysis

System of boundary of this study will be cover from source of household hazardous waste to the final treatment. System consist of two pathways **(Figure 3-2)**

- Municipal solid waste (Collect everyday)

Household hazardous waste discard together with municipal solid waste and go to landfill without any treatment method along with municipal solid waste

– Household hazardous waste (Collect on 1st and 15th)

Household hazardous waste is collect twice a month from drop off center of the community. HHW will be store at temporary hazardous waste storage in each district then collect by private company for proper treatment.

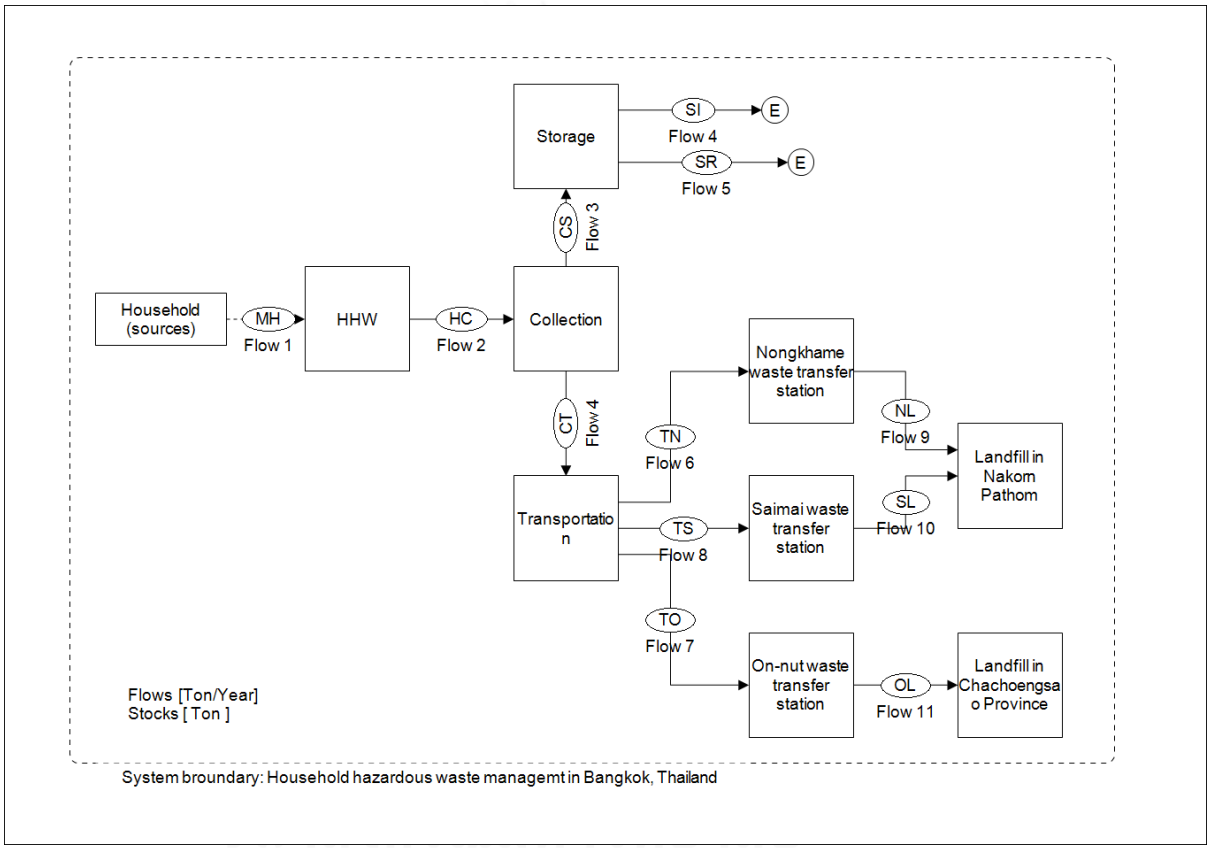


Figure 3- 2: System Boundary Model of MFA of HHW Management in Bangkok

3.7.6 Result and discussion (Identification of weak points in the system)

After getting MFA diagram of household hazardous waste, identification of weak points in the system will take place. The result of discussion will be very useful for setting effective policy in the future.

3.8 Analyze management strategies for HHW management in the future

From MFA diagram of household hazardous waste in Bangkok, we will understand the overview of HHW management operate in Bangkok. Management

plan can be take place under the overview. This part can be recommended from questionnaire survey (**Appendix B**). The section 4 and 5 of the questionnaire will be adding as recommend of future management strategies.

CHAPTER IV

HOUSEHOLD HAZARDOUS WASTE GENERATION RATE AND FRACTION COMPOSITION

This chapter presents important statistics analysis such as percentage frequency of income, residential type and education of sampling group. The questionnaire survey was conducted to collect relevant information and to evaluate household hazardous waste generation rate, fraction composition of household hazardous waste, behavior analysis, and suggestion recommendation. The total questionnaire was sent to 12 districts in Bangkok were 500 copies and total return questionnaire were 416 copies. The percentage of returning questionnaire is 83.2% from total. 416 questionnaires can be good representatives of majority population in Bangkok because questionnaires were returned from respondents who live in 49 different districts in Bangkok. According to Yamane's theory (Yamane, 1973 referred from Sumranjai, 2001), it showed that for infinite number of population approximately 400 samples can be represent all population with 95% reliability. The main tool for questionnaire analysis used in this study is SPSS program version 17 (Statistical Package for Social Science).

The results of household hazardous waste generation rates compared among different 12 districts in Bangkok are presented and discussed. The results are divided in to three main sections; (1) questionnaire analysis, (2) Household hazardous waste generation rate in Bangkok (from residential sources), and (3) Fraction composition of HHW.

4.1 Backgrounds information from questionnaire analysis

The results and discussion about the background of the respondents are divided in 5 sections as following details;

Section 1 presented part 1 of questionnaire survey. This section analyzed about general information of the respondents live in Bangkok by using two type of questionnaire consists of *checklists* and *open ended*. Then result will show in term of distributive frequency.

Section 2 presented part 2 of questionnaire survey. The main idea of this section is to analyze general HHW's knowledge from respondents. This section *checklist* answer was used. The result of this section presented in from of table descriptive frequency.

Section 3 is quantitative section used for estimate HHW generation rate and the total amount of HHW generated in 1 year. There are 10 groups of household hazardous waste in this section. The respondents will do *checklist* on how many item they used per year. Then number of items multiplied by averaged weight of each item to estimate total waste and divided by family member to get number of household hazardous waste generation rate.

Section 4 analyzed on respondent household hazardous waste management behavior. In this section, questionnaire type also was used in from of checklist to represent each type of options.

Section 5 presented last part of questionnaire. This part also used checklist option. The highest frequency of each option used as suggested policy for household hazardous waste management plan in the future.

Demographic analysis from the questionnaire responses

Percentage of total respondents who are from different family size is summarized in **Table 4-1**. Respondents from questionnaire who live in Bangkok mostly have middle family size (38.7%) following by small family (27.6%) and large family (11.8%). Family that have member more than 7 is nearly equal to percentage of large Family (14.9%). Half of the respondents live in their current residential more than 10 years (53.4%) following by 1-3 years, 4-6 years and 4-6 years in percentage of 21.6, 18.0 and 7.0% respectively**. Table 4-2 shows** percentage of respondents based on period of living in current resident. From total 416 respondents, the highest percentage range group of income is 10,001-20,000 Baht (30.0%). The lowest percentage rang group of income is less than 10,000 Baht (7.0%) and 40,001-50,000 Baht (7.7%). **Table 4-3** shows percentage of respondents from different income ranges. **Table 4-4** presented percentage of respondents from various residential

types. About 37.5% of respondents live in single home, 30.3% live in townhome or condominium, 14.9% live in row house, 10.1% live in room rental and other 7.2% live in other type of residential such as dormitory, office welfare home. **Table 4-5** shows percentage of highest education level of respondents. From all respondents, 65.6% completed bachelor degree level following by high school (22.8%), higher than bachelor degree (7.5%) and elementary school (4.1%) respectively. In chapter 6 will be discuss influence of those factors to amount of household hazardous waste generation rate, waste segregation behavior and attitude of willingness to pay.

Table 4- 1: Percentage of respondents from different sizes of family

Family member	Number	Percentage
1-2	115	27.6
3-4	161	38.7
5-6	7	11.8
>7	62	14.9
Total	**416**	**100**

Table 4- 2: Percentage of respondents based on period of living in current resident

Living period (Year)	Number	Percentage
1-3	90	21.6
4-6	75	18
7-9	29	7
More than 10	222	53.4
Total	**416**	**100**

Table 4- 3: Percentage of respondents from different income ranges per month per household

Average income per month	Number	Percentage
Less than 10,000	29	7
10,001-20,000	125	30
20,001-30,000	96	23.1
30,001-40,000	80	19.2
40,001-50,000	32	7.7
More than 50,001	54	13
Total	**416**	**100**

Table 4-4: Percentage of respondents from different income ranges per capita

Average income per capita	Number	Percentage
Less than 5,000	72	17.3
5,001-15,000	234	56.3
15,001-25,000	64	15.4
25,001-35,000	27	6.5
More than 35,001	19	4.4
Total	**416**	**100**

Table 4- 5: Percentage of respondents from various residential types

Residential type	Number	Percentage
Single home	156	37.5
Townhome/Condominium	126	30.3
Row house	62	14.9
Room rental	42	10.1
Other	30	7.2
Total	**416**	**100**

Table 4- 6: Percentage frequency of highest education level

Highest education level	Number	Percentage
Elementary	17	4.1
High school	95	22.8
Bachelor degree	273	65.6
Higher	31	7.5
Total	**416**	**100**

4.2 Household hazardous waste generation rate in Bangkok

Questionnaire surveys in 12 districts were randomly selected for taking sampling based on various population densities. Questionnaires survey was completed with face to face interview and self-marking in April, 2014. The result presented 416 respondents living in 49 districts in Bangkok. **Table 4- 6** summarized the estimated household hazardous waste generation rates in sampling district.

According to the results, it elucidated that population density does not have any strong relationship or influence on the HHW generation rate. Evidently, the lowest household hazardous waste generation rate district is Wang Thonglang (0.363 Kg/capita/year) and the highest household hazardous waste generation rate district is Phawet (2.413 Kg/capita/year). These two districts are having same number of population density in range of 5,000-6,500 population per m^2. Hence, it can proved that population density does not influence to amount of generation rate. This variation of HHW generation rate may come from different in life style, consumption pattern and generation pattern (Buenrostroet al., 2001; Buenrostro and Israde, 2003; Buenrostro and Bocco, 2003 referred from Otoniel al., 2006). Socio-economic is also important factors of household hazardous waste generation rate. In Malaysia, different socio-economic groups contribute different quantum of hazardous components with the high-income group being the biggest generator (B.D. Otoniel et al, 2008).

Table 4- 4: HHW Generation rate in Bangkok from residential source

No.	District	Generation rate (Kg/capita/year)	No.	District	Generation rate (Kg/capita/year)
1	Chatuchuk	0.814	**26**	Khan Na Yao	1.11
2	LatPhrao	0.603	**27**	Bang Sue	0.491
3	Phathumwan	1.764	**28**	Bang Phlat	0.892
4	Bang Kho Laem	1.522	**29**	Sai Mai	0.772
5	Wang Thonglang	0.363	**30**	Khlong San	2.394
6	Don Mueang	1.171	**31**	Ratchathewi	1.094
7	Din Daeng	0.953	**32**	Huai Khwang	0.991
8	Rat Burana	0.741	**33**	Lak Si	0.666
9	Phaya tai	2.153	**34**	Sathon	1.032
10	Phasi Charoen	0.524	**35**	Thon Buri District	0.673
11	Bang Kapi	0.971	**36**	Bangkok Noi	1.011
12	Bang Khaen	1.126	**37**	Bang Bon	1.271
13	Lat Krabang	1.039	**38**	Taling Chan	0.643
14	Min Buri	0.999	**39**	Bang kae	0.441
15	Phra Nakhon	0.767	**40**	Yan Nawa	1.953
16	Nong jock	1.008	**41**	Phra Khanong	1.431
17	Khlong Sam Wa	1.256	**42**	Prawet	2.413
18	Dusit	1.053	**43**	Bang Na	1.051
19	Thung Khru	1.508	**44**	Khlong Toei	0.787
20	Bueng Kum	0.537	**45**	Watthana	0.456
21	Bangkok Yai	1.613	**46**	Saphan Sung	1.597
22	Pom Prap Sattru Phai	1.099	**47**	Suan Luang	0.746
23	Thawi Watthana	1.92	**48**	Bang Khun Thian	1.074
24	Bang Rak	0.473	**49**	Samphanthawong	0.85
25	Nong Khaem	0.852		**Average**	**1.033**

Average amount of household hazardous waste generation rate in Bangkok from residential source is approximately 1.033±0.82 Kg/capita/year or 2.9±2.2 g/capita/day. In Vietnam, HHW generation rate were study in 2008 the estimated rate was 0.554 g/capita/year (Thanh, Matsui, & Fujiwara, 2010). The similar studied also has done in India and HHW generation rate is 5 g/capita/year (Lakshmikantha & Lakshminarasimaiah, 2007). When comparing the result of this study with other

countries, it was found that the results of this work are fall in the middle range of those countries hence the estimated HHW generation rate in this research is reliability.

Based on the amount of household hazardous waste generation rate from the research, the total amount of household hazardous waste in Bangkok from residential source was estimated, shown in **Table 4-7**. The total amount of household hazardous waste generated in 2013 is 9,374.88 tons. The result estimated from using HHW generation rate multiplied by total number of population from both registered population and non-registered population in Bangkok 1.033 Kg/capita/year × (5,975,386+3,100,000) = 9,374.88 tons). Percentage composition of household hazardous waste from total municipal solid waste steam is 0.26%.

Table 4- 5: Percentage of HHW from total MSW

Registered population in Bangkok 2013	Non-registered population in Bangkok 2013	HHW generation rate (Kg/capita/year)	Total amount of HHW from residential source 2013 (Ton)	Total amount of MSW in Bangkok 2013 (Ton)	% HHW from total MSW
5,975,386*	3,100,000*	1.033***	9,374.88***	3,636,593.55**	0.26***

* Office of Register, department of the Interior, Ministry of Interior (2013)

** Department of Environmental control (2013)

*** This work

Table 4-8 shows percentage of household hazardous waste from MSW and compares with the percentage in other countries. Percentage of household hazardous waste from total municipal solid waste stream in Bangkok shows the lowest concentration. This partly may come from different methodologies and scope used for evaluation. This study represented only household hazardous waste generated from residential source only (household) whereas, other authors refer to total amount of household hazardous waste from many sources such as household, commercial area and other activities. Another reason is that the research does not include electronic wastes in our survey though it considers as hazardous waste. This

is because normally electronic waste does not enter to waste management collection system in Bangkok but go to junkyards instead. Based on a report from department of pollution control (2012), electronic waste can divide into 7 types; television, air condition, refrigerator, computer, printer, mobile phone and digital camera. Total amount of electronic waste generated in 2012 was 359,714 tons or 70% from total household hazardous waste in Thailand.

Table 4- 6: Percentage of household hazardous waste from MSW from different countries

Study	% of HHW from total MSW	Scope of work	References
Bangkok, Thailand	0.26	Not included electronic waste	This work
Bangkok, Thailand	0.68	Incluce all HHW waste	BMA cooperated with Spain
Cuitzeo Basin, Mexico	1.03	Not included electronic waste	Otoniel al.(2006)
Mexicali, Mexico	3.7	Incluce all HHW waste	Otoniel al. (2006)
United Kingdom	0 - 1.0	Incluce all HHW waste	Slack et al. (2004)

4.3 Percentage composition analysis

After divided, all fractions were asked to questionnaire respondents (“how many item of each fraction they used per year?”). The total amount of each item was multiply to average weight of each item (**Table 4-10**), and then total amount of each fraction was estimated. The average weight of each item was done by choosing the top tree popular brands/products and having different size of each fraction at least three items. HHW was weighted and then calculated mean and standard variation. Average weight of each fraction was weighted by the research using digital weighing machine. Each product was weighed, including the weight of the containers per product plus any product remaining inside the container.

Table 4- 7: Average weight of household hazardous waste per item

Fraction	Sampling item	Weight (g)	Mean	SD	% SD
Chemical container Cleaning product	Mirror cleaner	60.20	68.00	7.95	11.70
	Floor cleaner	67.70			
	Toilet cleaner	76.10			
Insecticide	Insecticide A	34.12	36.00	3.73	10.37
	Insecticide B	33.58			
	Insecticide C	40.30			
Air fragrances	Air fragrances A	147.34	182.10	35.38	19.43
	Air fragrances B	180.90			
	Air fragrances C	218.06			
Self-care product	Lotion	68.14	75.40	25.00	33.15
	Shampoo	112.69			
	Conditioner	80.30			
	Sun block	43.41			
	whitening	72.46			
Light bulb	Fluorescent green	220.00	400.00	187.22	46.81
	Fluorescent cycle	512.33			
	Ecotone high lumen	603.91			
	Fluorescent small	263.76			
Battery	AA	27.00	111.60	81.77	73.27
	AAA	37.90			
	D	102.50			
	9V	201.01			
	9V	189.59			
Expire Cosmetic	Talcum powder	9.22	11.16	3.64	32.62
	Lipstick	15.36			
	mask	8.90			
Expire medicine	Oral	0.70	3.70	5.54	149.64
	Injection	12.00			
	Syrup (Plastic container)	0.92			
	Food supplement	1.18			
Office equipment	Pen	60.00	40.18	19.94	49.64
	CD	16.00			
	Correction fluid	32.20			
	Glue	52.50			

From fraction analysis, fraction composition of household hazardous waste in Bangkok from residential source is found by comparing total weight of each fraction in percentage. **Figure 4-1** shows percentage of each type of household hazardous waste fraction. Self-care products show the highest composition (29.83%) following by light bulb (29.21%), chemical container (25.8%), battery (10.48%), office equipment (2.34%), expire cosmetic (1.63) and expire medicine (0.71%).

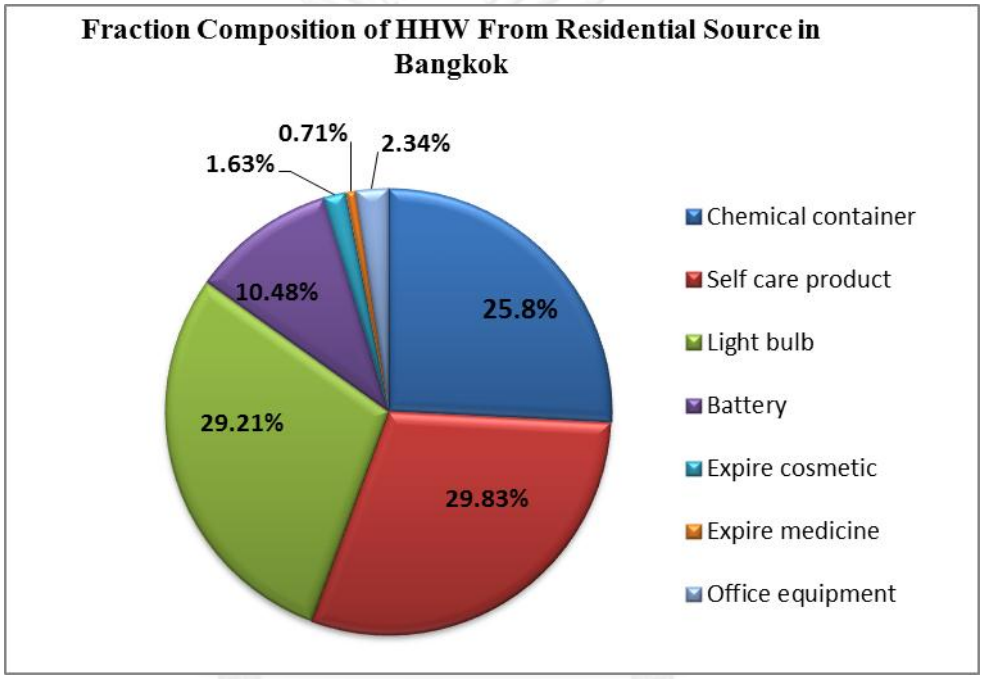


Figure 4- 1: Fraction composition of household hazardous waste from residential source in Bangkok

Self-care product presented the highest portion of fraction because this kind of item is necessary for every household. From questionnaire survey, every family buys self-care products almost every month. Second highest fraction is light bulb. Light bulb is normally change once or twice a year but it's come in the second highest because the product has highest average weight. For chemical container come in third highest portion, from questionnaire survey even normally this kind of product is an optional product but they have very high demanding. One reason due to urban community with requires comfortable choice without consideration of their impact. Battery comes up with only 10.48% this is because their long-term used. The

lowest portion come from three different fractions; expire cosmetic, expire medicine and office equipment. They show very small amount of generation because normally those kind of product get used until expire date. Therefore, the consumer will not discard them as often. Benefit of knowing percentage composition of HHW is use for set up treatment plan. Each fraction of HHW requires different method for proper treatment in the future.

In comparison with HHW percentage composition with other countries, in central Mexico HHW comprised 1.03% of municipal solid waste; the main categories in this fraction were represented by cleaning products (39%), self-care products (27.3%), and insecticides (14.4%) (O. B. Delgado et al., 2006). The above results in top three categories found different countries are similar to what is found in Bangkok Thailand by the research. Cleaning products share the highest proportion in HHW in other countries while self-care product was found to share the highest proportion of HHW in Thailand.

CHAPTER V

MASS FLOW ANALYSIS OF HHW MANAGEMENT IN BANGKOK

From chapter 4, the total amount of HHW was collected and evaluated. In this chapter, MFA diagram of HHW from residential source is developed to provide an overview for better understanding on current HHW management system in Bangkok. The results in this chapter will be divided in three main sections: (1) Analysis of each stage of HHW management processes, (2) MFA of household hazardous waste management in Bangkok, (3) Discussion on MFA of household hazardous waste management in Bangkok.

5.1 Analysis of each stage of HHW management processes

Each stage of HHW management processes in Bangkok in 2013 was analyzed using information from interviews and questionnaire survey with district officers and citizens in various districts. Also, the site visits to actual waste management facility help developing a clear understanding which all will be explained in this section.

The flow discussion consists of HHW generation, collection, storage, transportation, transfer station, incineration and landfill. The amount of HHW changed from stage to stage.

5.1.1 Household hazardous waste generation

According to **chapter 4 (Table 4-2**) the amount of household hazardous waste generated from residential source in Bangkok in 2013 is approximately 9,374.88 tons. **Table 5-1** also showed total amount of HHW generated in 2013 divided in different fraction. Report from Bangkok metropolitan administration in 2013 presented that only 584 ton (6.23%) of total amount of generated HHW sent to incineration and recycle but other 8,790.88 tons (93.77%) were still not separated and also disposed along together with municipal solid waste to landfill.

Table 5- 1: HHW from Residential Source Generated in Bangkok (2013)

Fraction	Percentage (%)	Total amount * (ton)	Send to landfill ** (ton)	Send to incinerator*** (ton)	Send to recycle (ton)
Chemical container	25.8	2,418.72	2,004.08	414.64	_
Self-care product	29.83	2,796.53	2,796.53	_	_
Light bulb	29.21	2,738.40	2,598.24	_	140.16
Battery	10.48	982.49	953.29	29.2	_
Ex. cosmetic	1.63	152.81	152.81	_	_
Ex. medicine	0.71	66.56	66.56	_	_
Office supply	2.34	219.37	219.37	_	_
Total	**100**	**9,374.88**	**8,790.88**	**443.84**	**140.16**

* Estimated from questionnaire survey (A)

** Total amount of HHW generated minus total amount of HHW send to incinerator (A-B)

*** Report from (BMA, 2012) (B)

5.1.2 Collection

Waste collection system takes place every day for MSW collection and twice a month for HHW. Collection system for waste of BMA consists of two pathways as following;

Municipal solid waste (Collect every day)

Household hazardous waste discards together with municipal solid waste is separated in hazardous chamber inside waste collection truck **Fig.5-1 (a)**. The HHW segregation process has done by the waste collector. These trucks are available in every district in Bangkok. At the present BMA have 2,031 vehicles, which are 1,477 rented vehicles or 73%, and 554 vehicles are owned by BMA or 27%. The largest

number according to type is the five-ton compacter trucks (1,038 or more than 50%) which are used for household waste collection.

(a) (b)

Figure 5- 1: Waste collection truck

(a) General waste collection truck (b) Household hazardous waste collection truck

Household hazardous waste (Collect on 1st and 15th or any others day agreed by district office).

Household hazardous waste is collect twice a month or any day that community agrees with district office from drop off center in the community by specific truck, as shown in **Fig. 5-1(b)**. Presently less than 10 trucks of this type of truck are available. Due to currently BMA does not have enough specific household hazardous waste collection truck provided for every district hence normal waste collection waste are using for household hazardous waste collection as well.

5.1.3 Storage

Household hazardous wastes were separated by waste collectors during collection process. After collected, HHW that segregated from MSW are stored at HHW storage area in each district. **Figure 5-2 (a) and (b)** is a temporary HHW storage area in Huai Khawang district and Nong khame transfer station respectively. Household hazardous waste will store until reaching target amount assigned according to BMA environmental management plan. The target amount of household hazardous waste in each district in 2013 is 0.016% of total municipal solid waste. Then HHW will send to Akkhie Prakarn Company (www.akkhie.com) for incineration.

(a) (b)

Figure 5- 2: Household Hazardous Waste Storage Area

(a) Storage area in Huai Khwang (b) Storage area in Nong kham transfer station

5.1.4 Transfer station

After collection, HHW that were discarded together with MSW and were not separated by waste collector will go to waste transfer station. There are three waste transfer stations in Bangkok, (1) Nong kham waste transfer station, (2) Saimai waste transfer station and (3) On-nut waste transfer station. On-nut waste transfer station has the highest capacity for transferring, around 3,800 ton/day following by Nongkhame waste transfer station 3,600 ton/day and Saimai waste transfer station 2,300 ton/day respectively. When waste arrives to those transfer stations, total amount of MSW was weighted and left in transfer building.

5.1.5 Transportation

There are two stages for transportation. First, wastes were transported from generation source to transfer station. This process has done by Bangkok metropolitan administration with two kinds of truck (Figure 5-1). Second stage is transportation from transfer station to landfill. **Figure 5-3** is specific truck use for waste to landfill. Wastes in transfer building are taken by those specific trucks to different landfills.

Figure 5- 3: Specific truck for transportation from transfer station to landfill

5.1.6 Waste treatment and disposal

In the past, HHW were treated by using solidification and stabilization but currently replaced by incineration. Only small amounts of HHW send to incineration while, the main portion still go along together with MSW to landfill.

(a) Incineration

In 2013, 443.84 tons of household hazardous waste goes to incineration. This process operates by Akkhie Prakarn Company located in Samudprakarn province.

(b) Recycle

Recyclable HHW such as light bulb, BMA send to private company for recycle without paying any fees as part of corporate social response. This is the project that BMA cooperated with private company. In this study, in 2013 we assumed that all light bulbs that kept in storage area were sent for recycled by private company which was approximately around 140.16 tons.

(c) Landfill

In 2013, the total amount of household hazardous waste disposal in this landfill is approximately 8,790.88 tons or 93.77% from total household hazardous waste. Today landfill area is located in two provinces. Household hazardous waste from Nongkhame waste transfer station and Saimai waste transfer station go to landfill in Kamphaeng Saen District, Nakhon Pathom Province. Wastes from On-nut waste transfer station go to landfill in Phanom Sarakham District, Chachoengsao Province.

5.2 Mass flow analysis of household hazardous waste management in Bangkok

Data from each stage of household hazardous waste management processes in Bangkok in 2013 was used of developed material flow analysis diagram. The MFA diagram show all flow processes from the source of waste generation to waste disposal.

Figure 5-4 is a mass flow of household hazardous waste in Bangkok in 2013. The total amount of household hazardous waste generated from residential source was 9,374.88 tons. During collection process, household hazardous waste is going in two different pathways. First, three types of household hazardous waste go to temporary storage area in each district. The reason of collected only three types of those waste because they are easy to segregate, transport, and storage. In the future collection program of BMA may cover more types and all types of household hazardous wastes. The flow shows total amount of each type that go to storage area. There are chemical container 414.64 tons, light bulb 140.16 tons and battery 140 tons. Then light bulb (140.16 tons) which is recyclable HHW from storage area were sent to private company for recycle, non-recyclable HHW were sent to Akkhie Prakarn Company for incineration. Akkhie Prakarn Company is a private company that government pays for hazardous waste treatment. In 2013, only 584 tons (6.23%) of household hazardous wastes were sent for proper treatment. The remaining majority of household hazardous wastes were going to second pathway. From collection processes, the remaining household hazardous waste goes along together with municipal solid wastes. There are 7 fractions of household hazardous waste transport to transfer station including chemical container 2,004.08 tons, self-care products 2,796.53 tons, light bulb 2,598.24 tons, battery 953.29 tons, expire cosmetic 152.81 tons, expire medicine 66.56 tons, and office equipment 219.37 tons. The total amount of household hazardous waste transported to transfer station is 8,790.88 tons. From maximum capacity of each transfer station, amount of household hazardous that go to each station were measured. HHW from Nongkhame and Saimai waste transfer station go to landfill in Nakorn Pathom province with 5,347.06 tons. HHW from On-nut waste transfer station sent to landfill in Chachoengsao Province with 3,443.83 tons.

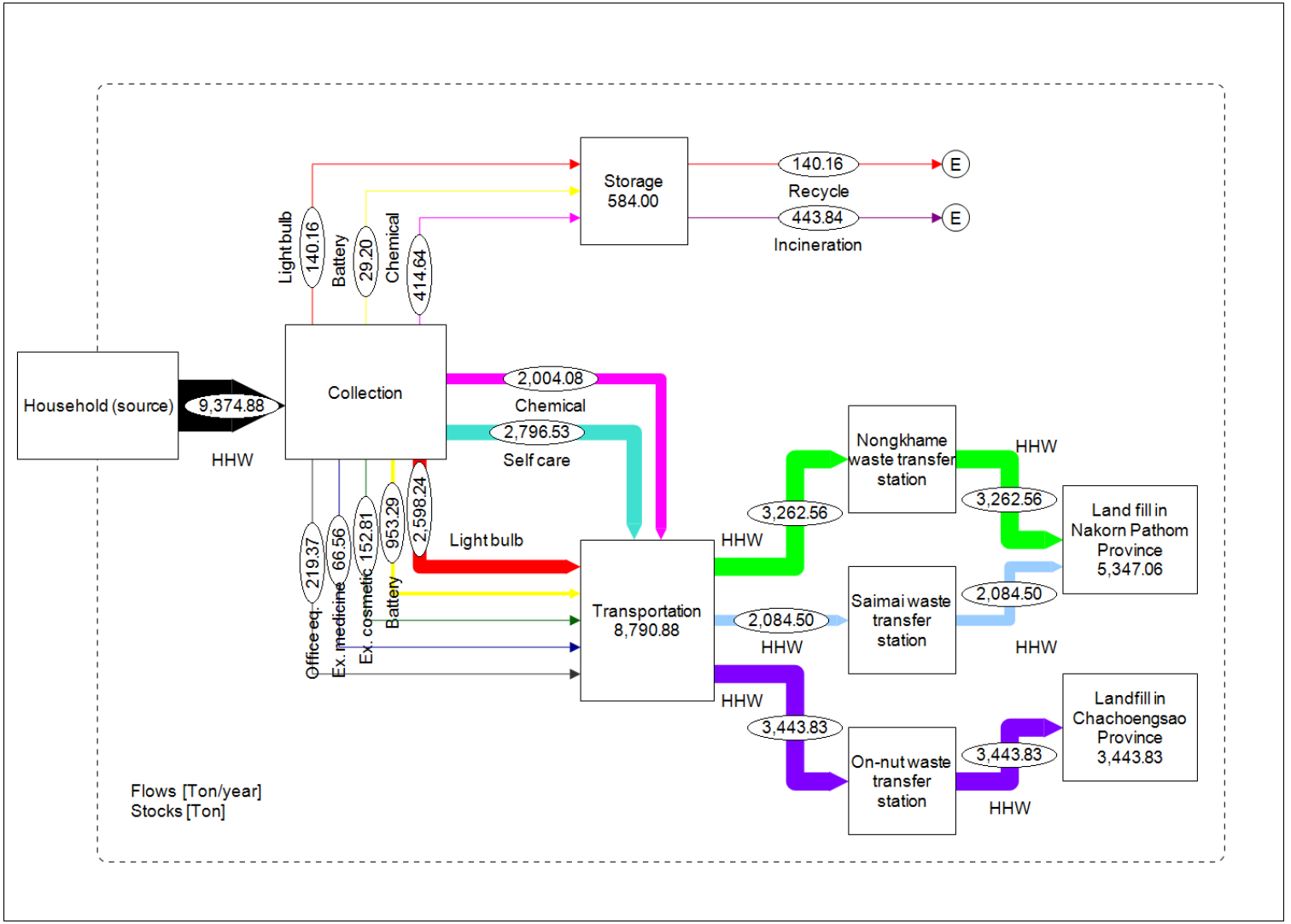


Figure 5- 4: Mass flow of Household hazardous waste management in Bangkok in 2013

5.3 Discussion on MFA of household hazardous waste management in Bangkok

Consideration of mass flow analysis of household hazardous waste management in Bangkok, the weak point of the system was found. The major concerns in the current HHW management system that the research found include details as following;

1. There is no waste segregation from source (household). Waste segregation was done during collection process but only small amount of HHW were aggregated. Only three main types of household hazardous waste were segregated from municipal solid waste. These are chemical container, light bulb and battery. It is because those three types are easy to segregate. In MFA shown that only 584 tons of household hazardous waste got prober treatment while, 5,588.57 tons still got improper treatment. Therefore, household hazardous waste is needed to be segregated from other household wastes and if possible, specific collection for household hazardous waste is required for increasing amount of proper household hazardous waste treatment.

2. There is no waste segregation before sending from waste transfer station to landfill. The other weak point of this system is that there is no segregation process for HHW before send to landfill. MFA of household hazardous waste in Bangkok shows total amount of HHW enter to each transfer station and transport forward to landfill. 2,291.51 tons were entered Nong Khame waste transfer station and the same amount of waste were transfer forward to landfill as same as household hazardous waste enter to Saimai (1,464.08 tons) and On-nut (2,418.72 tons) transfer station. From current situation, it is necessary for MBA to set up a process for HHW segregation before sending to landfill.

3. Temporary household hazardous waste storage area. Each district has temporary HHW storage area but it not really safe for worker and neighbor due to some district keep HHW in open area, some district just keep HHW on floor. Those behaviors are very dangerous. Hence, proper and

permanent HHW storage building should be built in each district to support amount of HHW that will be increase in the future.

4. Every year since 1992, BMA has done many campaigns to promote household hazardous waste management in Bangkok such as HHW banks, HHW drop off center, and green school. Those campaigns got very good feedback. But due to there is no continuous practice on each project, hence there is a little progress on this issue. In long term, this problem should be addressed and improved.

From discussion of all concerns, HHW management problem arise from both side; the citizens and government. The best way to solve this problem is co-operate between citizen and government. Waste segregation is majority problem need to be solved for better household hazardous waste management as well as municipal solid waste management. What condition will make people start to do waste aggregate will discuss in next chapter.

CHAPTER VI

BEHAVIOR ANALYSIS

Behavior analysis discusses about the influence of general characteristic such as income range, residential type, and education to amount of household hazardous waste generation. The same general characteristic also uses to find its influence with waste segregation behavior and attitude of willingness to pay. The relationship of those independent and dependent factors was analyzed by using statistic test (F-test) and single analysis of variation (One-Way ANOVA). When different of statistical significant found, multiple comparison tests was applied with Sheffe's method with 0.05 significant levels ($p<0.05$). There are three main sections in this chapter; (1) influence to household hazardous waste generation rate, (2) influence to waste segragation behavior and (3) attitude of willingness to pay for better waste management.

6.1 Influence to HHW generation rate

Hypothesis of this section is whether income, residential type and education level can have an influence to amount of HHW generation rate. Results are divided in to three subsections. The result showed that average income and residential type affect to amount of household hazardous waste generation but level of education does not affect the HHW generation rate.

6.1.1. Influence of income to generation rate

Result in table 6-1 showed significant level of income versus generation rate. The result found that significant level is 0.00 with lesser than 0.05. It means that various range of average income of respondent influence to amount of household hazardous waste generation. The relationship of two factors was analyzed in table 6-2 and table 6-3.

Table 6-2 shows multiple comparison range of income with amount of household hazardous waste generation. Amount of household hazardous waste generation increasing following income range due to mean different between each group is negative. **Table 6-3** shows relationship between income and generation rate

by comparing average household hazardous waste generation rate with each range of income. Result in **table 6-3** found that amount of household hazardous waste generation is increase with range of income.

According to study by R.S. Li (2010) in Canada, there was no clear correlation among income levels and household hazardous waste disposal. However, low-income families have the highest disposal rate of household hazardous waste (1.6 percent of total disposal waste) and the lowest disposal rate of other materials (14.9 percent of total disposal waste). S.H. Fauziah and P. Agamuthu studied the similar research in Malaysia but the result waste is slightly different. The result reported that the largest household hazardous waste (HHW) contributor was the middle income group (US$500-$1000) at 2.03% followed by the high-income group that earns more than US$1000 (1.8%) and low-income group earning less than US$500 (1.46%). Middle income generates the highest HHW generation rate because each middle income household influence the quantum of hazardous components as this group covered more than 50% of approximately 25 million populations in the country. From those two studied compare with our study, income does influence to amount of HHW generation rate but no clear correlation. In Canada, low range of income is the largest HHW generator and in Malaysia, middle range of income is the largest HHW generator where as in Thailand, high income range is the largest HHW generator.

Table 6- 1: The differential statistic significant of income versus generation rate

Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between group	117.383	4	29.346	73.774	0
Within group	163.487	411	0.398		

*P<0.05

Table 6- 2: Multiple comparison range of income with amount of household hazardous waste generation

Income (Baht/month)	$\bar{x}$	Generation rate (Kg/capity/year)				
		< 5,000	5,001-15,000	15,001-25,000	25,001-35,000	> 35,001
< 5,000	0.67	0	-0.07	-1	-1.4	-1.67
5,001-15,000	0.74			-0.93	-1.32	-1.6
15,001-25,000	1.67				-0.39	-0.28
25,001-35,000	2.07					0.25
> 35,001	2.35					0

Table 6- 3: Average generation rate in different income range

Income (Baht/capita)	Generation rate (Kg/capita/year)
< 5,000	0.67
5,001-15,000	0.74
15,001-25,000	1.67
25,001-35,000	2.07
> 35,001	2.35
Total	1.033

6.1.2. Influence of residential type to generation rate

Assumption of this section is space of living area (residential type) affect to HHW generation. Larger space may generate more waste compare with smaller of living spaces. **Table 6-4** shows differential statistic significant of residential type versus generation rate. Significant level of this hypothesis is 0.013 ($P<0.05$) with lower than 0.05 hence residential type is influence to amount of household hazardous waste generation. Then the relationship of each type of residential to amount of waste generated were analyzed in **table 6-5**., showing multiple comparison residential type with amount of household hazardous waste generation. Mean different between each group of residential type is in negative number hence

household hazardous waste generation rate must be increasing from the largest living space to the smallest living space or we can say single house with the largest living space generate the lowest HHW in unit of Kg/capita/year.

The relationship between generation rate and residential type are showed in **table 6-6**. Results found that amount of generation rate correlate with residential type. The study assume that the result from one respondent from survey represent the total amount of household hazardous generate from the entire family. When total amount of HHW is divided by family member from each respondent, amount of HHW generation rate of per capita was estimated. Single home generated the lowest amount of household hazardous waste (0.829 Kg/capita/year) due to normally big family is living in single home resulting in more sharing in waste generation. More number of sharing waste is less amount of household hazardous waste generation per capita even they have the largest living space.

Table 6- 4: The differential statistic significant of residential type versus generation rate

Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between group	610.449	380	1.606	1.864	0.013
Within group	30.167	35	0.862		

*P<0.05

Table 6- 5**:** Multiple comparison residential type with amount of household hazardous waste generation

Residential type	$\bar{X}$	**Generation rate**				
		Single home	Townhouse/ Condo	Row house	Rental room	Other
Single home	0.82		-0.27	-0.29	-0.42	-0.42
Townhouse/Condo	1.1			-0.01	-0.14	-0.14
Row house	1.12				-0.12	-0.12
Rental room	1.25					0
Other	1.25					

Table 6- 6**:** Average generation rate in different residential type

Residential	**Generation rate (Kg/capita/year)**
Single house	0.829
Townhouse/condominium	1.108
Row house	1.127
Rent room	1.254
Other	1.252
Total	**1.033**

6.1.3. Influence of education to generation rate

The last hypothesis of this section is influence of education to generation rate. The differential statistic significant of education level versus generation rate shows in **table 6-7**. Significant level of this hypothesis is 0.14 with greater than 0.05. Hence, the result suggested that education level does not affect to amount of household hazardous waste generated.

The relationship between average amount of household hazardous waste generation rate and education level were not able to identify. **Table 6-8** show average household hazardous waste generation rate in each education level. Without considering other factors, with educational background alone, group of higher than bachelor degree show the highest generation rate (1.245 Kg/capita/year) and group of high school level show the lowest generation rate (0.886 Kg/capita/year).

Table 6- 7: The differential statistic significant of education level versus generation rate

Education	$\bar{x}$	S.D	F	Sig.
Elementary school	1.1	0.92	1.801	0.14
High school	0.88	0.67		
Bachelor degree	1.05	0.83		
Higher than bachelor degree	1.24	0.99		

*P>0.05

Table 6- 8**:** Average generation rate in different education level

Education level	Generation rate (Kg/capita/year)
Elementary school	1.108
High school	0.886
Bachelor degree	1.052
Higher than bachelor degree	1.245
Total	**1.033**

6.2 Influence to waste segregation behavior

Hypothesis of section 6.2 is whether income, residential type and education level is influence to waste segregation behavior. Results are divide in to three

subsections. The result shows that waste segregation behavior influence by income and residential but by level of education.

6.2.1. Influence of income to waste segregation behavior

Table 6-9 shows the differential statistic significant of income versus waste segregate behavior. The significant level between income and waste segregation behavior is 0.027 which is lower than 0.05 (P<0.05) hence the results suggest that waste segregation behavior influence by income. In **table 6-10** the multiple comparisons of income and waste segregation behavior is shown. Pair of income 10,001-20,000 Baht/month with income more than 50,001 Baht/month make the different by 5% of acceptable error.

There was significant positive correlation between income and waste segregate behavior. It means that low income range has done waste segregation better than high income rage. Percentage of person who does waste segregation is increasing adversely increase in amount of income range.

Table 6- 9: The differential statistic significant of income versus waste segregate behavior

Variation	Sum of Squares	df	Mean Square	F	Sig.
Between group	0.896	5	0.179	2.564	0.027
Within group	28.643	410	0.07		

*P<0.05

Table 6- 10: Multiple comparison of income with waste segregation behavior

Income (Baht/month)	$\bar{x}$	Waste segregation behavior					
		< 10,000	10,001-20,000	20,001-30,000	30,001-40,000	40,001-50,000	> 50,001
< 10,000	1.2		0.11	0.12	0.15	0.11	.20*
10,001-20,000	1.08			0	0.03	0	0.08
20,001-30,000	1.08				0.03	-0.01	0.08
30,001-40,000	1.05					-0.04	0.05
40,001-50,000	1.09						0.09
> 50,001	1						

6.2.2. Influence of residential type to waste segregation behavior

The hypothesis of section 6.2.1 is to proof whether residential type is influence to waste segregation behavior or not. **Table 6-11** shows the differential statistic significant of residential versus waste segregate behavior. Significant level of hypothesis is 0.02 with lower than 0.05. Hence residential type is affected to waste segregation behavior.

Table 6-12 shows multiple comparison of residential type with waste segregation behavior. Number of mean different between groups is in negative and positive hence percentage of person who does waste segregation is unsteady in different type of residential. Considering the mean and mean different value of each resident type, person who lives in room rental shown the best waste segregation practice following by person who lives in townhouse, raw house and single home respectively.

Table 6- 11: The differential statistic significant of residential versus waste segregate behavior

Variation	Sum of Squares	df	Mean Square	F	Sig.
Between group	0.811	4	0.203	2.89	0.02
Within group	28.728	411	0.07		

*P<0.05

Table 6- 12: Multiple comparison of residential type with waste segregation behavior

Residential type	$\bar{x}$	Waste segregation behavior				
		Single home	Townhouse /Condo	Row house	Rental room	Other
Single home	1.04		-0.05	-0.01	-.14*	0.01
Townhouse/Condo	1.09			0.03	-0.09	0.06
Row house	1.06				-0.12	0.03
Rental room	1.19					0.15
Other	1.03					

6.2.3. Influence of education level to waste segregation behavior

Table 6-13 shows the differential statistic significant of education versus waste segregate behavior. It indicated that education level does not influence to waste segregation behavior. Significant level in this hypothesis is 0.20, which is higher than 0.05 hence hypothesis was rejected. Means different between group have both negative and positive value so the relationship between each group was not able to clearly identify.

Table 6- 13: The differential statistic significant of education versus waste segregate behavior

Education level	$\overline{x}$	S.D	F	Sig.
Elementary school	1.05	0.24	1.52	0.2
High school	1.11	0.32		
Bachelor degree	1.05	0.23		
Higher than bachelor degree	1.12	0.34		

6.3 Influence to attitude of willingness to pay for better waste management

Section 6.3 also consists of three subsections. The hypothesis of this section is to analyze the relationship between attitude of willingness to pay with income, residential type and education level. Result found that only residential type is influence to attitude of willingness to pay.

6.3.1 Influence of income to attitude of willingness to pay

Table 6-14 shows the differential statistic significant of income versus attitude of willingness to pay. Significant level is 0.90 with is higher than 0.05 hence range of income does not influence to attitude of willingness to pay.

Table 6- 14: The differential statistics significant of income versus willingness to pay

Education level	$\overline{x}$	S.D	F	Sig.
Elementary school	1.05	0.24	1.52	0.2
High school	1.11	0.32		
Bachelor degree	1.05	0.23		
Higher than bachelor degree	1.12	0.34		

6.3.2 Influence of residential type to attitude of willingness to pay

Table 6-15 shows differential statistics significant of residential type versus attitude of willingness to pay. Significant level of this hypothesis is 0.0 which is lower than 0.05 hence residential type is influence to attitude of willingness to pay. In

table 6-16 shows mean and mean different between groups of residential. Value of mean different between each group is in negative and positive value. Mean that, person who lives in row house has the highest attitude of willingness to pay following by person who lives in room rental, townhouse/condominium, and single home respectively.

Table 6- 15: The differential statistic significant of residential type versus willingness to pay

Variation	Sum of Squares	df	Mean Square	F	Sig.
Between group	2.661	4	0.665	4.09	0
Within group	66.724	411	0.162		

Table 6- 16: Multiple comparison of residential type with attitude of willingness to pay

Residential type	$\bar{x}$	Willingness to pay				
		Single home	Townhouse/ Condo	Row house	Rental room	Other
Single home	1.13		-0.07	-.22*	-0.17	-0.03
Townhouse/Condo	1.21			-0.14	-0.09	0.04
Row house	1.35				0.04	0.18
Rental room	1.3					0.14
Other	1.17					

6.3.3 Influence of education level to attitude of willingness to pay

Table 6-17 shows differential statistics significant of education versus attitude of willingness to pay. The result found there is no relationship between education level and attitude of willingness to pay. Result was decided due to significant level is higher than 0.05. Value of significant level in this hypothesis is 0.848.

Table 6- 17: The differential statistic significant of education versus willingness to pay

Education level	$\bar{x}$	S.D	F	Sig.
Elementary school	1.23	0.43	0.268	0.848
High school	1.17	0.38		
Bachelor degree	1.21	0.41		
Higher than bachelor degree	1.22	0.42		

From all hypotheses analysis, the results from collected samples can be suggested and summarized as following;

Amount of income have an influence to generation rate and waste segregation behavior but not influence to attitude of willingness to pay. From result found that amount of household hazardous waste generation increase when range of income increase. It is suggested that the intensity of waste production and disposal is higher in high income range when compare to middle and low income range. The reason is probably because of high income range have ability to consume more goods and products resulted in generated of more wastes. For income versus waste segregation behavior found that rang of income influence to waste segregation behavior. High income range was presented in better waste segregation behavior.

Different residential type influenced to all generation rate, waste segregation behavior and attitude of willingness to pay. Firstly, residential type influence to amount of household hazardous waste generation depends on family member as well as living space. The study assume that the result from one respondent from survey represent the total amount of household hazardous generate from the entire family Single home with large space and more family member generated the lowest amount of household hazardous waste while, room rental with normally small space and only 1 or 2 member, generated the highest amount of household hazardous waste. More waste sharing will be smaller in waste generation per capita. Hence single home generated the lowest amount of household hazardous waste generation per capita, following by townhouse or

condominium, row house and room rental. Secondly, the influence analysis of residential type to behavior of waste segregation. From result analyzed shown that the highest percentage of waste segregation behavior found that person who lives in room rental shown the best waste segregation practice following by person who lives in townhouse, raw house and single home respectively. Lastly, the influence of residential type to attitude of willingness to pay. In this part researcher found that person who lives in row house has the highest attitude of willingness to pay following by person who lives in room rental, townhouse/condominium, and single home respectively.

Education level does not influence to generation rate, waste segregation behavior and attitude of willingness to pay. From questionnaire analysis, the result was a surprise. The level of education does not significantly influencing to amount of household hazardous waste generation, waste segregation behavior and attitude of willingness to pa**y.** This is probably because of many education levels in Thailand does not really emphasize on the significance of awareness of environmental protection. Not only elementary school was lack of environment study but all classes of study in Thailand except the one who study about environment. According to questionnaire survey, promote environmental program in school is very important for children in the future.

Result from analyzed of influence of HHW generation rate found that income rang play the most significant influence to HHW generation rate following by residential type. Result from relationship between income and HHW generation rate indicated that household hazardous waste generation increase following increasing in range of income. Target group to reduce HHW generation should be high income rage group because they generated the highest amount of HHW generation rate per capita.

CHAPTER VII

RECOMMENDED MANAGEMENT STRATEGIES

This chapter analyzes what should be done to improve household hazardous waste management and recommend strategies for future improvement. The results of each recommendation were analyzed based on the percentage of responses from the survey. There are two main sections in this chapter; (1) general HHW background knowledge, and (2) recommendation strategies for future improvement.

7.1 General household hazardous waste background knowledge

General knowledge tested by using checklist questionnaire. It was divided in two questions with yes or no answer. This section is aim to test household hazardous waste general knowledge assessment. The result was used for investigating recommended strategies in public education section.

Question 1 is "Do you know that there are two types of HHW; (1) Electronic waste and (2) Other HHW such as chemical container, light bulb, battery etc?"

Question 2 is "Do you know if there is no proper HHW management, there will be an impact to health and environment?"

Table 7-1 showed percentage of responses from question number 1. Most respondents who live in Bangkok realized the meaning of household hazardous waste and also know that HHW have two different types with 88.0%. There is only 12.0% of respondent is who never known about household hazardous waste.

Table 7-2 shows percentage of responses from question number 2, 92.3% of the respondents realized that improper manage of household hazardous waste will cause impact to human health and environment such as water and soil contaminated but 7.7% of respondents still do not know.

Results of both questions show that most respondents know about HHW including their types and affect from the improper HHW management. For household hazardous waste management, if majority of the citizen already have knowledge

about household hazardous waste, next step is to create the appropriate incentive to do the right action.

Table 7- 1: Percentage on answer of question number 1

Question 1	Number	Percentage
Yes	366	88
No	50	12
Total	**416**	**100**

Table 7- 2: Percentage on answer of question number 2

Question 2	Number	Percentage
Yes	384	92.3
No	32	7.7
Total	**416**	**100**

7.2 Recommendation for improving HHW management

Currently, there are 4 mains process of household hazardous waste management system in Bangkok. Each process involved different group of stakeholders. In this study the policy suggestion will focus on the process that involve with the all citizens of the city. **Figure 7-1** shows diagram of HHW process in Bangkok from MFA diagram of household hazardous waste management in Bangkok. From the diagram, the origin point of the system is source of HHW generated. The main stakeholders of this process are the citizen of our country. Different problems from each process need to be solve separately. This study concerned about problem analysis process between HHW generation and disposal and collection process. When the questionnaire was developing, we assumed that the main problem of this process is from a lack of waste segregation from household. Hence all questions surveyed tried to identify if our assumption is correct and what could be solution for improving the performance of the HHW management.

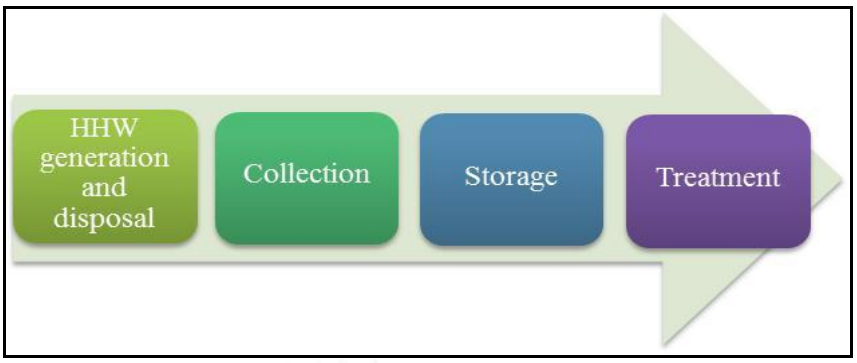


Figure 7- 1: HHW management process

Figure 7-2 shows the problem of HHW collection process. HHW always mix together with other municipal solid wastes due to no waste segregation from source. The three important tools normally applied for improving waste segregation behavior are following;

1. Economic instrument such as provide subsidy program and application of fees and charges for the generation, transport and disposal of HHW waste.
2. Regulatory enforcement and,
3. Education

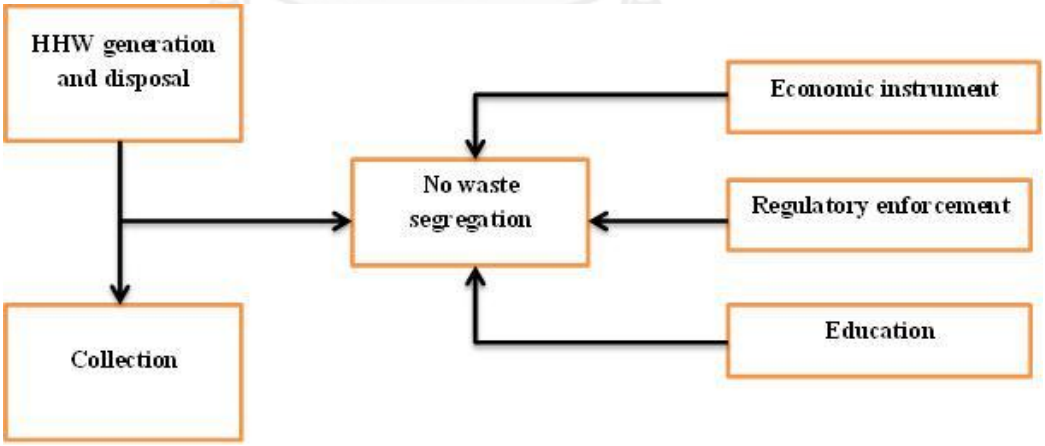


Figure 7- 2: Problem during collection process

There are 8 subsections showing different information on strategies in this sector. Each section was analyzed the percentage preference of each option that was selected by the respondent. The highest percentage of each question was used as first concern for recommending future policy strategies.

7.2.1 Policy propose for waste segregation

Table 7-3 shows percent preference of policy to enhance waste segregation. The results show that the most requested policy to enhance waste segregation is by using regulation enforcement (34.4%) following by awareness rising (26.4%), provide subsidy program (15.4%), and provide more information and advertisement (13.5%) and using penalty enforcement (10.3%).

Evidently, regulation enforcement is the most preferred option because it got the highest frequency however penalty enforcement got the lowest frequency due to people does not want to spend their money on penalty hence this two policies should be integrated. This is because one makes people follow the guidance and the other create disincentive for people not to do the wrong action by avoiding losing their money. The second option is raising awareness. Improving environmental knowledge particularly about waste management should be incorporated the knowledge about waste segregation topic since the elementary school level. Next is by providing subsidy program of a good practice on household hazardous waste management. For example, the public can bring HHW for getting discount for new product instead of discard together with other wastes.

Table 7- 3: Percentage frequency of policy to enhance waste segregation

Selected policy	Number	Percentage
Regulation enforcement	143	34.4
Raising awareness	110	26.4
Provide subsidy program	64	15.4
Provide more information	56	13.5
Penalty enforcement	43	10.3
Total	**416**	**100**

7.2.2 Regulation enforcement

Sometime regulation enforcement also was not really effective hence, before promoting any policy, public survey should be taking place. From previous table accepted that regulation enforcement will good tool for improving HHW management. What policy will make people follow shows in Table 7-4. The most effective enforcement that preferred as regulation enforcement is penalty enforcement (45.2%) following by parole enforcement (27.6%) and No waste collection if no waste segregation from source (27.2%). From percentage frequency of each option, penalty enforcement will be stringent regulation enforcement in the future.

Table 7- 4: Preferences about which enforcement should be used as regulation enforcement

Enforcement	Number	Percentage
Penalty enforcement	188	45.2
Parole enforcement	115	27.6
No waste collection if no waste segregation from source	113	27.2
Total	**416**	**100**

7.2.3 Fundamental need for household hazardous waste segregation

Table 7-5 shows percentage on fundamental needs for HHW segregation. The highest frequency is to establish household hazardous waste bank (35.8%) following by providing HHW knowledge (30.0%), establish household hazardous waste drop off center in each community (22.1) and provide clear date and avenue for collection (11.3%). Establish HHW bank is the best encouragement strategy because the bank gives value to HHW. The condition of HHW bank is HHW can be brings to the bank and get other goods for exchange. For example you can bring broken light bulb to exchange with new energy saving light bulb.

Table 7- 5: Percent preference on approaches to encouragement for HHW collection

Encouragement	Number	Percentage
Establish household hazardous waste bank	149	35.8
Providing HHW knowledge	125	30
Establish HHW drop off center in each community	92	22.1
Provide clear date and avenue for collection	47	11.3
Total	**416**	**100**

7.2.4 Avenue for household hazardous waste drop off center or household hazardous waste bank

From previous section, Drop off center is necessary for HHW management system. The advantage of drop off center in the future is following; 1) reduce operating time because can be collected from one area in one community instead of pickup from every house, 2) energy saving due to reduce in distant, and it will be comfortable for population in each community. Table 7-6 presented preferences of the avenue for drop off center. The most comfortable avenue for drop off HHW is the collectors go to pick up from house (40.8%) and HHW drop off center in community (40.1%) and HHW drop off center in department store (12.0%). The result show that preferences of picking HHW up from each house and HHW drop off center in community is nearly equal, only 0.7% of differentiation hence the avenue for HHW drop off can be in both areas. The reason of HHW drop off center in department store got the lowest frequency because of nobody don't wants to carry waste for such a long distant. Summarized of this section is due to drop off avenue should be pick up from home and establish drop off center in community is significantly similar considering with above discussion, the suitable HHW drop of center avenue should be in the community.

Table 7- 6: Percentage frequency of the best avenue for drop off center or HHW bank

Drop off area	Number	Percentage
Pick up from home	203	40.8
HHW drop off center in community	137	40.1
HHW drop off center in department store	50	12
Total	**416**	**100**

7.2.5 Who should be responsible party for HHW management program?

Table 7-7 shows preferences on responsible party for household hazardous waste management program. 43.3 % of respondent suggested that government should be responsible for setting up household hazardous waste management program following by community representative (31.7%), private section (16.1%) and co-operation by all sections (8.9%).

Table 7- 7: Percentage frequency of responsible party for household hazardous waste management program

Section	Number	Percentage
Government	180	43.3
Community representative	132	31.7
Private company	67	16.1
Co-operated	37	8.9
Total	**416**	**100**

7.2.6 Frequency of HHW collection

Due to HHW is very small portion if compare to municipal solid waste hence. Collection frequency should be correlated with amount of waste. The survey was analyzed which collection frequency will be suitable for HHW collection. Table 7-8

shows the highest frequency of HHW collection frequency is HHW should be collect every week (54.1%) following by monthly (22.6%), twice a month (21.4%) and every three months (1.9%). The result of this part is the suitable HHW collection frequency is collect every month.

Table 7- 8: Preference on frequency of HHW collection

Frequency	Number	Percentage
Weekly	225	54.1
Twice a month	89	21.4
Monthly	94	22.6
Every 3 months	8	1.9
Total	**416**	**100**

7.2.7 Attitude of willingness to pay

Current situation, MBA charges the citizens for waste management is 20 Baht/household. Report from BKK state of environment 2012, current collection fees is for waste collection only. The fee does not include waste treatment. Since HHW is harmful with require specific method for handling. If HHW management program are growing with problem on waste segregation has solved, the next step should be waste utilization and treatment. Survey of attitude of willingness to pay for batter waste treatment is to see whether it possible to treatment charge (Dwivedy & Mittal, 2013). From table 7-9 represented positive and negative attitude of willingness to pay. The percentage of positive attitude of willingness to pay is 78.8% and negative attitude of willingness to pay is 21.2%.

From positive attitude of willingness to pay was continuing to analyze on how much citizens are willing and can afford to pay for HHW management. Table 7-10 shows that 56.7% of respondent willing to pay 10 Baht more following by 20 Baht (35.1%) and 30 Baht (8.2%) respectively.

Table 7- 9: Percent preference of willingness to pay

Willingness to pay	Number	Percentage
Yes	328	78.8
No	88	21.2
Total	**416**	**100**

Table 7- 10: Percent preference of the amount of willingness to pay

Amount of adding fund per month (Baht)	Number	Percentage
10	186	56.7
20	115	35.1
30	27	8.2
Total	**328**	**100**

7.3 Recommendation for improvement

Efficiency in household hazardous waste management depends on several fundamental factors (Manomaivibool & Vassanadumrongdee, 2012). Important factors of particularly in a developing country may be classified as follows: (1) financial (e.g., budget, access to financing), (2) human resources (e.g., professional competence at the management and implementation levels, provisions for training personnel), and (3) pertinent political issues (www.unep.fr, 2005). The suggestion recommendation descripted as following;

7.3.1 Improving waste segregation behavior

a) Establish of environmental education programs in school

The results elucidated that more than 90% of population has general knowledge about household hazardous wastes but they may lack of awareness. Therefore, increase awareness about proper waste management in public education should be the key step. Children should be educated to increase awareness from

beginning before they grow up to have environmentally concerns. Education can be accomplished formally and informally. A formal approach would involve the establishment of environmentally educational programs in schools, as well as publicity campaigns. The program and campaigns would elaborate upon the benefits to be expected from proper waste management, and upon the baneful consequences of poor sanitation, while emphasizing the high costs associated with inadequate public cooperation.

Advantage

- Awareness rising can be more effective in children, when children have more concern on environment since they are young. They will grow up to be adult with adequate concerns for environment.
- If everybody have knowledge about HHW management problem, it will be easy for promoting any policy for proper management

Disadvantage

- It may take long time for promoting environmental program into school due to it have to be done by ministry of educational.
- There is no guarantee that environmental knowledge can certainly help raising environmental awareness as well.

b) Provide HHW drop off center in community

Result from questionnaire survey, 40.3% of respondent agree to do HHW segregation if proper drop off center is available in the community. Currently, BMA is promoting this campaign but in very few communities. In the future, drop off center should be promoted in all community in Bangkok. The avenue of HHW drop off center should be agreed from all community members. It should be in the center of the community, where everyone comfortable to drop their HHW waste and easy for waste collector to collect. HHW drop off center should decide in different chamber for different types of HHW such as chamber number 1 for chemical container, chamber number 2 for battery and chamber number 3 for light bulb etc. In addition,

if HHW drop off center is promoting the strong information about advantage and disadvantage of HHW drop of center to community should be done.

Advantage

- Comfortable for community member to go and drop off their household hazardous waste
- Easy for HHW HHW collector to come and collect and also can save time and energy
- Increasing in amount of HHW collected and will have more proper treatment on household hazardous waste

Disadvantage

- Drop of center need to locate in safety area with proper drop off bin therefore; different chamber for different type of HHW is needed. At least, the drop off areas should have two champers, one for recycle waste such as light bulb, electronic waste and some plastic container. And another chamber for non-recycle household hazardous waste such as chemical container etc.

c) Provide separated bin for household hazardous waste collection

For institutional such as school, university and all commercial area, separated bin for HHW collection should be promoted. Due to drop off center will be comfortable of community member only hence other part of HHW generator should be provide separated bin for HHW disposal. Even the main HHW generator is come from household but other generator also important hence HHW collection from other source of HHW generation also necessary to be included.

Advantage

- Increase amount of HHW collected
- Increase segregation behavior of the citizens

Disadvantage

- Use high amount of funding
- People may discard other waste in separate bin for household hazardous waste bin. If something like this happen, separated bin for different type of waste may not necessary.

7.3.2 Household hazardous waste collection

a) Training program for HHW collectors

Due to HHW is hazardous and toxic to the environment and human health if there is no proper collection and management practice. For example, light bulb contain lead if they broke will cause risk to the worker hence, HHW collector need to be train before working with hazardous waste. Each district should have training and education programs about all steps of appropriate of household hazardous waste management, protective equipment wear during the operation, types of household hazardous waste, risks and accidents caused from inappropriate management to their all personnel.

Advantage

- **Decrease the percentage of accident from all HHW management process**
- **Improve the efficiency of HHH collectors**

Disadvantage

- High training cost is required
- **Many programs are needed to develop for specific group of workers.**

b) Collection time

Currently, BMA do HHW collection twice a month on 1st and 15th of every month. The result found that 50.1% of respondents indicated that HHW should be collect weekly. The researcher suggested that if HHW segregation behavior were improved, the HHW collection time should be increase from twice a month to once a week. This is to prepare for increase in amount of HHW disposal in the future.

Advantage

- No waste storage in drop off center for long time, no toxic contamination in collection area.

Disadvantage

- In the beginning, amount of HHW collection may be quite small and may not be cost-effective.

c) Collection truck

Due to HHW generated is very small amount if compare to total municipal solid waste hence HHW collection truck should be smaller and the capacity of the truck should be suitable for amount of HHW. Currently, BMA provided specific truck of HHW collection as well but only few were used. In the future, the number of HHW collection truck should be increase to get enough to handle all HHW.

Advantage

- Can make sure that HHW will not mix with other wastes
- Appropriate and efficient for collection and transportation

Disadvantage

- Need a lot of funding for buying truck and train waste collector

d) Household hazardous waste storage building

Current situation is every districts have they own temporary HHW storage area before send to transfer station. Result from Interviews and literature reviews, researcher suggested that HHW storage building should be established in all three transfer stations therefore Nong Khame, Saimai and On-nut transfer station. When the HHW collection process has done, waste can be transfered directly to their nearest transfer station to store in HHW storage building. The advantage of doing this is to reduce cost for constructing storage building because it can build only three HHW storage building instead of 50 storages building in each district.

Advantage

- Have safety area for household hazardous waste storage
- Easy for HHW segregation for transport to recycle, treatment or secure landfill
- Saving costs because it can establish in three transfer station instead of 50 storages building in each district in Bangkok.

Disadvantage

- It require the specialist to operate under low risk condition
- The storage building need to be under standard for hazardous waste storage with cause in higher cost for building

7.3.3 Household hazardous waste treatment and management

a) Imposing waste treatment fees

Important measure for household hazardous waste management is regulation enforcement. Questionnaire survey found that 34.4% of respondent agree to be used regulation enforcement for improve HHW management system as well as other wastes. Penalty enforcement is the regulatory that respondent agree to get more cooperation for waste segregation and management. According to survey on attitude of willingness to pay found that 78.8% of total respondent agree to pay more for better household hazardous waste management system. From those two sections survey suggested that increase waste treatment fees must be imposed in the future for better household hazardous waste management in nearly future.

Advantage

- The citizens which is the main waste generator getting involve for better HHW management
- Improve the efficiency of HHW treatment in the future

Disadvantage

- May get negative feedback from some group of citizen

b) Promote take-back policy to producers

If BMA able to increase the capacity of HHW collection in the future, HHW treatment method and HHW management need to be reconsider. Producer take back policy is necessary to take place in the future due to HHW is specific type of waste with require different treatment method in different categories. Government does not have ability to build all different treatment plans for different types of HHW. Hence promoting of take-back policy to producers can be solving this problem. Each producer has to take responsible for wastes that come from their end of life products. If this type of policy can be promoted, all different type of HHW will be getting proper treatment.

Advantage

- Increase the amount of proper HHW treatment
- Reduce HHW management budget
- Give an incentive to producer to produce more environmental friendly or green products

Disadvantage

- Could increase the cost of products because producers would be adding recycling or treatment costs into the initial price of products

c) Promote green products campaign to producer and community

Another policy can be promote to producer is production of green products. Due to HHW is contain of hazardous substances with consider as health risk. If concentration of hazardous substances can be reduced or used less toxic and more environmental friendly alternative substances with can reduce risk level and environmental impact.

Advantage

- Reduce amount of household hazardous waste generation and disposal into the environment

- Helps the appearance of the environment the safety, may reduce the effect of global warming, acid rain and various other environmental problems.

Disadvantage

- Often be expensive than normal products for example, energy saving and rechargeable battery is more expensive than normal battery.
- Many of the products being in development can have unknown risks and reactions so many people may be reluctant to use them.

CHAPTER VIII

CONCLUSION

There are three main objectives in the research. The first objective is to develop mass flow analysis of household hazardous waste management in Bangkok. The second is to estimate amount of household hazardous waste generation rate and fraction composition. The third is to analyze HHW management behavior and relevant factor impacting HHW managing, and recommended strategies to improve the efficiency of the management.

The research methodology was done using questionnaire survey. Focus group was population who live in Bangkok. 500 questionnaires were distributed to 12 sampling districts. 416 questionnaires were returned with corresponding to whom live in various different districts. From all respondents, their resident distributed in to 49 districts. Tool for questionnaire analysis is instant computer program call SPSS. Key findings of this study were summarized following;

8.1 Mass flow analysis of household hazardous waste management in Bangkok

Mass flow analysis of household hazardous waste management in Bangkok is developed to better understand an overview of source, flow paths and final disposal of household hazardous waste as well as the current status of management. The results are summarized as follows:

1) Estimated amount of household hazardous waste generation rate in Bangkok in 2013 is 1.033 Kg/capita/year.

2) Total amount of household hazardous waste generated in Bangkok in 2013 is 9,374.88 tons

3) Percentage of household hazardous waste in total municipal solid waste stream in Bangkok is 0.26 %.

4) From estimated total amount of household hazardous waste generation, approximately only 584 tons (6.23%) of household hazardous waste was sent

to incineration while, other 8,790.88 tons (93.77%) still go along together with municipal solid waste to normal landfill.

5) Currently landfill area for waste disposal from Bangkok is located in two provinces; Nakorn Phanom and Chacheongsao province. 5,347.06 tons of HHW was sent to landfill in Bangsan district in Nakorn Phatom province while, 3,443.83 tons of HHW was sent to Phanom salakram district in Chacheongsao province.

6) Fraction composition of household hazardous waste was group in seven different fractions. Percentage of each fraction is chemical container (25.8%), self-care product (29.83%), light bulb (29.21%), battery (10.48%), expire cosmetic (1.63%), expire medicine (0.71%), and office equipment (2.34 %). The highest proportion is self-care products with significantly similar to light bulb.

7) Mass flow analysis of household hazardous waste in Bangkok shows the weak point of HHW management system in Bangkok. The main problem was waste segregation behavior. Currently, there is no waste segregation regulation or any incentive campaign for increasing waste segregation behavior from citizens. BMA has set target amount of household hazardous waste and encourage each district to collect household hazardous waste to meet those target amount. From above discussion, only government is trying to solve this problem but in reality citizens or waste generators should be involve.

8.2 Influence of HHW generation rate

From second objective of this study was to analysis the factor that influence to household hazardous waste generation rate. From behavior analysis of this research, the findings are summarized as following;

The questionnaire analysis demonstrated that income level was positively correlated with amount of household hazardous waste generation rate. High income group was the largest generator per capita following by middle income and low income. Residential type also positively correlated with amount of household

hazardous waste generation rate. Amount of HHW is increase following increase in space of residential. However, no significant correlations were found between level of education and amount of household hazardous waste generation rate.

The analysis of influence of waste segregation behavior was found that income level was positively correlated with waste segregation behavior. low income group has more practice on waste segregation behavior. Another positive correlated to waste segregation behavior is residential type, room rental did better practice on waste segregation behavior following by townhouse, condominium, raw house and single home. Education level also does not any relationship with waste segregation behavior.

The last relationship analyzed was influence of attitude of willingness to pay for improve better waste management plan. Only residential type was positively influence to attitude of willingness to pay. Person who lives in row house has the highest attitude of willingness to pay following by person who lives in room rental, townhouse/condominium, and single home respectively.. Income level and education level are negatively correlated with attitude of willingness to pay.

8.3 Recommendation for improving HHW management

According from MFA of household hazardous waste and questionnaire analyzed found that waste segregation behavior is majority key problem need to be improving of better waste management system. The recommendation strategy for improvement of household hazardous waste management system in Bangkok is following;

1) Establish of environmental education programs in school to enhance awareness to children. Create environmental concern mild prepare for future waste management system.
2) Provide HHW drop off center in the community for collect HHW from community member. The advantage of doing this is comfortable for citizens; reduce collection cost and comfortable for HHW collector.

3) Proper training and educational program need to be add for worker who involve with household hazardous waste management
4) Provide separate bin for HHW collection. Due to drop off center will be comfortable for community member but other commercial area and institutional such as school, company and hospital does not have hence separate bin should be provide in this area.
5) HHW collection time should be once a week using specific truck of HHW collection and government should be taking full responsible for this process.
6) Establish proper HHW storage building in three transfer stations. If amount of HHW collection were increase, proper storage building would be need. HHW storage building should be constructing in each transfer station like Nong Khame, Sai mai and On-nut transfer station.
7) Imposing take back and recycle policy to producers for improving efficiency of household hazardous waste recycle and proper treatment
8) Promote green product campaign to producer as well as to the citizen

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APPENDIX A

Table A- 1: Average weight of household hazardous waste per item with picture

Fraction	Sampling item	Example Picture	Weight	Mean	SD
Chemical container **Cleaning product**	Mirror cleaner		60.20	68.00	7.95
	Floor cleaner		67.70		
	Toilet cleaner		76.10		
Insecticide	Insecticide A		34.12	36.00	3.73
	Insecticide B		33.58		
	Insecticide C		40.30		
Air fragrances	Air fragrances A		147.34	182.10	35.38
	Air fragrances B		180.90		
	Air fragrances C		218.06		
Self-care product	Lotion		68.14	75.40	25.00
	Shampoo		112.69		
	Conditioner		80.30		
	Sun block		43.41		
	withering		72.46		
Light bulb	Fluorescent green		220.00	400.00	187.22
	Fluorescent cycle		512.33		
	Ecotone high lumen		603.91		
	Fluorescent small		263.76		
Battery	AA		27.00	111.60	80.01
	AAA		46.00		
	D		102.50		
	9V		201.01		
	9V		189.59		
Expire Cosmetic	Talcum powder		9.22	11.16	3.64
	Lipstick		15.36		
	mask		8.90		
Expire medicine	Oral		0.70	3.70	5.54
	Injection		12.00		
	Syrup (Plastic container)		0.92		
	Food supplement		1.18		
Office equipment	Pen		60.00	40.18	19.94
	CD		16.00		
	Correction fluid		32.20		
	Glue		52.50		

Table A- 2: Quantity analysis in 7 different fractions (Ton)

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
1	0.149	0.800	0.368	0.679	0.064	0.015	0.030	3	2.104	0.701
2	0.223	0.400	0.454	0.452	0.064	0.000	0.000	2	1.594	0.797
3	0.223	0.800	0.572	0.905	0.064	0.015	0.045	2	2.624	1.312
4	0.223	0.800	0.572	0.452	0.064	0.030	0.090	3	2.232	0.744
5	0.223	0.800	0.572	0.704	0.024	0.015	0.045	3	2.383	0.794
6	0.446	0.000	0.490	0.754	0.024	0.030	0.030	2	1.774	0.887
7	0.112	0.530	1.036	0.352	0.064	0.010	0.045	4	2.148	0.537
8	0.446	1.600	0.572	0.302	0.024	0.015	0.045	4	3.004	0.751
9	0.446	0.530	0.344	0.908	0.024	0.015	0.045	3	2.313	0.771
10	0.223	0.530	0.404	0.603	0.064	0.015	0.045	7	1.884	0.269
11	0.223	0.800	0.366	0.905	0.016	0.010	0.090	3	2.410	0.803
12	0.223	1.600	0.644	0.402	0.064	0.015	0.090	5	3.038	0.608
13	0.223	0.800	0.366	0.905	0.016	0.010	0.090	3	2.410	0.803
14	0.223	1.600	0.368	0.754	0.064	0.015	0.030	1	3.054	3.054
15	0.223	0.800	0.436	0.452	0.024	0.015	0.045	4	1.996	0.499
16	0.223	0.800	0.208	0.503	0.024	0.015	0.045	5	1.818	0.364
17	0.149	0.530	0.572	0.302	0.016	0.010	0.030	5	1.609	0.322
18	0.149	0.400	0.936	0.905	0.024	0.015	0.045	1	2.474	2.474
19	0.223	0.800	0.450	0.905	0.024	0.030	0.090	5	2.522	0.504
20	0.223	0.400	0.286	0.377	0.016	0.010	0.030	3	1.342	0.447
21	0.223	0.800	0.644	0.603	0.024	0.030	0.045	6	2.369	0.395
22	0.446	1.600	0.572	0.905	0.064	0.030	0.045	3	3.662	1.221
23	0.446	0.800	0.644	0.603	0.064	0.030	0.090	5	2.678	0.536
24	0.446	0.800	0.572	0.302	0.024	0.030	0.090	3	2.264	0.755
25	0.223	0.800	0.644	0.905	0.024	0.015	0.045	7	2.656	0.379
26	0.223	0.800	0.366	0.905	0.016	0.010	0.030	3	2.350	0.783
27	0.223	0.400	0.490	0.905	0.064	0.010	0.030	4	2.122	0.531
28	0.446	0.530	0.658	0.905	0.064	0.010	0.045	8	2.658	0.332
29	0.223	0.400	0.550	0.905	0.064	0.010	0.030	5	2.182	0.436
30	0.149	0.400	0.286	0.452	0.016	0.010	0.000	4	1.313	0.328
31	0.112	0.400	0.354	0.905	0.016	0.010	0.030	2	1.826	0.913
32	0.223	0.400	0.354	0.452	0.024	0.010	0.045	1	1.509	1.509
33	0.149	0.400	0.286	0.452	0.016	0.015	0.030	1	1.348	1.348
34	0.149	0.400	0.672	0.905	0.064	0.010	0.030	6	2.230	0.372
35	0.112	0.400	0.000	0.452	0.024	0.000	0.000	1	0.988	0.988
36	0.223	0.400	0.286	0.302	0.024	0.015	0.030	1	1.280	1.280
37	0.446	0.400	0.536	0.905	0.016	0.010	0.030	3	2.343	0.781
38	0.223	0.530	0.286	0.754	0.064	0.015	0.090	2	1.962	0.981
39	0.112	0.400	0.286	0.905	0.016	0.010	0.030	2	1.758	0.879
40	0.149	0.400	0.366	0.905	0.024	0.010	0.300	1	2.154	2.154
41	0.446	0.800	0.572	0.452	0.024	0.030	0.045	3	2.370	0.790
42	0.446	1.600	1.144	0.905	0.064	0.015	0.045	3	4.219	1.406

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
43	0.149	0.400	0.708	0.905	0.024	0.015	0.045	1	2.246	2.246
44	0.446	0.800	0.708	0.754	0.064	0.015	0.090	3	2.877	0.959
45	0.223	0.530	0.562	0.704	0.024	0.015	0.030	2	2.088	1.044
46	0.149	0.400	0.036	0.754	0.064	0.000	0.000	4	1.403	0.351
47	0.446	0.400	0.672	0.352	0.016	0.010	0.030	5	1.926	0.385
48	0.446	1.600	1.144	0.905	0.064	0.030	0.030	2	4.219	2.110
49	0.149	0.400	0.504	0.754	0.024	0.010	0.030	4	1.871	0.468
50	0.112	0.400	0.286	0.302	0.064	0.010	0.030	1	1.203	1.203
51	0.112	0.800	0.462	0.905	0.024	0.010	0.030	2	2.342	1.171
52	0.446	0.400	0.536	0.905	0.016	0.010	0.030	1	2.343	2.343
53	0.446	0.530	0.502	0.905	0.024	0.015	0.045	3	2.467	0.822
54	0.446	0.400	0.490	0.905	0.016	0.015	0.045	2	2.317	1.159
55	0.446	1.600	1.144	0.905	0.064	0.030	0.090	2	4.279	2.140
56	0.446	0.400	0.286	0.905	0.064	0.030	0.090	2	2.221	1.111
57	0.223	1.600	0.354	0.402	0.016	0.010	0.030	4	2.635	0.659
58	0.112	0.400	0.538	0.905	0.064	0.010	0.090	3	2.118	0.706
59	0.112	0.400	1.144	0.905	0.064	0.030	0.090	2	2.744	1.372
60	0.112	0.400	1.144	0.905	0.012	0.010	0.045	2	2.627	1.314
61	0.149	0.400	0.320	0.452	0.012	0.010	0.030	3	1.373	0.458
62	0.112	0.400	0.308	0.377	0.012	0.010	0.030	2	1.248	0.624
63	0.223	0.800	0.308	0.905	0.024	0.010	0.030	1	2.300	2.300
64	0.223	0.400	0.586	0.905	0.064	0.030	0.090	4	2.298	0.575
65	0.446	0.800	0.380	0.905	0.012	0.010	0.030	5	2.583	0.517
66	0.223	0.400	0.426	0.754	0.064	0.030	0.000	3	1.897	0.632
67	0.223	0.530	0.450	0.452	0.024	0.010	0.030	3	1.720	0.573
68	0.223	0.400	0.750	0.905	0.064	0.015	0.045	3	2.402	0.801
69	0.149	0.530	0.502	0.754	0.024	0.030	0.090	1	2.079	2.079
70	0.223	0.530	0.354	0.905	0.064	0.015	0.045	5	2.136	0.427
71	0.446	0.800	1.144	0.905	0.024	0.015	0.045	6	3.379	0.563
72	0.446	0.400	0.708	0.905	0.024	0.030	0.045	3	2.558	0.853
73	0.223	0.530	0.866	0.905	0.064	0.010	0.090	3	2.688	0.896
74	0.149	0.400	0.684	0.452	0.012	0.010	0.030	7	1.737	0.248
75	0.446	0.400	0.526	0.452	0.012	0.010	0.030	2	1.876	0.938
76	0.223	0.800	1.144	0.905	0.064	0.030	0.090	4	3.256	0.814
77	0.149	0.530	0.658	0.905	0.024	0.015	0.045	1	2.326	2.326
78	0.446	0.800	0.526	0.302	0.064	0.015	0.045	2	2.198	1.099
79	0.223	0.530	0.526	0.276	0.064	0.015	0.030	1	1.665	1.665
80	0.149	0.800	0.426	0.377	0.064	0.015	0.030	6	1.861	0.310
81	0.112	0.400	0.382	0.905	0.024	0.015	0.030	4	1.867	0.467
82	0.223	1.600	1.144	0.905	0.064	0.030	0.090	4	4.056	1.014
83	0.223	0.800	0.572	0.905	0.064	0.010	0.030	1	2.604	2.604
84	0.149	0.400	0.354	0.302	0.012	0.010	0.030	1	1.256	1.256
85	0.149	0.530	0.344	0.452	0.064	0.010	0.030	4	1.579	0.395
86	0.223	0.400	0.672	0.905	0.012	0.030	0.030	1	2.272	2.272

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
88	0.112	0.000	0.454	0.402	0.000	0.010	0.000	1	0.978	0.978
89	0.112	0.400	0.390	0.452	0.000	0.000	0.000	3	1.354	0.451
90	0.223	0.400	0.390	0.905	0.012	0.010	0.030	3	1.970	0.657
91	0.223	0.400	0.548	0.905	0.024	0.000	0.030	1	2.130	2.130
92	0.446	0.530	0.354	0.754	0.012	0.010	0.090	1	2.196	2.196
93	0.223	0.400	0.708	0.754	0.024	0.015	0.045	4	2.169	0.542
94	0.223	0.400	0.708	0.905	0.024	0.010	0.045	2	2.315	1.158
95	0.446	1.600	1.008	0.603	0.064	0.030	0.090	2	3.842	1.921
96	0.446	0.530	0.344	0.452	0.024	0.010	0.045	5	1.852	0.370
97	0.223	0.800	0.450	0.452	0.024	0.010	0.030	7	1.990	0.284
98	0.149	0.530	0.450	0.452	0.024	0.010	0.030	4	1.645	0.411
99	0.446	0.800	1.144	0.905	0.064	0.010	0.045	2	3.414	1.707
100	0.223	0.800	0.572	0.452	0.024	0.015	0.045	4	2.132	0.533
101	0.223	0.400	1.144	0.905	0.064	0.010	0.045	3	2.791	0.930
102	0.149	0.530	0.354	0.905	0.024	0.015	0.030	2	2.007	1.003
103	0.223	0.800	1.144	0.905	0.024	0.015	0.090	4	3.201	0.800
104	0.223	0.400	0.586	0.603	0.024	0.010	0.030	1	1.876	1.876
105	0.446	0.400	0.586	0.402	0.012	0.010	0.030	1	1.886	1.886
106	0.112	0.400	0.522	0.905	0.024	0.010	0.000	6	1.972	0.329
107	0.149	0.400	0.344	0.905	0.064	0.030	0.030	1	1.922	1.922
108	0.446	0.800	0.572	0.905	0.064	0.030	0.090	10	2.907	0.291
109	0.446	0.400	0.598	0.905	0.024	0.030	0.090	2	2.493	1.247
110	0.446	0.530	0.308	0.452	0.064	0.010	0.030	4	1.841	0.460
111	0.446	0.400	0.490	0.905	0.064	0.030	0.030	6	2.365	0.394
112	0.446	1.600	1.008	0.905	0.024	0.030	0.000	5	4.013	0.803
113	0.446	1.600	1.144	0.452	0.064	0.030	0.090	3	3.827	1.276
114	0.446	1.600	1.008	0.905	0.064	0.000	0.090	3	4.113	1.371
115	0.446	1.600	1.008	0.754	0.024	0.030	0.090	3	3.952	1.317
116	0.223	0.800	1.008	0.754	0.024	0.030	0.000	2	2.839	1.420
117	0.446	1.600	1.072	0.905	0.064	0.030	0.090	4	4.207	1.052
118	0.446	1.600	1.144	0.905	0.064	0.010	0.090	5	4.259	0.852
119	0.149	0.800	0.658	0.754	0.064	0.015	0.090	2	2.530	1.265
120	0.223	0.400	0.598	0.905	0.064	0.030	0.090	1	2.310	2.310
121	0.446	0.800	0.936	0.905	0.012	0.015	0.030	3	3.144	1.048
122	0.446	0.530	1.048	0.905	0.024	0.010	0.090	3	3.053	1.018
123	0.223	0.530	1.008	0.905	0.064	0.015	0.045	1	2.790	2.790
124	0.223	0.530	0.550	0.905	0.064	0.010	0.030	1	2.312	2.312
125	0.446	0.530	0.414	0.905	0.024	0.015	0.030	2	2.364	1.182
126	0.149	0.400	0.366	0.302	0.024	0.030	0.030	5	1.300	0.260
127	0.112	0.400	0.366	0.302	0.024	0.030	0.030	3	1.263	0.421
128	0.223	0.530	0.572	0.452	0.024	0.015	0.045	7	1.862	0.266
129	0.112	0.400	0.286	0.226	0.012	0.010	0.030	6	1.075	0.179
130	0.223	0.530	0.358	0.377	0.012	0.015	0.030	5	1.545	0.309
131	0.223	0.530	0.358	0.377	0.012	0.015	0.030	5	1.545	0.309

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
132	0.446	0.400	1.008	0.905	0.064	0.030	0.090	5	2.943	0.589
133	0.112	0.530	0.572	0.452	0.024	0.015	0.045	5	1.750	0.350
134	0.112	0.530	0.308	0.302	0.012	0.010	0.030	2	1.303	0.651
135	0.223	0.800	1.008	0.452	0.064	0.015	0.045	4	2.608	0.652
136	0.223	0.400	0.172	0.704	0.012	0.000	0.000	5	1.511	0.302
137	0.223	0.800	1.008	0.905	0.000	0.030	0.090	1	3.056	3.056
138	0.223	0.400	0.172	0.304	0.012	0.000	0.000	5	1.111	0.222
139	0.223	1.600	1.008	0.452	0.064	0.030	0.090	2	3.468	1.734
140	0.223	0.400	0.172	0.704	0.012	0.000	0.000	5	1.511	0.302
141	0.223	0.400	0.308	0.704	0.012	0.000	0.000	5	1.647	0.329
142	0.149	0.530	0.358	0.226	0.012	0.010	0.030	1	1.315	1.315
143	0.112	0.530	0.286	0.276	0.012	0.010	0.030	1	1.256	1.256
144	0.112	0.400	0.286	0.226	0.012	0.010	0.030	1	1.075	1.075
145	0.112	0.400	0.286	0.226	0.012	0.010	0.030	1	1.075	1.075
146	0.446	0.400	0.708	0.754	0.064	0.015	0.090	2	2.477	1.239
147	0.223	0.400	0.380	0.452	0.024	0.010	0.030	2	1.520	0.760
148	0.446	0.800	0.572	0.905	0.064	0.010	0.030	3	2.827	0.942
149	0.446	0.800	0.427	0.905	0.064	0.010	0.030	5	2.682	0.536
150	0.446	0.800	0.404	0.905	0.064	0.010	0.030	6	2.659	0.443
151	0.446	0.400	0.380	0.905	0.064	0.010	0.030	3	2.235	0.745
152	0.446	0.800	1.008	0.754	0.064	0.010	0.030	4	3.112	0.778
153	0.223	0.400	0.526	0.754	0.064	0.010	0.030	3	2.007	0.669
154	0.446	0.400	0.562	0.905	0.064	0.015	0.030	2	2.422	1.211
155	0.446	0.400	1.144	0.905	0.024	0.015	0.090	3	3.024	1.008
156	0.446	1.600	0.644	0.603	0.000	0.030	0.045	2	3.369	1.684
157	0.446	0.800	1.144	0.905	0.064	0.030	0.045	4	3.434	0.859
158	0.223	1.600	1.048	0.754	0.024	0.030	0.045	4	3.724	0.931
159	0.223	0.400	0.286	0.754	0.012	0.010	0.030	5	1.715	0.343
160	0.223	0.800	0.684	0.352	0.012	0.015	0.030	4	2.116	0.529
161	0.223	1.600	1.144	0.905	0.064	0.015	0.000	6	3.951	0.659
162	0.223	0.800	1.144	0.905	0.064	0.015	0.045	5	3.196	0.639
163	0.149	0.530	0.672	0.905	0.064	0.015	0.045	4	2.380	0.595
164	0.446	0.800	1.144	0.905	0.064	0.000	0.045	5	3.404	0.681
165	0.223	1.600	1.144	0.905	0.064	0.030	0.000	4	3.966	0.992
166	0.223	0.800	0.404	0.905	0.064	0.030	0.030	5	2.456	0.491
167	0.223	0.530	0.450	0.905	0.064	0.015	0.090	2	2.277	1.139
168	0.223	0.530	1.008	0.754	0.064	0.030	0.030	3	2.639	0.880
169	0.223	1.600	0.502	0.754	0.064	0.015	0.045	4	3.203	0.801
170	0.149	0.400	0.366	0.905	0.064	0.010	0.045	2	1.939	0.969
171	0.446	0.800	0.708	0.905	0.064	0.015	0.045	2	2.983	1.492
172	0.446	0.530	0.586	0.452	0.024	0.010	0.045	2	2.094	1.047
173	0.446	0.400	1.144	0.905	0.064	0.030	0.045	4	3.034	0.759
174	0.149	0.400	0.414	0.905	0.064	0.010	0.045	1	1.987	1.987
175	0.149	0.400	0.536	0.905	0.064	0.015	0.030	1	2.099	2.099

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
176	0.446	1.600	1.144	0.905	0.064	0.030	0.090	2	4.279	2.140
177	0.223	0.530	0.550	0.905	0.064	0.015	0.090	1	2.377	2.377
178	0.149	0.080	1.144	0.905	0.024	0.015	0.045	3	2.362	0.787
179	0.112	0.400	0.414	0.905	0.064	0.010	0.030	1	1.934	1.934
180	0.112	0.400	0.286	0.905	0.012	0.010	0.030	4	1.754	0.439
181	0.112	0.400	0.462	0.603	0.024	0.010	0.030	4	1.641	0.410
182	0.223	0.800	0.586	0.905	0.064	0.015	0.090	4	2.683	0.671
183	0.446	0.800	0.572	0.905	0.024	0.015	0.090	5	2.852	0.570
184	0.446	0.400	0.390	0.905	0.024	0.010	0.030	4	2.205	0.551
185	0.446	0.800	0.536	0.905	0.064	0.030	0.030	3	2.811	0.937
186	0.223	0.530	0.708	0.603	0.024	0.015	0.030	4	2.133	0.533
187	0.446	1.600	0.572	0.905	0.024	0.030	0.090	1	3.667	3.667
188	0.223	1.600	1.008	0.754	0.064	0.030	0.090	5	3.769	0.754
189	0.223	1.600	1.008	0.754	0.064	0.030	0.090	4	3.769	0.942
190	0.223	0.400	0.286	0.679	0.024	0.010	0.030	9	1.652	0.184
191	0.223	0.800	1.144	0.452	0.064	0.030	0.090	1	2.804	2.804
192	0.223	1.600	0.708	0.754	0.024	0.030	0.090	5	3.429	0.686
193	0.446	0.800	1.008	0.905	0.064	0.030	0.090	1	3.343	3.343
194	0.446	1.600	1.144	0.905	0.064	0.030	0.090	3	4.279	1.426
195	0.446	0.400	1.144	0.905	0.064	0.030	0.090	3	3.079	1.026
196	0.223	1.600	0.658	0.905	0.064	0.015	0.045	4	3.510	0.878
197	0.446	0.800	1.144	0.905	0.064	0.015	0.030	5	3.404	0.681
198	0.223	0.800	1.008	0.905	0.064	0.015	0.030	5	3.045	0.609
199	0.223	0.400	0.522	0.754	0.000	0.015	0.030	6	1.944	0.324
200	0.223	0.530	0.708	0.754	0.064	0.015	0.045	3	2.339	0.780
201	0.112	0.400	0.936	0.905	0.064	0.030	0.090	1	2.536	2.536
202	0.149	0.530	0.308	0.452	0.000	0.010	0.030	3	1.479	0.493
203	0.149	0.800	0.522	0.704	0.064	0.015	0.045	5	2.299	0.460
204	0.112	0.530	0.476	0.905	0.064	0.015	0.090	4	2.191	0.548
205	0.149	0.530	0.380	0.302	0.012	0.010	0.045	2	1.427	0.713
206	0.112	0.400	0.286	0.226	0.064	0.015	0.045	2	1.148	0.574
207	0.149	1.600	0.502	0.905	0.024	0.010	0.090	6	3.280	0.547
208	0.446	0.800	0.366	0.603	0.012	0.010	0.030	3	2.267	0.756
209	0.149	0.530	0.562	0.452	0.012	0.010	0.030	2	1.745	0.872
210	0.446	0.400	1.008	0.905	0.012	0.000	0.000	3	2.771	0.924
211	0.223	0.800	0.526	0.302	0.012	0.015	0.030	1	1.907	1.907
212	0.149	0.530	1.048	0.302	0.012	0.010	0.030	4	2.080	0.520
213	0.149	0.800	0.426	0.302	0.012	0.010	0.030	1	1.728	1.728
214	0.149	0.530	0.450	0.352	0.012	0.010	0.045	1	1.547	1.547
215	0.149	0.400	0.544	0.352	0.012	0.010	0.030	1	1.496	1.496
216	0.446	0.530	0.598	0.603	0.064	0.030	0.090	3	2.362	0.787
217	0.223	0.800	1.144	0.905	0.064	0.015	0.045	7	3.196	0.457
218	0.446	1.600	1.144	0.905	0.064	0.015	0.045	5	4.219	0.844
219	0.223	0.800	0.708	0.905	0.012	0.015	0.045	4	2.708	0.677

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
220	0.223	0.800	0.708	0.905	0.064	0.010	0.045	5	2.755	0.551
221	0.446	1.600	1.144	0.905	0.064	0.015	0.030	6	4.204	0.701
222	0.223	0.400	0.658	0.905	0.064	0.010	0.030	1	2.290	2.290
223	0.223	1.600	1.144	0.905	0.064	0.030	0.090	1	4.056	4.056
224	0.112	0.400	0.390	0.754	0.064	0.030	0.045	2	1.795	0.897
225	0.223	0.400	0.468	0.452	0.024	0.015	0.045	3	1.628	0.543
226	0.112	0.400	0.672	0.603	0.064	0.010	0.030	1	1.891	1.891
227	0.223	0.800	0.912	0.905	0.064	0.030	0.090	4	3.024	0.756
228	0.223	0.530	1.072	0.905	0.064	0.015	0.045	3	2.854	0.951
229	0.149	0.400	0.354	0.402	0.012	0.010	0.030	2	1.357	0.678
230	0.223	0.400	0.536	0.905	0.064	0.015	0.030	4	2.173	0.543
231	0.446	0.800	0.366	0.603	0.012	0.010	0.030	1	2.267	2.267
232	0.446	0.800	0.366	0.603	0.012	0.010	0.030	1	2.267	2.267
233	0.223	0.530	0.572	0.905	0.024	0.030	0.090	1	2.374	2.374
234	0.446	0.400	0.286	0.905	0.012	0.010	0.045	1	2.104	2.104
235	0.223	0.530	0.308	0.402	0.012	0.010	0.030	4	1.515	0.379
236	0.446	0.400	0.900	0.905	0.012	0.010	0.030	1	2.703	2.703
237	0.223	0.530	0.598	0.905	0.000	0.000	0.000	6	2.256	0.376
238	0.223	0.530	1.144	0.905	0.064	0.030	0.090	4	2.986	0.747
239	0.223	0.800	0.572	0.905	0.064	0.015	0.030	3	2.609	0.870
240	0.446	0.800	0.780	0.452	0.024	0.030	0.030	2	2.563	1.281
241	0.223	1.600	0.644	0.452	0.064	0.015	3.000	6	5.999	1.000
242	0.446	0.530	0.936	0.905	0.000	0.015	0.030	1	2.862	2.862
243	0.223	1.600	0.780	0.452	0.064	0.030	0.090	1	3.240	3.240
244	0.223	0.530	1.144	0.905	0.024	0.015	0.000	7	2.841	0.406
245	0.112	1.600	1.144	0.603	0.064	0.030	0.090	4	3.643	0.911
246	0.149	0.400	0.286	0.905	0.012	0.010	0.030	2	1.791	0.896
247	0.112	0.400	0.126	0.302	0.000	0.000	0.030	4	0.969	0.242
248	0.223	0.400	0.780	0.905	0.064	0.010	0.030	3	2.412	0.804
249	0.446	1.600	0.780	0.905	0.064	0.030	0.090	5	3.915	0.783
250	0.446	1.600	1.008	0.603	0.000	0.000	0.090	8	3.748	0.468
251	0.446	1.600	1.144	0.905	0.064	0.030	0.090	1	4.279	4.279
252	0.446	0.400	1.144	0.905	0.024	0.010	0.090	1	3.019	3.019
253	0.446	1.600	1.144	0.905	0.064	0.010	0.030	1	4.199	4.199
254	0.446	1.600	0.572	0.905	0.024	0.010	0.030	1	3.587	3.587
255	0.446	0.400	1.144	0.905	0.064	0.030	0.090	1	3.079	3.079
256	0.446	1.600	1.144	0.905	0.064	0.300	0.090	1	4.549	4.549
257	0.223	0.800	0.572	0.452	0.024	0.030	0.030	2	2.132	1.066
258	0.446	1.600	1.144	0.905	0.064	0.030	0.090	1	4.279	4.279
259	0.112	0.800	0.586	0.905	0.024	0.015	0.030	2	2.471	1.236
260	0.149	0.400	0.526	0.905	0.012	0.030	0.045	2	2.066	1.033
261	0.446	1.600	1.144	0.905	0.024	0.015	0.045	7	4.179	0.597
262	0.446	0.800	0.780	0.905	0.024	0.015	0.030	4	3.000	0.750
263	0.112	0.530	0.286	0.252	0.012	0.010	0.030	1	1.232	1.232

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
264	0.223	0.400	0.366	0.905	0.064	0.010	0.045	12	2.013	0.168
265	0.223	0.400	0.250	0.603	0.064	0.010	0.090	3	1.640	0.547
267	0.223	0.400	1.144	0.754	0.064	0.010	0.045	2	2.640	1.320
268	0.223	0.530	0.708	0.905	0.012	0.030	0.030	5	2.438	0.488
269	0.223	0.400	0.272	0.905	0.064	0.010	0.045	2	1.919	0.960
270	0.112	0.400	0.354	0.276	0.064	0.010	0.030	1	1.246	1.246
271	0.149	0.400	1.008	0.704	0.064	0.010	0.045	4	2.380	0.595
272	0.223	0.400	0.250	0.603	0.064	0.010	0.090	3	1.640	0.547
273	0.149	0.400	0.450	0.754	0.024	0.015	0.000	4	1.792	0.448
274	0.000	0.400	0.298	0.905	0.000	0.015	0.090	2	1.708	0.854
275	0.223	0.530	0.708	0.905	0.012	0.030	0.030	5	2.438	0.488
276	0.223	0.400	0.272	0.750	0.064	0.010	0.045	2	1.764	0.882
277	0.149	0.400	0.308	0.905	0.064	0.010	0.030	3	1.866	0.622
278	0.223	0.800	1.072	0.905	0.024	0.015	0.090	6	3.129	0.522
279	0.223	0.530	1.144	0.452	0.064	0.015	0.045	3	2.474	0.825
280	0.223	1.600	0.598	0.352	0.024	0.030	0.045	4	2.872	0.718
281	0.149	0.400	0.138	0.452	0.024	0.015	0.030	5	1.208	0.242
282	0.446	1.600	1.144	0.905	0.064	0.010	0.090	4	4.259	1.065
283	0.223	0.400	0.490	0.905	0.064	0.030	0.090	4	2.202	0.551
284	0.446	0.530	0.598	0.902	0.012	0.015	0.030	6	2.533	0.422
285	0.223	0.400	0.390	0.452	0.012	0.010	0.030	3	1.517	0.506
286	0.112	0.530	0.404	0.402	0.024	0.015	0.045	2	1.532	0.766
287	0.223	0.530	0.450	0.402	0.024	0.015	0.030	5	1.674	0.335
288	0.149	0.800	0.426	0.352	0.024	0.010	0.045	2	1.806	0.903
289	0.112	0.530	0.380	0.302	0.024	0.015	0.090	4	1.452	0.363
290	0.149	0.400	0.390	0.905	0.024	0.010	0.030	7	1.908	0.273
291	0.446	1.600	0.548	0.603	0.064	0.015	0.090	4	3.367	0.842
292	0.446	1.600	0.548	0.452	0.024	0.015	0.090	5	3.176	0.635
293	0.223	0.400	0.286	0.905	0.064	0.030	0.030	1	1.938	1.938
294	0.446	1.600	0.000	0.905	0.000	0.000	0.000	4	2.951	0.738
295	0.112	0.000	0.708	0.302	0.012	0.000	0.000	2	1.133	0.566
296	0.446	1.600	1.048	0.905	0.012	0.010	0.030	4	4.051	1.013
297	0.446	0.800	0.658	0.302	0.024	0.015	0.045	4	2.290	0.572
298	0.149	0.400	0.572	0.905	0.000	0.010	0.030	4	2.066	0.516
299	0.446	1.600	1.144	0.905	0.064	0.030	0.090	4	4.279	1.070
300	0.167	0.400	0.354	0.905	0.012	0.010	0.030	1	1.877	1.877
301	0.446	1.600	1.144	0.905	0.064	0.030	0.090	2	4.279	2.140
302	0.446	0.800	0.380	0.905	0.064	0.030	0.090	5	2.715	0.543
303	0.446	1.600	1.008	0.905	0.000	0.015	0.045	3	4.019	1.340
304	0.223	0.530	0.344	0.276	0.012	0.010	0.030	1	1.425	1.425
305	0.446	0.400	0.644	0.452	0.024	0.015	0.030	4	2.012	0.503
306	0.223	0.800	0.780	0.754	0.064	0.015	0.030	1	2.666	2.666
307	0.446	1.600	0.832	0.452	0.064	0.010	0.030	1	3.435	3.435
308	0.223	0.400	0.490	0.905	0.000	0.010	0.030	3	2.058	0.686

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
309	0.223	0.400	0.572	0.452	0.024	0.015	0.030	3	1.717	0.572
310	0.223	0.530	0.380	0.905	0.012	0.030	0.045	2	2.125	1.062
311	0.112	0.400	1.072	0.603	0.024	0.030	0.045	4	2.286	0.571
312	0.223	0.800	0.572	0.905	0.064	0.015	0.090	4	2.669	0.667
313	0.112	0.800	1.144	0.905	0.064	0.015	0.090	5	3.129	0.626
314	0.223	0.530	0.502	0.402	0.024	0.010	0.030	3	1.721	0.574
315	0.112	0.800	1.144	0.905	0.064	0.030	0.090	8	3.144	0.393
316	0.000	0.800	0.780	0.905	0.064	0.030	0.090	8	2.669	0.334
317	0.112	0.530	0.344	0.905	0.064	0.015	0.090	5	2.059	0.412
318	0.223	0.800	0.572	0.905	0.064	0.015	0.090	4	2.669	0.667
319	0.112	0.400	1.144	0.905	0.064	0.030	0.090	7	2.744	0.392
320	0.112	0.400	1.144	0.905	0.064	0.030	0.090	7	2.744	0.392
321	0.000	0.400	0.344	0.905	0.064	0.010	0.090	3	1.813	0.604
322	0.000	0.400	0.390	0.452	0.024	0.015	0.045	2	1.326	0.663
323	0.112	0.800	0.780	0.905	0.064	0.030	0.090	9	2.780	0.309
324	0.223	0.400	0.644	0.905	0.064	0.030	0.090	5	2.356	0.471
325	0.112	0.400	0.598	0.905	0.064	0.030	0.090	6	2.198	0.366
326	0.446	1.600	1.144	0.905	0.064	0.030	0.090	6	4.279	0.713
327	0.112	0.400	0.286	0.905	0.064	0.010	0.045	3	1.821	0.607
328	0.446	1.600	0.708	0.905	0.064	0.030	0.045	7	3.798	0.543
329	0.112	0.400	0.390	0.905	0.064	0.010	0.045	2	1.925	0.963
330	0.112	0.400	0.502	0.754	0.024	0.010	0.030	4	1.832	0.458
331	0.223	0.530	0.572	0.452	0.024	0.010	0.030	3	1.842	0.614
332	0.223	0.530	0.644	0.452	0.012	0.010	0.030	5	1.901	0.380
333	0.112	0.800	0.644	0.905	0.024	0.030	0.090	8	2.604	0.326
334	0.112	0.530	0.426	0.905	0.064	0.015	0.045	5	2.096	0.419
335	0.112	0.400	0.366	0.905	0.064	0.015	0.090	7	1.951	0.279
336	0.112	0.530	0.404	0.905	0.064	0.015	0.045	3	2.074	0.691
337	0.112	0.530	0.644	0.905	0.064	0.015	0.045	6	2.314	0.386
338	0.112	0.400	0.502	0.905	0.064	0.015	0.045	3	2.042	0.681
339	0.223	0.400	0.390	0.452	0.064	0.015	0.045	2	1.590	0.795
340	0.223	0.530	0.502	0.402	0.024	0.010	0.030	3	1.721	0.574
341	0.112	0.530	0.644	0.754	0.064	0.030	0.090	3	2.224	0.741
342	0.112	0.800	1.144	0.905	0.064	0.030	0.090	8	3.144	0.393
343	0.000	0.400	0.344	0.905	0.064	0.010	0.090	3	1.813	0.604
344	0.112	0.800	0.780	0.905	0.064	0.030	0.090	9	2.780	0.309
345	0.223	0.400	0.644	0.905	0.064	0.030	0.090	5	2.356	0.471
346	0.112	0.400	0.598	0.905	0.064	0.030	0.090	6	2.198	0.366
347	0.446	1.600	1.144	0.905	0.064	0.030	0.090	6	4.279	0.713
348	0.112	0.800	0.644	0.905	0.064	0.030	0.090	8	2.644	0.331
349	0.112	0.400	0.286	0.905	0.064	0.010	0.045	8	1.821	0.228
350	0.446	1.600	0.708	0.905	0.064	0.030	0.045	7	3.798	0.543
351	0.446	0.400	0.286	0.402	0.012	0.010	0.030	2	1.586	0.793
352	0.112	0.400	0.390	0.905	0.064	0.010	0.045	2	1.925	0.963

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
353	0.112	0.400	0.502	0.754	0.024	0.010	0.030	4	1.832	0.458
354	0.223	0.530	0.572	0.452	0.024	0.010	0.030	3	1.842	0.614
355	0.223	0.530	0.644	0.452	0.012	0.010	0.030	5	1.901	0.380
356	0.112	0.800	0.536	0.905	0.064	0.015	0.090	8	2.521	0.315
357	0.112	0.530	0.426	0.905	0.064	0.015	0.045	5	2.096	0.419
358	0.112	0.400	0.366	0.905	0.064	0.015	0.090	7	1.951	0.279
359	0.112	0.530	0.404	0.905	0.064	0.015	0.045	3	2.074	0.691
360	0.112	0.530	0.644	0.905	0.064	0.015	0.045	6	2.314	0.386
361	0.112	0.400	0.502	0.905	0.064	0.015	0.045	1	2.042	2.042
362	0.223	0.400	0.572	0.905	0.000	0.030	0.030	2	2.160	1.080
363	0.223	0.400	0.644	0.452	0.012	0.015	0.045	2	1.791	0.896
364	0.446	0.400	1.144	0.905	0.064	0.030	0.000	1	2.989	2.989
365	0.223	0.400	0.572	0.603	0.012	0.010	0.030	1	1.850	1.850
366	0.446	1.600	1.144	0.905	0.000	0.030	0.090	5	4.215	0.843
367	0.223	0.530	0.414	0.905	0.024	0.010	0.000	4	2.106	0.527
368	0.223	0.400	0.354	0.754	0.064	0.010	0.030	1	1.835	1.835
369	0.446	0.400	0.536	0.905	0.012	0.010	0.030	5	2.339	0.468
370	0.000	0.000	0.090	0.604	0.024	0.000	0.000	3	0.718	0.239
371	0.446	0.530	0.390	0.754	0.064	0.015	0.045	3	2.244	0.748
372	0.112	0.400	0.586	0.503	0.024	0.010	0.030	7	1.664	0.238
373	0.149	0.400	0.390	0.905	0.024	0.015	0.045	1	1.928	1.928
374	0.223	4.000	0.298	0.452	0.012	0.010	0.030	4	5.025	1.256
375	0.149	0.800	0.586	0.754	0.012	0.015	0.030	3	2.345	0.782
376	0.112	0.400	0.272	0.402	0.012	0.010	0.030	3	1.237	0.412
377	0.223	0.400	0.366	0.452	0.012	0.010	0.030	1	1.493	1.493
378	0.223	0.400	0.286	0.452	0.012	0.010	0.030	3	1.413	0.471
379	0.149	0.400	0.780	0.603	0.064	0.015	0.030	7	2.041	0.292
380	0.446	0.800	1.144	0.905	0.000	0.015	0.090	4	3.400	0.850
381	0.223	1.600	0.354	0.603	0.012	0.010	0.030	5	2.832	0.566
382	0.446	0.800	0.414	0.905	0.064	0.015	0.090	1	2.734	2.734
383	0.446	0.800	1.144	0.905	0.064	0.030	0.030	2	3.419	1.710
384	0.223	0.400	0.126	0.905	0.000	0.000	0.000	3	1.654	0.551
385	0.223	0.530	0.708	0.905	0.012	0.030	0.030	5	2.438	0.488
386	0.223	0.530	0.286	0.452	0.024	0.015	0.030	4	1.561	0.390
387	0.223	0.400	0.366	0.905	0.064	0.010	0.030	3	1.998	0.666
388	0.149	0.400	0.536	0.905	0.012	0.015	0.030	3	2.046	0.682
389	0.149	0.400	0.598	0.603	0.024	0.010	0.030	3	1.814	0.605
390	0.223	0.800	0.390	0.402	0.012	0.030	0.045	4	1.902	0.475
391	0.446	1.600	1.144	0.905	0.064	0.030	0.090	1	4.279	4.279
392	0.223	0.800	0.572	0.452	0.064	0.030	0.090	1	2.232	2.232
393	0.446	1.600	0.572	0.452	0.064	0.030	0.090	1	3.255	3.255
394	0.446	1.600	0.572	0.905	0.064	0.030	0.090	1	3.707	3.707
395	0.446	1.600	1.008	0.754	0.064	0.030	0.090	1	3.992	3.992
396	0.446	1.600	1.144	0.905	0.064	0.030	0.090	4	4.279	1.070

No.	Battery	Light bulb	Chemical container	Self-care product	Ex. cosmetic	Ex. medicine	Office Eq.	Family member	Total	kg/capita /year
398	0.112	0.400	0.354	0.276	0.012	0.010	0.030	1	1.194	1.194
399	0.223	0.530	0.364	0.603	0.064	0.000	0.090	3	1.874	0.625
400	0.000	0.400	0.298	0.905	0.000	0.015	0.090	2	1.708	0.854
401	0.223	0.400	0.450	0.905	0.012	0.010	0.090	1	2.090	2.090
402	0.112	0.400	1.048	0.905	0.064	0.015	0.045	3	2.588	0.863
403	0.223	0.400	0.490	0.704	0.012	0.010	0.045	2	1.884	0.942
404	0.112	0.400	0.526	0.905	0.064	0.030	0.045	1	2.081	2.081
405	0.446	0.800	0.490	0.905	0.012	0.015	0.030	4	2.698	0.674
406	0.112	0.400	1.036	0.754	0.012	0.015	0.030	2	2.358	1.179
407	0.446	1.600	1.144	0.603	0.064	0.030	0.090	2	3.978	1.989
408	0.112	0.400	0.572	0.754	0.064	0.015	0.045	4	1.962	0.490
409	0.223	0.400	0.286	0.754	0.012	0.030	0.030	4	1.735	0.434
410	0.223	0.530	0.426	0.352	0.024	0.010	0.000	6	1.565	0.261
411	0.112	0.400	0.390	0.905	0.064	0.015	0.090	4	1.975	0.494
412	0.446	0.800	0.708	0.905	0.024	0.010	0.045	4	2.938	0.735
413	0.149	0.530	0.936	0.905	0.064	0.015	0.090	4	2.689	0.672
414	0.446	0.800	1.048	0.905	0.012	0.010	0.045	5	3.266	0.653
415	0.446	0.530	0.708	0.905	0.000	0.010	0.030	1	2.629	2.629
416	0.446	0.800	0.598	0.905	0.064	0.030	0.090	4	2.933	0.733
Total	**106.18**	**295.80**	**261.257**	**302.075**	**16.493**	**7.180**	**23.745**	**-**	**1012.7**	**1.033**

APPENDIX B

Questionnaire for research (Translation form)

The analysis of household hazardous waste management in Bangkok for developing suitable suggestion policy for the future

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Statement

This questionnaire aims to survey on the amount and behavior of household hazardous waste from the community (household source). Household hazardous waste contains hazardous substances that are harmful such as toxic, flammable or corrosive properties. This can adversely affect to health and the environment if no properly managed. Meanwhile, some of the waste consists of materials such as metal and glass, which has a value if it has been handled by the recycling process. If resources can be recycled again it can be prevent harmful chemicals that may contaminate the environment. Therefore, the respondents please answer all questions to ensure the integrity of information. The result will be helpful in developing a strategic plan for better household hazardous waste management in the future. According to the respondents, this information will be used only to engage in this research. In this research, thank you for your assistance in providing information that is useful result analysis in the future.

The questionnaire consists of 5 parts

Part 1 Demographic information

Part 2 General household hazardous waste knowledge

Part 3 Amount of household hazardous waste generation

Part 4 Household hazardous waste management behavior

Part 5 Policy for household hazardous waste management in the future

Thank you for your cooperation

Miss. Piyanuch Sueb

M.Sc. Environmental management, Chulalongkorn University

Please fill symbol ✓ into ☐ of your best decision

Part 1 Demographic information

1.1 you are living in .....District

1.2 How many family members in your house? .....

1.3 How long do you live in current resident? .....Years

1.4 Average income of your family (Baht/month)

☐ Lower than 10,000 ☐ 10,001 – 20,000

☐ 20,001 – 30,000 ☐ 30,001 – 40,000

☐ 40,001 – 50,000 ☐ Higher than 50,001

1.5 Type of residential

☐ Single house ☐ Townhouse/ Condominium ☐ Row house

☐ Room rent ☐ other (Pleas identify).....

1.6 Highest education level

☐ Elementary school ☐ High school

☐ Bachelor degree ☐ Higher than bachelor degree

Part 2 General household hazardous waste knowledge test

Do you know?

2.1 There are two main type of household hazardous waste; 1) Electronic waste and 2) Household products such as light bulb, battery, chemical container etc.

☐ Yes ☐ No

2.2 IF household hazardous get improper management, it will be impact to our health and environment

☐ Yes ☐ No

Part 3 Pease estimate total amount of HHW that generated in your family

3.1 Average amount of HHW generated within 1 year

Batteries

☐ 1-3 Month/pieces ☐ 4-6 Month/pieces ☐ 7- Month/pieces ☐ 10-12 Month/pieces

Light bulb

☐ 1-3 Month/pieces ☐ 4-6 Month/pieces ☐ 7-9 Month/pieces ☐ 10-12 Month/pieces

Spay (Air fragrance, hair set, etc.)

☐ 1-3 Month/can ☐ 4-6 Month/can ☐ 7-9 Month/can ☐ 10-12 Month/can

Cleaning products(Toilet cleaning, floor cleaning, Mirror cleaning, etc.)

☐ 1-3 Month/bottle ☐ 4-6 Month/bottle ☐ 7-9 Month/bottle ☐ 10-12 Month/bottle

Insecticides

☐ 1-3 Month/can ☐ 4-6 Month/can ☐ 7-9 Month/can ☐ 10-12 Month/can

Self-care product (Lotion)

☐ 1-3 Month/bottle ☐ 4-6 Month/bottle ☐ 7-9 Month/bottle ☐ 10-12 Month/bottle Self-care products (Shampoo and conditioner)

☐ 1-3 Month/2 bottles ☐ 4-6 Month/2 bottles ☐ 7-9 Month/2 bottles☐ 10-12 Month/2 bottles

Expired cosmetic

☐ 1-4 Month/pieces ☐ 5-8 Month/pieces ☐ 9-12 Month/pieces

Expired medicine

☐ 1-4 Month/10 g ☐ 5-8 Month/10 g ☐ 9-12 Month/10 g

Office supply

☐ 1-4 Month/5 pieces ☐ 5-8 Month/5 pieces ☐ 9-12 Month/5 pieces

Part 4 Household hazardous waste management behavior

4.1 How did you do with your electronic waste?

☐ Keep at home ☐ Donated

☐ Sell to second hand shop ☐ Sell for backyard shop

☐ Sell to electronic repair shop ☐ Used for new product discounted

☐ Discards together with other waste

4.2 Do you do waste segregation? (Please choose yes or no, if yes please choose type of waste that your do segregation.)

☐ No

☐ Yes as following;

☐ Recyclable

☐ Non-recyclable

☐ Organic waste

☐ Hazardous waste

4.3 What is your barriers for doing waste segregation (Please fill number in all choices by 1=little 2= moderate 3=high)

_____No regulation enforcement

_____Wasted in time and money

_____Lack of knowledge for proper segregation

4.4 Do you think is it necessary to separate hazardous from other waste

☐ Necessary because (Please fill number to all choices from 1= very little 2= little 3=moderate 4=high)

_____Increase capacity of waste collection and transportation

_____Decrease environmental impact

_____Decrease health impact

_____Increase the efficiency for HHW treatment

☐ Not necessary because (Please fill number to all choices from 1= very little 2= moderate 3=high)

_____wasted of time

_____HHW is very small amount if compare with other

_____HHW problem is not urgent problem that need immediately solving

Part 5 Policy for household hazardous waste management in the future

5.1 Which policy will make you to start doing waste segregation
(Please fill number to all choices from 1= very little 2= very little 3=moderate 4=high 5=very high)

_____ Regulatory enforcement for waste segregation

_____ Using buying back policy

_____ imposing of waste management fees

_____Rising awareness by provide information

_____Establishment of environmental program in school

_____ Others.....

5.2 Which facility will be encouraging you to do waste segregation?

(Please fill number to all choices from 1= very little 2= little 3=moderate 4=high)

_____Provided all information about HHW

_____Establish HHW drop off center in community

_____Establish HHW market

_____Establish HHW bank

5.3 Which party should be responsible for HHW management program?

☐ Government ☐ Private section ☐ community representative ☐ Cooperated from all

5.4 Which place is the best avenue for HHW collection (Please fill number to all choices from 1= very little 2= moderate 3=high)

_____ Pick up from house

_____ Drop off center in department store

_____ Drop off center in community

_____ Others .....

5.5 What should be suitable frequency for HHW collection?

☐ Weekly ☐ Twice a month ☐ Monthly ☐ Every three months

5.6 Would you agree to pay more for better HHW management?

☐ Yes ☐ NO

5.7 If government impose treatment fees (Currently 20 Baht/Month) how many Baht can you offer?

☐ 10 Baht/month ☐ 20 Baht/month ☐ เพิ่ม 30 Baht/month

☐ Other , please fill amount .....Baht

5.8 What should be punishment if you did not do waste segregation? (Please fill number to all choices from 1= very little 2= moderate 3=high)

_____pay an extra fees if did not do waste segregation

_____No waste collection if no waste segregation

_____ Have to work for public social at less 12 hrs. For not doing waste segregation per 1 time

5.9 Do you have any recommendation for proper household hazardous waste management in the future?

.....
.....
.....
.....
.....
.....
.....

Very sincere thank you for your cooperation

แบบสอบถามเพื่อการวิจัย
การวิเคราะห์ลักษณะพฤติกรรมและแนวทางในการจัดการขยะมูลฝอยอันตรายจากชุมชนเพื่อพัฒนากลยุทธการจัดการที่เหมาะสมสำหรับประเทศไทยในอนาคต

คำชี้แจง

แบบสอบถามนี้ มีจุดประสงค์เพื่อวิจัยและสำรวจความคิดเห็นเกี่ยวกับปริมาณและพฤติกรรมการจัดการขยะมูลฝอยอันตรายจากชุมชน ขยะมูลฝอยอันตรายนั้นมีคุณสมบัติและองค์ประกอบที่มีความเป็นอันตราย เช่น เป็นสารพิษ สารไวไฟ มีคุณสมบัติกัดกร่อน เป็นต้น ซึ่งสามารถส่งผลเสียต่อสุขภาพและสิ่งแวดล้อมได้หากมีการจัดการที่ไม่เหมาะสม ในขณะเดียวกันขยะมูลฝอยบางชนิดก็ประกอบไปด้วยวัสดุที่มีมูลค่าจำพวก โลหะ อโลหะ และ แก้ว ซึ่งหากได้รับการจัดการโดยกระบวนการรีไซเคิลที่เหมาะสม สามารถที่จะนำทรัพยากรเหล่านี้กลับมาใช้ใหม่ได้อีกครั้ง พร้อมทั้งสามารถป้องกันสารเคมีอันตรายที่อาจจะปนเปื้อนสู่สิ่งแวดล้อมได้ ดังนั้น ผู้วิจัยจึงขอความกรุณาได้โปรดตอบแบบสอบถามทุกข้อ เพื่อความสมบูรณ์ของข้อมูลที่เกิดประโยชน์ในการพัฒนาแผนงานยุทธศาสตร์ในการเก็บรวบรวมและจัดการขยะมูลฝอยอันตรายเพื่อเข้าสู่ระบบการกำจัดอย่างเหมาะสมต่อไป ทั้งนี้ในการตอบแบบสอบถามนี้ข้อมูลของท่านจะถูกนำไปใช้เพียงเพื่อประกอบในงานวิจัยนี้เท่านั้น งานวิจัยนี้ขอขอบพระคุณอย่างสูงสำหรับความอนุเคราะห์ของท่านในการให้ข้อมูลที่เป็นประโยชน์ต่อการวิเคราะห์ผลการวิจัยต่อไปในอนาคต

แบบสอบถามฉบับนี้ แบ่งออกเป็น 5 ตอนได้แก่

ตอนที่ 1 ข้อมูลเกี่ยวกับสถานภาพของผู้ตอบแบบสอบถาม

ตอนที่ 2 สอบถามความรู้ทั่วไปเกี่ยวกับความรู้ความเข้าใจต่อการจัดการขยะมูลฝอยอันตราย

ตอนที่ 3 ปริมาณขยะมูลฝอยอันตราย

ตอนที่ 4 ลักษณะพฤติกรรมทั่วไปในการจัดการขยะมูลฝอยอันตรายของผู้ทำแบบสอบถาม

ตอนที่ 5 นโยบายในการจัดการมูลฝอยอันตรายจากชุมชน

ขอขอบพระคุณทุกท่านเป็นอย่างสูงที่กรุณาให้ความร่วมมือ
นางสาวปิญานุช สืบ
นิสิตปริญญาโท หลักสูตรสหสาขาวิชาการจัดการสิ่งแวดล้อม จุฬาลงกรณ์มหาวิทยาลัย

โปรดใส่เครื่องหมาย ✓ ในช่อง ☐ ที่ท่านเลือกหรือเติมข้อความให้ตรงกับความเป็นจริงของท่านมากที่สุด

ตอนที่ 1 ข้อมูลเกี่ยวกับสถานภาพของผู้ตอบแบบสอบถาม

1.1 ท่านอาศัยอยู่ในเขต.....

1.2 ครอบครัวท่านที่อาศัยในบ้านเดียวกัน มีสมาชิก.....คน

1.3 ระยะเวลาที่ท่านอาศัยอยู่ ณ ที่อยู่อาศัยปัจจุบัน .....ปี

1.4 ครอบครัวท่านมีรายได้เฉลี่ยเดือนละ

☐ ไม่เกิน 10,000 บาท ☐ ระหว่าง 10,001 – 20,000 บาท

☐ ระหว่าง 20,001 – 30,000 บาท ☐ ระหว่าง 30,001 – 40,000 บาท

☐ ระหว่าง 40,001 – 50,000 บาท ☐ ตั้งแต่ 50,001 บาทขึ้นไป

1.5 ประเภทที่อยู่อาศัย

☐ บ้านเดี่ยว ☐ ทาวเฮ้าส์ / คอนโดมิเนียม ☐ ห้องแถว / ตึกแถว

☐ ห้องเช่า ☐ อื่นๆ (ระบุ).....

1.6 ระดับการศึกษาสูงสุดของท่าน

☐ ประถมศึกษา ☐ มัธยมศึกษา-ปวช

☐ อนุปริญญา – ปริญญาตรี ☐ สูงกว่าระดับปริญญาตรี

ตอนที่ 2 ความรู้ทั่วไปเกี่ยวกับความรู้ความเข้าใจต่อการจัดการขยะมูลฝอยอันตราย

ท่านทราบหรือไม่ว่า

2.1 ขยะมูลฝอยอันตรายจากชุมชนสามารถแบ่งได้เป็นสองประเภทหลักคือ 1) ขยะอิเล็กทรอนิกส์เช่น เครื่องใช้ไฟฟ้า และ 2) ขยะมูลฝอยอันตรายอื่นๆ เช่น ถ่านไฟฉาย หลอดไฟ แบตเตอรี่ ย และเครื่องสำอางหมดอายุ เป็นต้น

☐ ทราบ ☐ ไม่ทราบ

2.2 ถ้าขยะอันตรายไม่ได้รับการกำจัดอย่างถูกวิธีจะส่งผลกระทบต่อสิ่งแวดล้อม เช่น อาจมีการปนเปื้อนของสารที่เป็นอันตราย เช่น โลหะหนัก ไปสู่ดินและน้ำใต้ดินซึ่งจะส่งผลกระทบต่อสิ่งแวดล้อมและสุขภาพได้

☐ ทราบ ☐ ไม่ทราบ

ตอนที่ 3 กรุณาประเมินปริมาณขยะมูลฝอยอันตราย ที่เกิดขึ้นภายในครอบครัวของท่าน

3.1 ขยะมูลฝอยอันตรายที่ท่านทิ้ง เฉลี่ยภายใน 1 ปี

ถ่านไปฉาย

☐ 1-3 เดือน/ ก้อน ☐ 4-6 เดือนต่อ/ก้อน ☐ 7-9 เดือนต่อ/ก้อน ☐ 10-12 เดือน/ ก้อน

หลอดไฟ

☐ 1-3 เดือน/ดวง ☐ 4-6 เดือน/ดวง ☐ 7-9 เดือน/ดวง ☐ 10-12 เดือน / ดวง

กระป๋องสเปรย์ (สเปรย์ปรับอากาศ สเปรย์พริกไทย สีสเปรย์ สเปรย์เซทผม ฯลฯ)

☐ 1-3 เดือนต่อ 1 กระป๋อง☐ 4-6 เดือนต่อ 1 กระป๋อง☐ 7-9 เดือนต่อ 1 กระป๋อง☐ 10-12 เดือนต่อ 1 กระป๋อง

ผลิตภัณฑ์ทำความสะอาด (น้ำยาทำความสะอาดห้องน้ำ น้ำยาถูพื้น น้ำยาเช็ดกระจก อื่นๆ)

☐ 1-3 เดือนต่อ 1 ขวด ☐ 4-6 เดือนต่อ 1 ขวด ☐ 7-9 เดือนต่อ 1 ขวด ☐ 10-12 เดือนต่อ 1 ขวด

ยาจำกัดแมง (สเปรย์กำจัดยุง แมลงสาบ และ อื่นๆ)

☐ 1-3 เดือนต่อ 1 กระป๋อง ☐ 4-6 เดือนต่อ 1 กระป๋อง ☐ 7-9 เดือนต่อ 1 กระป๋อง ☐ 10-12 เดือนต่อ 1 กระป๋อง

ผลิตภัณฑ์ดูแล บำรุงร่างกาย (โลชั่น)

☐ 1-3 เดือนต่อ 1 ขวด ☐ 4-6 เดือนต่อ 1 ขวด ☐ 7-9 เดือนต่อ 1 ขวด ☐ 10-12 เดือนต่อ 1 ขวด

ผลิตภัณฑ์ดูแล บำรุงร่างกาย(แชมพู ครีมนวด)

☐ 1-3 เดือนต่อ 2 ขวด ☐ 4-6 เดือนต่อ 2 ขวด ☐ 7-9 เดือนต่อ 2 ขวด ☐ 10-12 เดือนต่อ 2 ขวด

เครื่องสำอาง (ยาทาเล็บ/น้ำยาล้างเล็บ/รองพื้น ฯลฯ)

☐ 1-4 เดือนต่อ 1 ชิ้น ☐ 5-8 เดือนต่อ 1 ชิ้น ☐ 9-12 เดือนต่อ 1 ชิ้น

ยาหมดอายุ

☐ 1-4 เดือนต่อ 100 กรัม ☐ 5-8 เดือนต่อ 100 กรัม ☐ 9-12 เดือนต่อ 100 กรัม

CD/อุปกรณ์สำนักงาน

☐ 1-4 เดือนต่อ 5 ชิ้น ☐ 5-8 เดือนต่อ 5 ชิ้น ☐ 9-12 เดือนต่อ 5 ชิ้น

ตอนที่ 4 ลักษณะพฤติกรรมทั่วไปในการจัดการขยะมูลฝอยอันตรายของผู้ทำแบบสอบถาม

4.1 ท่านจัดการกับขยะอิเล็กทรอนิกส์และเครื่องใช้ไฟฟ้าอย่างไร

☐ เก็บไว้ที่บ้านโดยไม่ได้ใช้งาน ☐ บริจาคให้วัด/มูลนิธิ

☐ ขายให้ร้านสินค้ามือสอง ☐ ขายให้ซาแล้ง/รถรับซื้อของเก่า

☐ ขายให้ร้านซ่อมเครื่องใช้ไฟฟ้า ☐ นำไปแลกเป็นส่วนลด/แลกซื้อสินค้าใหม่

☐ ทิ้งรวมกับขยะทั่วไป

4.2 ปัจจุบันท่านคัดแยกขยะก่อนทิ้งหรือไม่ (กรุณาเลือกคัดแยกหรือไม่คัดแยก ถ้าท่านคัดแยกขยะเป็นประจำ ขยะชนิดใดบ้างที่ท่านคัดแยก)

☐ ไม่เคยคัดแยกขยะ

☐ คัดแยกขยะเป็นประจำ ได้แก่

☐ ขยะที่สามารถรีไซเคิลได้

☐ ขยะที่ไม่สามรถรีไซเคิลได้

☐ ขยะเปียก

☐ ขยะอันตราย

4.3 อะไรที่ท่านคิดว่าเป็นปัญหาและอุปสรรคในการคัดแยกขยะ
(กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก)

_____ไม่มีกฎหมายบังคับให้มีการแยกขยะก่อนทิ้ง

_____เสียเวลาและค่าใช้จ่ายเพิ่มขึ้นสำหรับการแยกขยะ

_____ขาดความรู้ว่าทำไมต้องแยกขยะ ควรแยกเป็นกี่ประเภท และจะจัดการกับขยะที่แยกแล้วอย่างไร

4.4 ท่านคิดว่าการแยกขยะอันตรายออกจากขยะทั่วไป เป็นเรื่องที่จำเป็นหรือไม่ (กรุณาเลือกจำเป็นหรือไม่จำเป็น)

☐ จำเป็น เพราะ (กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก 4=มากที่สุด)

_____ทำให้ง่ายต่อการจัดเก็บ และขนส่งไปจัดการต่อ

_____ทำให้ไม่ส่งผลกระทบต่อสิ่งแวดล้อม

_____ทำให้ลดความเสี่ยงในการเกิดโรคของประชาชน

_____ทำให้สามารถนำไปกำจัดอย่างถูกวิธีได้

☐ ไม่จำเป็น เพราะ (กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก)

_____เสียเวลาในการคัดแยก

_____ขยะอันตรายมีปริมาณน้อย

_____ปัญหาการจัดการขยะอันตรายยังไม่ใช่ปัญหาที่ควรแก้ไขเร่งด่วน

ตอนที่ 5 แนวทางและนโยบายที่เหมาะสมในการจัดการมูลฝอยอันตรายจากชุมชน

5.1 นโยบายใดที่ท่านคิดว่าจะทำให้ท่านสามารถแยกขยะมูลฝอยอันตรายออกจากขยะทั่วไปก่อนทิ้งได้
(กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อยมาก 2=น้อย 3=ปานกลาง 4=มาก 5=มากที่สุด)

_____ มีกฎหมายบังคับให้มีการแยกขยะอันตรายออกจากขยะทั่วไปก่อนนำไปทิ้ง

_____ มีผลตอบแทนสามารถนำขยะอันตรายไปแลกเป็นส่วนลดกับสินค้าชิ้นใหม่ได้

_____ บังคับให้มีการจ่ายเงินสำหรับค่าเก็บและจัดการขยะมูลฝอยอันตราย

_____ส่งเสริมสร้างความตระหนัก โฆษณาประชาสัมพันธ์ถึงอันตรายของมูลฝอยอันตรายจากชุมชน

_____ปรับปรุงการอบรมและการเรียนการสอนตั้งแต่ระดับเด็กเล็กให้เข้าใจและทำได้

_____ อื่นๆ.....

5.2 สิ่งใดที่จะส่งเสริมให้ท่านแยกขยะมูลฝอยอันตรายจากชุมชน ออกจากขยะทั่วไปจากที่อยู่อาศัยของท่านได้
(กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก 4=มากที่สุด)

_____มีการประชาสัมพันธ์ให้ความรู้ ชี้ให้เห็นถึงผลกระทบจากขยะอันตราย และขั้นตอนการแยกขยะที่ถูกต้อง

_____มีศูนย์รับทิ้งขยะอันตรายตามสถานที่ต่างๆ ที่สะดวกในการนำไปทิ้ง เช่น ศูนย์กลางชุมชน / พื้นที่เขต / ห้างสรรพสินค้า เป็นต้น

_____มีการนัด วันเวลา และสถานที่รับทิ้งขยะอันตรายที่ชัดเจน เช่น ทุกๆ วันที่ 1 และ วันที่ 15 ของเดือน บริเวณลานอเนกประสงค์ของหมู่บ้าน เป็นต้น

_____มีการจัดตั้งธนาคารขยะอันตรายตามหมู่บ้านหรือชุมชนให้ประชาชนนำขยะอันตรายไปแลกกับของใช้อื่นๆ ที่จำเป็น

5.3 ท่านคิดว่าถ้ามีการจัดตั้งศูนย์รับทิ้งขยะมูลฝอยอันตรายจากชุมชนหน่วยงานใดควรเป็นผู้รับผิดชอบ

☐ รัฐบาล ☐ เอกชน ☐ ตัวแทนชุมชน ☐ ร่วมมือกันทุกภาคส่วน

5.4 ถ้ามีการจัดตั้งศูนย์รับทิ้งขยะมูลฝอยอันตรายท่านคิดว่าวิธีใดจะทำให้ท่านสะดวกในการนำขยะเข้ามาในระบบมากที่สุด (กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก)

_____ มีเจ้าหน้าที่มาเก็บหน้าบ้าน

_____ มีศูนย์รับทิ้งตามหน้าร้านค้า ห้างสรรพสินค้า

_____ มีศูนย์กลางสำหรับรวบรวมตามชุมชนหรือหมู่บ้าน

_____ อื่นๆ ระบุ.....

5.5 ท่านคิดว่าการจัดเก็บขยะมูลฝอยอันตรายจากชุมชน ควรมีความถี่มากน้อยเพียงใดจึงเหมาะสม

☐ ทุกสัปดาห์ ☐ ทุก 2 สัปดาห์ ☐ ทุกเดือน ☐ ทุกๆ 3 เดือน

5.6 ปัจจุบันทางเทศบาลเรียกเก็บเพียงค่าเก็บขนขยะไม่ได้รวมค่าบำบัดกำจัด หากจะมีการเพิ่มค่าใช้จ่ายในการเก็บขนและบำบัดกำจัดด้วย เพื่อนำไปจัดการขยะอันตรายให้เหมาะสม ท่านยินดีจะจ่ายค่าจัดการขยะเพิ่มหรือไม่

☐ ยินดีจ่าย ☐ ไม่ยินดีจ่าย

5.7 หากท่านยินดีจ่ายค่าจัดการขยะเพิ่มขึ้นจากปัจจุบัน (อยู่ที่ 20 บาทต่อหลังต่อเดือน) ท่านยินดีจะจ่ายเพิ่มขึ้นอีกเท่าใดเพื่อนำไปใช้ในการจัดการขยะมูลฝอยอันตรายชุมชนให้เหมาะสม

☐ เพิ่ม 10 บาท/เดือน ☐ เพิ่ม 20 บาท/เดือน ☐ เพิ่ม 30 บาท/เดือน

☐ อื่นๆ โปรดระบุจำนวน.....บาท

5.8 หากมีการออกกฎหมายบังคับให้มีการแยกขยะมูลฝอยอันตรายออกจากขยะทั่วไป ท่านคิดว่าข้อใจจะทำให้ท่านปฏิบัติตามได้มากที่สุด (กรุณาเรียงลำดับใส่ตัวเลขทุกข้อคำตอบ โดย 1=น้อย 2= ปานกลาง 3=มาก)

_____เสียค่าปรับทุกครั้งที่มีขยะอันตรายปนเปื้อนมากับขยะทั่วไป

_____เจ้าหน้าที่จะไม่เก็บขยะหากพบว่าไม่มีการแยกขยะ

_____ ลงทัณฑ์บนให้มีการบำเพ็ญประโยชน์ 24 ชั่วโมงต่อการทำผิด 1 ครั้ง

5.9 ท่านมีข้อคิดเห็นหรือเสนอแนะเพิ่มเติม ที่ท่านเห็นว่าจะเป็นการช่วยส่งเสริมให้มีระบบการจัดการขยะอันตรายจากครัวเรือนให้เกิดขึ้นได้เป็นรูปธรรมหรือดำเนินการได้อย่างแพร่หลาย อย่างไรบ้าง

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ขอบคุณมากค่ะที่กรุณาให้ความร่วมมือในการกรอกแบบสอบถาม

VITA

Name: Miss. Piyanuch Sueb

Date of Birth: 14th March 1989

Nationality: Thai

Education: Thachana School – High School

Bachelor degree of science in Life sciences - University of Delhi, Miranda house college, India

Presentation: Piyanuch Sueb and Chanathip Pharino, Current status of household hazardous waste management in Bangkok,Thailand. The 3R International Scientific Conference on Material Cycles and Waste Management (3RINCs) &13th Expert Meeting on Solid waste Management in Asia and Pacific Islands (SWAPI). (2014).