Developing a Sustainable Waste Management Strategy for the Khlong Toei Slum in Bangkok

March 7, 2014

Sponsored by the Duang Prateep Foundation

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An Interactive Qualifying Project Report

Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE and

CHULALONGKORN UNIVERSITY

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

In cooperation with

The Duang Prateep Foundation

Submitted on March 7th, 2014

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Abstract

Excessive amounts of waste exist in the Khlong Toei slum causing health and environmental problems for the local residents. Our goal was to propose a sustainable waste management strategy for the Khlong Toei slum. Through interviews and physical inspections we found that problems with waste management stemmed from the municipality's inconsistency in collecting and the residents' habits of open dumping of waste. Recommendations included implementing a communal dumping system and educating local children about proper waste disposal methods.

Acknowledgements

We would like to express our sincere gratitude to the following individuals, departments, institutions and organizations for supporting us throughout the completion of this project:

- The Duang Prateep Foundation for sponsoring the project and providing our team with the necessary accommodations and resources.
- Khru Prateep Ungsongtham Hata and Khun KanThong, from our sponsor organization, the Duang Prateep Foundation, for organizing the project and supporting the team while providing valuable information.
- P' Fai of the Duang Prateep Foundation for providing us with invaluable information, guidance, and feedback throughout our project.
- The staff and teachers of the daycare center of Locks 1, 2, 3 for their willingness to participate in our education plan, and their readiness to provide valuable feedback. Without their support, we would not have been able to successfully implement our educational program in the school.
- Paul Lord of Greenlight Plan, and Khun Peeda of the Science Center for Education in Bangkok for their valuable suggestions and ideas. Their input played a critical role in the outcomes of our project.
- Lindsey Gallagher of Worcester Polytechnic Institute for her aid in the project research and planning.
- Professor John Zeugner of Worcester Polytechnic Institute for his valuable insight into the previous projects completed in Khlong Toei.

- Jason Anderson and Sandra Davis of Worcester Polytechnic Institute for allowing us to use their previous Interactive Qualifying Project Report of Waste Management in Khlong Toei as a reference to our project.
- Laura Hanlan, research librarian of the Gordon Library at Worcester Polytechnic Institute for her continuous support and guidance in researching information for our project.
- Ajarn Sumalee of Worcester Polytechnic Institute for her valuable lessons on Thai language and culture. She also gave us valuable background information on Khlong Toei that proved to be vital to our understanding of the area.
- Our advisors, Ajarn Numpon Insin, Professor Creighton Peet, Professor Gary Pollice and Ajarn Siripastr Jayanta for their guidance and assistance throughout the entire project. Their help proved to be critical in the successful completion of the project.
- Chulalongkorn University and Worcester Polytechnic Institute for providing the opportunity for both Thai and American students to work together on the project in Thailand.
- The Office of the Department of Science and Bachelor of Science in Applied Chemistry (BSAC) Department for providing the appreciated workspace at Chulalongkorn University.

Authorship

All members of the project team edited all parts of this IQP

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Executive Summary

Poverty and urbanization in recent years have contributed to the formation of slums in developing countries world-wide (Davis, 2006). The continuous growth of urban centers, roughly 70 million more urban dwellers globally each year, has limited the ability of urban economies to support adequate services, housing, and employment opportunities for their populations (Carpenter, 2004). The city of Bangkok alone has over 2 million residents living in informal settlements. The Khlong Toei district of Bangkok is host to one of the largest slum communities in Thailand, containing over 20,189 households (BMA, 2012). The estimated 103,225 Khlong Toei slum residents generate a large amount of waste that if not dealt with properly, causes numerous problems including poor sanitation and health. Ineffective waste management strategies also affect the environment and aesthetics of the area (Rushton, 2003).

The Duang Prateep Foundation (DPF) (2013a) aims to improve the quality of life within the Khlong Toei slum through educational programs. In 1994 the DPF worked with a group of students from Worcester Polytechnic Institute to propose a set of recommendations to improve solid waste management in Khlong Toei (Anderson & Davis, 1994). However, the DPF wanted to reassess the waste situation to identify recommendations for improvements to the existing waste management strategy in the slum area. Our recommendations to the DPF focused on behavioral changes for local residents and changes to the municipal waste management system run by the Bangkok Metropolitan Administration (BMA).

By reassessing the waste situation, we hoped to facilitate a decrease in the social and environmental effects of poor sanitation through our recommendations to the Khlong Toei slum residents, the BMA, and other parties involved in waste management. To accomplish our goal we developed and achieved

four main objectives. For these objectives we determined predominant types of waste based on reusability value to the residents and how each category of waste is handled, the limits of the current municipal waste management system in the Khlong Toei slum, the current lifestyle effects of waste production and management in Khlong Toei, and practical alternative waste management methods that address all parties involved in the current system. We formed recommendations that should better integrate the waste disposal habits of the residents with the municipal waste disposal system to optimize the effectiveness of the overall system.

To meet our objectives we conducted interviews with all the major parties involved in the current waste management system as well as physically inspected the Khlong Toei slum. We interviewed representatives of the neighborhood, companies involved in the private recycling sector, a representative of the BMA, along with additional resources to help develop recommendations. Through our interviews we were able to conclude that problems with waste management stemmed from the residents' habits of open dumping of waste and the BMA's inconsistent waste collection practices. To address the behavioral problem of open dumping in Khlong Toei we interviewed organizations that had been successful in behavioral changes related to waste management. Through these interviews we determined that the best way to initiate behavioral change in Khlong Toei is by educating the local children. To further encourage residents to recycle more materials, we first determined that residents only recycle materials that have value. We were also able to determine which types of waste hold value in Khlong Toei and how to possibly broaden this range of valued waste materials for the residents based on the demand in Bangkok.

From our interviews with the community leaders we also learned that the community board is planning to propose a communal dumping site initiative to the BMA. We, therefore, developed our recommendations so as to support their plan along with some additions to help improve its effectiveness.

We encouraged the community board to submit their proposal to the BMA for communal dumping sites on land that would be rented from the Port Authority of Thailand (PAT). For this new plan, we also recommended the community leaders propose that the BMA reduce the cost of waste removal for the residents. To address behavioral challenges around waste disposal, we developed recommendations for additional educational activities for school children to understand how to reduce their waste production and to properly dispose of hazardous waste. To promote the use of the proposed communal dumping sites, we also developed recommendations for activities involving art for residents. We have presented our report to the Duang Prateep Foundation with the intent that the organization will facilitate the implementation of the proposed recommendations to create a sustainable waste management strategy for the Khlong Toei slum.

1 Introduction

Poverty and urbanization have contributed to the formation of slums in developing countries worldwide (Davis, 2006). As of 2003, an estimated 31.6 percent of the world's total urban population was classified as residing in slums (United Nations, 2006). The continuous growth of urban centers, roughly 70 million more urban dwellers globally each year, has limited the ability of urban governments and economies to support adequate services, housing, and employment opportunities for their populations (Carpenter, 2004). The urban centers' inability to properly support this growing population has contributed to the proliferation of slums. These slums can provide inexpensive and accessible housing for impoverished residents but lack many of the services and infrastructure of formally settled areas.

Although the Thai government has been successful in reducing the magnitude of slums within the country as a whole, approximately 27 percent of Thailand's urban population still lived in slum conditions as of 2009 (United Nations, 2012). The Khlong Toei district of Bangkok is host to one of the largest slum communities in Thailand, containing well over 20,000 households (BMA, 2012; Daniere, Takahashi and Naranong, 2002). There exist many prominent problems including poor sanitation and health. The ineffective use and execution of the current Khlong Toei municipal waste management system and the persistence of the slum residents' open waste disposal habits have contributed significantly to poor sanitation within the area.

Through educational programs the Duang Prateep Foundation (DPF) (2013b) has helped to improve the quality of life within the Khlong Toei slum. A group of students from Worcester Polytechnic Institute worked alongside the DPF in 1994 to propose a set of recommendations to improve solid waste management in Khlong Toei (Anderson & Davis, 1994). This project involved a large educational

campaign for the locals on the dangers of poor waste management as well as a new districting plan for the municipal collection services of Bangkok. Some small-scale waste management initiatives have been successfully implemented in other, similar slum areas in Mumbai (India), Dhaka (Bangladesh), and Kampala (Uganda) (Rathi, 2006; Field, 1992; Tukahirwa, 2010). Each of the waste management plans for these slums utilized community participation to achieve successful recycling and composting schemes.

Although different groups within the Khlong Toei slum including the DPF have attempted projects to improve the current waste situation in the area, none have successfully alleviated the problems with waste disposal in the slum. Discrepancies exist between the BMA's intended methods of waste removal and what the system is actually accomplishing within the slum. No current research exists that addresses the limitations of the municipal system in the Khlong Toei slum. In order for the BMA's system to succeed, it must enlist active participation from the residents and therefore align with their waste disposal habits. No research has yet been conducted to determine the waste disposal habits of the local residents in Khlong Toei. To develop a sustainable strategy, research must not only address the habits of the people but also ways the municipal system and its waste collection methods can work together with residents of Khlong Toei.

The goal of our project was to propose a sustainable waste management strategy to improve sanitation and quality of life in the Khlong Toei slum. Our project was focused in one section of the slum chosen by our sponsor labeled Locks 1, 2, 3. By developing a system to help the Khlong Toei slum residents manage their waste, we hoped to facilitate a decrease in the negative effects of poor sanitation. We also hoped to optimize the waste management strategy by recommending ways for the municipal system and the local residents to work together. We accomplished this by completing the following objectives:

1. Identify predominant types of waste based on reusability value to the residents and how each category of waste is handled/disposed of;
2. Determine the limits of the current municipal waste management system in the Khlong Toei slum;
3. Determine the current lifestyle effects of waste production and management in Khlong Toei;
4. Identify practical alternative waste management methods by addressing the following three parties;
    a. The Bangkok Metropolitan Administration
    b. The residents of the Khlong Toei slum
    c. The Duang Prateep Foundation

To accomplish our objectives, we conducted interviews with all parties involved in the current waste management process; representatives from the Khlong Toei District Office of the BMA, local community leaders, local residents involved in waste removal, a private junk shop, recycling center and additional resources to help us determine successful alternative waste management strategies. Overall, we focused on identifying the perspectives of the residents, as their support was vital for our proposed solution.

Based on our research results we identified the challenges of the current waste management system used for Locks 1, 2, 3 and formed recommendations to address these challenges. To improve the waste management system we have presented recommendations to support the community board's proposal for a communal dumping site. Based on findings from interviews with educational resource persons we have presented recommendations to change the residents' behavior through educating children. In conclusion, we were able to provide the Duang Prateep Foundation and the residents of Khlong Toei in Locks 1, 2, 3 with a sustainable waste management strategy.

2 Background

To examine challenges to sustainable waste management in slum areas, such as those in the Khlong Toei slum of Bangkok, we review slum conditions and waste management initiatives in various slums world-wide in this chapter. These topics establish a basis for the conditions in a slum area and the challenges of managing waste in such an area.

2.1 Formation of Slums

Urbanization is often driven by the belief that greater job opportunities, economic advantages, and better quality of life exist in cities. According to Figure 1 below, increased urbanization caused the world-wide urban population to surpass the rural population around 2010, most of which occurred in developing countries (Hinrichsen, 2012). Today, almost half of the world's population lives in urban areas, approximately 3.4 billion people. Rapid population growth in urban areas leads to various problems for municipal services, including but not limited to providing affordable housing for low-income citizens.

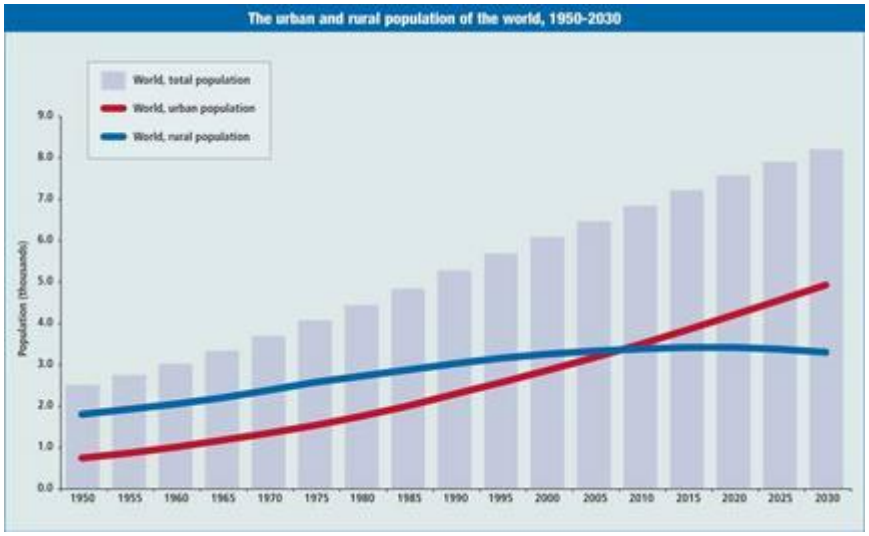

FIGURE 1: WORLD POPULATION GROWTH FOR URBAN AND RURAL COMMUNITIES FROM 1950-2030 (UNITED NATIONS, 2005)

One of the main causes of urbanization is a natural disaster (Sanitation and Hygiene, 2008). Many people migrate from rural to urban areas because their hometowns have been destroyed. For example, in Bangladesh residents faced extreme flooding that destroyed their crops and homes forcing them to move to the city to find a new source of income and housing.

Another cause of urbanization is inadequate income in rural areas (Population and Society, 2007). Many residents of rural communities earn their living in agriculture where their income depends heavily on climate and land conditions. Due to the insecurity of their work and the often low rate of return, many farmers leave their land and migrate to the city.

2.2 Slum Conditions World-Wide

Economic growth and urbanization has led to roughly 31.6 percent of the global urban population residing within slums as of 2009 (United Nations, 2012). Although characteristics of different slums around the world vary, general conditions are used to classify the majority of slum areas. A slum often becomes a place of residence for many people who cannot afford to live elsewhere because of expensive housing and facilities. Urban slums can give low-income laborers the opportunity to live in close proximity to their location of work within the city. Yet a number of issues arise from the undesirable conditions of slum life.

In general, slums are made up of densely packed, non-permanent housing units. This type of housing usually provides inadequate protection for inhabitants from the environment such as rain or natural disasters. In Mexico City, for example, squatters have been driven to unstable hillsides along polluted rivers (Davis, 2006). The squatter settlements are at constant risk of being destroyed by a natural disaster. Slum residents may also face insecure tenancy, with the constant possibility of eviction. Limited access to a safe and inexpensive water supply is also characteristic of slums. Water-borne

diseases, such as cholera and hepatitis, are caused by direct contamination and consumption of water (Unger, 2007). In Rio de Janeiro's slums, overcrowded households located in close proximity to open sewers presented higher risks of Hepatitis A (Almeida et al., 2001). Further health risks are also associated with the high population density of slums. Poor sanitation poses a threat to the well-being of slum dwellers with the overcrowding of slums allowing for easy transmission of epidemic infections.

2.2.1 Waste Management in Slums

The ineffectiveness of urban waste management systems intensifies poor sanitation in slums (United Nations, 2012). The large amount of waste generated in overcrowded slums can put great strain on the municipal waste disposal system. Management systems subsequently face difficulties disposing of the excessive waste and monitoring the system's disposal methods. Slum disposal systems also face varying challenges based on the location of the slum and the types of waste the residents produce.

Urban waste management systems specifically face difficulty when applying an organized collection method to a slum area. With a large number of inhabitants in a constrained area, slums as a whole produce large amounts of waste. Challenges arise from improper garbage disposal methods used by slum residents themselves, such as open dumping, as well as the inadequate collection techniques employed by municipal waste services (Visvanathan, 2003). Throughout this report, we will refer to "open dumping" as waste that has been placed in areas other than municipal waste bins or communal dumping sites. Open dumping then refers to waste that has been dumped in areas such as gutters or bodies of water, alongside walkways, underneath houses, and in abandoned properties.

Often negatively perceived and neglected by municipal systems, "scavengers" can play an important role in trash disposal (Medina, 2007). In Delhi, India, for example, over 300,000 scavengers, also known as rag pickers, earn 100 to 150 rupees ($1.60 to $2.40 USD) per eight hours of work, saving the municipal waste disposal system 600,000 rupees ($9,617 USD) per day (Asia: Scavenger Hunt; India's

Ragpickers, 2007). As scavengers collect waste for personal income, they gain demographic knowledge about their community. These waste pickers can actually be a vital resource to the local community rather than a nuisance.

A functioning waste management system is a key aspect of urban planning, especially in economically developing areas. Poor waste management within a slum directly affects proper sanitation and safe water quality. According to the United Nations (2006), over 381 million people in Asia live in poor sanitary conditions. Unhygienic practices amplify poor sanitation and negatively impact public health. Excessive, uncontained garbage in and around residential and commercial areas attracts rat infestations. Many diseases are not species-specific, allowing for easy transmission of deadly infections from rats to humans. Intestinal worms can also be contracted through exposure to open solid waste (Sheuya, 2008). Uncontained garbage and open sewers located near water supplies contaminate the quality of domestic water. Dirty water enables the spread of diseases such as diarrhea and cholera. Slum residents without access to proper sanitation are 1.6 times more likely to have diarrheal diseases. Diarrhea and pneumonia are responsible for the death of approximately 2 million children annually in slums.

2.3 Waste Management Case Studies

Urban slum populations exist worldwide and face similar challenges that can cause problems with waste management. Hard to reach locations and lack of funding are two common problems that municipal waste management systems face when providing services to slums (Tukahirwa, 2010; Rathi, 2006). Globally, communities have attempted different solutions to the problem of waste management by utilizing many different organizational structures.

2.3.1 Mumbai, India

Many communities world-wide that are similar to the Khlong Toei slum have attempted to implement waste management systems. In Mumbai, India, a slum community attempted a method focused on community participation through advanced locality management (ALM) (Rathi, 2006). The ALM included participation from community-based organizations (CBOs), non-governmental organizations (NGOs), and the Municipal Corporation of Greater Mumbai (MCGM). Local residents first created a community-based organization to implement and run the program. The process involved the local participating residents to segregate their waste into biodegradable and non-biodegradable. Local NGOs hired and trained "rag pickers" to collect and sort waste based on recyclability. After the rag pickers collected the waste, they sold the recyclable materials for revenue that then went back into supporting the system.

The collectors also delivered the biodegradable waste to local composting sites, which used vermicomposting, a composting method involving worms, or aerobic composting arranged and paid for by the MCGM (Rathi, 2006). The CBO sold the fully composted material, and the proceeds went back into supporting the system. The MCGM handled any waste not recycled or composted by transporting it to dump sites. The CBOs paid for the labor of waste collectors, the land for composting after initial setup, and the equipment used for removal of trash. The MCGM paid for transportation of non-recyclable and non-biodegradable waste to disposal sites, the disposal of waste at the site, and educational programs for the local community to explain how to separate waste.

Overall, the process reduced the amount of waste disposed of by the MCGM and therefore the cost of that disposal (Rathi, 2006). The process also created a self-sustainable CBO that ran on the profits of recyclable materials and compost and contributions from the residents for the rag pickers' salaries. As a result of the community participation approach, the neighborhood had healthier surroundings. Problems

with this system did exist, however. Not all members of the community agreed to participate, but educational programs to make the residents aware of the problems related to waste attempted, with little success, to encourage participation. Also, the compost did not generate enough revenue to cover all of the costs of implementation.

2.3.2 Dhaka, Bangladesh

In Bangladesh, another community similar to Khlong Toei has developed a successful waste management strategy. In Mirpur, Dhaka, Waste Concern (WC), a non-governmental research based organization, created a composting strategy to manage the local community's waste (Zurbrügg, Drescher, Rytz, Sinha, Enayetullah, 2005). For this system, households paid the WC a fee of Tk. 17 ($0.22 USD) per month for removal of their waste by rickshaw vans, or three-wheeled bikes. WC also collected waste for free from vegetable markets. The rickshaw drivers would bring the waste to the WC's composting center where ten workers would separate it into biodegradable, recyclable, and inert. WC sold the recyclable waste for income, while the Dhaka City Corporation would remove the inert waste. The workers then composted the biodegradable waste by using the Indonesian Windrow Technique, a non-mechanized aerobic process.

For the Indonesian Windrow Technique, the workers placed waste in long narrow rows that allowed for high contact with the air and mixed the piles while adding water to keep the material moist (Field, 1992). The workers removed the excess material from the fully composted waste. The plant would then sell the majority of its waste to MAP Agro Industries for additional processing and the remaining compost to local farmers and nurseries. The local Lions Club donated the land for the compost plant, which reduced the overall costs of the system. At half capacity, about 1.7 tons of waste per day, the plant just broke even, but at full capacity, around 3 tons, the plant increased its profit to about $3,745 USD per year based on the exchange rate in 2002. To encourage marketing of the compost in the local

area, the plant created a demonstration garden where it hosted educational programs. Other organizations, such as UNICEF, have encouraged similar strategies and have financially backed construction of composting plants in Bangladesh.

2.3.3 Kampala, Uganda

In Kampala, Uganda, an impoverished community implemented a different strategy for waste management that involved the local government, NGOs, CBOs and private companies (Tukahirwa, 2010). The NGOs and CBOs have focused most of their efforts on the slum communities of Kampala, similar to the Khlong Toei slum in Bangkok. In the impoverished areas, 62 NGOs and CBOs attempted waste management strategies for different communities. Of these organizations, 18 failed quickly due to financial limitations, but the others created an interwoven network of support throughout the city and the rest of Uganda. These organizations created programs to educate the community about types of waste and proper waste disposal methods. They accomplished this through local meetings, posters, music and drama. Some of the NGOs, which were part of larger international organizations, helped the local NGOs develop educational systems. The international NGOs also distributed grants to CBOs for waste removal equipment.

Overall, most NGOs and CBOs could not directly create waste removal systems due to the city's waste ordinance policy requiring large bank guarantees and expensive equipment to run a waste removal system (Tukahirwa, 2010). The city's policy forced most NGOs and CBOs to work with private companies for waste removal. For impoverished regions, the privatized companies could not always access the areas with their large trucks, and many residents could not afford the cost of removal. The city's policy was not as strict with recycling, however, allowing NGOs and CBOs to create recycling programs. Through the different programs, organizations successfully used waste for organic fertilizer, crafts, roofing materials, fencing, and others.

2.4 Thailand Slums

Similar to other developing nations worldwide, economic growth and urbanization has led to roughly 27 percent of Thailand's urban population residing within slums (United Nations, 2012). According to the Bangkok Metropolitan Administration (BMA), a slum in Bangkok is defined as "an overcrowded, unorderly, and dilapidated community with an un-ample environment which can be harmful for health and lives" (Moreno, 2003, p. 60). Overcrowding amplifies the problems with waste disposal within Bangkok slums.

2.4.1 Waste in Thailand

In Bangkok specifically, 8,473 tons of waste are produced on a daily basis. (Kaosol, 2010). Only 37 percent of waste is reported to be collected within municipal areas. The city has little space for the expansion of landfills as a way to dispose of garbage. Thailand has a hot, humid climate that causes organic waste to decompose quickly. For municipal collection services, the rapid decomposition requires frequent trips for waste removal. Daily transportation of waste from households and businesses to disposal areas may cost the city more than it is willing to pay. The bulk of waste is organic and biodegradable, with food waste making up 55 percent of the total garbage generated (Visvanathan, 2003). Plastic and paper combined make up roughly 20 percent of total waste composition. This is a relatively high percentage in comparison to other developing countries in Asia.

In Thailand, different methods exist for handling waste disposal (Visvanathan, 2003). Solid waste landfills with limited sanctions account for about 65 percent of waste disposal methods in Thailand. Incineration is utilized as an additional waste disposal method for roughly 15 percent of the trash, while sanitary landfilling and composting eliminate 20 percent of waste combined. Industrialization and western influences continue to increase the use of plastics and paper materials in Thailand. Recycling initiatives are also growing in Bangkok. The private recycling venture M/S Wongpanit has assembled

junk shops throughout Thailand. As of 2003, this enterprise had over 100 branches that purchase recyclable materials from locals. This venture encourages recycling as a disposal method through monetary incentives.

2.4.1.1 HAZARDOUS WASTE IN THAILAND

The Pollution Control Department of Thailand recognizes hazardous wastes and methods for properly disposing of them (PCD, 2014). Among some of these hazardous wastes are batteries and fluorescent light bulbs. The Pollution Control Department of Thailand believes these are two main household hazardous wastes. At the moment, they are piloting programs and studies to properly handle these two types of wastes to reduce the dangers to residents. Fluorescent light bulbs pose a risk to residents because they contain mercury (Johnson, 2008). When broken, the mercury inside the bulb can contaminate water sources and potentially cause health problems for anyone ingesting the water. Batteries contain chemicals that can also cause health problems including burns, rashes, and central nervous system damage (Lead-Acid Batteries - Hazards and Responsible Use, 2000).

2.4.2 Khlong Toei, Bangkok - "Garbage for Eggs"

In 1997, the Environmental Organization Group of Thailand conducted the Garbage for Eggs Project to reduce open dumping of waste (Jameison, 2000). The project occurred as a reaction to the flooding of canals and sewers in the Khlong Toei slum in Bangkok. During the rainy season public drains blocked with garbage overflowed and flooded many households and walkways. To motivate residents to clean up waste in the slum area, the Environmental Organization Group of Thailand created a program to allow for trading of sorted recyclable wastes for fresh eggs on Sundays. Volunteers and residents separated organic waste and recyclables to sell to private junk shops to generate money for purchasing more eggs. As a result of this project, within 8 months approximately 2,000 metric tons of garbage were sorted and removed from the area. Unfortunately, the volunteers encountered a number of problems and

the program did not last long. According to an employee (personal communication, January 24, 2014) from the DPF, there were an insufficient number of volunteers and the program did not have enough money for proper equipment.

2.4.3 Thai Environmental and Community Development Association

The Thai Environmental and Community Development Association (TECDA) launched the Magic Eyes campaign on January 14, 1984 (Sopchokcai, 1990). The goal of the campaign was to educate children on environmental issues and to encourage them to take action. By 1990 the TECDA had implemented 56 projects, some involving major sponsors such as the Bangkok Bank. One of their projects included televised cartoons to promote proper waste disposal. The TECDA's strong impact in Thailand could be seen through posters, t-shirts, bumper stickers and badges all over the country. Their bright green symbol was based on their jingle "Ah! Ah! Don't litter! Magic Eyes are watching you!" and was easily recognizable by children throughout Thailand (p. 4). Current representatives of the TECDA (personal communication, February 6, 2014) report that they believed they succeeded with their campaign due to the noticeable decrease in litter throughout the city of Bangkok.

2.4.4 Roong Aroon School - Zero Waste Program

In 2004, the Roong Aroon School located in Bangkok was producing an average of 206 kilograms of waste per day (Internet Foundation for the Development of Thailand, 2014). Due to the lack of an efficient waste management strategy, the excessive waste would often accumulate creating foul odors and aesthetic problems. After realizing the educational potential for properly managing waste, the school established a Natural Resources and Environmental Planning Unit to handle the waste problem. The purpose of this unit was to start a self-sufficient community waste management strategy based on reducing the amount of waste produced and reusing and recycling waste materials. The final strategy,

labeled the Zero Waste Program, enlisted the help of the school's students, teachers, staff, and family members. This strategy is still in place today successfully reducing the amount of waste the school produces as a whole.

The Roong Aroon School begins the process with education programs to raise the students' awareness about how much waste the school produces. They then encourage students to complete chores such as taking out the trash and sorting the trash they collect. The children sort the trash into five categories: organic, biodegradable, recyclable, hazardous, and non-recyclable. The school has arranged to handle each category in different ways. Recyclable waste is further separated into different categories as described in Figure 2 below.

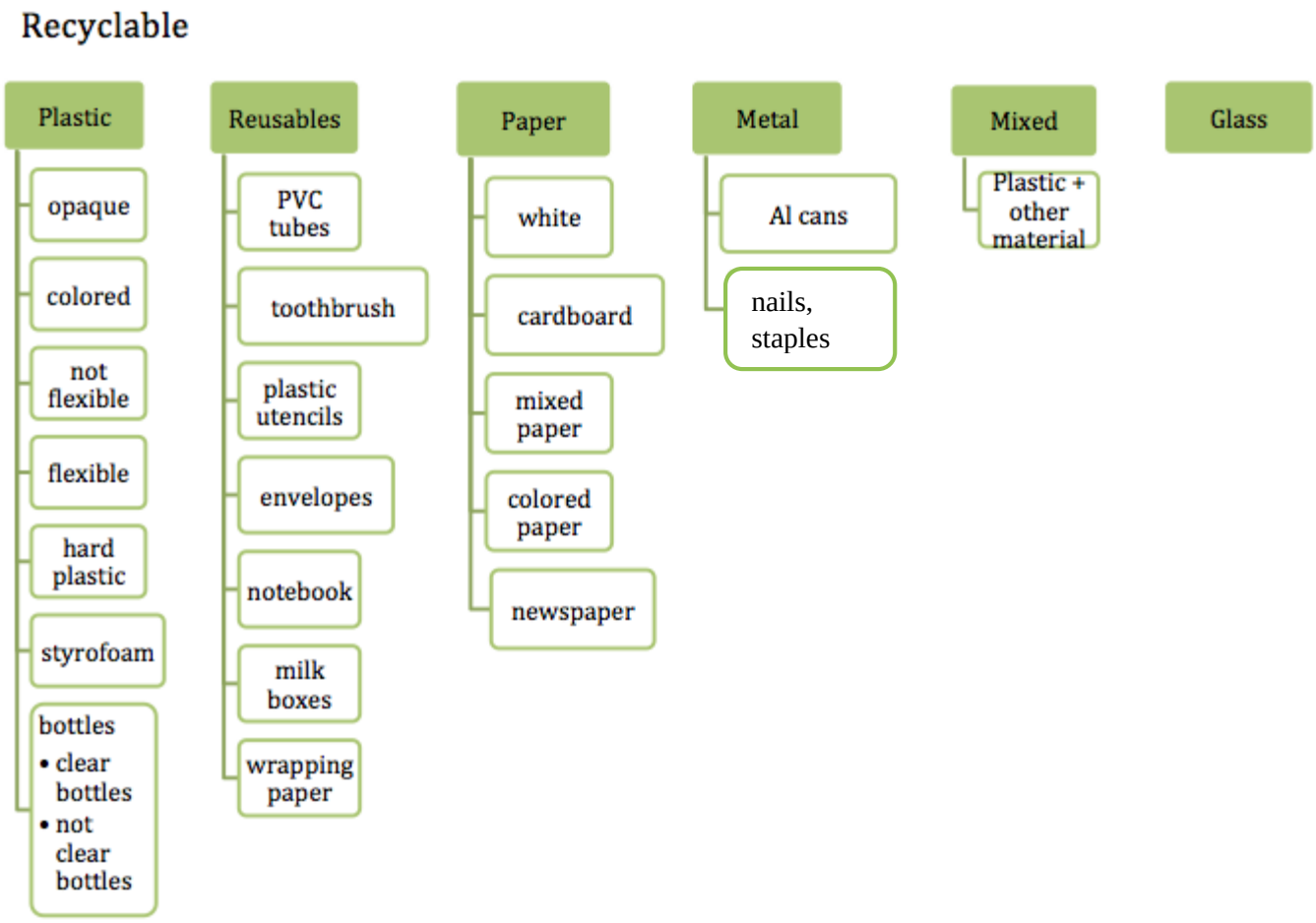

FIGURE 2: ROONG AROON METHOD FOR SORTING WASTE.

2.5 Khlong Toei Slums

The Khlong Toei district contains the largest slum in the city of Bangkok. According to the BMA (2012), 103,225 individuals make up 95 percent of the population of the Khlong Toei district. The 1.5 square kilometer area of the slum is densely packed with over 20,000 households, leaving space for only narrow roads and paths. Williams (2011) describes the population of the slum as consisting of ethnic Thais, both Khlong Toei born and from the provinces of Thailand, as well as migrant workers from the surrounding countries.

2.5.1 History of Slums in Khlong Toei

In the early nineteen fifties, workers of the Port Authority of Thailand (PAT) settled into cheap and temporary housing in the Khlong Toei region on land owned and operated by the PAT (DPF, 2013e). The port workers remained in the temporary housing due to its convenient proximity to the ports. As the PAT completed the ports, the slum grew larger and more populated, attracting other residents to the area. A map showing the location of the slum can be seen in Figure 3.

FIGURE 3: MAP OF KHLONG TOEI SLUM COMMUNITIES INCLUDING LOCKS 1, 2, 3 (GREEN), 4, 5, AND 6 (PINK), 70 RAI (BLUE) AS WELL AS THE HEADQUARTERS OF THE DPF (RED).

Throughout the nineteen sixties, Bangkok developed quite rapidly, triggering a rise in the cost of land (Anderson & Davis, 1994). As housing prices increased along with the cost of land, the percent of the urban population who could afford safe and suitable housing decreased. The government failed to (or refused to) "provide affordable housing opportunities" (p. 17). Migrant workers began to develop temporary housing on government-owned land with the assumption that government land was for the people. The Khlong Toei slum became convenient for both employers and workers, as workers could reside close to their place of work, and employers had cheap labor nearby.

However, as more residents migrated to the Khlong Toei slum, the slum became more crowded and expanded in size (DPF, 2013e). Residents no longer exclusively worked for the PAT, and yet the slum encroached on more of the land owned by the PAT, as well as other land owned by the city. As the city grew, the PAT's demand for land increased. Legally, the Khlong Toei slum residents had no rights to the land, and the PAT could evict them at any time (DiNiro, Garabedian, Ossa, & Smith, 2006).

In 1972, for example, the PAT aimed to increase development on more of its property (Warren, 2002). The slum dwellers became alarmed as the PAT threatened to demolish their homes. A temporary school organized by the influential Khru Prateep Ungsongtham Hata located on authority property was also vulnerable, as Khru Prateep had used her own temporary housing for its classes. Eventually Khru Prateep and her school gained enough publicity through contacting a reporter from the Bangkok Post, such that the PAT was forced to compromise. In 1974, the PAT allowed the school to relocate to a permanent building not far from its origin (Ramon Magsaysay Award Foundation, 2013). Four years later, in 1978, Khru Prateep organized the Duang Prateep Foundation (DPF) (2013d) to provide resources for the Khlong Toei residents, many of whom were impoverished. Since its founding, the DPF has aimed to improve the overall quality of life in the Khlong Toei slum. Despite the efforts of the DPF to strengthen and reorganize the community, many problems still exist within the Khlong Toei slum.

2.5.2 Problems within the Khlong Toei Slum

Every urban community has its own unique problems, and the Khlong Toei slum is certainly no exception. Due to poverty and risk of eviction, the residents have built their homes with cheap easily available materials (Anderson & Davis, 1994). As illegal residents on the land, the government has not always provided them with proper infrastructure and maintenance. Today many houses still lack necessary facilities and property rights that have also led to other issues in the slum. Many residents live in unhygienic, overcrowded, and unsafe environments that increase the risk of health problems.

In 2002 researchers conducted a survey of 200 households in the area (Daniere et al., 2002). They found 41.5 percent of the households said that the health of their children was either fair or poor. Waste management was also a large concern, with only 50 percent of the households using the municipal or community waste collection service. Despite the lack of many services, by 2002 much of the slum did have piped water and electricity.

The Khlong Toei slum was originally built on marshlands along the river. The residents constructed walkways using various materials to connect their houses, which were raised above the water. According to local residents, during the rainy months in Thailand, May through October, the area often floods (personal communication, January 21, 2014).

Fires are another common problem for Khlong Toei (DPF, 2014b). The cheap materials used to construct houses in the area are often flammable. The close proximity of the houses due to overcrowding can allow fires to easily spread through multiple homes. The narrow walkways between the houses can also decrease accessibility to fires within the slum.

Although the Khlong Toei residents face harsh conditions, their community remains quite strong and closely-knit as it provides for its residents in other, less obvious ways. Some believe the satisfaction of the slum residents is a reflection of the Buddhist-influenced “smiling Thai culture” (DiNiro, Garabedian,

Ossa, & Smith, 2006, p. 17). On the other hand, Anderson and Davis (1994) believe that the "physical closeness" of the community helps strengthen the neighborhood connections and allows for trust and respect among residents. Extended families and relatives live in close proximity to each other, leading to happier families and content family members (Carpenter, 2006). In addition, many residents live very close to their places of work. Residents can also properly register their homes to help protect them from eviction, allowing for more permanent housing (Anderson & Davis, 1994). Several areas of the slum can rent from landlords both private and government, to allow them temporary security. With help from organizations such as the DPF, the residents have been able to combat many of their problems.

2.6 Influence of DPF on Local Population

The DPF currently operates over 20 programs, all of which are created to give slum residents access to valuable resources (DPF, 2013d). The DPF focuses on five areas of service to the community: education, health, social services, human development, and emergency funding. The founder, Khru Prateep Ungsongtham Hata, based the DPF on the idea that the education of skills pertaining to slum lifestyles can greatly empower the people of Khlong Toei to improve their quality of life.

In 1994 Worcester Polytechnic Institute (WPI) students worked with the DPF to propose a solid waste management strategy for the Khlong Toei slum (Anderson & Davis, 1994). Their strategy not only suggested ways to improve the waste disposal and collection process but also ways to educate the residents on the issue. The project team adapted many of the DPF's educational tactics in an attempt to create a self-sustaining system. The project team distributed promotional brochures throughout the neighborhood to show the relationship between improper disposal of waste and disease. The group also used posters to spread the importance of a clean neighborhood and proper waste disposal techniques. T-shirts were given out as a reminder to the residents to maintain a clean lifestyle. However, the DPF has found that there is still a waste management problem in the Khlong Toei slum.

2.7 Comparison of Case Studies to Khlong Toei Slum

Waste management solutions are unique to a specific location. Their success is reliant on the area's specific strengths and weaknesses. Techniques implemented in other similar communities are useful in addressing the problems with waste management in Khlong Toei.

All of the case studies discussed in section 2.3 utilized community involvement and stressed the importance of raising awareness among the residents when trying to implement waste management solutions. The Khlong Toei slum has strong community organization and leadership, but not all residents are aware of their problem of improper waste disposal. The case studies also addressed problems with local municipal systems and attempted to develop solutions that decreased the amount of work for the municipal workers or redirected their efforts. Our project examined the problems with the existing waste management strategy in Khlong Toei from the perspectives of the residents and the municipal system. We attempted to develop solutions similar to those discussed in the case studies that satisfied all parties.

3 Methodology

The goal of this project was to propose a sustainable waste management strategy to improve sanitation and quality of life in the Khlong Toei slum, specifically in Locks 1, 2, 3. In order to accomplish this goal, we developed specific objectives. Our four main objectives were as follows:

1. Identify predominant types of waste based on reusability value to the residents and how each category of waste is handled/disposed of;
2. Determine the limits of the current municipal waste management system in the Khlong Toei slum;
3. Determine the current lifestyle effects of waste production and management in Khlong Toei;
4. Identify alternative methods for successful waste management.

We developed the following methodology to achieve these objectives, which included interviews, site visits, and personal observations of the area. Upon first arriving in Khlong Toei, we clarified the details of our project through a meeting with the DPF. Through this meeting we were able to determine the DPF's views on the issue of waste management and their intent for the project. For the purposes of our research, we define "recyclable" as an item that can be processed for recycling within Thailand. For a detailed list of these items see Appendix B: Wongpanit Recyclable Material Prices. The sections below outline the processes for and purposes of each individual method.

3.1 Identify Predominant Types and Values of Waste

To determine the actual waste situation in the Khlong Toei slum, we identified the types of waste the residents produce. We identified the predominant types of waste openly disposed of throughout the slum through a physical inspection. In addition, we determined the monetary worth of recyclable or reusable

waste materials to help us determine what types of waste could be of value to the residents, whether by reusing the waste, or by selling or recycling it.

3.1.1 Interview with Mercy Foundation Waste Bank

To identify the specific types of waste produced in the slum, we interviewed an employee at the Mercy Foundation, another non-governmental organization located in Khlong Toei. The Mercy Foundation currently manages a waste storage center for the residents to sell and store their waste. Through this interview we received a list of types of commonly produced waste in the area that can be resold to the local junk shop (see Appendix C: Mercy Foundation Semi-structured Interview Protocol).

3.1.2 Interview with Local Khlong Toei Junk Shop

During our physical inspection of Locks 1, 2, 3 in the Khlong Toei slum, our community liaison showed us the location of a local junk shop that buys certain used materials from residents in the area. We returned to the junk shop later and conducted an interview with a junk shop employee. The interview helped us find other private companies that purchase and process waste. The interview also gave us information about the monetary value of recyclable materials for residents selling to the junk shop (see Appendix D: Junk Shop Interview Protocol).

3.1.3 Interview with Recycling Center - Sivalai Reusable Co., Ltd.

Through our interview with the local junk shop, we found that the shop hires a middleman to buy, transport, and sell the recyclables to Sivalai Reusable Co., Ltd., a recycling center on Sukhumvit Soi 36. To determine the non-municipal waste management system of the slum we visited the recycling center and interviewed one of the owners of the company. From our interview we identified the demand that exists for certain types of waste and how this demand affects Khlong Toei. We also determined the

methods the center used for handling different types of valuable waste (see Appendix E: Sivalai Reusable Interview Protocol).

3.1.4 Interviews with Chulalongkorn University Waste Management Employees

To identify how waste management systems handle waste types specific to the Khlong Toei slum, we interviewed employees at Chulalongkorn University about the system used on campus. We interviewed the head janitor for the Mahamongkut building to determine the process used to separate the waste in the building (see Appendix F: Chulalongkorn University Head Janitor Interview Protocol). We also interviewed an employee involved in the waste cleanup at the dining hall of the economics department at Chulalongkorn (see Appendix G: Chulalongkorn University Facilities Interview Protocol). Through the interview, we determined how the waste from the dining hall is handled and what happens after it is removed from the building.

3.2 Determine Limits of the Current Municipal Waste System in Khlong Toei

We identified the current municipal system for waste removal in the Khlong Toei slum, and determined its capacity and limitations. We then identified what aspects of the system were ineffective or faced challenges to help shape our final recommendations.

3.2.1 Physical Inspection of Locks 1, 2, 3

During our visits to the Khlong Toei area, we gained an overall view of the waste problem. We photographed areas within the slum that we found to be relevant to waste and waste disposal. We documented high concentration dumping areas to identify the locations of the waste. We also inspected communal garbage collection sites in Khlong Toei to evaluate the use and effectiveness of these sites. At these sites, we observed what types of waste were being collected to identify the types of waste in the

slum. With this information we were able to offer recommendations for improvements to the communal collection service.

3.2.2 Interview with Duang Prateep Foundation

We conducted an informal interview with the Duang Prateep Foundation (DPF) regarding the municipal waste management/collection system. Because the DPF has close ties with the Khlong Toei slum, they supplied us with valuable insight into the efficacy of the collection services provided by the city of Bangkok. DPF staff were more open to speak about problems with waste collection than the residents themselves (see Appendix H: Duang Prateep Foundation Semi-structured Interview Protocol).

3.2.3 Interview with Local Residents Involved in Waste Process

During our physical inspection of Locks 1, 2, 3 in the Khlong Toei slum, our community liaison from the DPF introduced us to two residents who are involved in the waste management process. We interviewed one resident during our tour to determine her role in the waste management process and how it affects Locks 1, 2, 3. We later returned to the other resident to conduct an interview. The interview with the other resident helped us determine the system used in the slum by the BMA from the perspective of someone not directly working for the municipal system. The interview also allowed us to identify the local residents' involvement in the municipal waste collection process (see Appendix I: Local Resident Interview Protocol).

3.2.4 Interview with Local Junk Shop Representatives

During our interview with the local junk shop as explained in section 3.1.2, we asked questions about the amount of waste removed by the junk shop. We also inquired about the methods used for removal and sorting to determine how these methods affected the existing waste management strategy used in Khlong Toei Locks 1, 2, 3 (see Appendix D: Junk Shop Interview Protocol).

3.2.5 Interview with BMA Representative

To identify the current municipal collection system in Khlong Toei, we interviewed one employee of the Khlong Toei District Office, a sector within the Bangkok Metropolitan Administration (BMA). The interview focused on determining the total number of workers responsible for waste removal in Khlong Toei, the number and types of collection vehicles used by the workers, and the frequency and extent of the municipal collection in the slum area (see Appendix J: BMA Personnel Interview Protocol).

3.2.6 Interviews with Chulalongkorn University Employees

We interviewed two employees of Chulalongkorn University as explained in section 3.1.4 involved in waste management on campus to identify the limits of the municipal waste system.

3.2.7 Interviews with Community Board Members and Other Community Leaders

We interviewed local community board members for Khlong Toei and other leaders from the slum. From these interviews, we identified the current municipal waste collection system used in the slum from the residents' perspectives. We asked about the technical aspects of waste collection and if the residents had any suggestions for improvements. These questions were used to determine the perspectives of the slum residents regarding the effectiveness of their municipal waste management system. Interviewing locals who had first-hand experience dealing with the municipal system revealed its limitations. We compared the information from the BMA officials and slum residents to gauge the effectiveness of the current municipal collection service (see Appendix K: Community Leader Interview Protocol).

3.3 Determine the Lifestyle Effects of Waste Production in Khlong Toei

To determine the effects of open waste on the neighborhood within Locks 1, 2, 3 we interviewed residents of the Khlong Toei slum. As the Khlong Toei slum was too large for us to speak with all residents individually, we focused on the local community leaders including past and present members of the local community board. The community board consists of 25 elected residents of the Khlong Toei community with one elected head community leader. As a community board, these residents represented the views of their local neighborhoods about the issue of waste.

3.3.1 Interview with Community Leaders

To determine the opinions of the local residents on the issue of waste, we interviewed five local community leaders including the community leader of the board from Khlong Toei. We selected the members interviewed through recommendations from our sponsor liaison. We worked with the DPF to arrange the interviews at the leaders' homes in the Khlong Toei slum. From these interviews, we determined if the community leaders believed there was a problem with waste disposal and if they had made any attempts themselves to solve those problems (see Appendix K: Community Leader Interview Protocol).

3.3.2 Interview with DPF Representatives

From our interview with the DPF as explained in section 3.2.2, we determined what they believe to be the lifestyle effects of poor waste management (see Appendix H: Duang Prateep Foundation Semi-structured Interview Protocol).

3.3.3 Physical Inspection of Locks 1, 2, 3

From our physical inspection as explained in section 3.2.1, we determined how openly dumped waste could be related to hazards for the residents. We observed the locations where waste was disposed of, common types of waste openly dumped, and the amount of common types of waste.

3.4 Identify Alternative Successful Waste Management Methods

As part of recommending solutions for the population living in Khlong Toei, we identified alternative methods for managing their waste. We visited a private recycling center to determine ways to manage waste that are not being used by the municipal system. We also compared solutions to waste management challenges in other slums similar to Khlong Toei. From our research of alternative methods and our case study comparison, we developed recommendations for Khlong Toei and the BMA. We presented our final recommendations to the Khlong Toei residents to receive their feedback and adjust our recommendations accordingly.

3.4.1 Waste Disposal Methods Comparison

We conducted a comparative analysis of the waste management system in Khlong Toei to those in similar slum communities from all over the world. Examples of other communities' solutions can be found in section 2.3. The comparison allowed us to predict what other solutions might be feasible in Khlong Toei.

3.4.2 Interview with Thai Environmental and Community Development Association

We spoke with representatives from an environmental group known as the Thai Environmental and Community Development Association (TECDA) that has worked with Khlong Toei in the past

(Anderson & Davis, 1994). By interviewing representatives from TECDA we identified past and present projects that the organization has conducted (see Appendix L: TECDA Interview Protocol).

3.4.3 Interview with Teacher from the Roong Aroon School

We visited the Roong Aroon School in Bangkok and interviewed the teacher in charge of their Zero Waste Program. The teacher gave us a full tour of the facility including the classroom sorting stations and composting area. By identifying how the school successfully implemented and ran their Zero Waste Program, we could develop ways to help change the current waste management strategy in Khlong Toei. We determined how they instigated behavioral change and what resources they used to reduce the amount of waste they sent to landfills (see Appendix M: Roong Aroon School Interview Protocol).

3.4.4 Interviews with Community Board Members and Other Community Leaders

From our interview with local community leaders and members of the community leader board as explained in section 3.2.7, we determined the community leaders' initiatives on improving the waste management strategy for Khlong Toei and what current plans existed to improve the situation (see Appendix K: Community Leader Interview Protocol).

3.4.5 Meeting with Local Residents

After forming our initial recommendations we held a meeting to present our proposal to an employee of the Khlong Toei District Office, residents of the slum, and the Duang Prateep Foundation. Residents in attendance included those involved in our interviews as well as several other residents invited by the Duang Prateep Foundation. Attendees provided feedback regarding our recommendations, further information for our project, and suggestions for additional recommendations. We then used the information and suggestions from the meeting to finalize our recommendations (see Appendix N: Final Presentation to DPF and Local Residents).

Our sponsor also requested we record our presentation. This recording will be presented to residents from other areas of the slum to gain support for our waste management initiatives.

3.5 Summary

Using the methods explained in this chapter we were able to collect information to develop recommendations. Our recommendations aimed to help the Duang Prateep Foundation and the residents of Khlong Toei improve their waste management strategy. We determined the problem from the perspectives of all the main stakeholders through our many different interviews. Through these interviews, we also determined possible ways to improve the existing strategy in Khlong Toei. In the next chapter we discuss how the results of our methods led us to our conclusions and ultimately our recommendations for Locks 1, 2, 3 in Khlong Toei and for the BMA.

4 Results and Analysis

The goal of our project was to propose a sustainable waste management strategy to improve sanitation and quality of life in the Khlong Toei slum. By interviewing local residents as well as stakeholders in the current waste management strategy, we were able to develop the following findings. We organized our findings by how they helped our team accomplish each of our four objectives. The first finding below however, relates to all of our objectives and some of the limitations that kept us from obtaining individual data from each resident of the slum.

Finding #0: Research limitations exist in the Khlong Toei slum.

Research in Khlong Toei is difficult due to the residents' lifestyles and their lack of trust in outsiders. A previous Interactive Qualifying Project, which researched CCTV cameras in Khlong Toei, was unable to receive significant input from residents due to their limited willingness to participate (Gyening, K. O., Murillo, M. C., Trkulja, N. & Walcott, R. P., 2013). They also faced the challenge of illiteracy, which required that they conduct in-person interviews as opposed to handing out paper survey questionnaires. Further verifying the difficulties of gathering information from slum residents, our community liaison informed us that many residents do not trust outsiders when giving personal opinions regarding the municipal waste management system. He believed we would not have any success conducting door-to-door interviews. Our research regarding the residents had to rely on interviews with the DPF, community board members, other leaders of the slum, and physical inspections of the area.

4.1 Objective 1: Identify Predominant Types of Waste

In order to accomplish our first objective, we determined the types of waste that have value in Khlong Toei by conducting interviews. To determine how waste is handled we interviewed representatives from the private recycling sector, the BMA Khlong Toei District Office, the Mercy Foundation, a Chulalongkorn University janitor and cafeteria worker, as well as teachers of the local daycare in Locks 1, 2, 3.

Finding #1: Many types of waste have monetary value in Thailand.

In Thailand, many different types of waste have monetary value and can be bought and sold through a trash market. More than 150 different types of waste can be bought and sold through this market (see Appendix B: Wongpanit Recyclable Material Prices) (Wongpanit, 2014). In particular, private companies in Bangkok will buy recyclable waste in bulk to reuse to produce their goods. A new industry of recycling has developed from this demand. From our research we found that throughout Bangkok many different parties sort waste to sell the valuable items. As people and businesses retrieve valuable waste items and sell them to recycling centers, the amount of waste that accumulates in landfills decreases.

During our physical inspection of Locks 1, 2, 3 we found a local junk shop located on the edge of the neighborhood. Our interview with the local junk shop revealed that the shop handles most of the valuable waste sold from the slum. The junk shop sells the waste to a company to transport the waste to Sivalai Reusable Co. Ltd, a recycle center located near Khlong Toei. From our interview with junk shop workers, we found the junk shop makes about 6,000 baht a day from the sale of waste.

During our physical inspection, we also noticed certain types of waste were commonly dumped in open areas. These types of waste included plastic bags, chip bags, and expanded polystyrene foam. From our interview with the local junk shop, we found that the shop did not buy these materials from residents to

recycle because their middleman refused to purchase them. Since residents could not obtain value for these materials, they took less care in disposing of them.

Finding #2: Throughout every step of the waste system, waste is separated to remove objects that have value for personal or company profit.

From our interviews we found that in all waste management systems, including both local and private systems, waste is separated to remove valuable materials.

Local Disposal System

In the existing municipal system there is no method for processing recyclables. From our interview with a representative from the Khlong Toei District Office we found instead that workers remove the valuable waste for their own personal profit as they collect garbage. Any valuable waste that they miss then goes on to the landfills where workers will remove recyclables to sell for their own profit.

The local junk shop we interviewed works as a supplement to the Khlong Toei system by buying, sorting and selling recyclable waste from the area to a recycling center. We also interviewed two local residents involved in the waste removal process. Both sorted the waste they collected for their own profit to sell to the local junk shop and the recycling center we visited.

One downside to using recyclable waste as a primary source of income is the fluctuation in price for the materials. The price of certain materials will change depending on the supply and demand in the world market. Due to price fluctuations the Mercy Foundation started a waste-purchasing project. Through the project, the foundation will store valuable recyclables for local residents for a small fee until prices peak to maximize the profit for the residents.

Private Institutions

From our research we found private disposal systems also recycle valuable waste for profit. We visited the Roong Aroon School, a primary and secondary school in Bangkok, that has developed a Zero Waste

Program to reduce and recycle all waste produced by the school. The program has arranged for different private companies to buy or collect almost every type of waste they produce.

We researched Chulalongkorn University's waste disposal system to determine how they handle recyclable waste. From our interviews with some of the university's janitors, we found for each building at the university, the janitors who are responsible for collecting the waste remove the valuable waste to sell for their own profit. Workers that sort waste in the cafeteria also sell the recyclable wastes for their own profit.

Within Khlong Toei, we interviewed the teachers at the local daycare center for Locks 1, 2, 3. At this school, the teachers teach the children how to separate their valuable waste. The teachers then sell the valuable waste to help pay for the cost of meals for the children.

Finding #3: BMA's Onnut dumping site, used for the Khlong Toei slum, separates out hazardous waste.

Through our interview with the BMA representative we found that the Onnut dumping site is responsible for sorting the hazardous waste produced in the Khlong Toei slum. The BMA collects hazardous and non-hazardous waste together and sorts the waste at the Onnut dumping site. The hazardous waste is either put into landfills or is removed by private companies.

4.2 Objective 2: Determine the Limits of the Current Waste Management System

To complete our second objective, we identified the different parties involved in the waste management system in Khlong Toei and the many limitations of the system. We accomplished this through physical inspections of the slum area and interviews with slum residents and members of the local community board.

Finding #4: Waste management systems in Bangkok include both the BMA and private companies.

From our background research and initial interview with the DPF, we found that a municipal system exists to manage waste in the Khlong Toei slum (BMA, 2012). From our interview with a representative from the BMA's Khlong Toei District Office, we found that the municipal system is responsible for collecting waste throughout all of Bangkok. The municipal system, however, does not process recyclables. Instead, private companies collect and sell the recyclable materials for profit.

Municipal Involvement

A section of the BMA Khlong Toei District Office is responsible for waste collection in the Khlong Toei slum. The waste collection service dictates that municipal workers collect waste from the specified BMA garbage bins (between 200-300 bins) every night and from the communal dumping site about three times a week. According to local residents, the workers collect waste every night from the slum, but not from every street within the slum. They also confirmed that the workers collect waste from the communal dumping sites approximately three times a week.

Private Involvement

Due to the large quantity of recyclable waste in Bangkok many of the current waste management systems utilize private sector involvement including junk shops, private recycling sites, and residential garbage collectors. Junk shops allow residents to make a profit from certain types of waste they produce. Local junk shops act as middlemen between local residents and private recycling sites, which ultimately sell waste to private companies willing to pay for the recyclable materials. All waste systems investigated for this project including those in Khlong Toei, at the Roong Aroon School, and at Chulalongkorn University, utilize private companies to handle their recyclables.

Another party involved in the existing waste management system in the slum is the local residents who are paid to transport trash to communal sites. Due to the distance of the communal dumping sites from

residents' houses, some residents are willing to pay extra to hire neighbors to deposit their waste at the dumping site. Residents hired to transport the waste often sort what they collect and sell valuable materials to the junk shop.

Finding #5: Not all residents can afford to pay the BMA's waste removal fee.

From our interview with the Khlong Toei District Office, we found the BMA charges each household 240 baht a year for waste removal services. We also learned that while Khlong Toei residents are required to pay for municipal waste removal, only 30-40 percent of slum residents pay the fee. If residents do not pay the fee, the BMA is not obligated to collect their waste. The BMA claims to keep a list of all residents who have paid. The waste removal workers use this list to identify from which houses to remove waste. It is unclear as to if the BMA exclusively does not collect waste from residents who do not pay, however.

The DPF and local residents confirmed that not all residents pay. The residents informed us that people do not pay either because they cannot afford to pay, or they are unwilling to pay the yearly fee. We were unable to obtain the average income of Khlong Toei residents, and therefore only have residents' testimonies to support that some residents cannot afford to pay. The majority of the 30-40 percent of the total residents who do pay for municipal waste collection, though, choose to pay 20 baht monthly rather than 240 baht annually, an option offered by the BMA. From our interviews with community leaders we found some residents opt for monthly payments because they do not live in the slum all year. We do not know if all residents are aware of the monthly plan, however all residents we interviewed acknowledged both options.

Finding #6: There is a limited amount of garbage that can be removed by municipal and private garbage trucks daily.

In Locks 1, 2, 3 of the Khlong Toei slum, the Bangkok Metropolitan Administration has two municipal trucks that remove waste daily. From our interview with the Khlong Toei District representative, we

found the trucks each can carry up to seven tons of waste and only collect once per day. The trucks collect waste in the Locks between 11 PM and four AM. Approximately three times a week, the same trucks also collect from some of the dumping sites under the highway near the railroad tracks. In total, the municipal system can collect up to 14 tons of waste per day.

For valuable wastes, the local junk shop we interviewed in Locks 1, 2, 3 has a second company buy and transport the waste to deliver to Sivalai Reusable Co., Ltd. The transport company purchases two to three truckloads of recyclables each day from the local junk shop. Each truck holds about one ton of waste. In total, the junk shop has two to three tons of waste removed per day. Not all of this waste originates from Locks 1, 2, 3 though, as the junk shop will accept waste from anywhere.

Although we do not know how much total waste the residents of Locks 1, 2, 3 produce per day, the current system permits only about 16 to 17 tons of valuable and non-valuable waste removed per day.

On average, a resident of Bangkok produced 1.2 kilograms of waste per day in 2013 (Kongasi, 2014). This would mean that the 7,126 residents in Locks 1, 2, 3 produce approximately 8,551 kilograms (8.6 metric tons) of waste per day (Bangkok Metropolitan Administration, 2014). We were unable to obtain information on the exact amount of waste removed daily from the slum, however based on our estimation, the BMA should be able remove the daily production of waste in Khlong Toei. This could indicate that the problems in the slum related to waste management are not related to the capacity of the current system. Rather the problems regarding waste management most likely lie within the slum.

Finding #7: Municipal garbage trucks are too large to fit in the slum walkways and roads.

Due to the organization of the Khlong Toei slum, garbage trucks are unable to enter the dense slum areas to remove all of the waste produced by the communities. During our physical inspections, we found that all houses in the slum area are organized in such a way that only small sois run between each house.

These sois are only wide enough for one or two people to walk through at a time. Municipal garbage trucks are 2.55 meters wide, 12 meters long, and 4 meters high, by far exceeding the physical limitations of the sois in the slum (Transportation and Logistic Industry, 2000). As a result, municipal garbage collectors must enter the slum on foot to remove waste from the 200 to 300 240-litre garbage bins distributed throughout the slum area (Kongsai, 2014). This requires additional daily work on foot that the municipal garbage collectors assigned to Locks 1, 2, 3 must complete in order to successfully remove the waste produced in the slum.

Finding #8: Some residents do not entirely trust the BMA's municipal waste system because they believe the workers are inconsistent with the waste removal.

From our interviews with community leaders, we found that not all residents trust that the BMA will remove the residents' waste to the extent that district claims. In some areas of the slum that are harder to reach and further from main roads, the residents stated the BMA workers do not always collect the waste. From our interview with the BMA Khlong Toei District Office, the representative stated that the workers remove waste from every street if the residents have paid the fee. Through our interviews, it is unclear whether the residents' unwillingness to pay the BMA's fee resulted in inconsistent waste removal or if the BMA's inconsistency resulted in the unwillingness of the residents to pay.

Finding #9: The local Khlong Toei junk shop commonly used by the residents of Locks 1, 2, 3 has limited space to store items before they are sold to the recycling center.

From our interview with the local junk shop and our final presentation to the DPF and local residents, we found that the junk shop has limited space to store materials before the middleman purchases them.

Finding #10: The local Khlong Toei junk shop commonly used by the residents of Locks 1, 2, 3 does not collect all possible waste materials that hold monetary value.

The local junk shop we visited in Khlong Toei does not currently accept plastic bags, snack packaging and expanded polystyrene foam (EPS foam). Through our interview with a representative from the junk

shop we determined that other junk shops within the Khlong Toei slum also do not currently accept these materials.

As stated in Finding #9, from our interviews with the junk shop and our final presentation to local residents and the DPF we found that the junk shop has limited space to store materials. The space limitation in turn limits how many types of materials the junk shop can purchase.

Upon visiting the recycling center on Sukhumvit 36, we were informed that plastic bags and snack packaging can be recycled, contrary to what we were told by the junk shop workers in the slum. In addition, we found other businesses around Bangkok that provide melting services for EPS foam materials. We found that although these materials do in fact have monetary value and could be sold to companies in Bangkok, they are often openly dumped with other non-valuable types of waste because the junk shop does not currently purchase them.

Finding #11: Residents often hire other residents to transport their waste to dumping sites.

From our interviews with community leaders we found that many residents hire other residents to transport their waste to dumping sites as requested. Residents who do not pay for BMA services or produce too much waste for the BMA bins, are often willing to pay someone else to remove the waste from their home. The fee for these residents varies although one local worker we spoke with charges ten baht per removal. The hired residents sort out the recyclables to resell to the junk shop and bring the remaining waste to various dumping sites.

4.3 Objective 3: Determine the Current Lifestyle Effects

We determined the lifestyle effects of waste production and management through physical inspections as well as interviews including the DPF and members of the community board.

Finding #12: Many residents in the Khlong Toei slum do not understand the effects of hazardous waste and as a result do not handle it properly.

After presenting our initial intentions for the project to our sponsor, the Duang Prateep Foundation (DPF), we interviewed DPF representatives to determine the specific problems they would want us to address. Many of the representatives felt it was necessary that we address hazardous waste. One representative recalled an encounter with a resident who had used old car batteries to create a walkway through a swamp area next to their house. Another representative recalled watching children playing with fluorescent light bulbs and using them as "light sabers" in a sword fighting fashion. All representatives expressed their concerns with hazardous waste and the improper ways in which local residents handle it.

Since most residents have not had formal education, most do not understand how and why hazardous waste is considered dangerous. Many residents often handle hazardous waste the same as they do non-hazardous waste: open dumping or reusing the waste for other purposes. The municipal system handles hazardous waste similarly to non-hazardous waste as well. Municipal workers collect hazardous waste combined with non-hazardous waste and transport it to a landfill. At the landfill, workers then separate hazardous and non-hazardous into two separate dumping sites.

Finding #13: Open dumping of waste is a prominent problem within the slum that creates many fire and flood hazards.

Through our interviews with members of the community leader board, we found that occupants of the slum dispose of their waste in places other than municipal trash bins for two main reasons: it is often more convenient than finding a municipal waste bin to dispose of waste and there is no associated municipal cost in dumping the waste. Upon completing a physical inspection of the area, we determined that much of the garbage that is openly dumped is composed of materials considered valueless within

the slum such as expanded polystyrene foam (EPS) and plastic bags, some of which, are highly flammable (European Manufacturers of Expanded Polystyrene, 2002).

Abandoned houses in the Khlong Toei slum often become dumping sites for residents. According to members of the board, many residents often temporarily move out of or abandon their houses for various reasons. The original residents maintain ownership of the land making the property uninhabitable or unusable legally. These houses can become full of valueless and often flammable types of waste that create serious fire hazards for the Khlong Toei slum. Often lit cigarette butts ignite the flammable waste dumped at such sites, which in turn starts fires that render the houses uninhabitable. The charred sites continue to be used for dumping, creating a continuous cycle.

Often during the rainy months in Thailand, May through October, many of the walkways and houses in the slum flood. Garbage often blocks overflow drains further intensifying the flooding conditions. Throughout our physical inspections, we observed that many of the households in the Khlong Toei slum are built over small bodies of water interconnected and filled with garbage. Bad habits and the continual presence of waste in the water perpetuate the open dumping below the houses.

In this way open dumping not only causes more problems for the slum residents, it also reduces the amount of space available in the slum that could be used for additional housing or community initiatives. With little space available in the slum due to overcrowding, any recommendations for communal dumping sites must focus on finding space outside the slum.

Finding #14: The community board has led successful events to clean the water source used for emergency response.

Through interviews with the local community board members, we found that the members have led successful events to clean a water source used for emergency responses. The DPF fire station uses this water source, located in the slum to extinguish fires. Through our physical inspection we found that

large amounts of openly dumped waste collects in this area. In the past community board members have held events using the help of volunteers to clean the water. While the events have successfully cleaned the water, the water eventually fills again with waste.

Finding #15: Local residents expressed concern about the waste openly dumped on and around the railroad tracks.

Through our physical inspections we found that there is a large amount of waste located on the railroad tracks. According to the residents we interviewed, trash in this area not only came from the residents but also from visitors to the slum and train passengers. The residents believe that the existing waste in the area has encouraged people to continue to openly dump waste. One local resident expressed concerns about the safety of the train running over the excessive amount of waste that often covers the tracks. After our final presentation to the local residents, a community leader explained how at times the train gets stuck on the tracks for hours because it looses traction due to the waste. Other than these testimonies, the actual risk associated with the garbage covered railroad tracks is still unknown.

4.4 Objective 4: Identify Alternative Successful Waste Management Methods

To achieve our final objective, we identified successful waste management methods that could be applied to the current waste management system in Khlong Toei. To accomplish this objective, we conducted interviews with local residents of the slum, representatives of the Roong Aroon School, and the Thai Environmental and Community Development Association. We also contacted additional professionals to aid in our research.

Finding #16: Institutions in Thailand wanting to instigate behavioral change related to waste disposal can succeed by educating children.

From our interviews with local residents, we found that historically when food packaging was made out of biodegradable materials, such as banana leaves, Thais often disposed of waste openly. As packaging

became manufactured from artificial materials, their behavior did not change. The habits of Thai people led some organizations to want to improve the overall waste situation in Thailand. Two successful programs, Magic Eyes run by the Thai Environmental and Community Development Association and the Zero Waste Program run by the Roong Aroon School, have focused their efforts on educating children about proper waste management techniques. Details about these programs can be found in the section 2 of this report.

Both programs educated children about disposing of waste in proper bins, limiting the amount of waste they produced, and separating their waste. They educated the children by using recurring messages in their daily lives. Magic Eyes created a cartoon that was repeated often on television advising children to put waste in trash bins and encourage their parents to do the same. The campaign also involved stickers and posters plastered all over Bangkok featuring the image of the Magic Eyes to remind children not to litter. The Roong Aroon School, still a functioning program, starts with children in kindergarten. The teachers remind the students daily to wash their trash and separate it until the process becomes routine.

The success of these programs can be seen in two different ways. According to the TECDA representative we interviewed, cleanliness improved on the streets of Bangkok within the first five years of the Magic Eyes campaign. From our visit to the Roong Aroon School, we found the Zero Waste Program continues to succeed at the school more than ten years later. The program has now grown to invite parents of students to bring their waste from home to the center to separate it and decrease the overall waste being sent to landfills and incinerators.

Finding #17: The local community board of Khlong Toei plans to present a communal dumping site proposal to the BMA.

Through our interviews with Khlong Toei community board members we found that the board plans to present a communal dumping site proposal to the BMA. Currently, the residents unofficially use the site

for dumping, but it is not well maintained and the BMA does not always collect the waste. They will request that they receive funding in order to rent land from the PAT located under the highway along the railroad tracks. On the site, they plan to reconstruct concrete boxes that will be used for communal dumping. According to the head of the board, the most recent leaseholder of the land damaged the boxes, whose intended use was unknown.

Finding #18: Slum communities in other countries have successfully implemented sustainable waste management systems involving compost.

From our background research, we found many slum communities world-wide have successfully implemented waste management solutions by utilizing composting. In Dhaka, Bangladesh, for example, the entire waste management system was funded mainly by the profits of the compost sold to a fertilizer company. For every successful system, however, education was also necessary to raise awareness about the potential for different types of waste and how to properly incorporate them into the new strategy.

Finding #19: Involving art in community initiatives can help bolster the success of a project.

From our interviews with the TECDA and Paul Lord, Jr., a professional urban planner, we found that art can help bolster community initiatives. The TECDA recommended we have children draw arrows or create other signs to spread around the slum encouraging residents to use the communal dumping sites. Paul Lord, Jr., stated that other community initiatives have been successful by involving local artists or children in supporting change. He recommended we include art in our final proposal to encourage beautifying and keeping the slum clean.

Finding #20: The local daycare in Locks 1, 2, 3 currently teaches students how to sort valuable and non-valuable waste.

The only school that exists in Locks 1, 2, 3 is a daycare for children three to six although other schools for older children are located nearby. From our interview with teachers from the local daycare in Locks 1, 2, 3, we found that the teachers educate the students about valuable and non-valuable waste. They

have the students bring recyclable materials from home for the teachers to sell to the local junk shop. The teachers use the money from the recyclables to buy more food for the children.

Finding #21: Interactive and visual learning are effective methods for teaching kindergarten-aged children.

From our interview with Khun Peeda, an employee at the Science Center for Education in Bangkok, we found interactive and visual learning can be effective methods for educating young children. Khun Peeda recommended we involve a visual storyline such as a play or video to spark the children's interest in a topic. She also suggested we use interactive learning, such as a field trip through the neighborhood to show the children waste, to effectively communicate the importance of the topic.

Finding #22: In Thai schools, teachers only use yes or no questions or multiple choice answers to teach young students.

From our interview with Khun Peeda from the Science Center for Education, we found that teachers only use yes or no questions and multiple-choice questions to educate young students in Thai schools. She recommended when creating a lesson plan, we only use these types of questions to increase student participation and reduce any confusion.

4.5 Summary

The findings above were created based on research conducted through interviews, site visits and physical inspections of Locks 1, 2, 3. These findings helped us to determine the process used for the current waste management system as well as to identify alternative successful waste management methods feasible in the Khlong Toei slum. We have used the findings to form recommendations, which are described in section 5.

5 Conclusions and Recommendations

Based on our background research and our findings presented in the results and analysis section, we have developed overall conclusions and recommendations regarding the waste management strategy in Khlong Toei Locks 1, 2, 3 and ways to improve it. Although our recommendations are specifically aimed at Locks 1, 2, 3, they can be adjusted to fit other areas of the slum. The following section is divided into four parts; recommendations for the community board, for the local school, for the DPF, and for the local residents.

5.1 Conclusions

Based on our research we found that a community board existed to help represent and support the local residents. This board has in the past successfully held programs to clean areas of the slum. The board also plans to present a communal dumping proposal to the BMA Khlong Toei District Office in hopes of improving the current waste management situation in the area. From our research we also found that the current waste management system run by the BMA faces physical limitations and resident disapproval. Many of the residents already use the communal dumping sites unofficially, but neither the BMA nor the local residents properly maintain these sites. Based on these findings we concluded that the most effective way to improve the waste management situation in the slum was to encourage the community board's communal dumping proposal. We developed recommendations around supporting this initiative.

From our final presentation to the local residents, we found many of the leaders were concerned that residents would not use the communal dumping site only increasing the problem of open disposal in the

community. Based on their concerns and the current open dumping habits of the residents, we also developed recommendations to address behavioral changes for the local residents.

Finally, we found that problems exist in the slum related to open dumping of waste. We concluded that the best ways to address these problems were by reducing the amount of prominent non-valuable types of waste produced in the slum and reducing the number of locations for residents to openly dump their waste.

5.2 Recommendations for the Community Board and BMA

From our research we found the local community board plans to propose a communal dumping project to the Khlong Toei District Office. Based on this finding we have developed the following recommendations to support and to help improve their plan.

A) We recommend that the local community board follow through with their proposal to the BMA for rental of land to create communal dumping sites.

The local community board for the Khlong Toei slum plans to propose a communal dumping project to the BMA Khlong Toei District Office. The project will involve renting land from the Port Authority of Thailand under the highway located next to the slum to build concrete dumping sites where the residents of Locks 1, 2, 3 can dispose of their waste. From our discussion after our final presentation, we found some community leaders also would like bins to be picked up from the communal dumping sites. This would allow residents to continue to use their bins, but they would need to bring them or hire someone to bring them to the communal dumping location.

Many residents already dump their waste in this location, but it is not always removed thoroughly by the BMA, as the land under the highway is not part of their required route. This proposal also stemmed from the BMA's physical limitations of working with large trucks that cannot enter the small sois in the

slum. The BMA's trucks should have the capacity to remove all waste from the communal dumping sites, as the daily amount of waste produced will not change.

With the current waste management system, many residents do not trust that the BMA workers will walk into the slum to remove their waste bins. If the BMA instead promised to collect waste daily from only the proposed communal sites and was able to accomplish this, they could restore trust with the residents that could in turn spark more frequent use of the communal sites. If the BMA workers were to continue to enter the slum to remove trash, it would be on their own accord and for a separate cost. Thus we recommend the community board follow through with their proposal to help reduce the amount of waste accumulating in open dumping areas and rebuild the residents' trust in the BMA's system.

B) We recommend that the BMA readjust their fee structure and approve the community board's proposal for communal dumping sites.

With the current municipal waste management system, many residents are unable or unwilling to pay the yearly fee. Along with the proposal for the communal dumping sites, we recommend that the BMA consider decreasing their fee for waste removal. From our interviews, we found the current fee is collected either yearly or monthly, depending on what each resident can afford. We recommend, with the new decreased fee, continuing the monthly payment system for residents who do not live in the slum all year or who cannot afford to pay the whole fee at once. Although we were unable to determine the exact costs of the current waste removal process and the number of residents paying the current fee, a decreased fee could increase the number of residents willing to pay. We recommend when deciding how to structure their fees for the communal system, the BMA consider the following: the number of residents currently paying versus the number they expect to pay for the new system and the cost of the existing system versus the cost of the new communal system including labor and equipment.

C) We recommend that the community leaders host an event to clean the railroad tracks.

Active railroad tracks run through the Khlong Toei slum, which in some areas have become commonly used as dumping sites for the residents. Some local residents have expressed concerns about the waste openly dumped on and around the railroad tracks. The community board of Khlong Toei in the past has led successful events to clean the water source used for emergency response. To encourage use of the communal dumping sites and reduce concern among residents, we recommend the community board initiate a project to clean up the railroad tracks near the location of the communal dumping sites. Many residents and visitors believe it is acceptable to openly dispose of their waste around the railroad tracks due to the large amount of uncollected waste accumulated there. We recommend the community board create a program similar to the water cleanup with local volunteers to remove the waste. A clean environment could encourage residents and visitors to properly dispose of their waste in the communal disposal boxes.

5.3 Recommendations for the Local School

From our research, we found educating children is an effective method for instigating behavioral change in Thailand. We also found there are difficulties in attempting to communicate or educate local residents of Khlong Toei. Based on these findings we developed recommendations for the local daycare in Locks 1, 2, 3 to help improve the waste disposal behavior of the local children.

A) We recommend that the school for Locks 1, 2, 3 introduce a canvas bag activity into the school's curriculum.

Communities in Thailand wanting to instigate behavioral change related to waste disposal have succeeded by educating children. The daycare in Locks 1, 2, 3 currently teaches children about recyclable waste, but does not teach them about reducing the amount of waste they produce. Therefore, we developed a lesson plan about reduction of waste for the local daycare. We focused our plan on one

form of waste that does not have value and is often littered throughout the area, plastic bags. Our plan encourages the reuse of canvas bags to replace plastic bags received from stores. We recommend that the daycare implement this program for their kindergarten class. We recommend they evaluate the effectiveness of the lesson plan by using the student questionnaire (see Appendix O: Lesson Plan for Daycare in Locks 1, 2, 3). We recommend the teachers ask the questions individually to each student before and after the lesson plan to evaluate the students' understanding of the material. After the first year, if successful, we recommend local teachers implement a similar program with adjustments to fit the age of the students for older grades throughout the community.

This program could decrease the amount of plastic bag waste children produce and could encourage the local residents to adopt similar habits. As part of our deliverables we have initiated a trial run for the daycare center by helping the teachers to facilitate the activity.

After conducting a pilot test of our canvas bag activity the teachers filled out evaluations of the lesson plan (see Appendix P: Daycare Pilot Teacher Feedback). Through the evaluations we identified concerns teachers have regarding our activity. While teachers feel the students enjoyed the activity and learned the material, many of the teachers are concerned that the activity will not have a lasting effect due to costs and lack of continual participation of the students. We recommend that the DPF provide funds for the school to be able to afford the materials and to continue this project in the future. We also recommend that the school utilize a poster in the classroom in order to keep track of each time a student reuses their canvas bag. This will provoke competition among the classmates and motivate the students to continually use their canvas bag.

B) We recommend that the school for Locks 1, 2, 3 educate children about the types and effects of hazardous materials.

The BMA's Onnut dumping site is responsible for separating hazardous waste produced by the Khlong Toei slum. Therefore the residents are not responsible for separating hazardous and nonhazardous waste prior to the BMA's collection. In addition to our canvas bag lesson plan, we also recommend the school in Locks 1, 2, 3 educate students about hazardous waste. Due to the combined garbage removal, we recommend that the teachers do not educate the students about how to sort hazardous waste, but rather how to identify and properly handle hazardous waste. Since they are working with young children, we recommend the teachers educate them about two common types of hazardous waste in the slum, batteries and fluorescent light bulbs (see Appendix O: Lesson Plan for Daycare in Locks 1, 2, 3). We recommend the teachers evaluate the effectiveness of the lesson plan by using the student questionnaire included in our deliverable similar to the canvas bag activity. We recommend the teachers ask the questions individually to each student before and after the lesson plan to evaluate the students' understanding of the material. After the first year, if successful, we recommend local teachers implement a similar program with adjustments to fit the age of the students for older grades throughout the community.

From our interview with Khun Peeda, we found visual learning is an effective method of teaching kindergarten-aged children. Therefore, we included a puppet performance as part of our lesson plan to help the children understand the effects of hazardous waste.

Although hazardous waste has no value to the residents, it can negatively impact their health as explained in section 2.4.1.1. Therefore, it is important to educate the local children about how to identify hazardous material so that they will be more likely to properly dispose of these materials.

5.4 Recommendations for the Duang Prateep Foundation

After completing our project we found that more work and research is needed by the DPF to ensure the success of improvement to the waste management system. We have recommended different areas for the foundation to continue our research to address the problems with the current waste management strategy.

A) **We recommend the DPF propose revised public policy to the government related to land ownership requirements of abandoned houses.**

Some residents of the slum dispose of their trash on abandoned properties creating fire hazards and allowing the perpetuation of open disposal habits. We recommend the DPF conduct research to re-evaluate the land ownership requirements for these homes. One of the community board members we interviewed mentioned this could help alleviate the dangers associated with waste on abandoned properties. With fewer abandoned properties in Khlong Toei, there in turn could be fewer areas for residents to openly dump their trash. With fewer such areas, the residents could be motivated to utilize the communal dumping sites, and there would be less risk of fire for the neighborhood. We recommend the DPF conduct further research to determine the specific hazards associated with abandoned homes, the length of time these hazards take to develop, the reasons residents abandon their homes, and the number of people who return to their abandoned properties.

B) **We recommend the DPF conduct research to determine if a communal composting project would be feasible and how it could be implemented.**

Slum communities in other regions similar to that of Khlong Toei have successfully implemented sustainable waste management systems involving compost. Based on the success of programs such as those discussed in sections 2.3.1 and 2.3.2, we recommend the DPF conduct research to determine how much organic waste is produced in the slum and if a composting scheme could help reduce the overall

amount of waste produced. The Khlong Toei slum faces many challenges with composting including lack of space and funding, but our research shows with the proper support compost initiatives have been successful in similar areas. The benefits to a composting system could include a decrease in the amount of waste collected by the municipal system and a potential source of income for the neighborhood from the sale of the resulting fertilizer.

C) We recommend the DPF record evaluations of the lesson plans for the daycare in Locks 1, 2, 3 and determine how to implement a similar plan for other local schools.

Communities in Thailand wanting to instigate behavioral change related to waste disposal succeeded through educating children. Their success reinforces that a successful education program should be spread throughout the Khlong Toei schools to help ignite change. Once the teachers at the daycare in Locks 1, 2, 3 have made the proper preparations to teach their students, we recommend the DPF arrange for teachers from the local schools in Khlong Toei to observe its implementation. After the observation, we recommend the DPF distribute a survey to each teacher to receive their feedback about the education plan and how to potentially adapt it for other ages and schools. With these surveys, we recommend the DPF along with local teachers, create lesson plans with similar goals to apply to all grade levels and schools in Khlong Toei (see Appendix Q: Teacher Feedback Survey). Further research should be done to recommend effective strategies for educating older children about proper waste disposal or reduction techniques.

D) We recommend the DPF monitor the communal dumping strategy monthly after implementation until the DPF deems the program a success or a failure.

Currently many residents pay monthly for municipal waste removal. With the implementation of the new communal dumping plan and the new fees associated with it, we recommend the DPF monitor the new strategy monthly to ensure the satisfaction of the paying residents. Each month, the DPF should evaluate the system based on interview responses using the protocol provided (see Appendix R:

Interview Protocol Post Communal Implementation). We recommend they interview the residents who live near the railroad tracks and communal dumping sites as well as other residents throughout Locks 1, 2, 3.

E) We recommend the DPF show the recording of our final presentation to residents from other areas of the slum and request feedback from the residents.

After our final presentation to the DPF and local community residents, Khru Prateep requested we record our presentation for the foundation to show to the 42 other communities of Khlong Toei. With this presentation we intend for the foundation and local leaders to receive feedback and adjust our recommendations accordingly to fit each area.

5.5 Recommendations for the Local Residents

As part of our recommendation for the community leaders to pursue their communal dumping site project, we have also developed recommendations for local residents surrounding this project. With these recommendations we hope to involve the local residents and gain their support for communal dumping.

A) We recommend that the residents paint the walls of the concrete boxes used for communal dumping.

From our interview with Paul Lord, Jr., involving art in community initiatives can help bolster the success of a project. We found that community participation can increase local interest in projects. To decrease the amount of waste openly disposed of around dumping sites we recommend that the walls of the proposed communal dumping sites be painted. From the physical inspection of Locks 1, 2, 3 we found that residents often dispose of their waste around the dumping boxes rather than inside them. In order to encourage changes in the behavioral habits within the slum to dispose of waste inside the dumping boxes we recommend that the outside of the communal dumping boxes be decorated.

After our final presentation to local residents of Khlong Toei and the DPF, many of the residents responded positively to idea of incorporating art. Khru Prateep specifically recommended we make the design for the art on the concrete boxes a competition among school children. The DPF also mentioned they could support the cost of this project with fundraisers and supplies (see Appendix N: Final Presentation to DPF and Local Residents).

B) We recommend that students from the Locks 1, 2, 3 school paint directional arrows that lead to the communal dumping sites.

From our interview with Paul Lord, Jr., we found community participation can increase the local interest in projects. In order to remind residents to properly dispose of their waste in the communal dumping sites, we recommend that the residents paint directional arrows pointing to these sites on the paths within the slum. We suggest the DPF support and run this project as a competition for children similar to the one recommended for the concrete boxes. By involving the children, we intend for all residents to in turn accept and support communal dumping.

C) We recommend that the local Khlong Toei junk shop commonly used by the residents of Locks 1, 2, 3 expand their list of valuable materials they handle.

We found that the market for waste in Thailand created a way for residents of the Khlong Toei slum to make profit from certain types of waste. The local junk shop, the most convenient source for selling their waste, does not purchase all materials that hold value in the Thailand waste market especially at the local recycling center where the junk shop ultimately sells their waste. In addition, from our physical inspection, we found residents commonly do not properly dispose of materials such as packaging made from expanded polystyrene foam (EPS), plastic bags, and snack packaging. We recommend the DPF work with the local junk shop in the Khlong Toei slum to contact another business or to negotiate with the current middleman to buy and transport these additional valuable materials that are prominent throughout the slum. We recommend the foundation and junk shop speak with the recycling center

about other possibilities for transporting the waste. This recommendation intends to decrease the amount of commonly littered items accumulating throughout the slum while also increasing profit for the junk shop.

D) **We recommend that the local Khlong Toei junk shop commonly used by the residents of Locks 1, 2, 3 advertise their expanded list of valuable items**.

From our final presentation to the local residents and DPF, we found many residents are unaware of all materials that are valuable in Bangkok. We also found that the junk shop has a limited amount of space to store the materials before they sell them to the recycling center. We recommend with the expansion of the valuable materials list at the local junk shop, that the DPF also help the junk shop create large advertisements in popular public areas of the slum. With this recommendation, we intend for more residents to sell all types of valuable waste, reducing open dumping, and for the junk shop to generate enough revenue to support additional space needed for the new materials they would collect.

5.6 Summary

Our proposed recommendations aim to create a sustainable waste management strategy for Locks 1, 2, 3 of the Khlong Toei slum. Our recommendations not only focus on how the municipal system can be improved, but also how local residents can improve their behavior and habits related to proper waste management. We hope that by introducing the residents to proper waste disposal methods, and by supporting the community board's decisions we could potentially involve the entire population in the waste management process, creating a community sustained system.

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Appendices

Appendix A: The Duang Prateep Foundation

Founded by Khlong Toei's own Khru Prateep Ungsongtham Hata, the Duang Prateep Foundation (2013d) has spent the last 35 years creating educational programs to improve the overall quality of life within the slum. Khru Prateep created the program in 1978 with the intent to empower the slum through educational programs and other projects.

When Khru Prateep was 11, she began to save her wages in order to receive secondary school education (Manila, 1978). It was not until the age of 15 when she was finally able to pay her way through school. Her own struggle to afford education inspired her to open a school in her home. Khru Prateep's "One Baht a Day School" not only provided children with education but also a refuge from the slum life. This opportunity gave children a chance to learn and work together, in turn creating a stronger community. Her efforts earned her the Magsaysay and Rockefeller award, and with the prize money she was able to start the privately funded Duang Prateep Foundation (2013d).

The name Duang Prateep means "guiding light", and its symbol in the shape of a flame represents children (DPF, 2013e). In order for a population to develop, the DPF feels that educating the younger generation is the most important step. The foundation focuses on the education of children and currently supervises 8 kindergartens in Bangkok slums. In Thailand public education still has many costs that need to be accounted for in order to attend school. Each year the DPF helps to sponsor over 2,300 less fortunate children living in slum and rural communities. As the foundation continues to grow, the DPF has managed to sponsor children beyond the Khlong Toei slums.

The DPF (2013d) began with only five people in a single small office but now consists of twenty employees and over one hundred volunteers. Since its start in 1978 the DPF has initiated and run 20 projects. In 1988 the DPF (2013c) started an AIDS awareness campaign throughout the Khlong Toei slum district. The foundation has since then become a leader across Thailand in educating the public about HIV/AIDS. Over the past two decades the incidence rate of HIV in Thailand has reduced from 143,000 to 10,853 (World Health Organization, 2013). While the decrease in HIV cases shows progress, AIDS continues to be a prevalent problem in the Khlong Toei slum. There are currently four full-time staff at the DPF who work specifically on the AIDS awareness campaign along with over 300 volunteers who continue to help spread information throughout the slum (DPF, 2013c). The volunteers are often local slum dwellers and therefore are a crucial vehicle towards spreading awareness within the slum. Posters, leaflets, and condoms are freely distributed to the residents as ways to raise awareness and educate the slum population about the disease.

Today projects include collaboration with the Department of Health to campaign against dengue fever (DPF, 2013c). In 2013 alone, there had been 109,468 reported cases of dengue fever and of those 102 were fatal. The DPF held an event featuring many guest speakers, in order to inform the public of the rising epidemic. The speeches were followed by an educational performance by the Nithan Caravan puppet troupe. The Nithan Caravan was created by the foundation as an entertaining method of education. The original intent of the mobile puppet show was to foster interest in books, to teach children about Thai culture, to address environmental concerns, and to instill good morals in their audience. In 2013, however, the Nithan Caravan adapted its performances to teach current concerns pertaining to the residents, and they continue to share their dengue fever performance with students and teachers at over 200 schools in Bangkok.

The DPF has recently begun a program to offer children who suffer from drug addiction, exploitation, and crime the opportunity for a second chance (DPF, 2013c). Donations and government grants fund the DPF projects. However, Khru Prateep's recent political involvement with the red shirt rallies has caused the DPF domestic donations to decrease by 40 percent (Ashavagachat, 2012). Regardless of the decrease in funding, the organization has remained committed to its educational projects for local children and the whole population of Khlong Toei.

Appendix B: Wongpanit Recyclable Material Prices

Metal							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Grader blade	13.8	Shock Absorber	6.8	Black C Shape Pipe	7	Car/Pickup truck	5.5
Thick Iron, Cut (length does not exceed 80cm)	9.3	Wire Rope, Untangled	7.7	Big Cast Iron	9.5	Steel Cable, Tangled	7.2
Thick Iron, Uncut	9	Wire Rope, Tangled	6.9	Small Cast Iron	9	Swarf Iron	3
Short Thin Iron Scrap (length does not exceed 50 cm)	8	Iron Nails	8	Iron Engine	8.8	Thick A/C Zinc Pipe, New	4.5
Uncut Metal Scrap	7.7	Thin Iron Scrap, Uncut (length does not exceed 50 cm)	8	1" Tie steel cable (more than 1 meter)	9.4	1/2"-5/8" Tie steel cable (length 50cm)	9.2
		Thin Iron, Uncut	7	Can	5.3	Zinc Scrap	4.3

Paper							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Carton	3.5	Mixed paper	1.5	Black/ White paper	6.2	Newspaper, dirty	3.5
Color paper/paper box/shoe box/fruit carton	1.5	Book paper, coated paper (surface gloss)	1.5	Notebook	6.2	Newspaper clean and organized	3
Proof paper	1.5	Cement bag	1.5	Computer paper	6.2	Milk/ Juice Carton	0.4
						Single surface gloss paper	0.3

Glass Bottles							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Maekong bottle	1.8	Black label bottle only	0	Medicine bottle Big	1.8	Carabao Dang	1.5
Maekong bottle, full case	25.5	Black label with box	5	Small clear medicine injection bottle	2	Clear glass	1.8
Chang, Acha (clean box)	12	Water bottle/piece	0.7	Lipo	1.5	Red glass	1.5
Leo (clean box)	7.5	Water bottle with box	12.5	Rangyer, M-150	1.5	Green and mixed pieces of glass	1.5
Dek somboon bottle 12/case	4	Small flat bottle	0.2				
Dek somboon bottle 24/case	6	Small flat bottle / 12	5.5				
		Big soda bottle	2				
		Small soda bottle	0.5				

Plastics							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Clear PET bottle	14	Saline bottle with cap	11	Big PE plastic bag	1.3	PVC slippers	6.5
Color PET bottle	4.5	Saline bottle without cap	7.5	HDPE plastic bag	1	PVC boots	13
Brown PET bottle	N/A	Big plastic, crispy and sink	0.5	Dry Big Black Bag	0.7	PP, TD 10,20 (half floating/half sinking)	2
HDPE white bottle	18	Packing strap (float)	1.5	Color PP board	2	PC headlights of car	2
20L HDPE plastic bottle	6	VCD	12	Black PP board	1.2	Soft water hose	7.5
Mixed plastic	7	DVD	2.5	Blue/Yellow PVC pipe	9	Hard water hose	5.5
Plastic cap	0.5	PVD bottle color/clear	0.4	Grey PVC pipe	0.5	Green hose	5.5
Acrylic plate	12	Cement bag (dry, clean)	1	PVC door/frame	0.7	Clear PS CD case	1
		PVC carpet	3.4	Big black PVC wire cover	6.5	Foam (clean)	3
				Small black PVC wire cover	5.5		
				Color PVC wire cover	3.5		

Highly Valuable Metals							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Aluminum can	38	Al alloy	26	Al blinds	23	Thin brass	126
Thick aluminum scrap	46	Al fire	0.5	Al net	19	Brass radiator	121
Engine aluminum, piston, gear, engine	50	Thin Al scrap, clean	42	Al radiator	29	Brass swarf	78
Big aluminum piston	46	Al cable	51	Copper-Al radiator	100	Aluminum swarf	9
Aluminum max wheel	50	New al frame	48	Copper no.1 peeled, new	209	No. 304 stainless steel	31
Electric aluminum wok (clean)	29	Al plate	44.5	Copper no.2 electrically shocked	196	No. 301 stainless steel	7
Aluminum electric	29	Al lid pure	29	Copper no.3 burnt	191	Soft lead	41
Aluminum wok	29	Al lid with plastic	12	Copper no.4 small	189	Hard lead	29
Aluminum brake pad	27	Al pesticide bottle	2	Copper no.5 white coated	179	Lead-zinc	22
Burnt Aluminum	2	Drinking water bottle al with plastic	18	Thick brass	136	White case battery	25.4
		Drinking water bottle al without plastic	9	Small battery	8	Black case battery	21
		Al jug	12			Motorbike battery	22.9

Office machines and electronics							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Computer monitor, keyboard	2	VCD, DVD player	3	Electric kettle	4	Water heater	4
CPU	5	Stereo	3	Food blender	3	Gas stove	6.5
TV	0.5	Amplifier case	1	Electric stove	5	Vacuum cleaner	6
Printer, mouse	5	Fan, ceiling fan	6	Rice cooker	6.5	Washing machine	6
UPS	5	A/C	8.5	Electric water filter	4	Water pump	7
Fax machine	5	Air purifier	4	Electric wok	6	Electric lawn mower	7
Copy machine	5	Ventilators	4	Electric Iron	6	Water cooler	6
Telephone, mobile phone	2	Refrigerator + compressor	6.5	Hair dryer	1	Submersible pump	7
IC chip, CPU with Gold	1000	Oven, microwave	5	Sewing machine	7.5	Wall clock	1
No. 1 PCB	200	No.3 PCB	50	Camera	1	Safe T-Cut	5
No. 2 PCB	100	No.4 PCB	2	Emergency power unit	5.5	Toaster	5

Others							
Item	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht)/ Unit**	**Item**	**Price (baht) /Unit**
Big candle	5	Used cooking oil/20L. New gallon	180	Dry coconut meat	10.5	Kapok mattress	5
Candle scrap	3	Used cooking oil/20L. Old gallon	150	Dry shredded coconut	6.3	Blue stripe wells	3
Used cooking oil/kg	8			Coconut shell	N/A		

Appendix C: Mercy Foundation Semi-Structured Interview Protocol

Interview Response: Mercy Center Trash Bank

Interviewee: Anonymous Representative

Location: Mercy Foundation

Date: February 11, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

We saw some trash outside. What are you doing with it?

We started a Trash Bank program for the slum dwellers in 2011. It is run by a group of housewives in the community. The Trash Bank is basically a place where the slum dwellers can sell their trash to and keep an account of how much they earn. They can also withdraw the money instantly or keep it for later.

Are there many people participating?

We currently have 110 members in the projects including many kids. The kids tell their friends and other kids join but there are also a lot of older people.

How do you get the word out?

People in the community recommend it to other people. We do not do any advertising.

What types of materials do you accept?

We take everything that has value and sell it to the local junk shop. We take a certain percent off of the items for processing fees to keep the project running. We used to have buyers come pick the trash up from us but since there is not much, it is not worth the buyer's time and transportation fee.

What makes your project running even though you also sell to the same junk shop as the locals and you take a percent off?

People can receive the money from the trash they brought in or exchange for things such as toothpaste, shampoo, soap, detergent, rice and etc. We get sponsored by Colgate and that is why we are able to give the slum dwellers a lower price than them buying at a 7-11 or a traditional convenience store.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

Appendix D: Junk Shop Interview Protocol

Interview Response: Junk Shop

Interviewee: Anonymous Representative

Location: Junk Shop, Khlong Toei

Date: January 29, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

May we take pictures of your shop?

Yes.

How do you separate the trash?

We separate them by types.

How many types of trash?

There are about 5-6 types of plastic bottles. Including clear and different colored bottles. Cans are in a different category. We also accept pieces of metal, glass bottles.

Do you buy electronic wastes such as computers and mobile phones from the residents?

Sometimes we get computers and laptops. Then we need to separate the parts of the computers before we can sell them to a larger junk shop.

Do you get batteries or other hazardous materials?

We also get batteries from the people.

Do you buy and sell the batteries?

Yes, but we need to bring it to the buyer by ourselves. We sell it with aluminum cans and copper wires.

Are there any materials you do not accept?

We don't buy or sell wood.

What type of trash do you get most often or in the largest amount?

We mostly get plastics from people who sell it to us.

What type is the least?

We rarely get aluminum cans.

Are there more people who separate the trash before they sell it to you compared to those who don't?

The people who know how to separate will separate their items because the price is different. Those who don't know how to separate will get a lower price but they are willing to get less because they don't want to separate by types.

How much do people get if they don't separate it?

They (the slum residents) get 4-5 baht per kilo because we have to separate it ourselves.

Do you prefer the trash separated or not?

We don't want to separate them ourselves because it is a waste of time.

What types are recycled?

All the plastic, for sure.

What are the prices of each types of trash?

We get 3 baht for cans, metals are 7 baht, clear bottles are 14 baht, and plastic buckets and containers are 8 baht.

Where to you normally sell it?

We bring it to Soi Sukhumvit 36 or Soi San Sabye.

Do you only sell to this place?

No, we bring it to 2-3 other places.

Do recycling company come to pick the trash up from your junk shop?

We only deliver metal scraps to the place, other trash is pick up from the buyer.

How much trash do you sell at a time?

Truck loads, which is about 1 ton per truck.

How much trash do you get in a day?

We get 2 full trucks from the residents, which is around 6 thousand baht.

How much do you get for selling the trash?

We get 5 to 6 thousand baht for a full truck. If the truck is small, we can get around 3 to 4 thousand baht.

About the price, we know it fluctuates, so we want to know if you store some type and wait for the price to be acceptable or not?

No, we don't wait. We sell it every day. If the price goes down, we go down with it.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

Appendix E: Sivalai Reusable Interview Protocol

Interview Response: Sivalai Reusable Co., Ltd.

Interviewee: Anonymous Representative

Location: Sivalai Reusable Co., Ltd.

Date: February 9, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

May we take pictures of your shop?

Yes.

Who do you collect trash from?

We get all kinds of recyclable materials from local sam-laws (three wheeler) or trucks. We also get materials from construction sites, hotels and supermarkets.

Do you separate trash given to you or do you only accept sorted trash?

We do not sort the trash, people that sell to us already sorts all them.

Are there more people who separate the trash before they sell it to you compared to those who don't?

All of the trash must be sorted because we do not accept ones that are not sorted.

What types of trash do you buy?

We buy everything except hazardous wastes.

What are the (current) prices of the trash that you buy?

- PET bottle 17 baht per kg.

- White paper 7 baht per kg.

- Aluminum cans 43 baht per kg

How often does the price of trash change?

Everyday.

What controls the price change?

The price depends of world market and the supply and demand of each item.

How much money do you make from the trash?

N/A

What do you do with the waste purchased? Do you sell the wastes? Who is the buyer? How often?

We sell it to other places. We sell paper to a publishing company, which recycles the paper, and make them into books or notebooks. Plastic bottles are sold to the factory that makes them and gets recycled into new bottles. This process is same with all materials we buy and sell. Everything gets recycled, everything is money. We ships off the materials everyday to various factories.

How do you dispose of hazardous waste?

We do not accept hazardous waste because it too dangerous.

Do you know where the trash goes after you sell them to whomever?

Most of the trash is recycled such as paper, plastic, PET bottle.

How much trash do you collect a day?

N/A

What types of trash is valuable? What is not?

Copper wire is the most valuable. It is 400 baht per kilograms.

How much trash do you sell at a time?

We sell everything every day, depends on what type comes in most, it will be sold most.

What type of trash do you get most often or in the largest amount?

Paper, PET bottle, Carton

What is the least?

N/A

Do you store certain types of trash and wait for a better price?

No, there is not enough space to store all the trash. The space we have is barely enough to store materials we receive each day.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

Appendix F: Chulalongkorn University Head Janitor Interview Protocol

Interview with Chulalongkorn University Worker

Interviewee: Head Janitor

Location: Mahamongkut Building, Faculty of Science

Date: January 28, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

What is your role in the waste management process?

I usually collect and sort the trash from the Mahamongkut building. Each floor has 2-3 janitors. We sort trash into toxic wastes and chemical wastes, valuable and non-valuable, and other trash.

Where does the trash go/who takes care of it?

I sell valuable materials to junk shop which willing to pay for recyclable materials.

And for non-valuable material such as non- recyclable trash, BMA will collect every 2-3 days per week.

Does the university pay to have waste removed?

N/A

Does the university sell any of its waste?

N/A

Is there a profit?

N/A

How is the trash sorted?

Mahamongkut Building, trash is sorted into five categories: 1) Recyclable 2) Non-Recyclable 3) Hazardous 4) Chemical wastes 5) Biodegradable. We have arranged to handle each category in different ways. For example, we will remove the valuable waste for our own profit; I sell recyclable material such as PET bottles, plastic and paper to junk shop. Hazardous waste such as batteries, Chulalongkorn has provided a box for keeping them. But I don't know where it goes. For non-valuable material, it will be later collected by BMA. Chemical wastes are separated by Laboratory's assistance and later sent to some private organization but after that, I don't know what they do with this type of waste.

How often is trash removed from on campus dumpsters?

I sort the trash every day and BMA will collect trash approximately 2 days per week.

How much trash does the university produce?

I don't know an exactly amount of trash the university produce. But I think that a lot because only Mahamongkut building, you can see that bins are always full of trash.

What type of trash do you get most often or in largest amount?

Plastic bottles are number one and follow by paper.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix G: Chulalongkorn University Facilities Interview Protocol

Interviewee: Trash sorter

Interviewee: Anonymous Representative

Location: EBA canteen, Faculty of Economic

Date: January 28, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

What is your role in the waste management process?

We sort trash in this cafeteria. We separate plastic bottles, cups, and aluminum cans and sell it for our own profit. Food waste and other trash are picked up by the BMA. We return the plates and redeemable glass bottles to where it needs to be.

Where does the trash go/who takes care of it?

The BMA collects the organic trash, food scraps and other non-recyclable & non-valuable materials.

Does the university pay to have waste removed?

N/A

Does the university sell any of its waste?

N/A

Is there a profit?

N/A

How is the trash sorted?

We separate food scraps into one bin. Valuable materials such as bottles and cans in the same bin and it will be sorted once it is bought. The other trash that is not in the two categories above is thrown into a different bin. We do not care what it is. Sometimes students put their water bottles in the Chula's recycling box. We do not own the things in the box. It belongs to the university.

Does the trash remain sorted throughout the entire process?

It is sorted again more thoroughly once it meets the buyer.

How often is trash removed from on campus dumpsters?

It is removed 1-2 times a week, depending on how much trash there is.

How much trash does the university produce?

About 3-4 full buckets a day, which is around 5 liters.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix H: Duang Prateep Foundation Semi-structured Interview Protocol

Interview Response: Duang Prateep Foundation

Interviewee: DPF Representative

Location: Duang Prateep Foundation

Date: February 11, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

Why does the DPF believe there is a problem with waste management in Khlong Toei?

We believe that the district (BMA) is not doing a good enough job judging by how much waste is left in the community.

What does the foundation perceive to be the effects of the lack of waste management?

Due to lack of an efficient waste management system in Khlong Toei slum, the excessive waste creates foul odor, bad environment, the community looks dirty, bad water quality and garbage often blocks overflow drains during rainy season.

Who do you believe is responsible for managing the waste?

The district (BMA) is responsible for collecting the trash but they don't collect it from everywhere in the community, which means that some residents who live far away don't always benefit from the system.

What do you know about the communal collection sites (who uses them, who collects them, etc.)?

There is one site for Lock 4, 5, 6 and there are other areas but we we're unsure because it is not an official communal collection site. People just see that there is a lot of trash being thrown there and they just follow. The dumping area on Lock 4, 5, 6 is not set up by anyone, it just happens to be there. The BMA sometimes drags trash out and sometimes the slum residents help.

Have any attempts been made to address this issue before, such as the 1994 IQP?

There are projects such as garbage for eggs, trash for baby powder, books, and pencils, depending on the area. Most of the projects are conducted in 70 Rai community.

Why was this project not successful?

The project is not successful because there were not enough funds to keep buying rewards.

Even though the DPF funded the initial funding, the trash that received and sold is not sufficient for the new purchase for eggs. For example, the first purchase for eggs is 2,000 baht. The people trade trash for egg and sell the trash. The money from selling trash is only 1,800 baht, which means we didn't reach the break-even point and the project is discontinued.

Are there other problems you would like to address?

Everyone in the community separates valuable trash and sells it. Most of the people who do this are old people because they do not have a job. They often sell trash everyday because there is no place to store it. This is an issue because the price of trash fluctuates every single day. If the prices go down, the people do not have enough to eat.

What are the DPF's limitations as far as assisting in a possible implementation?

We do not have enough space in the community nor the funds to keep projects going on for a long time.

Is the TECDA still involved in Khlong Toei or have they ever been involved?

No. Khlong Toei community is not their focus group.

We would like to interview a local health professional about common health issues in Khlong Toei that could be related to poor waste management. Do you have a recommendation for a hospital or doctor that Khlong Toei residents often go to?

Most of residents in the community often go to Bangkok Health Center 41 not far from community and also Pracharat Hospital at Bang-ruk. They can use 30 Baht Health Care Scheme.

How did the residents clean the water used for fire extinguishing? Volunteers, paid, etc.?

The water for fire extinguishing doesn't need to be clean. But we have events to clean a water source and there are volunteers to fetch the trash out because it can block the pipes used to extinguish fire.

What would you like us to focus on? Hazardous, organic, general solid waste, etc.?

The priority is solid waste that is collect by the BMA. We also want to educate people about hazardous and toxic wastes because most people do not know the harm it can do to them. There are cases that kids used fluorescent light bulbs as a light saber and once there were residents that used old batteries to build a walkway.

Does the foundation have any funds they would be willing to put towards a possible proposal?

Foundation doesn't have a budget for environmental projects.

We would also like to interview local community leaders to ask them about their problems with waste management. Could you help us set this up?

You can contact an additional representative to set up meeting on 4th floor at Duang Prateep Foundation.

How many community leaders are there?

There is 1 community leader and 25 community board members.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

Appendix I: Local Resident Interview Protocol

Interview with Local Resident

Interviewee: Garbage Sorter

Locations: Locks 4, 5, 6

Date: January 29, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

What is your role in the waste management process?

I sort garbage that is dump in front of my house.

How long have you been doing this?

I have been doing this for 9 years. The place used to be a big pile of trash (30 years' worth) because the PAT dumps it there. Then it is made into a school. So I sort the trash that is left. (Now they dump it at Onnut Sukhumvit 77)

How do you make money from the trash?

I will sort a valuable trash such as plastic bottles and my daughter brings it to Sukhumvit 62. And the reason that I don't sell it to junk shop around here that because I will get less money.

Where do you take the trash?

My daughter brings it to Sukhumvit 62.

How much money do you make from the trash?

I get 400-500 baht per month and store it until there's a lot.

Do you sometimes wait until the prices are higher for your trash?

Yes, sometimes I will wait until the prices are higher

How often does the BMA remove trash?

BMA will remove trash 3-4 days at night from the specified BMA garbage bins at night

Do you pay for this process?

No. Actually, each house have to pays 250 baht per year but most of the houses don't pay because they cannot afford to pay the whole fee at once and not all residents trust that the BMA will remove their waste.

Did you work for the BMA in the past?

Yes

What did you do when you worked for the BMA?

I worked as road sweeper.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix J: BMA Personnel Interview Protocol

Interview with Public Cleansing and Public Park Section at Khlong Toei District Office

Interviewee: Anonymous Representative

Location: Khlong Toei District Office

Date: February 7, 2014

Introduction: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

How many waste collection workers within the department are assigned to the Khlong Toei district? How many are assigned to the Khlong Toei slum?

N/A

What types of vehicles are used for waste removal in Khlong Toei?

What is the waste capacity of these vehicles?

We have 5 workers per 1 garbage truck. One is the driver, the other 4 collect garbage. The 5-ton truck can carry up to 7 tons of garbage.

How many collection vehicles of each type are assigned to remove waste in Khlong Toei?

There are 4 trucks collecting garbage from the Khlong Toei slum area. The normal route is the route that workers have to go collect trash every day. We have 1 truck to collect from Arj Narong Road to Lock 4, 5, 6, which collects approximately 6 to 7 tons per day. We have 1 truck to collect from 70 Rai, which collects approximately 7 tons per day. We have 2 trucks collecting the road near the DPF and Locks 1, 2, 3 and under the expressway, which collects about 7 tons per day. We also have an extra route to collect under the expressway and railroad every 3 days.

How often do municipal workers collect waste in Khlong Toei?

The workers collect waste in Khlong Toei every day at night from 11pm to 4am. The time also depends on how much work they have that day, so it varies.

Where is the waste collected from, i.e. the exact pick-up locations?

a) Are there enough pick up location?

Yes. It depends on the people's behavior, if people in community have discipline, that's fine. If the people keep on throwing trash everywhere, the municipal system cannot possibly clean up everything after them.

b) Are there problems when collecting waste?

There is very limited space. Sois [streets] are very small. These sois are wide enough only for one or two people walk. So, it's hard for us to go in and get the trash out. Also, there are a lot of garbage bin (approximately 200-300) but people take them into their houses.

Once the waste is collected, where do the municipal services bring the waste?

Some of the trash, such as recyclable materials, is sold to a junk shop for our own profit. Besides valuable trash, we dump it at the Onnut dumping site.

Is the waste separated? When is the waste separated?

Different types of waste are separated on the trucks. There are bags on the sides of the truck and the workers will separate bottles and other valuable trash. The workers make profit from sorting the trash. Non-valuable trash is dumped at the Onnut dumping site.

What happens to toxic and hazardous waste?

The dumping site at Onnut has a separate area to store the hazardous waste. The hazardous waste is either put into landfills or a private company will take the waste and dispose of it.

What happens to organic waste?

Organic waste is also sent to landfill at Onnut.

Can we visit this place?

You must make a letter to ask for a site visit but I guarantee that it is impossible because of the way it is operated.

Do the residents pay a fee for the municipal waste collection services? If so, how much? How is the money collected?

The people pay 20 baht per month or equivalent to 240 baht per year. But only 30-40 percent of the residents pay the collection fee. We have a list of houses that paid from the civil registration so we know who paid and who didn't.

Does the municipal system use recycling?

Yes

a. Private or BMA run system?

Private

b. Does the Khlong Toei district sell the waste?

Yes

Can you tell us the current values of recyclable materials, or could you tell us where to find this information?

N/A

What are the requirements for a household to have its waste removed?

Land rights, taxes, etc.

The resident needs to pay collection fee of 240 baht per year per house to get their wastes removed.

Is it possible for Khlong Toei to receive funding from the district to manage its own waste management system?

No.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix K: Community Leader Interview Protocol

INTERVIEW 1

Interview Response: Community Leaders

Interviewee: Community Leader 1 and Community Leader 2

Location: Community Leader 1's house

Date: February 11, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

What is your most important role?

Community Leader 1: I was a community leader.

Community Leader 2: I was the treasurer on the community board.

How do you dispose of your waste?

a. Do they recycle?

b. Do they compost?

Community Leader 1: I share a trashcan with two other houses and pay 40 baht per month. For valuable trash, I sell it to local junk shop but I do not compost.

Community Leader 2: I take out the trash to dumping site under the expressway every day. And I sell the valuable trash. My cousin collects the valuable trash and sells it at a local junk shop at the end of each month but I do not compost.

How do most of your neighbors dispose of their waste, if applicable?

a. **Do they compost or sell to the junk shop?**

Community Leader 1: I share a garbage bin with my neighbor. And some of my neighbors pays for the trash collection to the distinct, some don't.

Community Leader 2: My neighbors are my family, they have little trash so they take it to the dumping site everyday or one of my cousin collects them. Most of the neighbors sell the valuables but they do not compost.

If municipal:

a. **How often does the system collect your waste?**
b. **Do you pay for the system? How much?**
c. **Do you think this system is effective? Why/why not?**
d. **What are the problems with this method, if any?**

Community Leader 1: The district picks up trash everyday in the evening or at night. The amount depends on how much trash. Most of the time it's 20-40 a month per household. The system is effective but the people in the community are not and I have no recommendations but it depends on the people behavior. Even though there is a bin, they do not care to take out the trash, etc.

Community Leader 2: I agree with Community Leader 1. The system itself is effective but the people in the community are not.

Do you think any changes need to be made in managing the area's waste?

a. **If yes:**
    i. **How does poorly managed waste affect your neighborhood?**
    ii. **Have you tried implementing any changes? If so, what are they and how have they been (successful/unsuccessful) and why?**
    iii. **What recommendations do you have on ways to improve the situation?**
    iv. **Do you know of any possible locations trashcans could be placed for a communal site? Playgrounds, community centers, etc.**

Community Leader 2: There is a space such as community center that is not used, but there is nobody to supervise.

Would you be willing to share trashcans by block?

Community Leader 1: I don't have the need to share a trashcan because I take out my trash every morning but I agree that each lock [neighborhood] should have a dumping area.

Community Leader 2: I agree that each lock [neighborhood] should have a dumping area.

How do you cooperate/interact with the district? (Only for board)

Community Leader 2: When I was in the board, I took care of budgeting. The budget from the district is only five thousand baht at that time. Now it is ten thousand baht. The community board will take on matters in the community and send in a report to the district to get the money they needed. And there was also a cleaning project for the water body near the community center. The district supports the

community by sending in garbage trucks and workers for free. There are also volunteers from the community to clean the water. They use the money to buy food and drinks for the workers and volunteer.

Have you received a trash bin from the BMA?

a. **How did you receive this bin? Did you pay for it?**
b. **Do you know if all local residents receive them?**
c. **Have you noticed local residents using BMA trash bins in their houses?**

Community Leader 1: The cans are free when there is a campaign from someone who is running for the Bangkok Metropolitan Council. Or the district distributes cans to people who pay. Some community members do not pay the collection fee, but they might have a free can. The trash will pile up until the service fee is collected. And I received a trashcan from the district because I paid the collection fee.

Do you think open disposal of waste can cause health problems for the local population? Why?

Community Leader 1: There is definitely an impact from improper waste disposal. The community looks dirty because the trash and dog litter. It is not appealing to visitors.

May we have permission to use any quotes from this interview as cited by your role in the community?

Community Leader 1 and Community Leader 2: Yes

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

INTERVIEW 2

Interview Response: Community Leader 3 and Community Leader 4

Interviewee: Community Leader 3 and Community Leader 4 (Current community Board Members)

Location: Community Leader 4's house

Date: February 12, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding Khlong Toei. All responses will be kept anonymous.*

Questions:

What is your role as a community leader in the Khlong Toei community?

Community Leader 3: The role we play in waste management is to be the voice of the slum people. We contact sectors of the Khlong Toei District Office with problems in the slum such as water, electricity, water source for fire extinguishing and residential problems. If the sectors of the district cannot follow through, we simply contact other sectors or private companies. We are just representatives of people in the Khlong Toei slum and also representatives of the District Office. We work like the BMA workers but we are not their employees because we do not get a salary. We dedicate our time, aside from our primary job, to volunteer as community leaders.

Community Leader 4: We contact the District Office because we cannot do the job on our own. We do not have the funds. When we don't have funding, we need help from outsiders. Waste management is a very big problem and is not entirely supported. Our community is very big and we want the trash to stay

outside of the community but because some people are careless, they litter everywhere. There is no law in the community or anyone to enforce proper disposal of trash, so people neglect the situation. For example, we have to clean the water body we use for fire extinguishing multiple times but people still throw trash into the water and say “no matter what you do, you won’t be able to clean up all the trash.” To make this successful, people must change their habits and improve orderliness. The hardest thing to accomplish is the last S of 5S, sustainability.

Community Leader 4: If you can see, the space between houses is full of trash. The people in the community see this hole and dump trash in there even though it is not their house, especially because it is not their house. It would be a great idea if the District Office could build a communal dumping site. The problem is we don’t have enough support, we don’t have an official dumping site and the BMA is not picking up trash frequently enough and the abandoned houses are a popular place where people dump their trash.

Community Leader 3: The community is an open community with exits all around. This makes it harder to control where people dump their trash. We can’t really tell the slum residents what to do because we are not the law enforcers and we don’t have law in the community.

We saw some abandoned houses that has piles of trash, is that a designated dumping area? Is anybody collecting trash from areas like that?

Community Leader 3: Even though it is an abandoned house, or a house nobody lives in anymore, we could not go in and clean it up because there is still ownership to the house and they have the legal rights to their house. Unless there is a new policy to take care of abandoned houses. We do not have the support from the District Office in this area because the BMA does not come into the community and take out trash because it is far, inconvenient, and they do not get money from the residents. Sometimes

the district claims they cannot come to the community to pick up trash because they have other locations to go to. When the district does not come on time, the trash in cans distributed throughout the community decomposes and sends out a foul smell.

Community Leader 4: It's not that we don't care about this problem but it is a big problem. In the past, we have been working with DPF. We have big cleaning day project. The community was clean for only 3-4 days but after that the community looked dirty again because there was not enough people picking up the trash.

Are there any suggestions to tackle the trash on abandoned houses?

Community Leader 3: If there is an official dumping site and garbage trucks to come pick up at the site every day, there will not be trash build up inside the community but the problem is still people are too lazy to take out their trash and will dump it at abandoned houses.

Are there any other problems you would like to address?

Community Leader 4: Open dumping caused drains and pipes to be blocked. When the drainage system could not work properly, we get floods. There were attempts to build a gate to keep the trash out from the drain but it is not successful because not matter how many gates or nets we build, the trash will overflow because trash come from people's houses. We had plans to build a proper community hall and build more nets to keep trash out.

Could you tell us more about how the municipal system works?

Community Leader 3: When the BMA puts garbage cans in the community, in front of somebody's house, it becomes the responsibility of the house owner. It is a problem because when there is a trashcan, people just put their trash in any can they find. The house owner will have to pay for collection fee even

though they didn't use that particular can in front of their house. If it is possible, a member of the household should take out trash everyday to the communal dumping site when they are on their way to work. This will decrease the amount of trash inside the community. The only thing we can do right now is motivate people to throw trash in the designated area outside the community. We also like the foundation to help with this problem such as "Clean House Project", to encourage people to take care of their house and maintain the cleanliness.

We know from other sources that the BMA collects a collection fee from the community. What is your opinion about this fee? Do you think the BMA is efficient?

Community Leader 4: We see that even if we pay the annual collection fee, the BMA workers do not even collect all the trash in the community. They do not come in and drag cans out to their truck and they are not efficient. We do not feel that the BMA is working efficiently because the residents have to pay the district and also bring out their own trash. If it is possible, the BMA should set up a site so people can throw their trash at this area and collect from that area only. They also should collect the service fees monthly because not all people can afford to pay the annual fee at once. We think that 240 baht per year is too much, especially if the people's houses are far and the BMA does not come to collect trash. They feel that why do they have to pay for no service from the BMA.

Community Leader 3: The BMA must understand that people in this community is very poor, they cannot afford to pay for their food, let alone garbage collection fees.

Community Leader 4: When the BMA does not come in the community to take trash out, the people pays for trash haulers to take their trash out for them. They think it is unnecessary that they need to pay 240 baht per year for no service and a certain amount to a non-government trash hauler to take their trash to a dumping site.

Community Leader 3: The problem with the system is that we do not live in apartment or developed housing, so we don't have maintenance fee. We don't have enough people to care for the community.

Can you tell us about the turnover rate of people in the Khlong Toei slum?

Community Leader 4: We cannot tell you the exact number of people living in the slum because they may have their house registration at the slum but they do not live here anymore. Some people have houses in the community, but goes to work in another province. Some people live in the community, but they do not own a house. So we can only count how many houses exists in the community. Sometimes people migrate into the slum when the drought season because they cannot do farming. When the drought is over, they move back. There are approximately 80 percent of the people who stays in the slum permanently.

Do you have any recommendations for the BMA?

Community Leader 4: We would like to have a communal dumping site and daily collection from the BMA. We also like a big cleaning day to be held in order to keep the whole community clean.

What is some trash that you see frequently in the community?

Community Leader 4: Most of it is Styrofoam. Styrofoam cannot be recycled and does not have value in the community. This also includes other plastic food packaging.

Do you have any area as suggestions for a communal dumping site?

Community Leader 3: In the past, we have concrete boxes under the highway but because the PAT allowed people to rent the space, those concrete boxes were destroyed.

Community Leader 4: When the people rent a space, they can do whatever they want for the space. We cannot have our concrete boxes anymore. But the space under the highway is an ideal spot for a communal dumping site.

We also contribute to the managing waste by taking out our trash everyday but we also need support from the BMA by collecting waste every day.

At this moment, everyone dumps their trash under the highway but there is nobody collecting it.

It is also a problem because we do not have policy or funds to support this cause.

The monthly community development money from the District Office is not enough to take care of all the problems in the community.

What recommendations do you have on ways to improve the situation?

Community Leader 3: We do not have an office for the community leaders; we think it would be good to have this space so we can have a meeting spot for all the members of the community leader committee.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix L: TECDA Interview Protocol

Interview Response: TECDA

Interviewee: Representative of the TECDA

Location: TECDA Office

Date: February 6, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding community approaches in your environmental advocacy as well as recycling methods. All responses will be kept anonymous.*

Questions:

What is the mission statement of the TECDA?

TECDA major mission statement is to create an awareness and social responsibility, especially among the children, to protect and preserve our environment. Our main objective is to persuading people to stop littering, throw a trash in the bin and get rid of the garbage in public area as much as possible.

What is the history of Magic Eyes?

Magic eyes started because in 1983 Bangkok became one of the dirtiest cities in the world. This is due to habits if Thai people. In the olden days, we used to have banana leaves and other natural things for packaging food and even toys. When the city grew, we stopped using those materials and turn to plastics and Styrofoam. Since the banana leaves decompose, people just throw it to the grounds and there is no harm done but that lifestyle does not work with plastics. The founder of TECDA has many connections

in the media industry and a lot of funds. TECDA started by doing a lot of PR and finding many sponsors. We focus on educating Thai people and communicating with them. We also had projects in the past, funded by sponsors such as ThaiBev on reducing, recycling and reusing. We are now planning to bring back our project with many sponsors in Thailand.

Have you ever tried to expand Magic Eyes campaign to the Khlong Toei region?

The thing you have to know about Thai people is that we sorts waste by valuable and non-valuable. The scavengers work day-to-day, collecting materials from many places, they also collects from communities in Bangkok. We didn't focus on slum communities because we mainly focus on Bangkok as a whole. We think the Khlong Toei project will not be sustainable because the turnover rate of the community. We also learn of mafia in the slum that interferes when the organization try to reach out to them.

Have any of your past initiatives been directed towards slum areas? If so, what have you found to be effective methods of educating slum residents to become more environmentally aware?

We think the most effective way is to show that we care for them. The TECDA once held a seminar for the scavengers, to try to educate them about recyclable materials and types of waste. We found that they responded well with the activity because we show that we really cared for them but it is hard because people in the community are not permanent residents. We also think that it is important to teach kids because behavioral change is easiest when they are younger.

Do you have any other successful activities or ideas we can use for educational program within the slum?

We would recommend you to start with kids in K-3, older kids will be harder to work with but they can be great leaders to younger kids. You can make the kids focus on one type of waste at a time. For example, you can bring out a jar in the classroom and ask the kids to collect all their candy wrappings

for 1 month or week or day. The kids will be able to see how much trash they are making each day/month and you can teach them that they can produce less trash. You can change the types to plastic bags, packaging and Styrofoam.

You can also incorporate activities related to recycling into their curriculum such as in art classes. The kids can make 1 banner every week saying things such as “Refuse Plastic Bags” or “Recycle paper”. By making the activity related to their existing behavior, it is easy for the kids to study new things. The kids also like cartoons and songs. We show them Magic Eyes cartoon and sing songs with them.

Do you have recommendation about organic wastes or anything related to composting?

Composting is a viable option. We did composting with earthworms and making EM.

We were thinking of proposing a communal dumping site, but we weren’t sure how to tackle this idea. Are there any other suggestions you can maybe give us?

Firstly, you can make signs on to the dumping site. You can make an arrow trail so the people can easily follow to the garbage site. You can also decorate the site and put up signs and of course you can teach kids to make up signs as an activity.

Our sponsor, the Duang Prateep Foundation, wanted us to educate the community about hazardous wastes? Do you know any effective ways to do this?

Managing hazardous wastes in Thailand is very difficult. It is something the BMA must do, to make policies, but they do not have the manpower or support. The only way to manage hazardous waste right now is to bring it to Onnut dumping site and put it in a landfill or incinerate it.

Can you tell us the current values of recyclable materials, or could you tell us where to find this information?

We do not focus in this area because we are just trying to encourage people to keep the city clean.

Can you provide information regarding private recycling companies?

N/A

May we have permission to use any quotes from this interview as cited by your organization?

Yes, no problem.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at khlongtoey14@wpi.edu.*

Appendix M: Roong Aroon School Interview Protocol

Interview Response: Roong Aroon School

Interviewee: Teacher from the Roong Aroon School

Location: Roong Aroon School, Bangkok

Date: February 5, 2014

Introduction Statement: *Hello we are students from Faculty of Science, Chulalongkorn University and Worcester Polytechnic Institute, United States. We are researching waste management strategies in the Khlong Toei slum area. We would like to ask you a few questions regarding the Khlong Toei community. All responses will be kept anonymous.*

Questions:

Why did it start?

Roong Aroon School used to have an issue with the overwhelming amount of trash piling up, and causing unpleasant odor and sight. Also the main source of pests such as flies and roaches. They generated about 206 kg of waste per day, with a total of approx. 1 ton of waste a week.

How and when did the project start?

The Zero Waste Program started 10 years ago.

How are the students involved with this program? What are the activities?

The Roong Aroon School started the program by educating and raising awareness of the waste school makes each day to the students. The teacher teach the children to sorting out trash and clean them before they get categorized at the Zero Waste site on their regular basis. The school categorized wastes into 5

categories: Organic wastes (from food), Biodegradable wastes, Recyclable wastes, Hazardous wastes and Non-Recyclable wastes. There are also student activities such as sing a song about sorting wastes, waste sorting competitions, waste for prize and also use trash for crafting.

Plastic foams can be sent to SCG to be recycled into rulers and pencil cases. Wires and e-wastes are sold to junk shops. Plastics are separated into different types. Tags are removed from plastic bottles for better prices. BMA comes twice a week to collect non-recyclable waste.

How often do you do these activities?

We teach the children every day and incorporate it into their daily routines. The students take turns in groups to take care of the waste

How did you introduce the project to your students?

We introduce the project to our students by showing them the negative effects of having piles of unsorted trash around the area.

What types of trash do you recycle? What don't you recycle? Why?

We do recycle papers, all types of plastics, aluminum, snacks packaging, cardboard, and milk cartons.

What do you do with your waste that is not recyclable?

We will put toxic and hazardous, toxic and not recyclable waste in separate container and BMA will collect it.

How do you recycle the waste?

We sent some recyclable waste such as plastic to SCG; this material will enter reprocessing process to produce a new product for example pencil cases. Some material such as aluminum caps. We give to

Siriraj hospital to make artificial legs. And smooth A4 paper. We sent to be used at the Bangkok Blind School. Some of them can be reuse in the school for school project and school activities. Certain types of plastic, plastic bags, cans and CD cases sent to junk shop.

What is the ultimate goal of the program?

The goal of this program is to minimize the waste as much as possible

Have you made any changes to the project since its founding?

No

Are there any costs associated with the project?

Is there any profit from the program?

Not significant. Although the main goal was to reduce waste not making profit

What are the factors that keep this program running?

The school making it a daily basis of the students school life to sort and recycle the waste.

Do you consider the project a success? Why?

The project is a success in terms of significant decrease in the amount of wastes generated. However, the rate of cooperation is slightly declining.

Is there support within the school and with students' families?

Yes

Are there any other projects related to trash?

We convert the biodegradable wastes into compost to use for plant fertilizers while feeding the fish with organic wastes from food.

Closing Statement: *Thank you for your time and participation. Just as a reminder, everything that was said in this interview will remain anonymous unless otherwise permitted. If you have any questions or concerns for us in the future, feel free to contact us at klongtoey@wpi.edu.*

Appendix N: Final Presentation to DPF and Local Residents

Location: DPF Meeting Room

Date: March 3, 2014

Time: 5:00 PM

Attendees: Local members of the slum, representatives from the Duang Prateep Foundation, the Bangkok Metropolitan Administration, members of the local community board, ajarns and students from Chulalongkorn University and Worcester Polytechnic Institute.

Introduction Statement: *Now that we have completed our presentation regarding waste management in the Khlong Toei slum, we would like to start a conversation. Feel free to comment on our presentation, ask questions or express concerns. We would like to open up a discussion on waste management in your neighborhood.*

Discussion Comments:

Current Community Board Member 1:

"The problem is that the BMA doesn't come pick up trash everyday. We understand that there is a lot of work to be done but it is not enough pick up for the community. There is around 2000 households in Locks 1, 2, 3 and huge amounts of trash. If the BMA doesn't come and pick up in 2-3 days, it gets nasty. The railroad picture in the presentation was when I took the students to see. The next day Feb 11, I called the district to ask for garbage trucks to clean the trash up because when the train comes, it gets stuck for hours because the slippery plastic bags on the tracks making it very dangerous [for the train]. It is difficult to handle because that area is for rent and people are careless about trash because it is not

their land. I also recently asked the district for help, to build a dumping hole but the district is too busy and cancelled. If there is such place like in the project recommendations then I agree but the problem is who will do this, because waste is not the only problem in this community."

"Abandoned houses are also a problem because most of the trash are old pieces of wood and we don't know how to handle it because we don't know who the owner is. Even if the trash is taken out of the community, it is not picked up by the BMA because there is not enough cans, so there should be cans in the communal dumping site as well. Some people throw their trash in their own cans in their houses and hire somebody to haul the trash out to the dumping site. It is a problem because the trash has nowhere to go. I appreciate the efforts from you all and I agree with your recommendations but we need a way to fix it, something to store the trash and the painting idea."

Bangkok Metropolitan Administration Representative:

"I work in the Department of Trees…" "Right now, about the cans, the district has already followed through with the paperwork and pick up dates. Thank you for all the information you have given us. All the information will be concluded and pass on to by superior on the recommendations and the possibilities. I cannot say much right now, but there will be changes in the future."

Representative 1 of the Duang Prateep Foundation:

"The DPF gets this hot topic question about waste management and worries about health effects from dumping especially during floods. We are also worried about the health of kids. We try to explain to our guests about the situation but it is not very successful. The DPF staff wants to promote behavioral change and order to the community. We think that residents should have discipline in throwing and sorting trash. I want to say that it doesn't matter how much trash we can pick up in a day, but I think we should focus on reducing the trash produced in the community. Nowadays, merchants commonly use

Styrofoam bowls for everything. I want to promote behavioral change to properly throw trash, reduce trash and even in little kids."

Representative 2 of the Duang Prateep Foundation:

(Directed to community members) *"Would it help if the foundation gives money as a reward for keeping in front of your houses clean and also your neighbor, 100 baht per month for winner or something? Because Khru Prateep might be able to get some funding for this new woman project. Maybe if everybody help to keep their area clean instead of waiting for the BMA to come in the community and clean the community for reward, will it help fuel motivation?"*

Previous Community Board Member 1:

"I agree with the communal site, I think it's a great idea but the BMA garbage truck must come everyday, not just 3-4 days per week. Right now, the BMA collects 40 baht per month per house for the houses on the (street in front of DPF with many shops) and collects there everyday. This means the BMA collects little garbage daily and only pick up once in a while where there is a lot of garbage (dumping area under highway)."

"Less pick-ups on that road. More pick up under highway."

"Sometimes, we clean the streets and dog litter but we throw it into some trash can and the neighbors complain because that can will smell."

Khru Prateep, of the Duang Prateep Foundation:

"Thank you professors and students. We must be aware of our standing, aware of how the outsiders see us and how we see ourselves. If we live here and always think that "how do we keep our community clean", even though we are poor but we are clean, we have culture so people can feel that the

community is beautiful. We need to build awareness to care for the community. Even though our neighbors might not want us to clean around their houses, we just keep smiling and doing so. Right now the BMA is much better, they didn't even come into the community in the past because they were scared. But because the community leaders and the BMA try to communicate with each other, the relationship is much better. I'd like to show this presentation to all the other 42 communities in Khlong Toei. We need to show these recommendations to the other communities so they can see that the outsiders, the students even from the United States, care about our community. Our community is one of a kind, we're special, or else they wouldn't show interest at us. The recommendations for sorting valuable trash, reducing plastic bags by using canvas bags for kids and lastly for a communal site. If the BMA (district) does not have funds, we'll raise money from Kathin Ceremony, 50 baht or something per house, and use the money for building. If you don't have the color for kids, we do. If you don't have art teachers, the DPF has art teachers for you. We can start from kids drawing their design for the dumping site on a paper, for a competition. The kids can send in their design and we award the winner and paint that on the walls of the dumping site"

Ajarn 1 of Chulalongkorn University:

"I think the students did a great job in point out the problem because now we are aware of the problem. Now we need to find a way to keep this awareness until the next year, after the students leave. Maybe there should be a monthly meeting about this topic."

"The group pointed out 3 valuable items that the locals do not sort and sell. They pointed out that an outside company actually buys it."

Current Community Board Member 2:

"... The junkshop is a good way, but the people do not have storage for plastic bags, snack packaging and Styrofoam because one kilo of those things requires a lot of space. Some people don't know that it is valuable. But storage is the biggest problem right now."

Previous Community Board Member 2:

"I agree with the communal site, I think it's a great idea but the BMA garbage truck must come everyday, not just 3-4 days per week. Right now, the BMA collects 40 baht per month per house for the houses on the (street in front of DPF with many shops) and collects there everyday. This means the BMA collects little garbage daily and only pick up once in a while where there is a lot of garbage (dumping area under highway)."

"Less pick-ups on that road. More pick up under highway."

"The problem is most residents doesn't know these things (plastic bags, snack packaging, Styrofoam) are valuable or they don't have storage."

Local Resident 1:

"In the past, there were some people picking up plastic bags and cleaning them and selling them but that practice didn't catch on."

"We can ask people to pick the things up, and find a place to store it. Then we need to find a buyer, which the students informed us. But the problem lies in transporting the items because it requires a lot of each items."

Khru Prateep of the Duang Prateep Foundation:

"If the community is interested, the DPF manager suggests we contact the owner of the recycling company (Suk 36) and ask for recommendations and ways we can sell those items to them."

Ajarn 1 of Chulalongkorn University:

"People in the community [should] visit Roong Aroon's Zero Waste Center because they recycle everything and do not use a lot of space."

Conclusion Statement: *Thank you for your time and comments. We will take all recommendations and concerns into consideration for our final report.*

Appendix O: Lesson Plan for Daycare in Locks 1, 2, 3

LESSON 1: HAZARDOUS WASTE

Student Questionnaire

Ask the following questions to the students individually before and after each activity in order to assess the effectiveness of the lesson.

1. Which of the following are dangerous?

   batteries bananas chairs light bulbs plastic bags books

2. Should you play with these items?
3. Where do old batteries and light bulbs go?
4. If you see a battery or light bulb in the neighborhood should you touch it?
5. Who should throw batteries and light bulbs away?

Lesson's Concept

Hazardous wastes are easily found in the house. Exposure to hazardous waste from improper disposal methods by contact or ingestion can cause serious health impacts.

Purpose

Students will learn the importance of identifying and disposing of hazardous waste properly.

Overview

Grade: K-3

Length: 2-3 hours

Vocabulary:

Battery

Light bulb

Hazardous

Preparation

Prepare materials for activities

Visual aids: pictures of hazardous items

Materials

1. Puppets (5)
    a. Battery
    b. Light bulb
    c. Healthy kid
    d. Sad kid
    e. Adult
2. Puppet script
3. Posters
4. Coloring materials

Procedure

Activity 1 - Questions for students

As the following questions to your students:

Root question: Do you know what hazardous waste is?

- Is hazardous waste good?
- Is hazardous waste bad?

- Is a flower hazardous waste?
- Is a light bulb hazardous waste?
- Is a battery hazardous waste?
- Is a mango hazardous waste?

Root question: Do you know what can happen if you are exposed to hazardous wastes?

- Will hazardous waste hurt you?
- Will hazardous waste hurt your friends?
- Will hazardous waste hurt a flower?
- Will you get cut if a light bulb breaks?
- Will you get burned if you touch a battery with your bare hands?

Activity 2 - Puppet story (see script below)

Activity 3 - Create Poster

1. Hand out hazardous waste posters
    a. Each poster has three images:
        i. Battery
        ii. Fluorescent light bulb
        iii. Picture of an adult throwing out trash for a child
2. Explain the importance of the poster and each individual image
    a. The poster acts as a constant reminder that hazardous waste is dangerous
    b. The images of both the battery and the light bulb are reminders that they are dangerous
    c. The image of the adult with the child reminds students to seek assistance in order to handle dangerous waste (batteries and light bulbs)

3. Explain to the students to color and decorate the poster
4. Tell the students to sign their name next to the phrase “Remember to throw out bad trash”
    a. Ex. “Kelsey remember to throw out bad trash”
5. Tell students to bring the posters home
6. Suggest students hang poster in their house

LESSON 2: PLASTIC BAGS

Canvas Bag Lesson Plan

Ask the following questions to the students individually before and after each activity in order to assess the effectiveness of the lesson.

1. Which of the following do you see on the ground in the slum?

   batteries bananas chairs light bulbs plastic bags books

2. How did plastic bags get on the ground?
3. Why is it bad to leave plastic bags on the ground?
4. Why are there so many plastic bags?
5. How can you reduce the amount of plastic bags you use?
6. Why is it good to reuse bags?

Lesson's Concept

Plastic bags are one of the main types of waste openly disposed in the community. Unlike most recyclable materials, plastic bags currently have no value to the community. Local businesses continue to "freely" distribute plastic bags for each transaction.

Purpose

Students will be encouraged to refuse plastic bags from stores and use their own canvas bags to reduce the amount of waste they produce.

Overview

Grade: K-3

Length: 2-3 hours

Vocabulary

Plastic Bags

Canvas Bags

Materials

Sample plastic bags

Paper to count number of bags on walk

Paper for coloring pages

Canvas bag for each student

Fabric crayons

Preparation

1. Decorate sample bag
2. Draw sample pictures for bags
3. Print coloring pages, 1 per student + no plastic bag sign

Procedure

Activity 1 - Field Trip

1. Explain to students you are going on a field trip around the community. Tell the students they will count the number of plastic bags they see along their walk. Every time they see a plastic bag, they must tell the teacher they are with who will keep the total count. Hold up examples of plastic bags to show the children. Tell them also to pay attention to where the bags are located.

2. Split class up into equal groups based on the number of available teachers. Each teacher takes their group on a 10-minute walk around different areas of the community. On the walk, children will tell the teacher every time they count a plastic bag.
3. Activity 2 - Coloring Pages
4. After the walk, all groups return to the school. Sit the children down and ask them questions about how many bags they counted and where they saw the bags. For example:
    a. Who saw a bag in the water?
    b. Who saw a bag on the ground?
5. Then hand out the coloring pages of sad animals and plants. Have a teacher color the one page with the no sign over the plastic bag. Have each student color the pictures. Hang the pictures on a poster or wall and have the no sign hung in the middle.
6. Explain that the plastic bags can end up in the water or nature and hurt the animals and plants.
7. Activity 3 - Canvas Bags
8. Instead of plastic bags, tell the students they can use canvas bags. Give examples of what to use the canvas bags for such as:
    a. Carrying books
    b. Carrying snacks
    c. Toys
    d. Blankets
    e. Families can use them for groceries
9. Explain that the students will each get their own bag to decorate.
10. Tell them about the rewards program. If they bring their bag to school with things in it (snacks, toys, books, etc.) they get a stamp (tally if not available). Keep track of the stamps on a piece of paper hung somewhere visible in the classroom.

11. Show the students a sample decorate bag before you give them the bags (something personal so not all students copy exactly). Also show students paper with other pictures they could draw on their bag (smiley face, sun, heart, etc.).
12. Have children decorate the bags using fabric crayons.
13. Once they are done decorating, reinforce what they can use their bag for. Ask questions such as the following:
    a. Are plastic bags good?
    b. Are plastic bags bad?
    c. Do plastic bags hurt the environment?
    d. Should you use canvas bags instead of plastic bags?
    e. Can you use a canvas bag to carry food?
    f. Can you use a canvas bag as a hat?
    g. Can you use a canvas bag to carry toys?
    h. Can your family use a canvas bag to carry groceries?

Post Activity Evaluation

Notice:

This evaluation form is for evaluating the satisfaction for Lesson 1 Hazardous Wastes and Lesson 2 Reduce Plastic Bag for the education year 2014.

Part 1: Personal Information

Name_____

Part 2: Evaluation

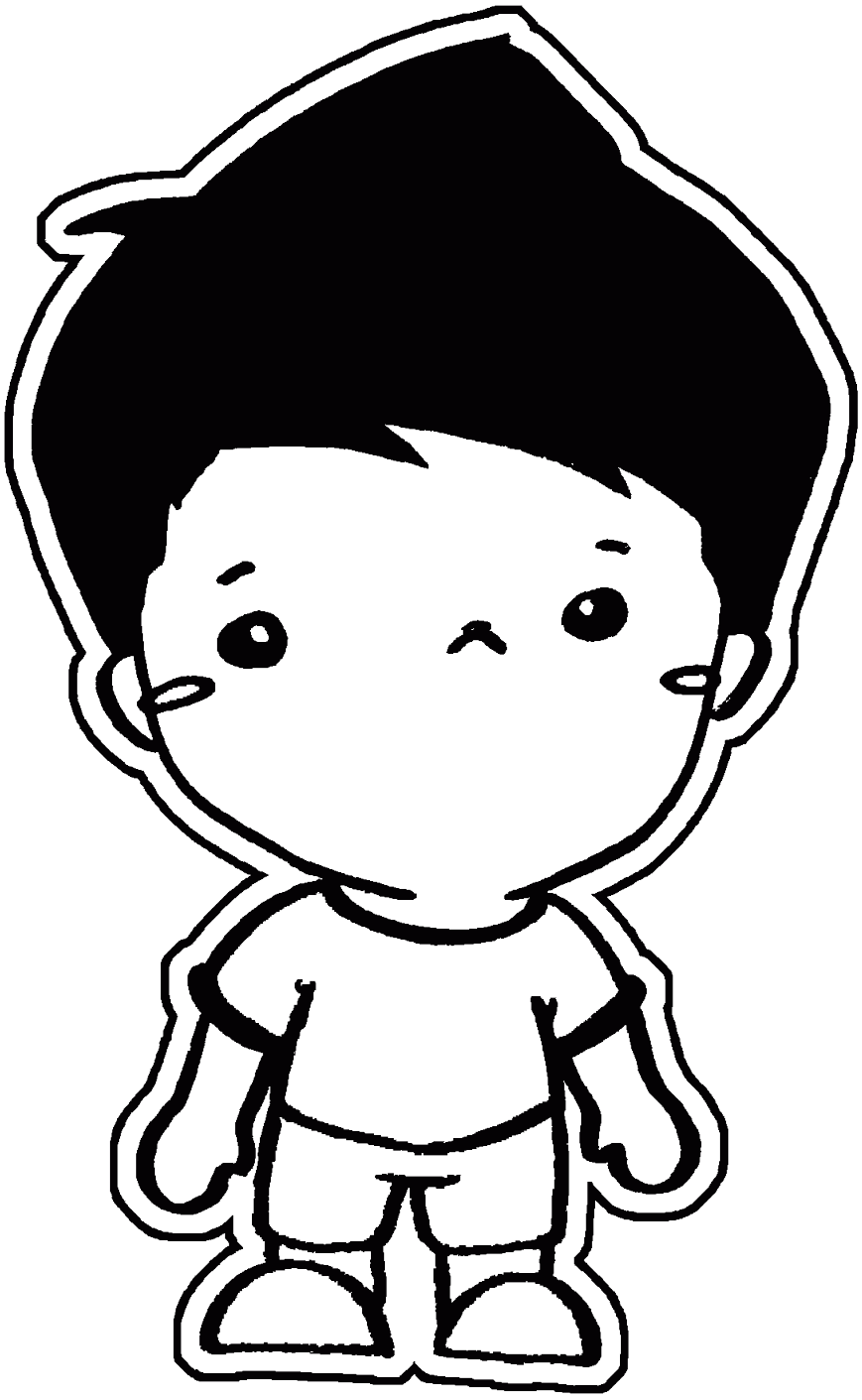
	Criteria	**Suggestions**
1	Is the lesson plan easy to understand and follow?	
2	Do the students show understanding of the subject?	
3	Are the activities in the lesson plan creative?	
4	Do you think the activities are successful or not?	

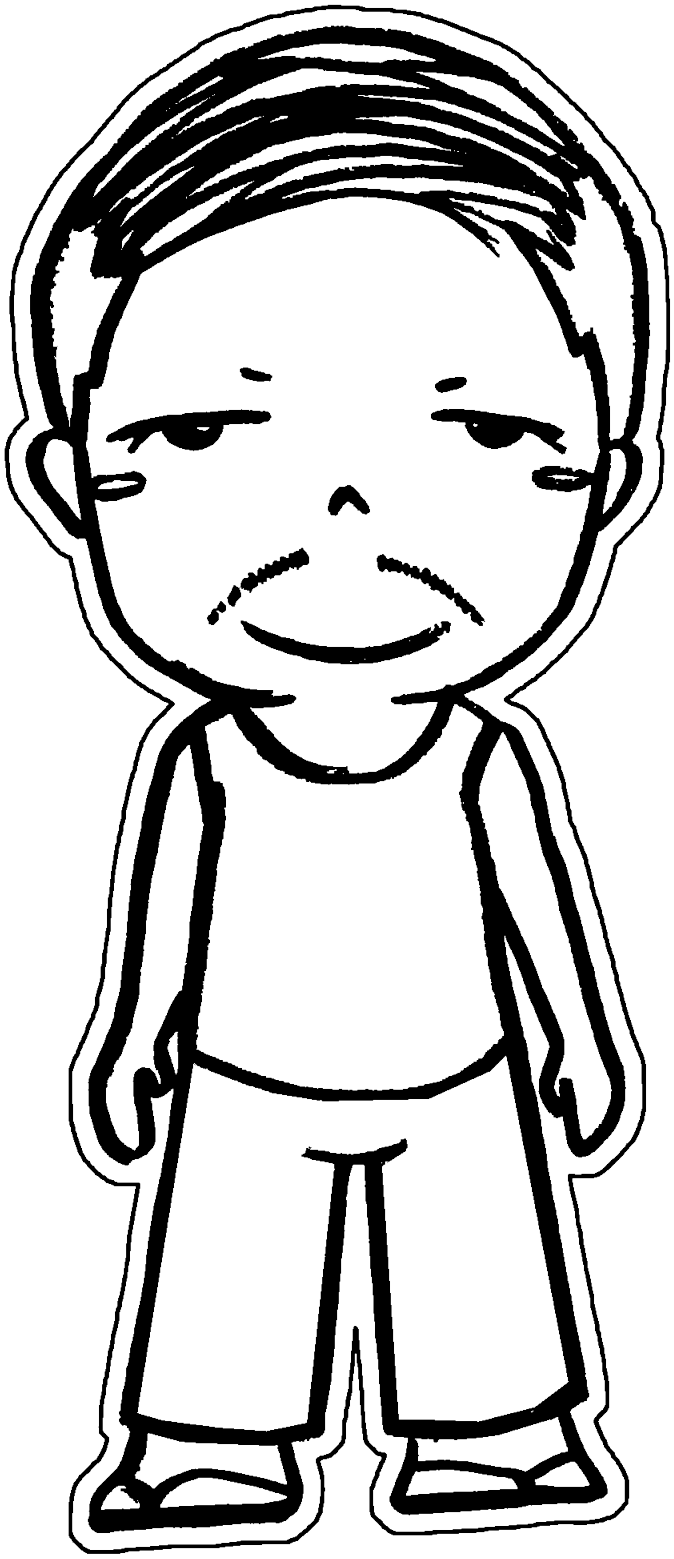
5	What type of activities do you find most effective?	
6	What activity do you think the students enjoy the most?	
7	Are the students showing interest and participation to the activities?	
8	Do you think these activities will impact the student's behavior in the long run?	

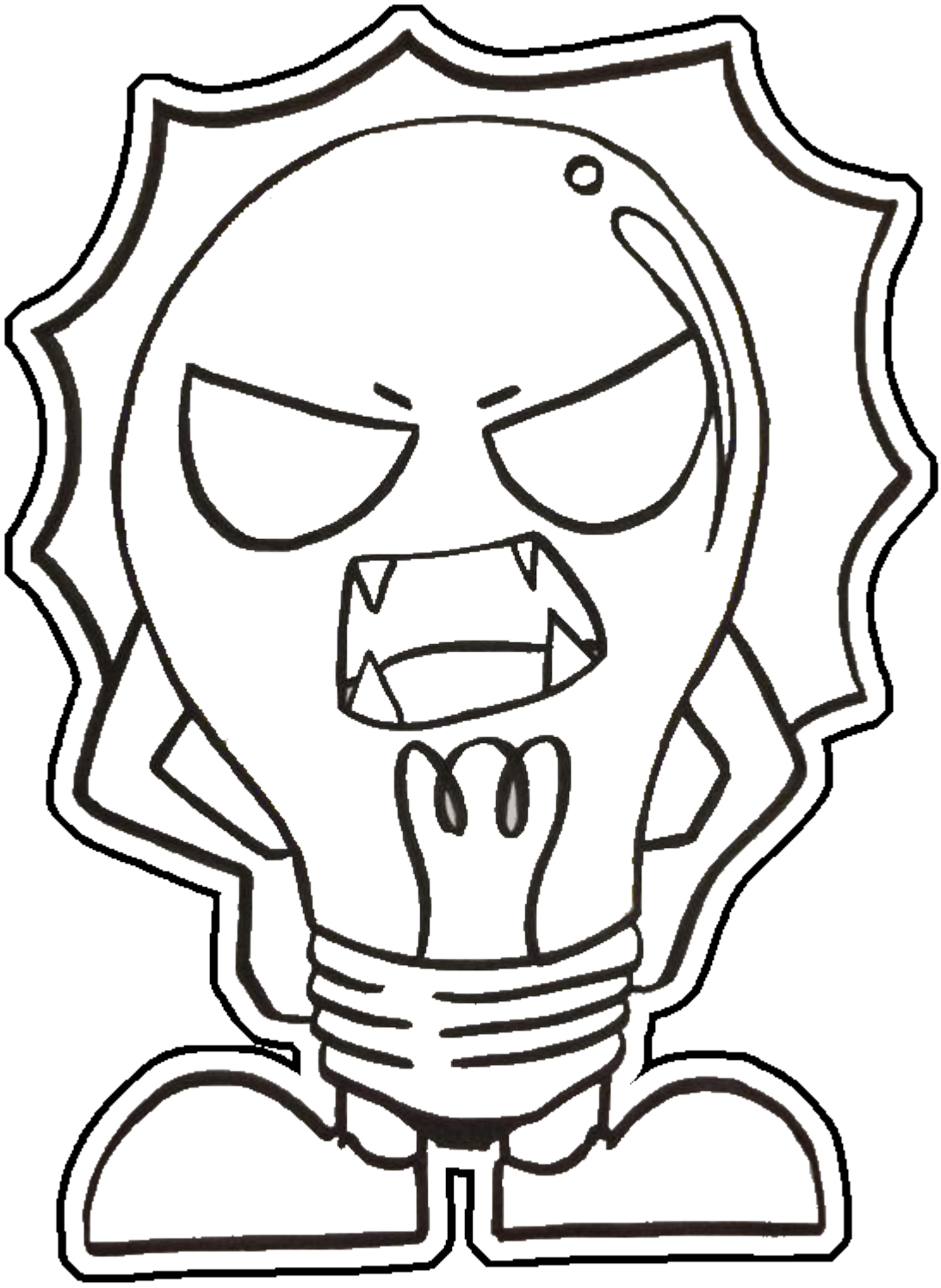
Additional Suggestions: _____

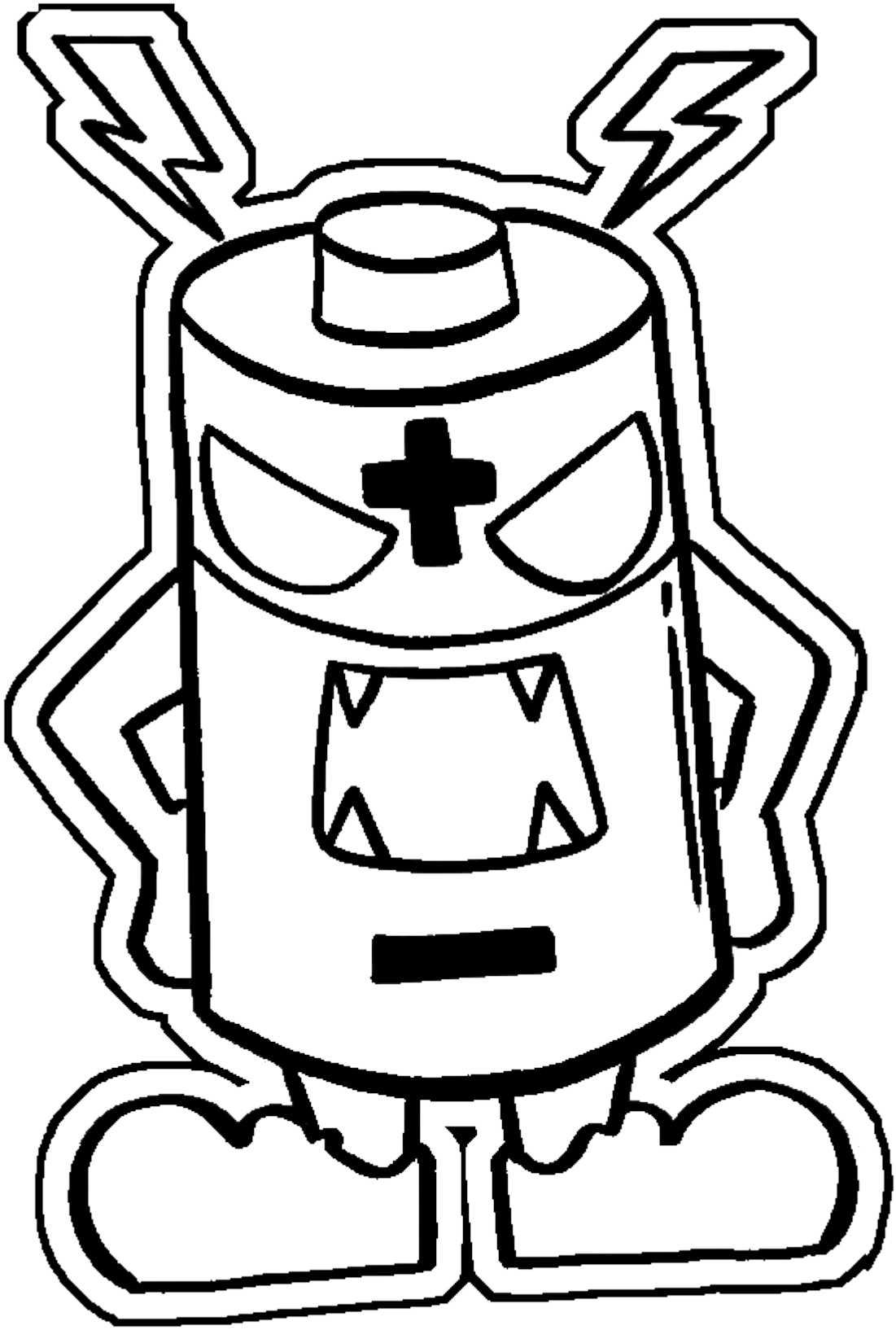
_____

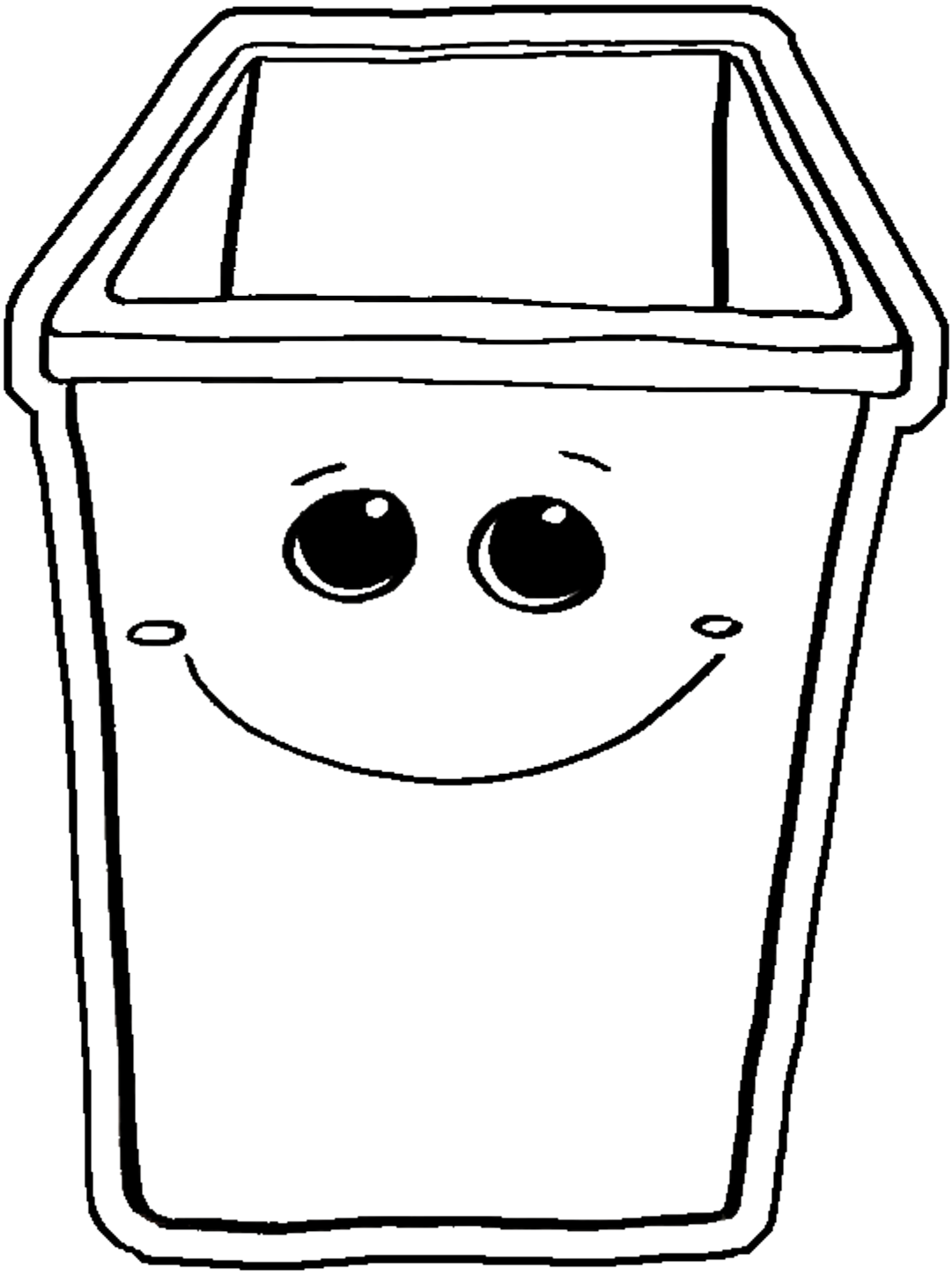
_____











Script for Lesson 1 Activity 2

Scenario 1 Little Boy and Battery

Once upon a time, in a peaceful community of Khlong Toei, a little boy is taking a leisurely stroll. The little boy walks to the dumping site to throw away his trash he carried from home. The boy then spotted a used battery on the side of the sidewalk.

Mr. Battery: Hey there little boy, my name is Battery. Would you like to play with me?

Startled by the Mr. Battery, the little boy replied

Little Boy: Hi Battery, I'm Little Boy. What are you doing here?

Mr. Battery: I've been thrown out from a house. I don't have any friends and I'm so lonely right now. Can you please play with me?

Little Boy: Sure! I also want a friend.

The boy picks up the battery and plays with it, laughing with joy.

When the sky is about to get dark, the boy's grandpa went looking for him.

Grandpa: Let's go home.

The little boy said goodbye to the Battery and ran home to his grandpa.

Little Boy: Bye bye Mr. Battery!

Mr. Battery: Don't forget to come by tomorrow!

The next morning, Grandpa goes to the little boy's room to wake him up.

Grandpa: Wakie wakie!

Little Boy: Grandpa! I don't feel well at all, and I have itchy rashes all over my body!

Grandpa: What did you do yesterday?

Little Boy: I played with Mr. Battery on the way home.

Shocked by the boy's answer, Grandpa warned him

Grandpa: NO! Used batteries are not toys and you shouldn't play with them! When you touch them they give you rashes all over your arms, face, and body. Promise me you won't play with them again. Do you understand?

Little Boy: Yes, grandpa.

Grandpa: From now on when you see a used battery, you tell me and I will get rid of it for you.

A week later while the Little Boy and his Grandpa are walking in a park, the boy noticed a used battery on the sidewalk. The Little Boy then told his Grandpa about the battery.

Little Boy: Grandpa! I see a used battery over there!

Grandpa: Let me see.

Little Boy: Okay

Grandpa approaches the used battery, covered his hand with a plastic bag, and then picked up the battery from the ground.

Grandpa: Boy, do you know what will happen if other kids come by and happen to pick up this battery with bare hands? They will get sick and have rashes like you did. Since batteries are hazardous wastes, we have to pick them up properly and put them in the red bin, which is for hazardous wastes only.

Grandpa then drops the battery into the red bin.

The boy says goodbye to Mr. Battery.

Scenario 2: Little Boy and Light Bulb

Once upon a time, in a peaceful community of Khlong Toei, a little boy took a leisurely stroll. The little boy walked to the dumping site to throw away his trash he carried from home. The boy then spotted a used light bulb on the side of the sidewalk.

Mr. Light Bulb: Good morning Little Boy, I am Mr. Light Bulb. Let's play!!

Little Boy: Hello Mr. Light Bulb, I'm Little Boy. What are you doing here alone?

Mr. Light Bulb: I was left behind by one of the slum residents, I'm very lonely, and there is nobody to play with me. Would you want to be my friend?

Little Boy: Yes!! I'd like a friend too.

The Little Boy walked up to Mr. Light Bulb and grabbed it.

"AHHHHHHH", the Little Boy cried in agony. Mr. Light Bulb cut him because Mr. Light Bulb was broken. The Little Boy's grandpa heard his grandson's scream and hurried to the Little Boy.

Grandpa: What happened? Why are you bleeding?

Little Boy sobbed and replied, " I was playing with Mr. Light Bulb, when I grabbed him, and he broke in my hands. Grandpa, it hurts so much."

Grandpa: OH NO!!!! Little Boy, listen to me carefully. It is not good to play with Mr. Light Bulb. If a little boy or a little girl like you touches light bulbs, you will get hurt. The next time you see a light bulb lying around, tell Grandpa. Grandpa will take care of it for you. Remember, DO NOT TOUCH IT.

Little Boy: Yes, grandpa. I'll never play with Mr. Light Bulb again.

After that, grandpa hurried to bring the Little Boy to the hospital. The nurse put a bandage on the Little Boy's hand.

Little Boy: Grandpa, my hand hurts so much, and this bandage is so annoying. I can't go out to play with my friends anymore.

Grandpa: See. This is what happens when you play with bad things. So don't do it ever again.

Little Boy: Yes, Grandpa.

A week passed.

The Little Boy and his grandpa are out at the park. They spot a light bulb lying on the grass. The Little Boy called out to his grandpa.

Little Boy: Grandpa, I saw a light bulb lying on the ground right over there!

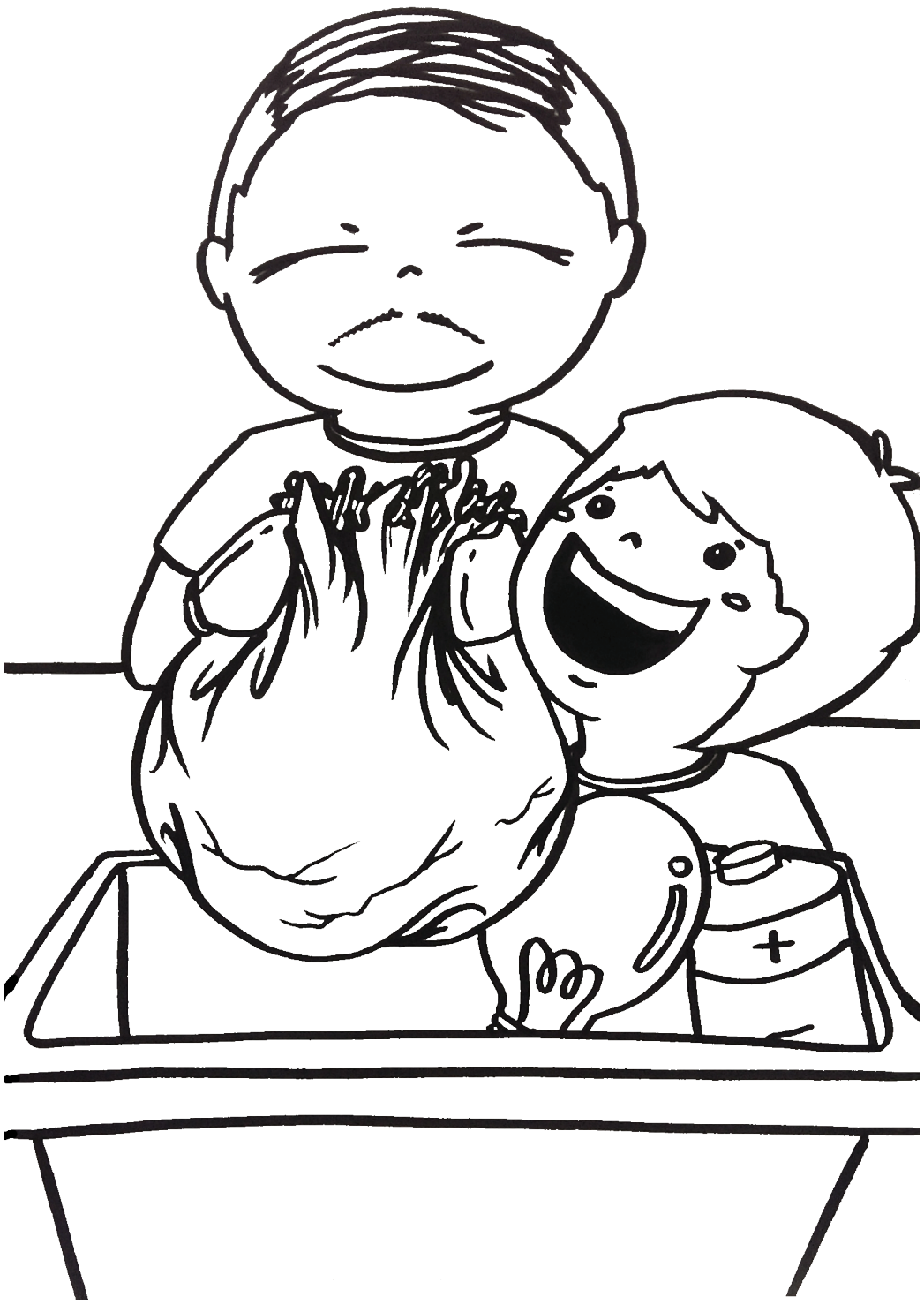
Grandpa: What? Where? Take me to it. I'll take care of it for you.

The Little Boy guided his grandpa to where the light bulb was. His grandpa used a plastic bag to gently pick the light bulb up.

Grandpa: Little Boy, remember light bulbs are very bad. If it is lying on the ground and some other kid grabbed it, you could get hurt. You should tell me or other adults because we know how to throw it away.

Grandpa walked over to the garbage can and threw the light bulb in it.

Little Boy: Bye bye, Mr. Light Bulb.



Chulalongkorn University
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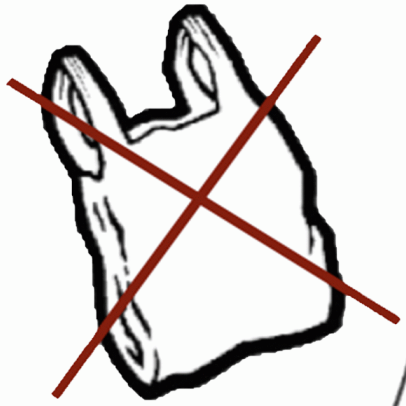

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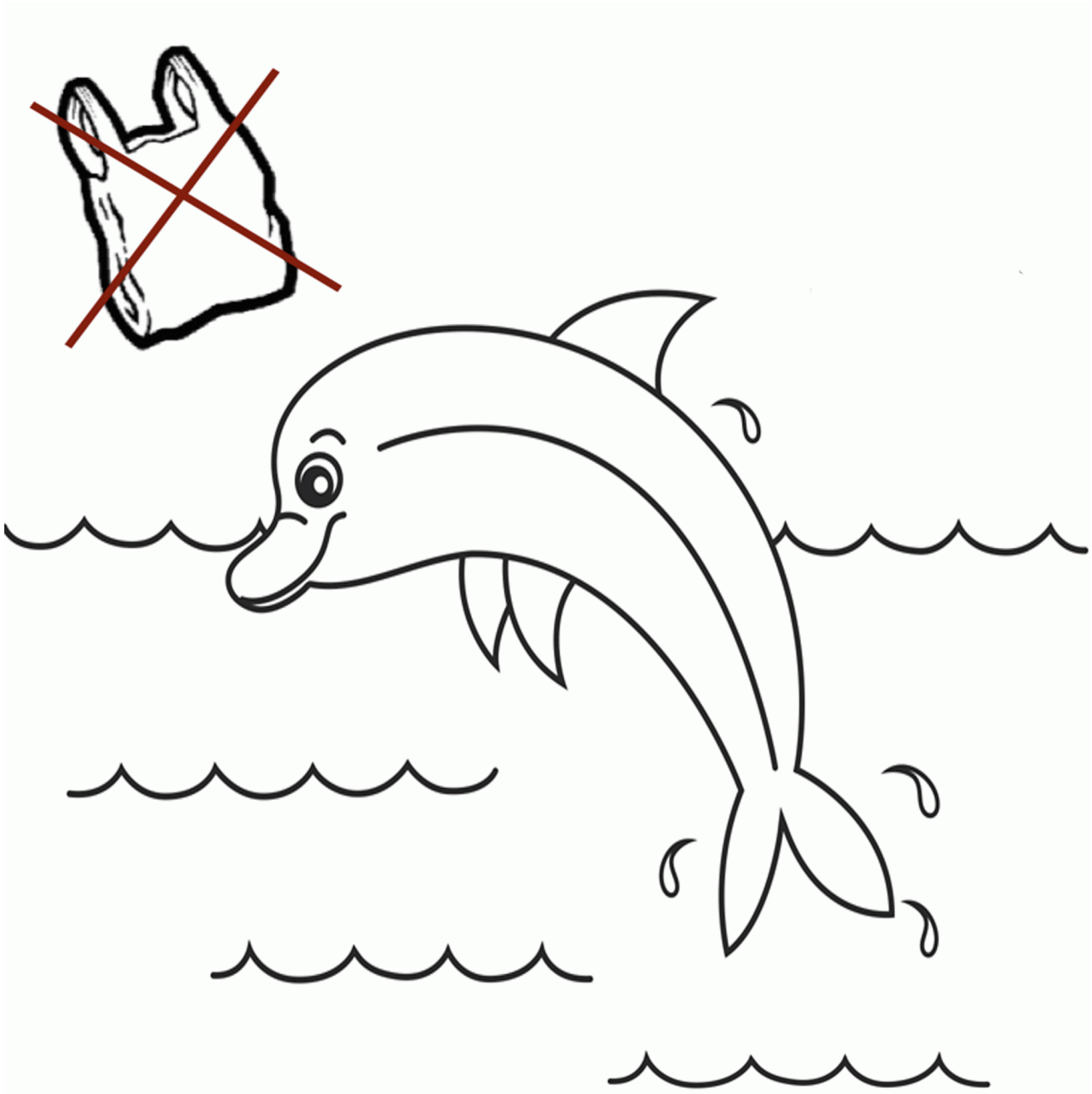

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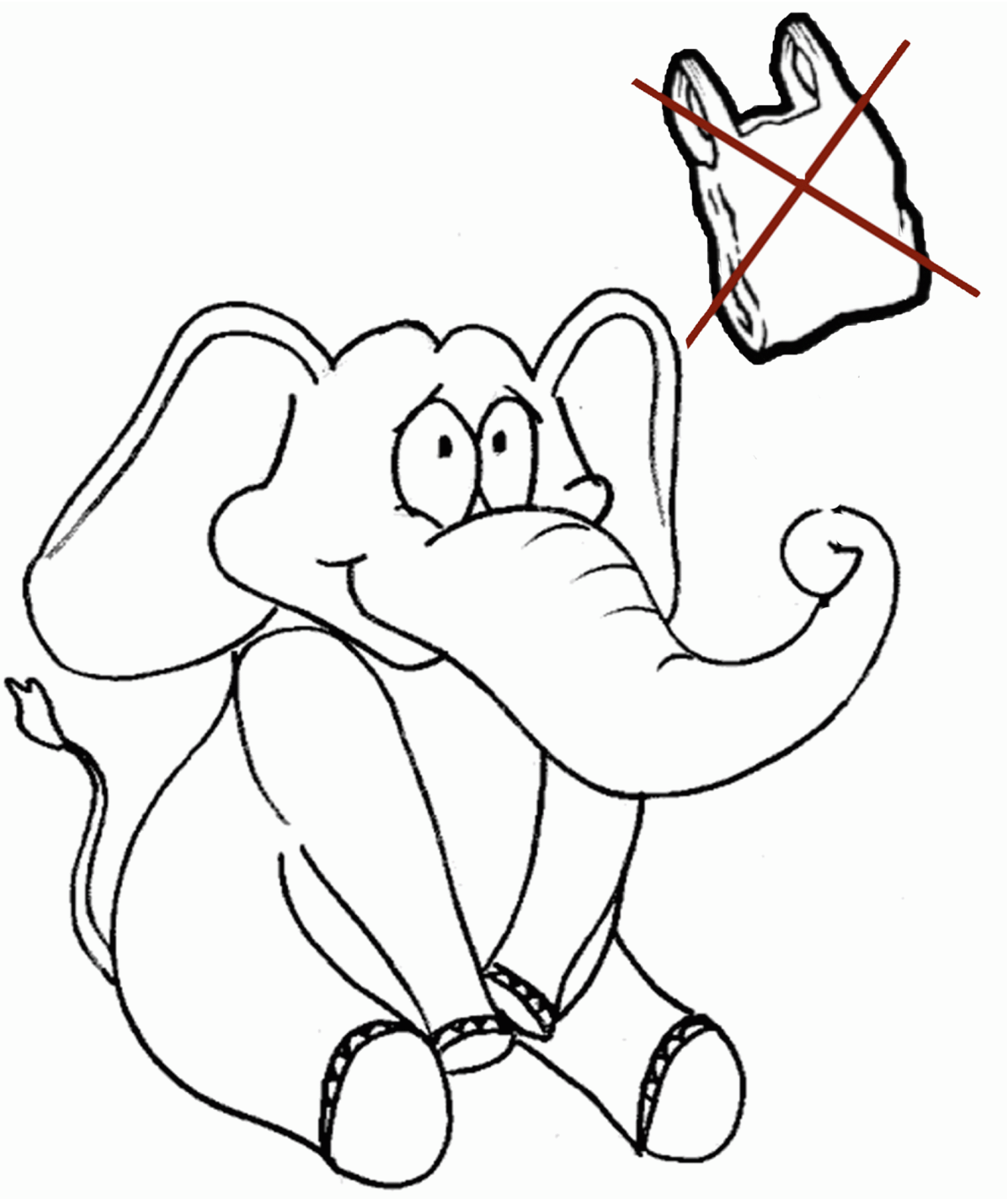

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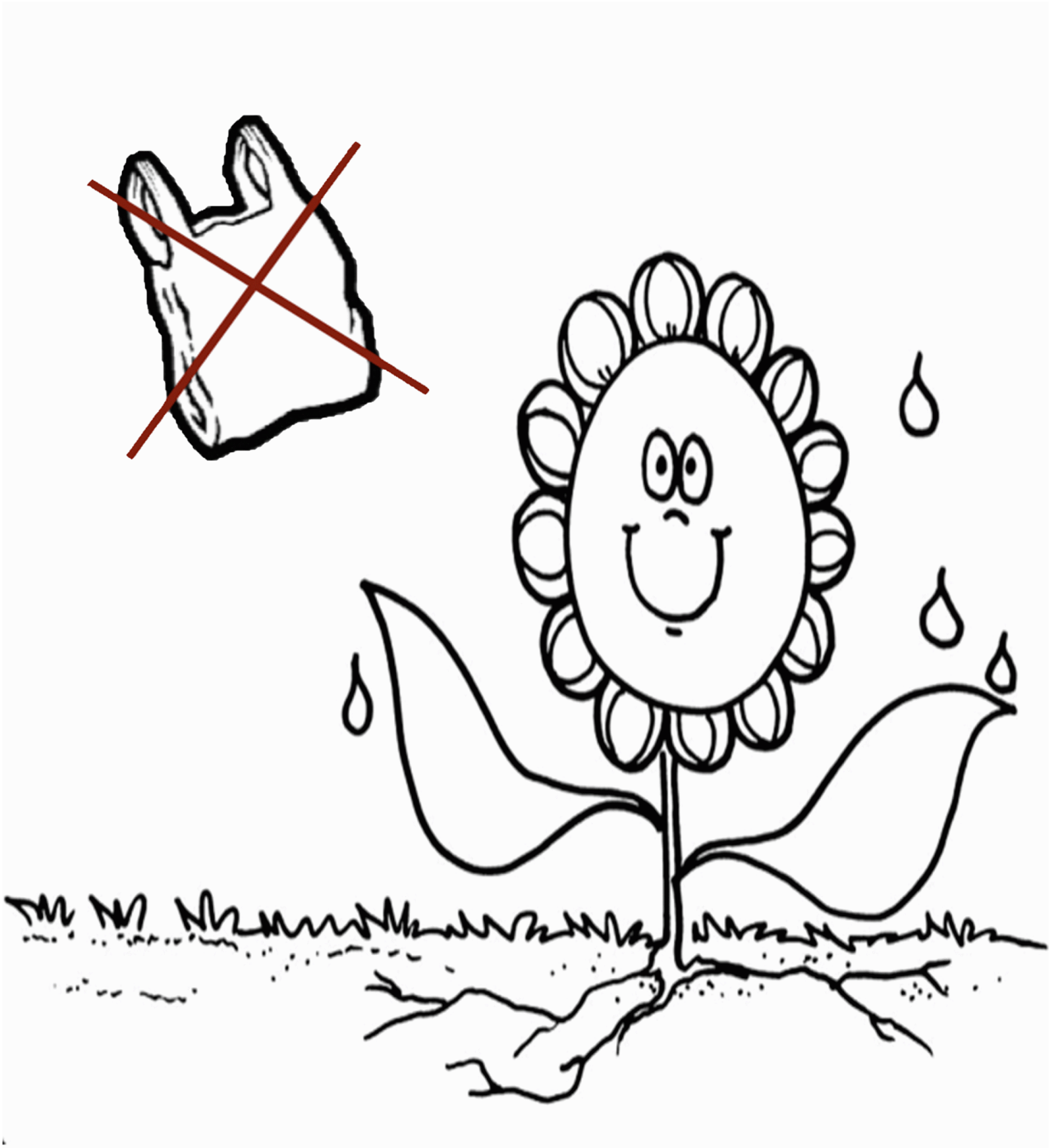

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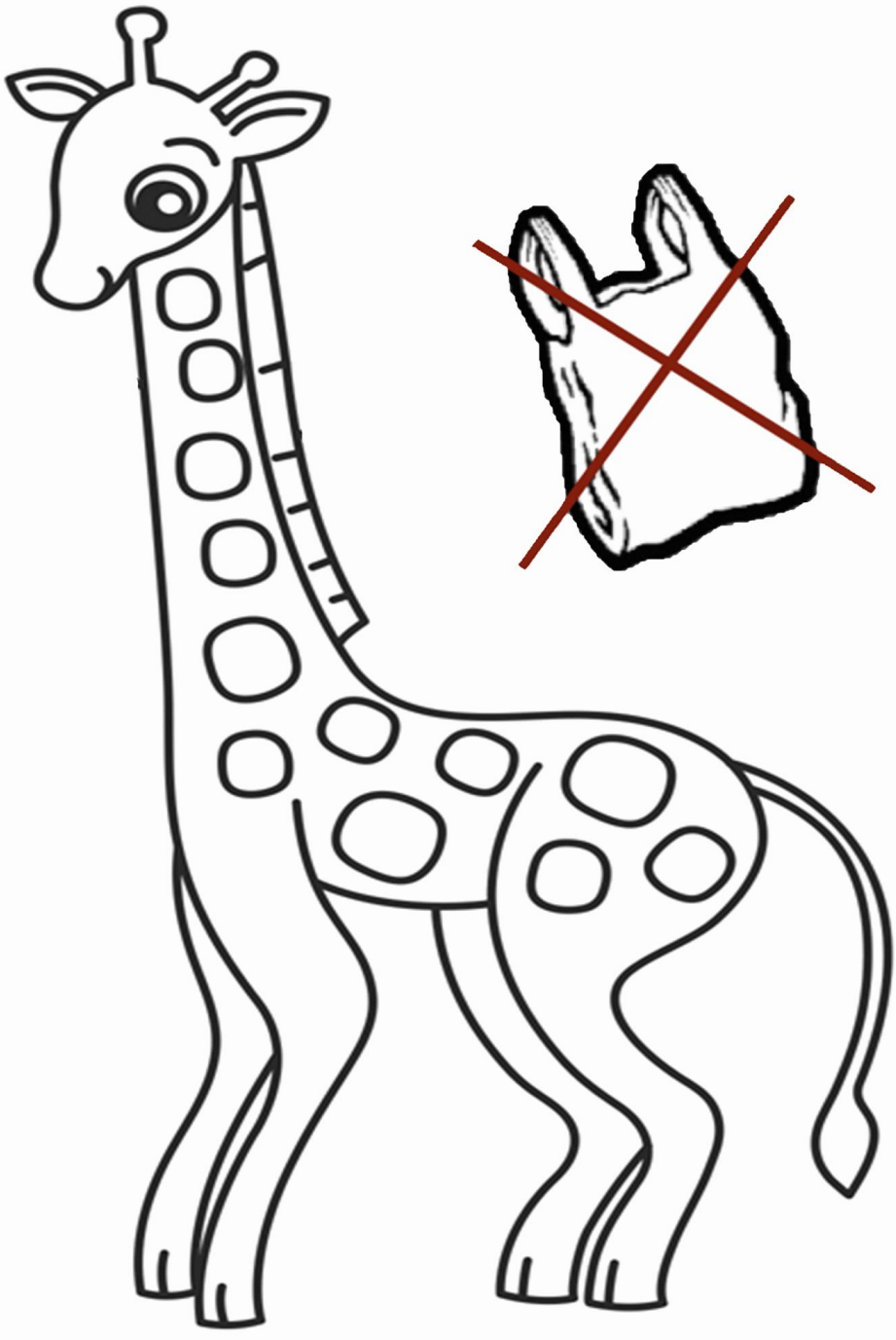

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Appendix P: Daycare Pilot Teacher Feedback

Name: Teacher 1

	Criteria	**Suggestions**
1	Is the lesson plan easy to understand and follow?	It is easy to understand. The students are very responsive to the lesson and questions.
2	Do the students show understanding of the subject?	I think the students show great understanding because when I teach them, they responded to what is said to them all the time.
3	Are the activities in the lesson plan creative?	I think the lesson plan is very creative. The students really liked the canvas bag activity because they can express their imagination on the canvas bags and all of the said they feel proud and happy to be able to make the canvas bag their own.
4	Do you think the activities are successful or not?	I think it is successful but I'm not sure about the long-term success because we do not have enough funds to buy materials for the kids.
5	What type of activities do you find most effective?	I think the activities in the lesson plan are already effective. Basically, the students will like activities that they can use their creativity and activities that they can be part of, such as answering questions. The most important task is the teacher, we must teach and explain the students for them to completely understand the topic.
6	What activity do you think the students enjoy the most?	I think the students enjoy the canvas bag decorating activity most because the students can really make use of it. All of the kids said that they love this activity because they get to color their own personal bag. Many students came back and tell me that they told their parents to reduce plastic bags and use canvas bags instead. Most of the kid also came bag to school the next day with their canvas bag.
7	Are the students showing interest and participation to the activities?	Yes. All the students are very interested in this activity and all paid attention to the lesson.
8	Do you think these activities will impact the student's behavior in the long run?	I think we will have to evaluate this later because the future is not certain. But right now, all the students bring their bags to school as we told them to.

Name: Teacher 2

Criteria	**Suggestions**
Is the lesson plan easy to understand and follow?	Yes, it is.
Do the students show understanding of the subject?	I think the students understood the lesson because the students paid attention and answer questions throughout the lesson.
Are the activities in the lesson plan creative?	It is very creative. There are many students that told us they like this activity.
Do you think the activities are successful or not?	Yes, it is.
What type of activities do you find most effective?	Smaller kids will like activities that everyone can participate and work together. I think the lesson plan is very good and the students really liked it.
What activity do you think the students enjoy the most?	The students really like the canvas bag activity because they can draw on their own bag. Many parents came in and told me that their kids told them about reducing plastic bags.
Are the students showing interest and participation to the activities?	Yes. They are very interested and all of them participated.
Do you think these activities will impact the student's behavior in the long run?	Since they are just kids, I think it is difficult to make them focus on just one thing for a long time. Some students will forget their canvas bags but we try to remind them everyday and make it a habit.

Name: Teacher 3

Criteria	**Suggestions**
Is the lesson plan easy to understand and follow?	I didn't see the activity first hand but from what the students said, they understood the lesson.
Do the students show understanding of the subject?	Yes. The students showed understanding of the subject. Many kids bring their canvas bags to school and brag it to their friends of what they drew.
Are the activities in the lesson plan creative?	Yes. It is. The students really liked it.
Do you think the activities are successful or not?	I think it is successful.
What type of activities do you find most effective?	The activities that students like the most are dancing, singing, coloring and storytelling.
What activity do you think the students enjoy the most?	The canvas bag.
Are the students showing interest and participation to the activities?	Yes. I feel that the kids showed interest.
Do you think these activities will impact the student's behavior in the long run?	Yes, because many students bring their canvas bags to school.

Name: Teacher 4

Criteria	**Suggestions**
Is the lesson plan easy to understand and follow?	Yes. I've read the lesson plan and I think it is easy to understand.
Do the students show understanding of the subject?	Even though I wasn't doing the activity with them but from what I saw the students are very active.
Are the activities in the lesson plan creative?	Yes.
Do you think the activities are successful or not?	Yes. The students like it and always bring their bags in to show it off to us.
What type of activities do you find most effective?	They like all kinds of activities as long as they can participate in that activity.
What activity do you think the students enjoy the most?	The canvas bag decoration.
Are the students showing interest and participation to the activities?	From what I saw, all the kids participated.
Do you think these activities will impact the student's behavior in the long run?	I'm not sure about this but currently, all the students bring their canvas bag to school.

Name: Teacher 5

Criteria	**Suggestions**
Is the lesson plan easy to understand and follow?	I wasn't at the school on the day of the activity but from what I heard from other teachers, I think it is easy to understand for us and also easy for the little kids to follow.
Do the students show understanding of the subject?	From what I was told, all the kids understood the subject.
Are the activities in the lesson plan creative?	It is. It's good because the students can use their imagination.
Do you think the activities are successful or not?	Yes.
What type of activities do you find most effective?	From my teaching experience, I think the smaller kids like activities that everyone can be part of such as dancing, singing and coloring.
What activity do you think the students enjoy the most?	The canvas bag decorating. And currently, all students bring their canvas bag to school.
Are the students showing interest and participation to the activities?	Yes.
Do you think these activities will impact the student's behavior in the long run?	Same as Teacher 3. I'm not sure about this. But currently, all the students bring their canvas bag to school and we try to remind them everyday.

Appendix Q: Teacher Feedback Survey

Lesson Evaluation:

What school do you teach at?

What grade do you teach?

What activities did you like/think were effective from this lesson?

What activities did you not like/think were not effective?

How do you think the lesson could be adapted to teach a similar message for your class?

Appendix R: Post Communal Dumping Implementation Interview Protocol

First month interview:

Are you aware of the new communal dumping program?

Do you use the communal dumping sites?

If so, how often?

Do you think many residents are using the communal dumping sites?

Do you like the new communal dumping program?

How often have you noticed the BMA removing garbage?

Are you satisfied with the price of waste removal?

Have you noticed an improvement in the amount of waste dumped on the railroad tracks?

Do you have any concerns about waste management in the community (involving the new program or in general)?

For returning surveys:

Have you noticed more residents using the communal dumping sites this month?

Are you consistently using the communal dumping sites?

Does the BMA come more frequently to remove garbage/are they consistently removing garbage daily?

Appendix S: Summative Team Assessments

Understanding personal strengths and weakness as well as cultural differences played a fundamental role in our group dynamic. As a team we worked to identify each other's strengths and weakness and developed tasks for each team member accordingly. Our strengths were based on our interests for example certain members showed interest in the project website and the education plan. These members therefore took the lead in completing these tasks.

For this project we also learned about cultural differences in a team setting specifically between Thai and American students. We found that WPI students were often more outspoken, at times overshadowing the opinions and ideas of the Chulalongkorn students. Therefore WPI students learned to frequently ask the opinions of the Thai students.

Finally we learned how to overcome unexpected challenges during our project. Throughout the project protests limited our ability to work as a team in person and therefore we had to develop strategies to overcome this. Often our group would work on google drive that allowed all members of the team to work on a document together and comment throughout the process. We also constantly stayed in contact through messaging services to keep all members informed about the project.