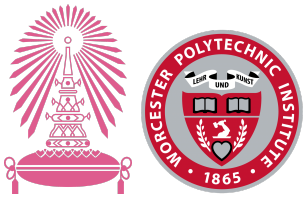

Improving Waste Management in Baan Thung Noi

An Interactive Qualifying Project and Interactive Science and Social Project

Sponsored by
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Subdistrict Administrative Organization of Baan Thung Noi

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Abstract

Waste management is necessary for keeping communities clean and healthy. However, due to different cultures, standards, and attitudes, waste management systems vary across the communities they serve. One overarching theme between successful waste systems is the involvement of the community. The village of Baan Thung Noi struggles with an inefficient system, resulting in unmanaged waste within their community. Our project has investigated the causes of these issues and recommends future steps to be made by the villagers and our sponsor towards bettering their community.

Keywords Waste management, waste management system, recycling, litter, waste, direct observation, semi-structured interviews, community-based efforts, empowerment, Integrated Solid Waste Management (ISWM).

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Executive Summary

Waste management systems are necessary to keep global communities clean and habitable (Alqahtani et al., 2022). There are many different methods for handling different kinds of waste, though mismanagement of solid waste and recyclables often results in polluted communities (Balew et al., 2022). To protect the environment and community health, waste management improvement is consistently a high priority across the globe.

Different waste management systems may require different approaches in making improvements. Distinct cultures, standards, and attitudes toward handling waste have produced diverse methods and solutions. For example, Saudi Arabia has benefited from a more technical approach, using self-learning algorithms to optimize waste collection routes (Alqahtani et al., 2022). On the other hand, Brazil required a more legal approach by creating jobs for formerly unofficial ‘waste pickers’ (Silva et al., 2019). In general, the reviewed literature also indicates that public education efforts are crucial in making social change, which requires a thorough understanding of the target audience (Harvie & Jaques, 2003; Markel & Selber, 2022). In the small fishing village of Baan Thung Noi, our sponsors Singha R-Sa and the Subdistrict Administrative Organization (SAO) of Baan Thung Noi sought to improve their waste management. This project focused on designing an approach unique to the village.

The goal of this project was to suggest future action for long-term improvements in Baan Thung Noi’s waste management system. To achieve this goal, our objectives were to understand the technical factors of the village’s current waste management system, the socioeconomic factors of the current waste management system, and to collaborate with leaders in the community to identify improvements. We utilized methods of observation and evaluation such as direct observation of waste management practices and litter within the village, semi-structured

interviews with the villagers and those involved with the waste management system, and employing the philosophies of participatory action research (PAR) by collaborating with community leaders in developing our proposed future plans.

To fulfill objective one, we first directly observed the entire village to determine the magnitude of the litter and waste problem. We used a guided checklist of various factors and mapped the locations of bins and litter on ArcGIS to identify issues with litter and infrastructure. Finally, we investigated the municipal waste management system by interviewing the SAO.

To fulfill our second objective, we researched locals' knowledge of waste management practices through semi-structured interviews. We sought to understand what public outreach strategies would be most effective by identifying social media preferences and education at the local school. Media preferences can include digital or printed documents. As we learned more about the community and its population, we were able to identify how their current state of public knowledge may factor into their waste management practices.

After collecting data regarding the system and villager preferences, we fulfilled our final objective by collaborating with Singha R-Sa, the SAO, and other community leaders to plan towards the village's waste goals. Through our collaboration, we organized a pilot community event or workshop titled *Trash Challenge Community Involvement: Phase I*. Additionally, we have further researched past waste management strategies used in Baan Thung Noi through interviews with villagers and community leaders. This collaboration process and community event allowed us to assess what strategies may be most effective in Baan Thung Noi.

We have determined eight findings from our research. Overall, we identified how villagers utilize the current municipal waste system. We discovered that many villagers are already aware of and practice waste separation, yet the municipal management system lacks

official separation bins. Additionally, there is an overall lack of bin accessibility in public areas. Villagers already indicate they care about proper waste management, yet their infrastructural system does not support their efforts.

Moreover, our findings defined how social and environmental factors contributed to the low impact of past waste management efforts. There have been multiple attempts to improve waste management in the village, yet they had limited impact. More specifically, there have been past workshops in the village and a zero-waste model applied at the school. However, these efforts were not enforced consistently; community-wide activities did not occur as frequently and emphasis on waste management reportedly lessened over time. In regards to past community efforts, we investigated the most recent effort to educate the village on waste practices; the SAO worked in conjunction with an outside organization to educate individual households about composting. The topic of education and method of communication were ultimately in conflict with the interests of a village of fishermen who prioritize their jobs, which likely contributed to the reported short-term effects. Additionally, villagers reported feeling demotivated due to uncontrollable environmental factors, such as stray animals and the tide. These environmental factors negate the community's efforts to clean the village as the tide brings in litter they did not create, and animals rummage through and spread trash. Inconsistent efforts in the face of persistent demotivating factors have resulted in low-engagement across the community.

Finally, we were able to assess what factors will be most vital moving forward. As previously mentioned, villagers have reported a desire to improve their waste management, yet their infrastructure and organized efforts from the SAO do not align with that intent. Still, our research found that the village already has high interest among the local school students, as well as emerging leadership throughout the village; our community event was made in collaboration

with a group of community leaders, showing their intent to take the lead in these efforts. Additionally, the students who participated in our event were engaged and enthusiastic about the activities. These factors will be crucial in maintaining consistent efforts in the future.

From our findings, we have produced four recommendations:

1. Upgrade the waste bin infrastructure
2. Singha R-Sa should conduct further research on current public knowledge
3. The village should form a leadership group that will lead waste management efforts
4. Conduct further research on the school waste management system

These recommendations focus on creating a foundation that will encourage and support villagers in taking action toward improving their waste management. First, upgrading the waste management infrastructure will allow villagers a systematic environment that aligns with their current waste and separation practices. Next, further research on current public knowledge will allow our sponsor, Singha R-Sa, to better understand what approaches will be most applicable and engaging to the village. Creating a leadership group will also be vital to further organizing the community; members of the community in leadership positions will best understand how to approach the rest of the village (Dearden et al., 2017). Lastly, investigating the school waste management system will provide more insight on how to prepare the future generations as they grow into more active roles in the community. Overall, these recommendations are meant to develop a foundation for the consistency the village has lacked in the past. With this foundation, the community will finally be able to move further in achieving long-term change.

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1. Introduction

Waste management systems are an essential structure for the maintenance of clean and livable communities (Alqahtani et al., 2022). Managing waste can become a challenge for areas that suddenly begin to generate more waste (Dileep, 2007; Guo et al., 2021; Kaewmanee & Wijaya, 2014; Sasana et al., 2022; Silva et al., 2019; Tsai et al., 2021). This phenomenon has been observed around the world for various reasons, including rapid urbanization and other unprecedented circumstances such as the COVID-19 pandemic. Although a global concept, waste management differs across cultures, socioeconomic circumstances, and governments (Challcharoenwattana & Pharino, 2015; Charuvichaipong & Sajor, 2006). However, improper management overall often leads to poor environmental conditions and pollution (Challcharoenwattana & Pharino, 2015). The chemicals, microplastics, and diseases in polluting waste also puts public health at risk (Alqahtani et al., 2022). Additionally, wasteful practices are detrimental to the economy by increasing the cost of municipal services (Kaviarasan et al., 2022; Kim & Stepchenkova, 2015). Innovative technology and social changes have been developed over time to minimize these undesirable consequences.

Finding solutions to proper waste management can be difficult for various communities as some may lack financial resources and general awareness on proper waste management. This disproportionately affects developing countries (Guo et al., 2021). For example, Thailand is ranked 5th world leader in plastic pollution as a developing nation (Kaviarasan et al., 2022). They rank above the United States, whose population is five times greater than that of Thailand (Chartered Institution of Water and Environmental Management [CIWEM], n.d.). The evident lack of effective waste management in Thailand puts both their coastal environment and people

at risk (Guan et al., 2023). The presence of microplastics in the environment presents the risk of severe health concerns across whole communities as waterways and sources are ultimately connected. However, the health risks can particularly concern coastal villages who rely on fish as a food source such as Baan Thung Noi (Tsai et al., 2021). Due to this concern, our sponsors, Singha R-Sa and the Subdistrict Administrative Organization of Baan Thung Noi, sought to improve the village's waste management system (T. Watthanaamorn, personal communication, October 7, 2022; P. Thedyam, personal communication, October 7, 2022).

Waste management problems are caused by different factors depending on cultures, governments, or locations. Causes can include sudden increases in generated waste, rapidly growing populations, or logistical issues within the management system (Balew et al., 2022). These different factors have created different solutions around the world. Some examples include creating jobs specifically for waste separation in Brazil, optimizing collection routes to minimize fuel consumed by garbage trucks in Saudi Arabia and Vietnam, or creating an entirely new program unique to one specific community in Worcester, Massachusetts(Alqahtani et al., 2022; Dinh et al., 2022; J. Kempton, personal communication, December 2, 2022;). Overall, balancing technical and social solutions according to specific circumstances is crucial to a successful waste management system. Our reviews of case studies around the world and their factors of success will provide insight into what must be assessed in Baan Thung Noi to improve their waste management system.

Our research covered many infrastructural and social causes for waste management issues in Baan Thung Noi. One logistical concern was the lack of public bins near the beach and harbor area. Many villagers claim to already practice waste separation at home, however we found that the municipal system lacks formal separation bins for collection. Villagers also

reported issues regarding uncontrollable environmental factors that contribute to the waste; the design of the bins allows for animals to access and rummage their waste. However, the most pressing and overarching issue was the social aspect of motivation. Villagers reported a lack of motivation within the community to maintain long-term change. Overall, the village lacks many crucial aspects of waste management in regards to infrastructure and community-interest that is necessary for improving waste management as a whole.

The knowledge and opinions of the local residents were also important to consider in assessing and developing waste management. Understanding how the locals treat their waste, their values, and how they conceptualize proper waste management allowed us to fully characterize their current relationship with the waste systems already in place. It also allowed us to gauge how they might perceive our recommended future actions. We investigated these matters by interviewing the villagers, local activists, staff at the local elementary school, members of the Subdistrict Administrative Organization (SAO), and the head of the village.

Overall, our goal is to suggest future action for long-term improvements in Baan Thung Noi's waste management system. Considering the importance of balancing the technical and social aspects of waste management, we have constructed the following objectives to achieve our goal:

1. Assess the technical factors of Baan Thung Noi's current waste management system.
2. Assess the socioeconomic factors of Baan Thung Noi's waste management system.
3. Collaborate with village leaders to propose future plans based on our investigation within the village.

We plan to identify existing issues in their waste management system through direct observation of waste within the village and semi-structured interviews among the locals. We

assessed the socioeconomic factors of Baan Thung Noi's waste management system through semi-structured interviews. We interviewed teachers at the local schools, as well as a conveniently selected sample. We also conducted interviews with willing participants and individuals of interest to gain open-ended answers to our survey questions. Lastly, we determined what approaches will be most effective in Baan Thung Noi based on our research. This preliminary research will help our sponsor to understand what the most effective steps are to improve the waste system in Baan Thung Noi.

2. Background and Literature Review

Waste management is a strategy implemented to handle different types of waste (Tsai et al., 2021). In general, solid waste management can be broken into four main steps: separation, collection, transportation, and disposal, otherwise called Integrated Solid Waste Management (ISWM) (Balew et al., 2022). Proper waste management is vital to maintaining clean and habitable communities, yet waste management systems often fall short at any of the defined steps in ISWM. Factors that may affect the structural sequence of ISWM are infrastructure, law and policy, and public awareness and knowledge (Guo et al., 2021; Sasana et al., 2022; Silva et al., 2019; Tsai et al., 2021). Furthermore, the accumulation of litter is a manifestation of improper waste management (Zaman & Lehmann, 2013).

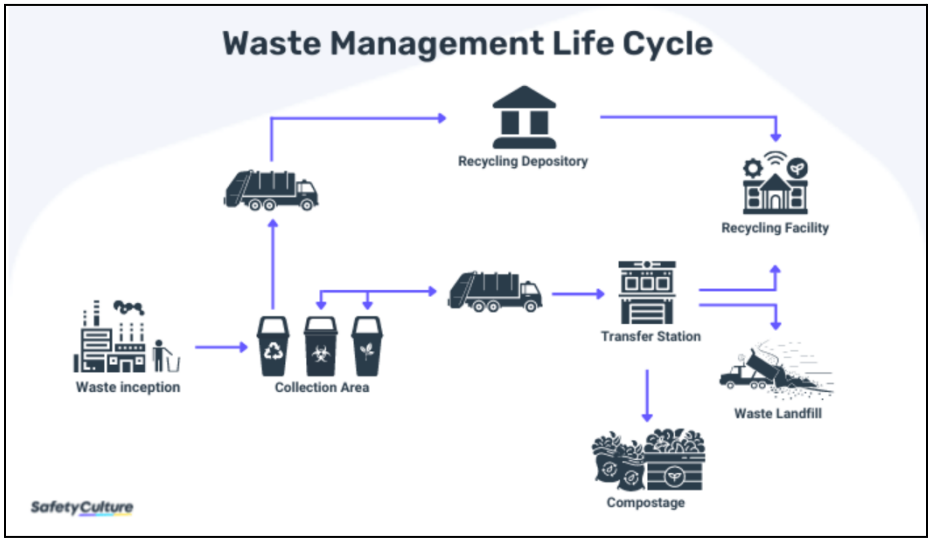

Figure 1. *Waste Management Life Cycle* A flow diagram of waste treatment system and methods (SafetyCulture, 8 Dec 2022)

A well-known symbol for poor waste management is the Great Pacific Garbage Patch, which is a collection of floating, solid waste in the Pacific Ocean sourced from countries all over the world (Lebreton et al., 2022). The garbage patch threatens the marine environment and

public health due to the chemicals, bacteria, and microplastics that may contaminate food and water resources (Silva et al., 2019; Tsai et al., 2021). As there is no identifiable point-source, the intersectional nature of the Great Pacific Garbage Patch makes improving waste management a global concern. Different global factors such as geography, culture, and environment may create an infinite number of causes and solutions, exemplifying the complex nature of waste management (Omeyer et al., 2022; Sasana et al., 2022; Simmons & Fielding, 2019).

To understand the ways waste management can be improved, we will provide examples of effective waste management systems around the world. We have explored (1) causes of waste management issues and their significance, (2) ways waste management has developed around the world, and (3) how waste management has developed in Thailand. This background research will provide insights into our recommendations on improving Baan Thung Noi's waste management.

2.1 Causes of Waste Management Issues

Waste management issues occur around the world, but overall manifest in high amounts of unmanaged waste, or litter (Zaman & Lehmann, 2013). Although waste management systems are unique to different locations, environments, and cultures, they can be overwhelmed by similar factors. Balew et al. (2022) describe a structure for solid waste management that can be generalized for waste management systems worldwide. The structure is called Integrated Solid Waste Management (ISWM). Its general sequence is: separation, collection, transportation, and disposal (e.g. incineration, recycling, composting). Poor implementation of any stage of ISWM can create waste management issues.

Poor separation of waste on a large scale may be due various factors across smaller communities such as differences in resources, and decisions of governing bodies

(Charuvichaipong & Sajor, 2006; Sasana et al., 2022; Tsai et al., 2021). For instance, the developing nation of Brazil struggled with the disconnect between the national government and their community-based waste practices (Silva et al., 2019). Like many developing nations, Brazil's pre-existing waste management system was overwhelmed by the rapid increase in waste production as communities grew. However, the increase in waste resulted in the creation of informal sectors of "waste pickers" who sort valuables and recyclables from others' waste for profit. These informal agents of waste separation were vital in reducing landfill usage, but were not recognized or utilized by any organization. Instead, Brazil struggled with recycling rates as low as 2% of produced solid waste. Thus, despite the presence of waste pickers, Brazil still struggled with low waste separation due to the disconnect between their waste management policies and practices. These logistical gaps are causes for waste management inefficiencies.

The consequences of poor waste separation also goes beyond human environments and civilizations, as it may affect our interactions with other living beings, such as plants or animals (Hambali et al., 2019). The city of Malacca, Malaysia, did not practice full separation of solid waste and food waste. This practice led to conflicts between civilians and the nearby macaque population, as trash bins became an attractive source of food for the local primates. The macaques would rummage the trash bins and contribute to the litter around the city. Of course, there was the factor of non-animal-proof trash bins, but food waste is still a main attractor for animals to rummage. Properly separating out food waste from these bins would prevent the animals from searching the bins for food, and thus prevent them from spreading litter.

The vital collection and transportation steps of ISWM are also potential sources of waste management inefficiencies if improperly organized (Alqahtani et al., 2022; Dinh et al., 2022). Inefficient waste collection routes include factors of time, distance traveled, and fuel consumed.

Before implementing new collection routes, Dinh et al. calculated that Hoi An, Vietnam's waste collection services cost almost 12% more. Additionally, garbage trucks traveled almost 70% more than they do on the new routes. Rapidly developing areas typically experience issues with collection and transportation as sudden increases in waste production overwhelm their pre-existing systems (Alqahtani et al., 2022; Dinh et al., 2022). However, other factors may cause unexpected increases in waste. For example, the city of Worcester, Massachusetts in the United States has a largely renowned waste management system, yet experienced a significant delay in waste collection during the early months of the COVID-19 pandemic (Bird, 2013; J. Kempton, personal communication, December 2, 2022). Initial city-wide quarantines nearly doubled the normal amount of waste produced. Thr garbage trucks could not hold the additional waste during routine pickups, and had to delay certain routes. Overall, collection and transportation issues mainly involve the overwhelming of systems in place, typically due to increased waste production.

Problems with proper separation and disposal of waste can commonly be sourced to household waste practices (Alqahtani et al., 2022; Challcharoenwattana & Pharino, 2015; Dinh et al., 2022; Rudnik et al., 2021). In fact, tourists and residents who are unaware of the impact of their waste management decisions are major contributors to beach litter in Thailand (Kaewmanee & Wijaya, 2014). However, ISWM cannot be properly executed if there is no system in place to properly dispose of waste (Balew et al., 2022). Balew et al. demonstrated what a rapidly developing town with no pre-existing waste management system might look like with a case study based in Robe, Ethiopia. This town had a growing population and consequently more waste, yet had no established disposal system. Instead, residents had a community garbage dump in the middle of the village. This not only created environmental concerns, but also health and

economical concerns as it was taking up space near households (Alqahtani et al., 2022; Balew et al., 2022). Although most sources emphasize the importance of education and community involvement, there must be a sufficient system in place (Balew et al., 2022; Silva et al., 2019).

Of course, there are still social factors that limit the effect of waste management systems (Sasana et al., 2022). This category mostly involves the social, psychological, and cultural aspects of waste management practices. Normalized habits at the individual level affect entire communities, as it often reflects their community's culture, education, and expectations. For example, Sasana et al. (2022) found that education on waste separation and recycling was insufficient in Indonesia, which may be a reason why the nation is among the top five contributors to marine litter (CIWEM, n.d., p. 10). Evidently, waste management is a complex matter as it relies on the logistics of municipal waste management, the values of different cultures, and the willingness of individuals within communities. Thus, effective waste management solutions require systemic, social, and individual changes.

2.2 Solutions to Waste Management Issues

Due to varying factors in governments, cultures, and values in waste management, communities around the world developed waste management solutions unique to their circumstances (Bourgault et al., 2005; Simmons & Fielding, 2019). We will now describe solutions implemented in various locations including the U.S., Saudi Arabia, Latin America, India, and Southeast Asia. Despite their unique systems and solutions, they all agree on the importance of community-based efforts, where the members of the community are directly involved in the planning and execution of efforts (Alqahtani et al., 2022; Challcharoenwattana & Pharino, 2015; Dinh et al., 2022; Guo et al., 2021; Tsai et al., 2021).

2.2.1 General Waste Management Methods

There are many possible waste management strategies and methods. These techniques can be merged or rearranged to form an organization-specific waste management system. Modern waste disposal strategies are designed to be environmentally friendly as environmental sustainability is a current global concern (SafetyCulture, n.d.). Other waste management options include waste reduction, reuse, and recycling.

The major types of waste include general waste, recyclable waste, and organic waste (Menon et al., 2017). General waste is an overarching term for all types of solid waste. Recyclable waste is waste that can be physically reprocessed and repurposed. This category is mainly inorganic materials such as plastic, glass, and metals. Organic waste is biodegradable waste. A common method of repurposing organic waste is composting. The most common way of handling general solid waste is by dumping it in landfills, which poses potential problems in odor, health, pollution, and cost (Alqahtani et al., 2022; Challcharoenwattana & Pharino, 2015; Faircloth et al., 2019; Prateep Na Talang & Sirivithayapakorn, 2022). To minimize the drawbacks of traditional waste management, new waste practices have developed over time. However, the development of these new practices required unique approaches to different situations, which is guided by varied cultures, environments, and resources. Therefore, the research we conduct must focus on the particular situation of Baan Thung Noi.

2.2.2 International Developments in Waste Management

The city of Worcester, Massachusetts, created a unique, economically-based solution to waste management called the Pay-As-You-Throw (PAYT) program. James Kempton (personal communication, December 2, 2022), the Acting Director of Street Operations & Sanitation of Worcester Public Works & Parks explained how the PAYT system works. The core concept of

PAYT is that residents buy Worcester-specific trash bags. The money from those purchases then funds their municipal waste services. The city will only collect properly discarded waste disposed of in those bags. Since residents directly fund waste management services, it encourages them to produce less waste (Bird, 2013). The system was initially created in 1993 during a budget crisis and was made with the intention to create more funding for Worcester waste management services. PAYT was unique to the city's circumstances at the time and has successfully remained in place for nearly three decades. The PAYT program demonstrates how cultural values, such as money, convenience, and cleanliness influences the design of successful waste management systems.

To tackle the issue of route optimization, smart-technology has been implemented as a tool in nations like Saudi Arabia and Vietnam (Alqahtani et al., 2022; Dinh et al., 2022). In Saudi Arabia, Alqahtani et al. determined potential trash collection routes through self-learning algorithms. One algorithm they used is the ant colony system, which allows the garbage trucks to travel freely and randomly. Over time, patterns repeat, and model what is likely most efficient. Another example is assigning zones which will then be analyzed on an individual scale for optimal collection. In Vietnam, Dinh et al. used software such as ArcGIS to optimize collection routes, and have found a reduction of 59.12% in distances traveled by collection trucks. These two approaches exemplify how smart programs are a possible solution should route optimization be a pressing waste management concern.

Many waste management systems of developing nations will include the role of informal waste pickers (Dinh et al., 2022; Quiroga et al., 2011; Rudnik et al., 2021; Silva et al., 2019). Waste pickers, or scavengers, sort through waste for valuable items such as recyclables. They then either keep their findings or sell them for profit. These groups of people are typically of

lower class; in Brazil, they have found successful improvements to waste separation by formally implementing waste picking into their waste facilities (Silva et al., 2019). The national government collaborated with the facility to legally protect the employment of these waste pickers. There is also a presence of waste scavengers in parts of Thailand, called *salengs* (Rudnik et al., 2021). Since Thailand's recycling rate is fairly low, these scavengers are able to sort the recyclable materials that they can later sell to other scavengers or recycling facilities for profit. A system is in place in the village of Baan Thung Noi where a day or every couple of days a collector comes in and buys the plastic bottles. Therefore, a similar legal approach may apply to waste management in Baan Thung Noi.

A more aggressive approach is the "Zero Waste" policy (Dileep, 2007; Zaman & Lehmann, 2013). Rather than focusing on managing waste, Zero Waste aims to eliminate waste entirely–or reach a net-zero flux of waste. In Kovalam, India, they model this solution with the 3E's: Efficiency, Economics, and Ethics (Dileep, 2007). Rather than only focusing on ways to handle existing waste, the 3E's aim to prevent the buildup of waste at all. Efficiency refers to increasing the performance of waste elimination; Economics refers to balancing efficiency with improving economic benefits; Ethics ensures that these methods remain socially and economically responsible. There are various ways of eliminating waste, such as incineration, composting, or anaerobic digestion, though each varies in environmental advantages and drawbacks. For example, composting is a more ethical and environmentally conscious disposal method than incineration. Additionally, this approach can involve changing the type of waste produced in the first place by changing what types of materials people are using and implementing systems to specifically deal with those materials. "Zero Waste" is an environmentally ideal solution, but requires major cultural, systemic, and social reconstruction.

From this concept, we learn that there may be more ways to approach waste management than the traditional route of Reduce, Reuse, and Recycle. All of these approaches involve economics, technology, and innovative methods.

2.2.3 Significance of Public Awareness

A common point throughout the cited literature on waste management systems is the importance of community involvement and public awareness of waste management (Guo et al., 2021; Tsai et al., 2021). All efforts mentioned so far rely on the compliance of the collective, so determining methods of public outreach is vital to any waste management changes. According to Tsai et al., community involvement increases the likelihood of any program's longevity. Public awareness can be improved through various strategies, such as implementing educational efforts in schools, or simply providing clear labels on waste bins for proper separation (Guo et al., 2021; Rudnik et al., 2021; Sasana et al., 2022). The most effective way to investigate the current state of public knowledge and opinion was through researching local programs, local education, and collective beliefs about waste management. Similarly, improving public awareness often requires a catered approach for the effective communication with an intended audience (Harvie & Jaques, 2003; Markel & Selber, 2022). Therefore, identifying individual opinions about waste management may provide insight on how to best create impactful education efforts for Baan Thung Noi.

According to Saseanu et al. (2019), individuals naturally adopt more environmentally responsible behavior as they become more aware of the consequences of environmental issues. Therefore, long-term education is vital for encouraging sustainable behaviors. For example, institutions can start by focusing on small-scale initiatives such as raising awareness of unsustainable human actions, recycling campaigns, courses focused on sustainability, and the

gradual transition to integrating sustainability into the whole system. Thus, a simple lecture of a professor bringing to the students the problem of saving trees by limiting the excessive use of paper can be seen as a first step in raising awareness. Approaching the education system within the village may be a good approach to implementing long-term behavioral changes and consciousness in conjunction with the technical approaches.

2.3 Waste Management in Thailand

Waste management is a global issue, yet is especially prominent in Southeast Asia (SEA). This region is one of the greatest contributors to the Great Pacific Garbage Patch, with multiple SEA countries ranking within the top 10 contributing nations as of 2015 (Jambeck et al., 2015; Lebreton et al., 2022). According to Thailand's Pollution Control Department (2021), nearly a third of 24.98 million tons of waste generated in Thailand in 2021 was improperly disposed of.

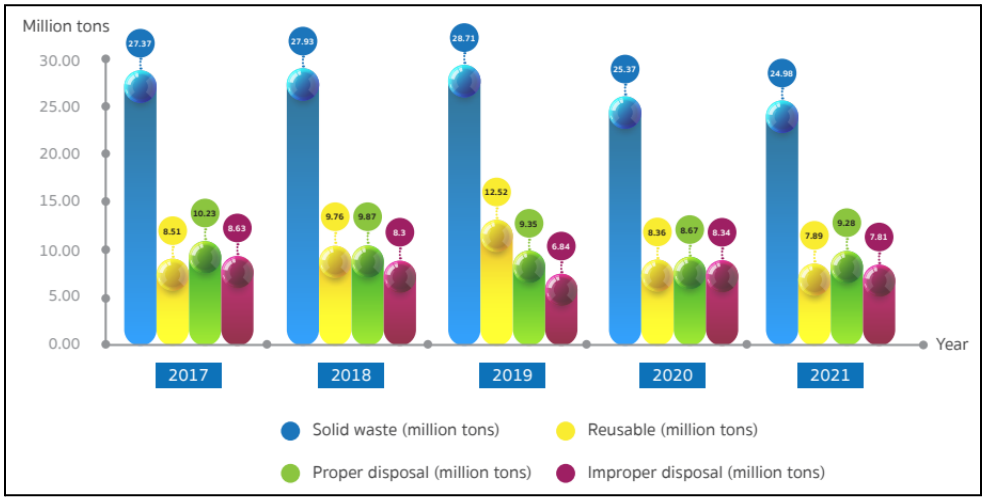

Figure 2. *Waste Treatment in Thailand (2021)* Depicts how Thailand has managed waste from 2017-2021 (Pollution Control Department, 2022)

Furthermore, the Pollution Control Department reported that there was a 6% decrease in repurposed waste. However, there was still an overall increase in proper disposal at the

municipal level. Overall, the waste separation in Thailand is ineffective at recycling the large quantities of waste it produces.

One contributor to Thailand's overconsumption of waste may be the normalized use of disposable, plastic items (Rudnik et al., 2021). According to Less Plastic Thailand (n.d.), a Thai environmental organization, each person in Thailand uses about eight plastic bags per day. Another factor may be the historically centralized government system in Thailand (Dearden et al., 2017). Making changes at the municipal level did not take place until the 1990s. Additionally, the fishing market is a significant part of Thailand's economy. The fishing industry is a leading cause of marine pollution, contributing to plastic fishing equipment such as nets in the ocean (Kaviarasan et al., 2022). Therefore, fishing is also likely a significant factor in Thailand's role as a major contributor.

2.3.1 Thailand Case Studies

To gain a better understanding of situations unique to Thailand, we have reviewed case studies from communities in Thailand. These cases range from small fishing villages to largely populated areas and how each of them deal with waste management.

A similar case to Baan Thung Noi is the town Koh Pitak which is another small fishing village in Thailand that struggled with handling its waste (Dearden et al., 2017). Dearden et al. have conducted a study in Koh Pitak, a fishing island off the coast of Thailand on their relationship with the environment. The villagers of Koh Pitak aimed to improve the appeal of their village to increase tourism, which included bettering their waste management. Koh Pitak is similar to Baan Thung Noi as they are both small fishing villages with the aim to improve their waste management. Due to increased pressure on the fishing industry, Koh Pitak and many other small Thai villages suffered from a sudden decrease in resources. The central government was

not able to support each village, so Koh Pitak turned to community-based leadership and programs to improve their situation. They adopted the philosophy of a 'sufficiency economy,' where they valued perseverance over exploitation of natural resources.

The community was united with the intention to improve their economy, which involved preserving their natural resources. This intention incited the requirement of a more effective waste management system. Efforts started with the villagers cleaning up the waste in their community, but then began to include more innovative solutions. The village used balls of microorganisms to digest their organic waste and repurposed waste water for gardening. In summary, they were successful in making changes to their individual behaviors and across the community's waste management system.

Dearden et al. (2017) have attributed Koh Pitak's success to the overlap of organizational and social changes in the community. The head of the village both led and organized community-wide meetings that were democratic and transparent to the entire village. This sparked greater trust between individual households and assisted in unifying everyone under the same cause. This change in perspective assisted in their new 'sufficiency economy' mindset. These factors of consistent leadership, community-wide collaboration, and a collective goal drove Koh Pitak's success, and may be important factors to consider in Baan Thung Noi.

2.3.2 Inconsistencies and Gaps in Previous Research

Overall, there is strong agreement in the reviewed literature regarding methods to properly support waste management systems as they collectively refer to the importance of community-based outreach (Challcharoenwattana & Pharino, 2015; Charuvichaipong & Sajor, 2006; Guo et al., 2021; Tsai et al., 2021). However, one point of contention that has arisen was whether the solution lies within the local legal system or through a community effort and

involvement. When the problem is approached by creating a legal precedent, it ensures the support of the local government and will most likely be a better funded project, yet is less likely to succeed as it more likely neglects social impacts and repercussions (Tsai et al., 2021). In contrast, when waste management is crafted by the community's opinions and efforts, the solution is more likely to be accepted, and will more closely represent what the community wants in a waste management system (Challcharoenwattana & Pharino, 2015). This potential conflict must be resolved by improving the communication and relationship between the village as a whole with their local government (Challcharoenwattana & Pharino, 2015; Silva et al., 2019).

The only other significant disagreement in the literature was defining the end goal when designing a waste management system. It should either focus on reaching zero waste in the community or on getting the waste in the community to an acceptable level. Getting a community to zero waste has countless benefits, including improved public health, a healthier environment, and a more visually appealing community (Dileep, 2007; Prateep Na Talang & Sirivithayapakorn, 2022). However, the biggest roadblocks when trying to achieve a zero-waste community are the time investment and the money investment. Achieving zero waste is a lengthy, expensive project as it requires both policy changes, social reconstruction, and time.

While these case studies help to contextualize issues related to waste management strategies, we must consider the specifics of Baan Thung Noi's situation. The first step in understanding a waste management project is determining the source, type, and distribution of waste. The next step is understanding the social and cultural aspects of Baan Thung Noi's waste management. We must contextualize how the residents of Baan Thung Noi feel about the waste in their village, their current waste management system, and the power dynamics between the

residents and their local government. Our research will aim to answer all of these questions to ultimately create a unique approach for creating long-term waste management improvements.

3. Methods

The goal of our project was to suggest future action for long-term improvements in Baan Thung Noi's waste management system. In this chapter we describe and justify the following research methods we used in achieving our objectives and, ultimately, our goal. The objectives we used to track our progress were:

1. Assess the technical factors of Baan Thung Noi's current waste management system.
2. Assess the socioeconomic factors of Baan Thung Noi's waste management system.
3. Collaborate with community leaders to propose future plans based on our investigation within the village.

3.1 Assessing the technical aspects of Baan Thung Noi's Current Waste Management System

In this section, we describe the methods we used to assess the technical aspects of Baan Thung Noi's current waste management system. These methods include direct observations and semi-structured interviews.

3.1.1 Tour and Direct Observation of Current Waste Management System

In order to suggest any improvements to Baan Thung Noi's waste management system, we must understand the currently utilized system. To do so, we toured the local dump site, as well as the harbor, the local school, and restaurants in the area to understand how much waste is in each area. We used an open-ended observation method for this step, and all observations were noted for further analysis including pictures for documentation.

3.1.2 Site Surveys

We first used direct observation to analyze the village's current relationship with waste and litter. We guided our site surveys through checklists which we used to gauge the severity of the waste issue. Each observer ranked the locations on a scale 1-10 based on the cleanliness, however each observer might justify the numbers differently. Therefore, the data can not be used as an objective measurement but rather an indication of problem areas by comparing overall ratings between locations. We took photos of the streets and other public locations to document the presence and abundance of waste. Other questions on the checklist include: “What type of waste is present? Where is the litter accumulated? Was there a smell present, and if so what kind?” Refer to Appendix B for the full checklist of questions in the site survey.

To gain further understanding of the infrastructural system, we collected data using ArcGIS. We marked waste bin locations and the varied concentrations of litter throughout Baan Thung Noi. We used ArcGIS software containing the two layers. One layer was to record the waste bin locations, and the other to record ratings of litter concentration. We collected data by walking along all residential streets, the harbor, and lastly the beach while documenting locations of waste bins. The GPS function on the tablet allowed for easy collection of locations. Simultaneously, we collected data points rating the concentration of waste along the streets on a scale of 1-10.

After collection, we uploaded the data to ArcGIS to create a visual representation. We procured a map depicting locations of waste bins, and a heat map displaying the concentration of litter in the village. From locations on this map we assessed the accessibility of waste management, by measuring distances between bins and identifying areas that lack bin accessibility. This factor may affect peoples’ waste handling behaviors (Dinh et al., 2022).

Limitations of this method include accessibility to certain areas and the subjectivity of rating litter concentration. The data was also limited to areas that could be seen from the road or other public places. Although mapping data was collected by a single observer for consistency, it still has the limitation of being a subjective measurement. This data may not be an objective measurement of the concentration of waste but it is a useful metric to gauge the severity of waste pollution, especially in comparison with the rest of the village.

3.2 Assess Socioeconomic Factors of Baan Thung Noi's Waste Management System

Improving local knowledge is crucial to improving waste management, as community-based efforts have proven most effective in waste management (Challcharoenwattana & Pharino, 2015; Guo et al., 2021; Tsai et al., 2021). Therefore, we focused on properly contextualizing waste management issues from the locals' perspective to ultimately determine potential action regarding public knowledge. We approached this step by collaborating with our sponsor, community leaders, and local schools to generate possible improvements, as the residents of the village will best understand their circumstances.

3.2.1 Semi-Structured Interviews and Qualitative Coding

To understand the attitudes and culture surrounding waste in the village we conducted semi-structured interviews. We facilitated these semi-structured interviews with villagers through casual conversation. We selected our interview participants through convenience sampling; as we walked around the village, we interviewed those who were willing to participate. Documentation of these interviews were in the form of generalized notes sorted by the pre-planned question. We focused on gaining interviews from households, local businesses, restaurants, and fishermen. The guiding questions are listed in Appendix C and response notes. To record the information learned

during these semi-structured interviews, we took notes of answers to the interview questions and any additional information interviewees provided.

After collecting data, we used analytical and qualitative methods to interpret villager responses. For quantitative questions (i.e. multiple choice questions) we were able to break down the data by percentages of responses for each question. The open-ended responses were documented by taking notes during the interview process which were used to conduct thematic and axial qualitative coding (Flick, 2013). In this method, we first separated villager responses by villager and question prompt. We then conducted an initial round of coding to gauge what themes and patterns are repeated throughout all the responses. For example, some notable key themes in the notes when asked for suggestions in future solutions were: head of the village, SAO, teach, and assembly. From these themes, we extrapolated patterns into more general topics. *Head of the village* and *SAO* were grouped into "leadership." Then *teach* and *assembly* were grouped into "community event." Next, we conducted another round of coding with those generalized topics; we scanned through the interview response notes again under the same topic of suggestions for future solutions, this time noting how many participants seemed in favor of leadership, community event, or both. Finally, we compiled this data into quantitative values to reflect how many participants supported or desired certain ideas and suggestions.

The main limitation of this method was the time required to interview a member of one household. As a result, we were only able to interview a small portion of the village, which was 27 of 233 total representatives of households. An additional limitation is inherent response bias. These biases include the tendency to choose a certain answering style, such as acquiescence response bias, where the participant defaults to agreeing with questions (Wetzel et al., 2016).

This response bias may arise due to the shame associated with admitting poor individual waste management.

3.2.2 The Local School

The school was one of the most important investigation sites to assess public knowledge as it is where children in the village are taught norms and behaviors (Sasana et al., 2022). Therefore, we visited the local school to evaluate what the students learned about waste management. We first interviewed the principal of the school and asked questions about the school's waste management system, and efforts they may have conducted that focus on waste management. For instance, "How does the school deal with waste? Which past activities did the school engage in? And how do children cooperate?" The full list of interview questions can be found in Appendix D.1. These questions ultimately helped us understand what the children are being taught about waste management and the skills they are taking home to their families.

Additionally, we observed the school waste management system. For example, we noted what kinds of bins are at the school, and what materials the students use on a daily basis. These observations helped us determine our focus for further research, such as conducting more interviews and further investigating the system within the school. This investigation would then serve to guide possible solutions for the entire village.

3.3 Collaborate with Village Leaders to Purpose Future Plans Based on our Investigation Within the Village

We looked at case studies with similar waste management issues and geography as Baan Thung Noi to learn about potential solutions. This outside research aided our understanding on what has worked elsewhere and what issues they encountered in the process of improving their

waste management. An important matter we investigated was how to motivate residents to engage in waste management efforts, which mostly involves participation in community-wide efforts and workshops. Motivation is crucial to having the locals cooperate and want to change their habits and help fix the waste management system as a whole as without it, nothing will be done (Tsai et al., 2021). Based on the information we gathered about Baan Thung Noi, along with our conducted background research, we were able to develop a potential community-based plan for the village of Baan Thung Noi and its residents.

3.3.1 Pilot Community Event: Trash Challenge Community Involvement Phase 1

We hosted a community event in the village to gather insight and gauge community interest for possible future workshops. To prepare for this event, we utilized the philosophies of PAR, where we emphasized collaborative work with those involved in the community to create solutions rather than imposing a solution based on our own perceptions (Auerbach et al., 2022). Thus, we worked closely with community leaders and the school to choose what activities to include. The school principal helped us organize a creative activity with the children to gain their interest. Then, we organized an active-learning session to collect data on current recycling knowledge among the students. Lastly, the community activist recommended a community clean-up event to continue his activism in cleaning the village. The activities we held throughout the day were designed to encourage collaborative work within the community and with community leaders to further facilitate greater interest, engagement, and feelings of empowerment among the villagers.

The first event of the day was designed for children, where they were challenged with designing a trash bin out of recyclable materials. From this event, children learned about the impact of plastic pollution on the environment, and creative ways of repurposing waste. We

chose this event to be engaging and creative to incite curiosity among the students. The school has done multiple activities that are creative and innovative such as ecobricks, therefore we thought of a challenge that is similar. We thought the children would enjoy a competition and enjoy participating in the activity while learning about the effects of litter. During this activity, observations were taken on how engaged the students were. In the next activity, a volunteer from Chulalongkorn's CU Zero Waste organization led an interactive presentation at the community center on the beach. This activity was ideal for the audience. It allowed them to learn about the "Three R's" (reduce consumption, recycle plastics, reuse) based on a CU Zero Waste model. The children were able to discuss what they know in groups and present it to everyone. We were able to collect data on the knowledge of younger children. The final activity was a competitive group clean-up activity of the litter on the beach. Beach clean-ups are an activity the village does monthly. The clean-up was intriguing to the audience as we made it a competition. Throughout the day, we collected data on engagement and interest through direct observation. After the event, we collected feedback by interviewing teachers and SAO members, and other community leaders that attended the event.

4. Results and Analysis

The goal of this project was to suggest future action for long-term improvements in Baan Thung Noi's waste management system. We divided our research goal into three main objectives: assess the technical factors of Baan Thung Noi's current waste management system, assess the socioeconomic factors of Baan Thung Noi's waste management system, and collaborate with village leaders to propose future plans based on our investigation within the village. To assess the technical factors of Baan Thung Noi's current waste management system, we used site surveys and direct observation of the physical factors in the village's waste management system. To assess the socioeconomic factors of Baan Thung Noi's waste management, we conducted interviews with locals as well as with people with influence in the village. Lastly, we collaborated with active members of the community to design a pilot community event. During this event, we gained feedback and suggestions to recommend how to plan future improvements and efforts.

4.1 Research Findings

We have applied a variety of methods to fulfill our objectives, including direct observation, site surveys, mapping, semi-structured interviews, and hosting a pilot community event to observe engagement of participants and receive feedback from community leaders. In this section, we will present our findings from our data. To define the waste management system and potential improvements, Findings 1-3 characterize the infrastructural aspects, Findings 4-6 focus on the socioeconomic aspects, and lastly, Findings 7-8 provide outlook on key factors for future efforts.

Finding 1: Defining the current waste management system

Through our various interviews and direct observations within the village we have come to understand how the current waste management system operates in Baan Thung Noi. We defined the waste management system as shown in the flow diagram in Figure 3. The system starts with the waste generated by households and individuals, which varies in treatment.

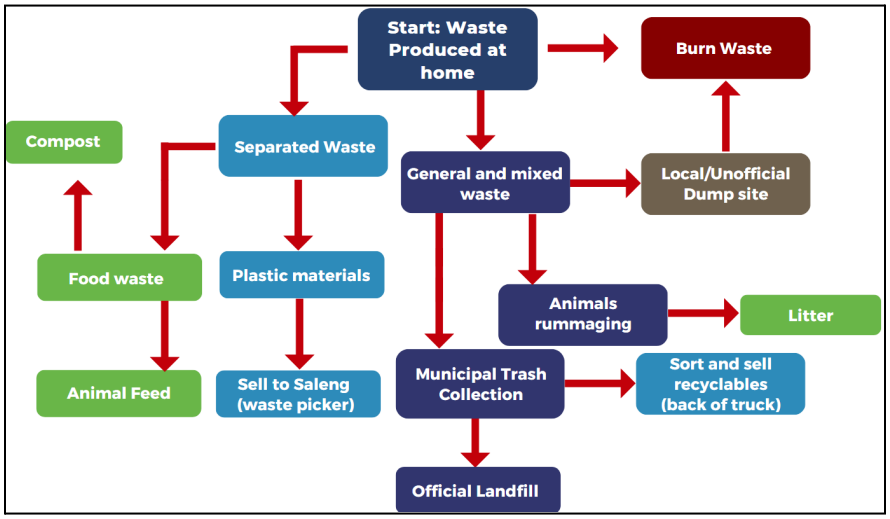

Figure 3. *Baan Thung Noi Waste Management* A flow chart of the current waste management system in Baan Thung Noi

First, waste may be separated within the household. We interviewed 27 household representatives out of the 233 total households in the village, which revealed that 23 of 27 interviewed households report practicing some form of waste separation. The two main categories of separated waste were food and plastic waste. Those who reported separating their food waste either feed the waste to animals or use it in compost. Those who reported separating plastics mainly separate fishing nets and plastic bottles, which they can sell to waste pickers who travel to the village in varied weekly schedules. Interviewed villagers claimed that used fishing nets can sell for a range from 10 to 30 THB per kilogram depending on the quality of the net, and plastic bottles can be sold for a range of 5 to 10 THB per kilogram; a kilogram of bottles is

approximately 60 bottles. These selling prices are considerably low, which may explain why some households did not report separating their waste. However, many households still list selling waste as an incentive to separate their plastic bottles. The waste that is not separated is general mixed waste that may end up in different places depending on treatment.

We observed that throughout the village, mixed waste including unseparated food and plastics were put into blue general waste bins, dumped in the local dumpsite, disposed of on the ground, or incinerated by individuals. Pictures depicting these areas of disposal are shown in Figure 4.

Figure 4. *Baan Thung Noi Waste Disposal Sites* From left to right, top to bottom, images depict general waste bins, unofficial dumpsites, incineration, litter, and leaving fish nets left on ground along the harbor

Through interviews with the villagers, we found that one issue the village faces is that stray animals and wild monkeys get into the general waste bins and contribute to the litter around the village. The waste that stays in the general waste bin gets picked up by the municipal trash collection. All resellable plastics are separated out on the back of the truck and the rest is taken

to an off-site landfill. The waste that ends up in the local dumpsite either remains there or is incinerated by some of the villagers.

Figure 5. *Back of the Garbage Collection Truck* Waste is separated within the truck by the garbage men. After dumping waste from the bins into the back of the truck, they pick out recyclable items by hand.

Finding 2: Many villagers are aware of and practice waste separation

Through interviewing villagers and community leaders, we found that the people of the village already separate their waste and claim they are aware of proper waste management. Every household and business has its own waste bin, and they pay 40 THB monthly for municipal pickup. As stated in Finding 1, 23 of 27 interviewed representatives from households reported practicing waste separation at home. However, there were no separation bins or recycling bins throughout the village. The school was the only location with waste separation due to their zero-waste model. The zero-waste model at the school incorporates teaching students about sorting bins such as general waste, recycling, and food waste by practicing separation in their daily school life.

To learn more about the zero-waste model, we interviewed the school principal. She described the school's system that ideally uses multiple separation bins. The zero-waste model was introduced to the school by SAO 3 years ago. In this model, the students practice separation

of the waste they produce into four categories: general waste, recyclables, hazardous waste and organic waste. Organic waste includes food waste and plant material, or waste that can be composted. Hazardous waste includes electronic items such as batteries as well as masks. Recyclables include recyclable plastics such as plastic bottles. General waste is a mixed waste bin for all the additional waste that can not be recycled or composted and is not hazardous to handle. Additionally, the school hosts events for beach clean-ups monthly. In summary, our investigation into the school showed evidence that students have exposure to waste management practices. However, these practices are not enforced as strongly outside of school grounds.

When asked why these practices from the school are not reflected within the rest of the village, the principal suggested that the difference between enforced separation bins at the school and lack thereof throughout the village itself is enough to discourage students from continuing their waste management practices at home. We have also observed this lack of official separation infrastructure; all bins on the streets were blue general waste bins, with no recycling bins as shown in Figure 6. However, we were unable to determine if the lack of official recycling bins was a true cause or not with our data due to the time constraint of our project.

Finding 3: There is a lack of public bins along the beach and harbor

After conducting our site surveys of the beach, harbor, school, businesses, and residential areas, the data indicated the beach and harbor as problem sites. This indication is also apparent in the maps we created of the village, one depicting locations of bins, as seen in Figure 6, and the other depicting concentration of litter, as seen in Figure 7. Both of these maps show a correlation between the locations without bins and the areas with higher concentrations of litter. The two main areas where this correlation was apparent was along the beach and harbor. Compared to residential streets where there is at least one bin per household, the harbor and beach have almost

no bins. All households own their own trash bin, yet there are only a few official, public bins in these areas. For example, there were only 5 bins along the harbor leaving approximately 365 meters of distance from the furthest point of the harbor to the nearest bin. Distances of this size have been found to cause a sharp increase in the rates of improper waste management (Dinh et al., 2022). Therefore, the distance between bins in Baan Thung Noi may be a contributing factor to the high amounts of litter.

During our initial tour of the village, we also observed the village's unofficial waste dumpsites. According to our interviews with the head of the village and the villagers, these unofficial dumpsites were intended for organic waste but are largely misused. Now, they are filled with plastic waste such as food containers and fishing nets as shown in Figure 8.

Figure 6. *Waste Bin Locations in Baan Thung Noi* A map of bins along the streets of the village

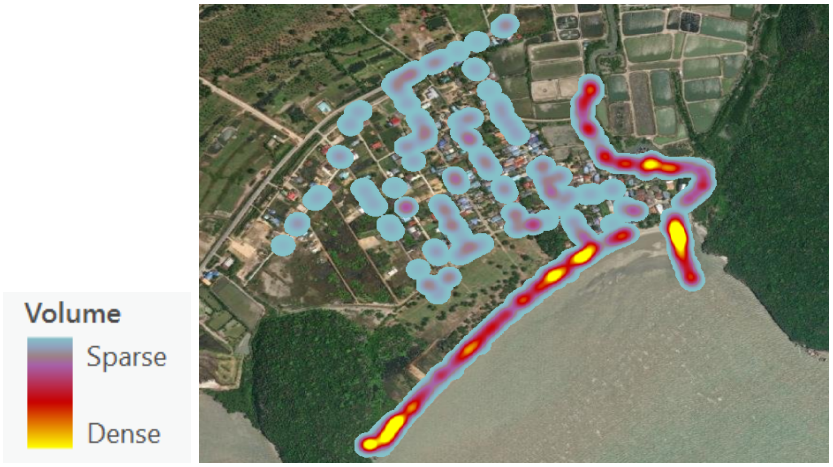

Figure 7. *Litter Concentration in Baan Thung Noi* A heat map depicting concentration of litter along streets of the village

Figure 8. *Village Unofficial Waste Dumpsite*

Our site surveys gave us a better understanding of the technical situation of waste management in Baan Thung Noi. We further supplemented these observations by discussing the current waste management system's capabilities in an interview with garbage men from the SAO. The garbagemen recognized the problem area of the beach and harbor. They explained that when the tide is low, the head of the village will hire people and gather volunteers to pick up the

waste brought in by the waves. This answer indicates the focus of waste collection among villagers on the beach and that public bins may make it easier for clean-up efforts to occur.

Finding 4: Past efforts for social change only had short-term effects due to design flaws

In interviews with members villagers about the current system, we discovered there were past efforts regarding personal waste management that only had short-term impacts. To understand why these efforts fell short, we asked for more details in our interviews with the SAO. According to our interview, the most recent attempt took place a year prior. The local government worked with an outside organization with the goal to decrease the amount of organic waste. The SAO conducted informational discussions with villagers about innovative composting methods. Their method of spreading information was by visiting individual houses to teach about handling organic and fish. During these visits, the SAO informed residents how to repurpose organic waste as fertilizer. However, our villager interviews found that only 4 of 27 interviewed representatives of households reported practicing compost methods. Evidently, lasting impacts of previous efforts were limited. Possible reasons for the short-term impact include the content taught to the villagers, the time commitment of learning waste management practices, and the inconsistency of these efforts by the SAO and visiting organization.

The content of these household visitations was composting, which may have posed a problem within this village. First, composting may have been an intimidating method to teach the villagers as it requires more manual labor and time. When we discussed composting as a possible solution in our research with the community activist, he explained that the process is time consuming. This issue makes composting difficult to implement in a low-income village where residents prioritize their own jobs. Thus, this effort to educate the public failed because villagers were likely unable to commit to workshops or to adapt new waste habits such as composting as it

conflicts with their time needed to work. Additionally, composting may not appeal to this specific group of people as they are not an agricultural village but a fishing village. Approximately 80% of the village households get their income from fishing, and 20% of which get their income from owning small businesses such as restaurants and shops. Since not many people in the village have a use for compost other than restaurants or shops, and villagers do not have the availability for the time commitment of composting, it is not the most effective or practical topic to introduce to Baan Thung Noi.

Interviews across multiple groups of people (villagers, SAO, head of the village) indicated that these efforts were also not persistent. For example, our post-community event interviews with the SAO and other community leaders indicated that they would want more frequent events. However, the most recent event was almost a year ago. The low, organized activity likely contributes to the low interest or engagement with the events or efforts they do conduct.

Another possible reason for the educational modules' low impact is villager availability. As previously mentioned, Baan Thung Noi is a low-income community and must work every day. Accordingly, only 4 of 27 participants in our villager surveys claimed they are willing to attend workshops or adapt new waste management practices. We can infer that this low interest is a result of their commitment to their daily jobs status as a low income community; residents may be more concerned with making time for work and other means of monetary gain. For example, 12 of the 23 representatives of households reported separating waste specifically mention selling the plastic bottles they collect. This data indicates monetary gain as a motivator for waste separation. On the other hand, two villagers who reported to not separate their waste explained they did not do so because it takes too much time to properly separate. Although the

SAO took the time to communicate with households individually to ensure each person has an opportunity to learn, they did not account for the willingness of each household to commit their time to learn and adopt new waste practices.

Finding 5: Uncontrollable factors and circumstances demotivate the villagers

Uncontrollable factors such as the environment and the community's socioeconomic standing impact villagers' motivation to attend workshops and adopt new waste practices. Villagers cite uncontrollable factors as main contributors to the village's waste problem. They claim animals rummage through waste bins, scattering waste. They also claim the tide brings in the majority of waste along the beach. Our team's site surveys and observations agree with these claims as we rated the harbor and beach as areas with higher concentrations of litter. For example, we rated the residential streets, school, stores and restaurants, harbor, and beach on a scale of 1-10 of litter concentration in the site survey, with 1 representing little to no litter, and 10 representing high concentrations. When compared to the other areas, the beach and harbor were rated much higher with an average of 7.2 and 7.625, respectively, while residences, businesses, and the school were rated below a 5. Additionally, we observed that the concentration of waste along the shoreline was where the tide met the sand, further supporting the claim that the tide contributes to the litter along the beach.

These uncontrollable components in Baan Thung Noi's environment may correlate with low villager motivation. For example, during an interview with the community activist about past efforts he contributed to, he explained that he sometimes feels like his efforts to clean the beach had no lasting effect because the tide continually introduces more waste. Similarly, our interview with the garbage men revealed that the SAO already hires people regularly to clean the beach when the tide is low. Still, the beach and harbor remain the areas with the most waste due

to the tide. Although we only interviewed the community activist about the impact of the tide on his motivation, it is possible his experience applies to the other community members who desire a cleaner village. For instance, some interviews reported that villagers are hesitant to pick up the waste brought in by the tide as they did not directly produce that litter. Some interviews explained that villagers occasionally argue about who is going to pick up the trash from the tide. As a result of these uncontrollable factors and indirect sources of waste, members in the community lose the motivation or drive as they feel their efforts will not have much effect.

Finding 6: The zero waste system implemented at the school had short-term impact

When investigating the school to learn about education on waste management in the village, we discovered that the SAO implemented a "zero-waste model" at the school. This model aims to introduce sustainable practices to the students, such as waste separation and using reusable items. For example, the cafeteria serves food and drinks with reusable plates and utensils and requires students to separate their food waste after meals. The policy claims to have four overall categories of waste separation: general waste, recyclables, organic waste, and hazardous waste. Hazardous waste includes items such as batteries, chemicals, and cleaning solutions. The students are provided with the incentive to comply through a reward system. If they properly manage waste, their teacher will sign the student's notebook of signatures. Once a student collects enough signatures, they can get extra credit toward their grade. The students also completed projects such as creating eco-bricks from leftover food container waste. These eco-bricks can be seen in Figure 9.

Figure 9. *Ecobrick Activity* Ecobrick Tree Borders at Local Village School

If executed properly this system would be a good model for the rest of the village. However, an SAO member claimed that the system was not effective in engaging the children in the long-term, and the program was only used for a temporary period of time. He did not elaborate further about the reasons behind this claim.

Finding 7: School children are enthusiastic about waste management, but may require further education

During our community event as explained in 3.3.1, attendees participated in many activities throughout the event. All participants in the community event were school children ranging from elementary to high school. In one activity, the children gathered in groups and brainstormed a list of common waste items they produce in a day and ways to reduce them. For example, they listed individual items like plastic bottles, food containers, and face masks. Then, using that list they wrote down which ones they think they can reduce and recycle in their daily lives. We collected their worksheets and categorized the items they brainstormed into broader categories, such as clothing, food waste, hazardous waste, non-recyclable plastic waste, recyclable plastic, other recyclables, and general waste. We considered recyclable plastic and other recyclable as recyclable and food waste, general waste, plastic waste as non-recyclable.

Then, we analyzed how they suggested reducing or disposing of them by noting if the item they suggested recycling was truly recyclable or not. We considered recyclable items to be cans, cardboard, glass, paper, and plastic bottles. Non-recyclable items include the categories of food waste, non-recyclable plastic waste (e.g. plastic utensils and containers), general waste (e.g. napkins and face masks) and clothing (e.g. shoes and jewelry). Half of the participants' recycling suggestions were non-recyclable items, including clothing, food waste, non-recyclable plastic waste, and general waste. These results suggest that the children may require further education about proper recycling and waste management practices in general.

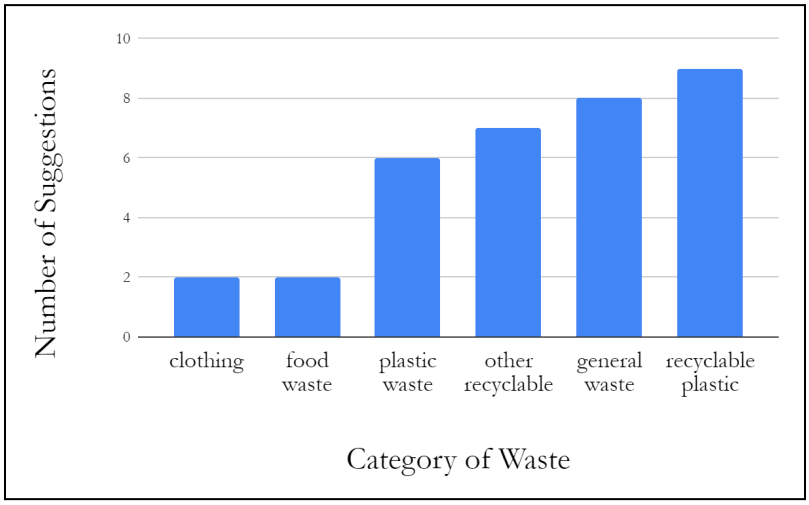

Figure 10. *What Types of Waste Can You Recycle?* Children brainstorming activity results. Number of suggestions is how many items the children suggested in a certain category. For example, 9 suggestions under recyclable plastic means that overall, out of the total 34 items suggested for recycling, 9 of them were recyclable plastic. Overall, 18 of the 34 items they suggested were non-recyclable and 16 were recyclable. For further data, refer to Appendix F.2.

Finding 8: There is a group of community leaders who are motivated to instill change within the community which is a vital factor in creating community-based change

During the 2nd field visit, we held a meeting with community leaders including the community activist, the head of the village, members of the Subdistrict Administrative

Organization, and any community members who chose to join. They collectively expressed a strong desire to clean the village. SAO explained they conducted the past efforts in the village mentioned in Finding 4 in conjunction with outside organizations. The community activist also explained that he took a role in organizing the clean-ups conducted by the school. In fact, the majority of attendees at the event were students from local schools. The group of high school students he invited for the educational workshop and beach clean up events were the usual group of students he organizes clean-ups with. Additionally, the attendees from the meeting were the only adults to attend the pilot community event. The group of community leaders assisted us in organizing the event, and communicated a desire to hold more workshops in a similar fashion in their interviews after the event. Evidently, certain members of the community are already highly involved and take the initiative in striving for waste management improvements.

4.2 Analysis

There are two major aspects that directly affect the success of any waste management system, which are technical factors and socioeconomic factors. Technical factors in the village include bin accessibility. This issue is especially apparent in public areas such as the harbor and the beach as they have a limited number of bins. Socioeconomic factors include finances, motivation, and education. Most of the villagers are fishermen and business owners. According to the semi-structured interviews, their income is not stable because it depends on the amount of fish that they caught. Therefore, they prioritize their sources of income over attending workshops and community events. Another pressing matter is how to motivate the villagers to participate in waste management efforts. When considering what makes an event successful, we found an overall disconnect between what was taught, how it was taught, and what would be most

applicable to the people, which may affect how interested or motivated residents are to engage with new waste management efforts. This can conclude that education is very important to making effective changes in waste management, not only in community events and workshops but also in keeping the village clean through individual efforts. From these findings, we have developed recommendations on how to consider both the technical and socioeconomic factors when moving forward with waste management efforts in Baan Thung Noi.

5. Conclusions and Recommendations

The most important factor in a successful waste management system is the balance of the technical and socioeconomic aspects within a community. From our research, we determined there are many approaches to improving waste management in Baan Thung Noi. These approaches include considering the infrastructure of the village's waste management, as well as the social factors to current waste practices. The following recommendations are problem areas for our sponsor to focus on when making future developments within the village.

5.1 Recommendations

These are the four recommendations we have for Singha R-Sa and SAO in order to start the process of improving the waste management system in the village as well as continued efforts into the future.

Recommendation 1: Upgrade the waste bin infrastructure

Based on our findings, we have determined that the village lacks sufficient infrastructure as they lack accessibility of waste bins in certain areas as well as official separation bins for separated household disposal and municipal collection.

Recommendation 1.1: Add more waste bins to the harbor area

The data from Finding 3 indicate that the harbor area is an area of concern in waste management. From our findings we determined that the area contains one of the highest concentrations of litter. Also from the data from Finding 3, we found that the largest gap between waste bins in the harbor was over 350 meters in length. This large gap has been found to cause a sharp increase in the rates of improper waste management (Dinh et al., 2022). Due to this likely factor, our recommendation is to add more waste bins in the harbor area which will hopefully

reduce the percentage of improperly disposed of waste in that area. We recommend tracking amounts of waste along the beach to verify the impact of these newly implemented bins.

Recommendation 1.2: Add more types of waste separation bins

Our next recommendation is to add three new types of bins to the village: a yellow bin for recyclable materials, a green bin for organic waste, and a red bin for hazardous waste (batteries, old cellphones, etc.). This recommendation is based on Finding 2, which explains that villagers are already mostly aware of proper waste separation methods. Instead, they lack proper infrastructure to put their knowledge into practice. We recommend that the yellow bins get added as soon as possible as most villagers interviewed already widely separate recyclable plastics. Then, green and red bins can get added slowly going forward. We suggest slowly adding one type of sorting bin at a time to make sure that people in the village can get the education necessary to adapt with new sorting bins. Currently, our data does not support the immediate need for green and red bins; only 4 of 27 households reported separating organic (food) waste, while none mention separating hazardous waste. Therefore, adding the red and green bins would not do much without educating them on the importance and usefulness of separating out these types of waste. So along with these new bins, we recommend that an educational program (e.g. a workshop or facebook ad campaign) be rolled out at the same time so that the bins will be properly used. This matter will be discussed in further detail in Recommendation 2.

Recommendation 1.3: Adding lids to the bins

Another infrastructural recommendation is to add lids to all trash bins in the village. One recurring complaint we heard from Finding 3 from interviews was that animals, mostly stray dogs and monkeys, get into the trash bins. Thus, the animals contribute to the loose waste around the village. We think that adding lids to all bins in the village will help reduce the amount of

waste in the residential areas. The main issue with this recommendation is the matter of designing a bin lid that is easy to use while also not being able to be opened by monkeys. An additional matter is smell. Our interview with the SAO revealed that the village bins used to have lids, yet were always taken off due to the smell that would grow. Therefore, we recommend a lid design similar to the one in Figure 11 as it is open to the air, yet still keeps the waste inaccessible from the outside.

Figure 11. *Open Lid Design* Possible Lid Design for Waste Bins from Krabi, Thailand

Recommendation 2: Singha R-Sa should conduct further research on current public knowledge

Although our semi-structured interviews with the villagers indicated some knowledge of proper waste management, we observed various waste treatment methods that are particularly detrimental to the environment. As depicted in Finding 1, we notice some bad practices such as burning, littering and lack of proper separation. An image of waste leftover from a burn pile can be seen in Figure 12.

Figure 12. *Residual Waste from Trash Burning*

This conflicting information called for further investigation, but due to the time constraints of our project, we did not get the chance to study why the villagers still use these methods despite their reported knowledge. This conflict in information may also be due to our small sample size, which does not allow us to generalize the whole village.

Based on Finding 4, we know there were past efforts in the village in regards to workshops. We were able to look into the composting workshop conducted the year prior, yet we were unable to obtain the details of workshops before then. Therefore, we recommend more investigation into what was taught, how it was taught, and the information of those who attended. This step will allow further contextualization of what has been attempted before, how much of it the people truly learned, and what approaches can still be tried for different and better workshops in the future.

Recommendation 3: The village should form a leadership group that will lead the waste management efforts

We are recommending that the local residents of Baan Thung Noi form a group to lead the waste management efforts. According to Dearden et al. (2017), leadership and transparent organization of community events is crucial to the success of any community-based efforts. This

recommended group of community leaders in Baan Thung Noi should remain in close communication with our sponsor, Singha R-Sa. This will help our sponsor have someone to reach out to and collaborate with when continuing their efforts to clean the village. Based on Finding 8, there is already a group within the community that is motivated to create change. These community members would be a great place to start in creating this group as they are already motivated and well known in the community.

While this group is a good starting place, we also recommend creating a Facebook group in order to increase the outreach of the group. Based on our villager interviews, TikTok and Facebook are the main social media platforms used. Although we cannot extrapolate the same social media usage for the rest of the village, the community activist already utilizes Facebook as his main method of announcing his organized community events. Moreover, a Facebook group emphasizes collaborative discussion rather than simply announcing information. This attribute of Facebook groups makes it an ideal platform to emphasize the importance of democratic processes in conducting community-based efforts.

Recommendation 3.1: The group should continue to organize community events similar to the community event conducted in our research

Once this group is formed, they should host community events. We recommend hosting events and gatherings similar to the event that we facilitated at least once a month. These kinds of events are important to understand how useful the implemented changes have been, as well as where in the process of creating a cleaner, healthier environment the village is. In said event, we recommend having an activity for the children to participate in, because these children are a source of enthusiasm, but need to be taught more as stated in Finding 7. The events should also have an activity for all ages as well as a village-wide discussion on the current situation of waste

in the village to keep a wide range of demographics interested in further efforts. Both of these recommendations will get people working together and keep the residents of the village motivated and involved in the process of keeping the village clean. In order to make these informational workshops impactful, proper waste management processes should be more accessible and understandable on the individual level (P. Lamsam, personal communication, January 18, 2023).

Recommendation 4: Conduct further research on the school waste management system.

The school's zero-waste system was claimed to be a highly successful and effective method of managing and reducing waste. However, from Finding 6, the system may have had more flaws than we found in our interview process. We were unable to do further research to make observations to verify claims in either of the claims. The success and failures of this system could be studied in further detail to determine if any of the methods used in the school could be implemented effectively village wide, and the shortcomings can be studied to find improvements on the schools methods as well.

Recommendation 4.1: Further investigate the school waste management system

Our data from Finding 5 indicates that the school had an elaborate and effective waste management system that successfully reduced the waste produced by the school. The system included several separate separation bins to teach the children how to separate their waste and used reusable utensils, plates, cups etc. The school was also found to be the cleanest areas in the village. However, a member of SAO who worked with the school to implement the system claimed that the system was only successful in the short term. Due to this more investigation is needed to further understand the system. It is recommended that the school is observed to determine if the system is as effective as our interview data implied, or if the system was less

effective as indicated by the SAO member. Furthermore, the reasons for the system not continuing to work should be studied if the system is no longer as effective as it was. Interviews with the teachers would be valuable to learn where the zero-waste system failed, and how that could be prevented if a similar system was implemented in the whole village. What aspects of the system should also be studied to determine how they might function villagewide. Interviewing teachers and directly observing the children interacting with the system will most likely be the most beneficial methods of researching this. This information should prove useful in suggesting improvements to Baan Thung Noi's waste system.

Recommendation 4.2: Continue to emphasize involvement of children in future efforts.

According to Finding 7, the students at the event were engaged in and excited by the activities. The children were especially motivated when an element of competition was introduced for the beach cleanup activity. From Finding 6 we also learned that students are already involved in waste based projects such as beach cleanups and making the eco-bricks seen in Figure 9, or beach clean-up events hosted by their school. However, they required more education on waste management since half of their recycling suggestions during the brainstorm session were non-recyclable items. Moreover, the children can also bring their parents to join the activities as well, this could be an alternative way to increase community involvement too. Therefore, we recommend to continue to emphasize involvement of children as they are curious, energetic and powerful to advocate and make a change.

5.2 Conclusion

Forming a community waste management group within the village will be an effective first step in making improvements. Based on our research and literature review, leadership is vital to organizing action and change for a community (Dearden et al., 2017). The formed leadership group should meet on a regular basis based on the availability and needs of the members and group. We recommended they plan future events similar to the Trash Challenge events on a semi-regular basis to keep the village's interest growing rather than fading. The group should organize volunteer beach, or other location clean up events more often. Based on our team's observations of our event, framing the event as a competition may further excite the children and produce greater engagement. The team should decide on the locations of these clean ups, as well as discussing methods of preventing litter and improving the waste management system at the recurring meetings. This team should work with Singha to continue to work on creating a cleaner environment for the village.

The benefit of focusing on collaboration of the community with these organizations is that the community is empowered by having an impact on the village's cleanliness. This will mean that even past our team's project and Singha's support, the community can maintain excitement and persist in their efforts. We believe the continued cleaning of the village will also discourage villagers from littering and encourage behaviors such as picking up litter on the street, since the community is already working hard to clean the village. We also recommend the group spread awareness and information about waste management on social media, specifically TikTok and Facebook. From our villager interview data, villagers reported using TikTok and Facebook as their main social media platforms. Using these platforms to continuously and

regularly reach out to the community can provide them with valuable information, and increase interest in waste management among the community. This may also lead to the group growing in size due to the increased awareness. Overall, the community taking an interest in its own waste management is the best way to create long term change and for the community to think of the solutions that will work best for themselves.

These recommendations are made with the goal of creating long term improvements in villagers behavior and to implement any technical changes that need to be made to the waste system. This will allow the community and waste system to continually grow and improve over time, well past what our team can support. This will help the village to reach the goal we set for our project, creating a cleaner environment for the village in the long term. Unlike the previous attempts at making changes within the village, Singha R-Sa is looking to maintain a long-term relationship with Baan Thung Noi. If the community continues to work collaboratively with our sponsor, the interest that we noticed within the community will not diminish as soon as our project ends.

Finally, the continued support of Singha R-Sa will allow the village the resources, time, and availability to make changes in their daily lives. By emphasizing the importance of individual action through community involvement, the village's waste practices will become self-sustaining in the long term as they will already be involved in managing their own waste. By empowering the role of the individual as part of a community, the villagers have the potential to create real, lasting change within Baan Thung Noi.

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Appendices

Appendix A: Sponsor Description

The sponsors of our project are Singha R-Sa and the Subdistrict Administrative Organization of Baan Thung Noi. Singha R-Sa was founded as part of the for profit food and beverage company, Boon Rawd Brewery Company (About Us - SINGHA R-SA, n.d.). The sponsor's main goal is to maintain society in the face of various hardships. This charity organization focuses on volunteer opportunities, disaster relief, and facilitating a more sustainable culture. Accordingly, the organization is made up of over 20,000 volunteers worldwide, and is affiliated with networks, which include universities, other foundations and restaurant clubs(About Us - SINGHA R-SA, n.d.). Many of its volunteers are students, as the organization values leadership opportunities for the younger generation. It has formed a partnership with AIESEC Thailand to establish the World's Citizen Project (About Us - SINGHA R-SA, n.d.). Singha R-Sa has a large network of volunteers, and a long history of assisting and educating small communities. The Subdistrict Administrative Organization of Baan Thung Noi is a tambon, the third level of subdistrict organizations under districts and provinces. We currently do not have information about the size and funding of the organization due to lack of information and language barriers. Another organization working on waste management in Thailand is Less Plastic Thailand, which focuses on decreasing plastic usage and improving recycling systems.

Appendix B: Site Survey Data

1. Location:
    a. Harbor b. School c. Residential area (streets) d. Beach e. Local Businesses
2. On a scale of 1-10, 1 being no litter, and 10 being a high concentration of litter, rate the litter present in the location.
3. What type of waste is present? Can choose multiple.
    a. Organic waste b. Plastic waste c. Solid waste d. None e. Other:_____
4. Where was the litter accumulated? Can choose multiple.
    a. Near waste bins b. Residential/streets c. Sewage drains d. N/A f. Other ____
5. Was there a smell? If so, what type of smell was there?
  a. Fish smell b. Organic waste smell c. Animal smell d. Sewage smell e. None f. Other

Responses:

Harbor	
Rating 1-10 (1 = no litter, 10 = high conc.)	6, 6, 7, 8, 8, 8, 9; AVERAGE = 7.625
Type of waste present	Plastic Waste (x7); Organic Waste (x5); Solid Waste (x6)
Where was the litter accumulated?	Streets/sidewalks (x7), Sewage Drains (x1), Near the Water (x1)
Was there a smell? What type?	Fish Smell (x6), None (x1)

School	
Rating 1-10 (1 = no litter, 10 = high conc.)	1, 1, 2, 2; AVERAGE = 1.5
Type of waste present	Plastic Waste (x2), Organic Waste (x2), None (x1)
Where was the litter accumulated?	Near Waste Bins (x1), Streets/sidewalks (x1), N/A (x2)
Was there a smell? What type?	None (x4)

Residential Area (streets)	
Rating 1-10 (1 = no litter, 10 = high conc.)	3, 3, 3, 4, 4, 6, 7; AVERAGE = 4.29
Type of waste present	Plastic Waste (x7), Organic Waste (x4), Solid Waste (x6)
Where was the litter accumulated?	Near Waste Bins (x5), Streets/sidewalks (x7), Sewage Drains (x6)
Was there a smell? What type?	Organic Waste Smell (x1), Sewage Smell (x3), None (x3)

Beach	
Rating 1-10 (1 = no litter, 10 = high conc.)	6, 6, 6, 8, 10; AVERAGE = 7.2
Type of waste present	Plastic Waste (x5), Organic Waste (x3), Solid Waste (x5)
Where was the litter accumulated?	Streets/sidewalks (x3), Shoreline (x2)
Was there a smell? What type?	Organic Waste Smell (x1), None (x4)

Local Businesses (restaurants, stores, cafes, etc.)	
Rating 1-10 (1 = no litter, 10 = high conc.)	2, 2, 2, 2, 4, 4; AVERAGE = 2.67
Type of waste present	Plastic Waste (x6); Organic Waste (x3); Solid Waste (x5)
Where was the litter accumulated?	Streets/sidewalks (x3); Near Waste Bins (x3); Sewage Drains (x2)
Was there a smell? What type?	Organic Waste Smell (x2), Sewage Smell (x1), None (x3)

Appendix C: Villager Semi-Structured Interviews

C.1 First Field Visit Villager Interview Questions

1. What is your age? If you are under the age of 18, do not answer the rest of this questionnaire.
    a. 0-18 b. 18-30 c. 31-50 d. 51-70 e. 70+
2. What is your gender?
    a. Male b. Female c. other
3. What is your opinion on the cleanliness of the village?
4. Do you believe keeping the village clean is important?
5. Do you believe improper waste management is detrimental to public health?
6. Do you believe improper waste management is detrimental to the environment?
7. Do you believe protecting the environment is important?
8. Do you believe recycling is important?
9. Do you separate your waste by types of waste?
10. Which of these improvements would you like to see the most? Order the following based on which you would desire the most to least from **1-6**.
    ____ More waste bins/locations
    ____ Collect waste more often
    ____ Change collection time
    ____ Create incentives for proper waste management(ex: recycling incentives)
    ____ Create disincentives for improper waste management(ex littering fines)
    ____ Other:_____

11. Please list any specific recommendations, changes, or improvements you would like to see regarding waste management policy.
12. Which media source do you get the most information from? (e.g. television, newspaper, social media, other)
13. Furthermore, where specifically do you receive the most information from? (i.e. TV channel, social media website, newspaper provider)

C.2 First Field Visit Villager Interview Responses

Interviewing a group of five villagers, women (age range: 51-70)

- Improper waste management within the village is that some people burn styrofoam
- The interviewees separate only plastic bottles from waste to sell
- The interviewees throw food waste into the ocean
- Knowledge of local unofficial dumpsite: it is a place for ocean waste and is really stinky

Pair of business owners, women (age range: 44-45)

- They report not separating plastics (snack bags), they put them in the blue bin.
- They claim the animals knock bins down, contributing to the litter.

Group of fishermen, men (age range: 51-70)

- Improper waste management within the village is that people burn waste which contributes to pollution.
- Separate bottles but not food waste from their waste
    - Bottles can be sold (different bottles have different grades)
    - Fishnets: gather big piles and sell per kilo. (can be used for chicken fences)
        - Quality of fishnets: good = 30 baht, bad = 10 baht
        - Sold fishnets can be melted to produce plastic balls. (Factory)
- Claims the problem in the village is that there are more people littering than picking up
- Claim they see other fishermen throw the waste into the ocean after eating on the boats
- Suggestion for motivation: gather people for assembly. However, they admit that a potential problem is that only a few people will come due to insufficient time.

Fisherman wife, woman (age range: 31-50)

- Improper waste management within the village is burning of waste, she recognizes it is a bad practice
- Separate waste: separate bottles but not food waste
    - Fishnets can be sold per kilo
    - She claims that people that buy the bottles and fishnets come often.
- A problem she identified was other people's attitude toward waste management
- Regarding the unofficial local landfill: she has “no idea” where it is
- Claims that garbage men are inconsistent in pickup: some weeks they come only once

Fisherman, sell mackerel, man (age: 30)

- Most of the waste he produces: fishing nets, rope, plastic, styrofoam
- Improper waste management is that people throw everything into the blue bin
- Separate waste
    - Fishing net: sell (1 kg = 10 - 11 baht)
    - Seashell: landfill
- Identified cause of problem as the tide bringing in plastic waste

Fisherman, sell crab, man (age: 57)

- Separate waste:
    - Fishing net: sell
    - Food waste: fertilizer
- Identified cause of problem as a lack of bins, and blames SAO for “not taking care”
- Claims he doesn’t have time to do a workshop

Fisherman, old assistance of the head of the village, man (age: 56)

- He fixes the fishing net to reuse it
- Identifies problems in the village:

    - Uncontrollable environmental factors: tide/wave, animals (monkeys)
    - Attitude: people did not pay attention
    - The beach at Prachuap (อ่าวน้อย) is clean, but no bin
- Past workshops and efforts: workshop done last year about using organic waste as fertilizer
- Suggestions for sources of motivation are the leader (head of village) and the school
- He wants more separation bins

Restaurant owner and cook, man and woman (age ranges 51-60, 31-50 respectively)

- Identifies problems in the village:t
    - They claim the animal knock the bins down which spills waste on the ground
    - Villagers in general throw waste into the ocean and the tide brings back the trash.
    - There is a sign (no litter) but there is still a lot of trash around.
- Separate waste:
    - Separate bottles, people who buy the bottles come often
    - Food waste: feed dogs, use as fertilizer or if they are lazy they just put it in a plastic bag.
    - Styrofoam throw into the bin
- Still using styrofoam because it's cheapest.
    - Styrofoam = 90 baht, Plastic box = 140 baht, Paper box = expensive (non-exact price)
- Suggested solutions
    - Cheaper trash bin collection per month (used to be 20 baht, now is 40 baht)
    - Suggesting providing separation bins
- Suggested sources of motivation: start from head of the village

Noodle shop owner, woman (age range 31-50)

- Improper waste management within the village: poses a problem because it can cause pollution and allergy
- Recycling is important but she doesn't have enough time to do it properly
- Separate waste: separates bottles, separates food waste to feed her pets
- She also uses styrofoam as food containers.
- She is also interested in composting.
- Landfill: far and for ocean waste
- Suggestion for motivation: money (selling waste)
- Suggestion for improvements: adding separation bins
- Other: Facebook page for online order

Small cafe owner and employee (age range 51-70, 18-30 respectively)

- They know how to make EM and use composting techniques.
- Separate waste:
    - They separate bottles, but claim people that buy the bottles rarely come
    - Sell milk cartons
    - Plastic bags
    - Food waste is reused for planting (fertilizer/compost)

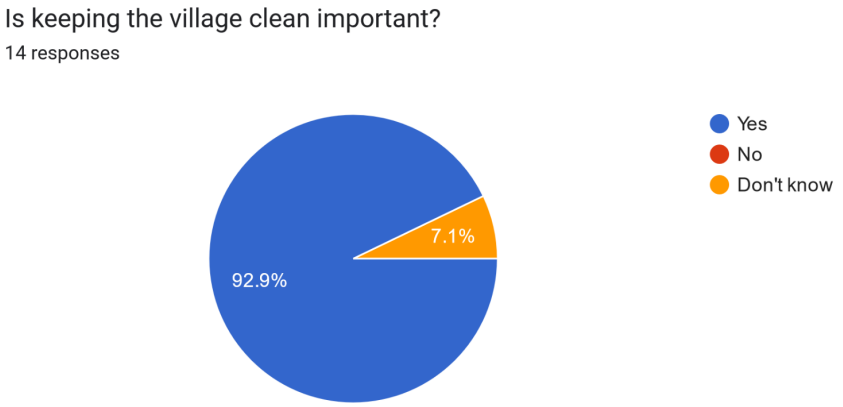
- Landfill: for ocean waste
- Suggestion for improvements: the blue bin is good enough but a separate bin would be good as well
- Suggestion for motivation: guest speaker at assembly by SAO

Coffee shop owner (age 40)

- Observed and claims that most of wastes for village: plastic, fishing nets, styrofoam
- Separate waste: plastic bottle, coffee grounds for fertilizer
- Uncontrollable factors: animals (dogs, monkeys) spread trash around village, ocean wave brings in trash
- Workshop:
    - Interested/Willing to attend
    - Not enough time to join
    - It already done before, the village used to provide workshop

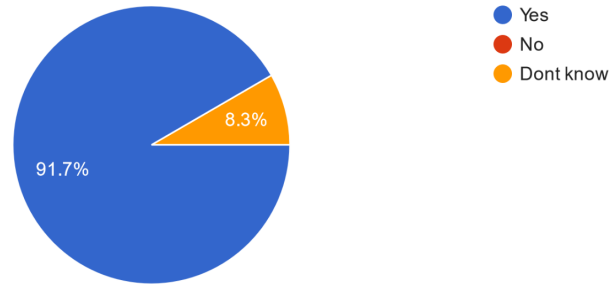
Noodle shop in front of temple

- Improper waste management: dirty water
- Past efforts: they said that the villagers already learned how to do composting but no one was interested so they stopped doing it.
- About recycling: they said if there is someone to teach it would be great.
- Separate waste: glass and plastic bottles, feed food waste to their dog
- Suggestion for motivation: money
- Suggestions for improvements:
    - Activity would be great but not many people would be interested
- Suggestion: adding more separation bins, providing more education



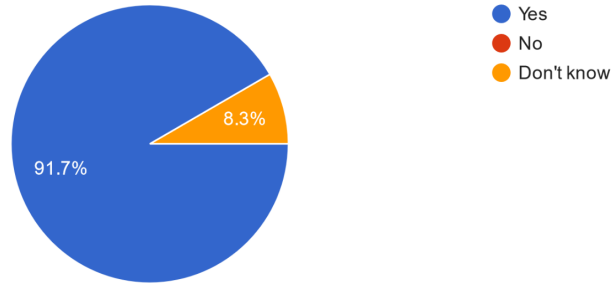
Is improper waste management detrimental to the environment?

12 responses



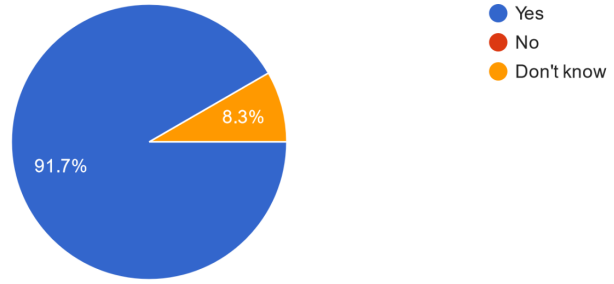
Is protecting the environment important?

12 responses

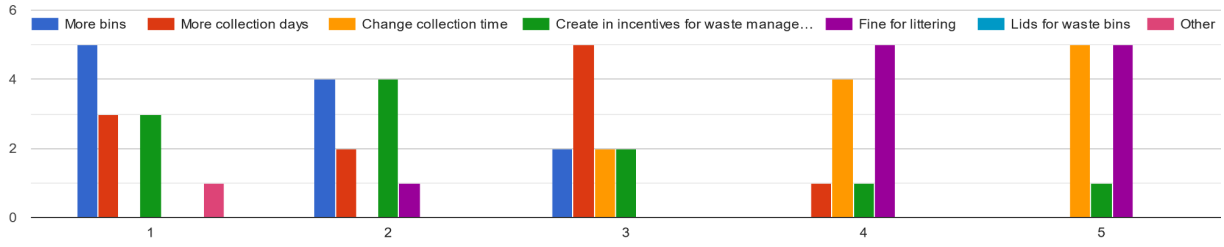


Is recycling important?

12 responses

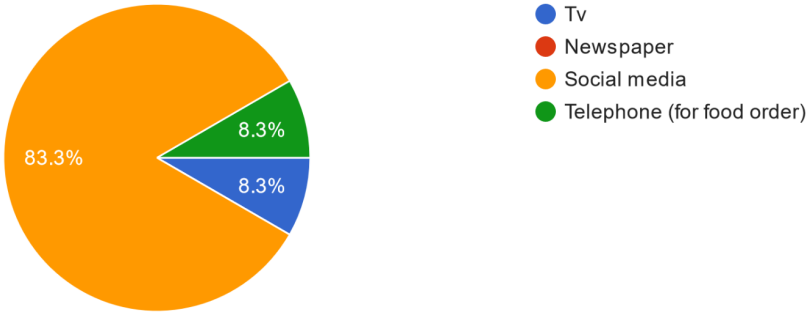


Which of these improvements would u like to see, rank in order of any you would like to see.



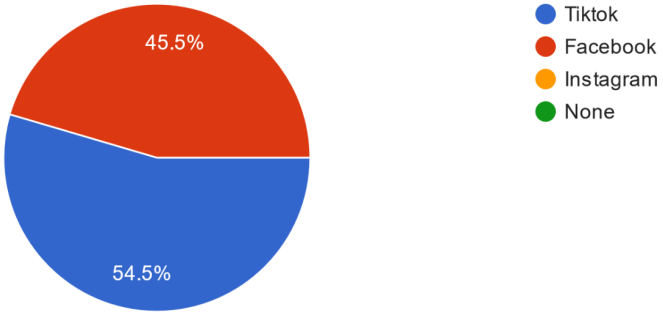
Which media source do you use

12 responses



Which social media platform?

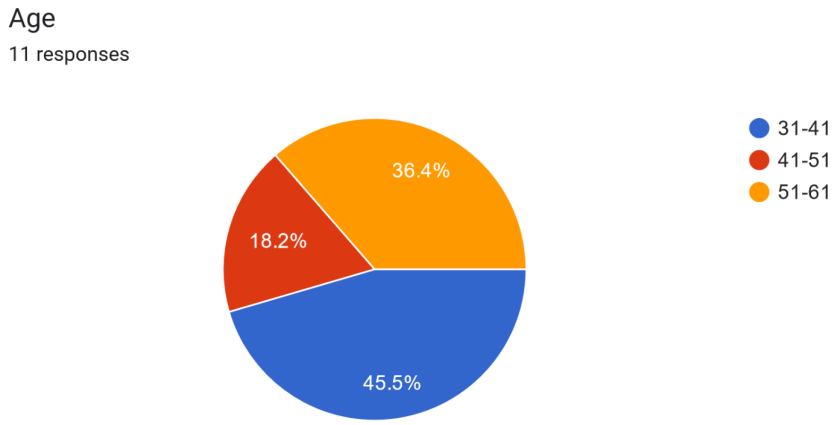
11 responses



C.3 Second Field Visit Villager Interview Questions

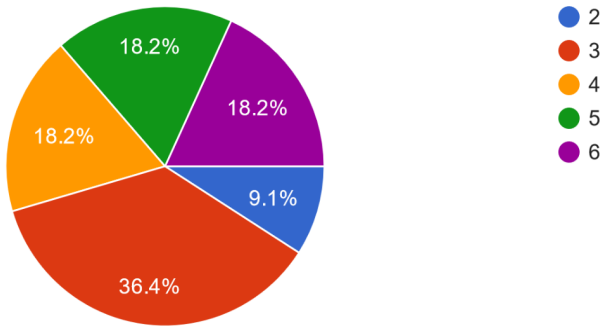
1. Age:
2. Gender:
3. Occupation:
4. How many people are in your household?
5. How much litter do you think is caused by animals rummaging through trash cans?
    1. Little to none 2. Only a little 3. Some of it 4. A lot of it 5. Most of it
6. Do you separate your waste by types of waste? If yes, what types do you separate?
    a. Non-recyclable Plastics b. Food c. Recyclable plastics d. Others_____
7. What are your opinions about these improvement ideas?
    - More separation bins (Y/N) (where, how many types) if we provide more color of bin (red, blue, green)
    - Provide lids (Y/N). If more trash bins were provided to the village, where do you think they should be located?
        a. Harbor b. Restaurants c. Homes d. Other:_____

C.4 Second Field Visit Villager Interview Responses



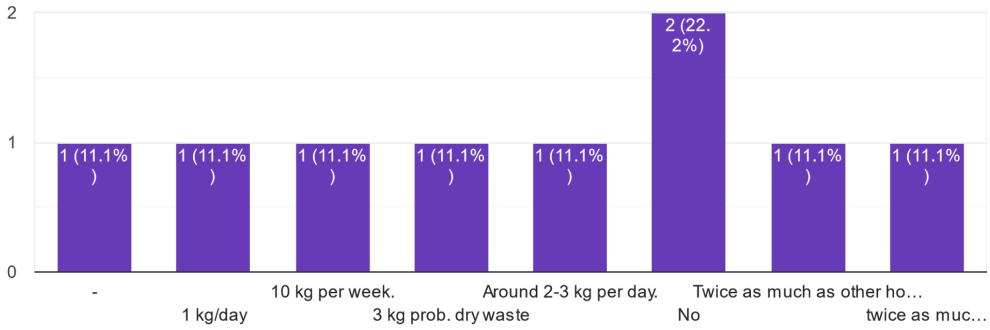
How many ppl in household

11 responses

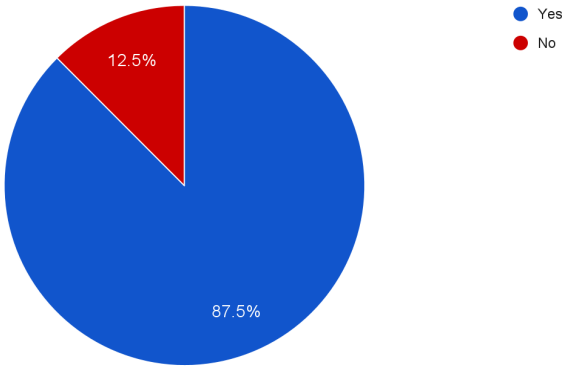


Can you estimate the waste produced from your household in kilograms and rank which one is the most produced?

9 responses

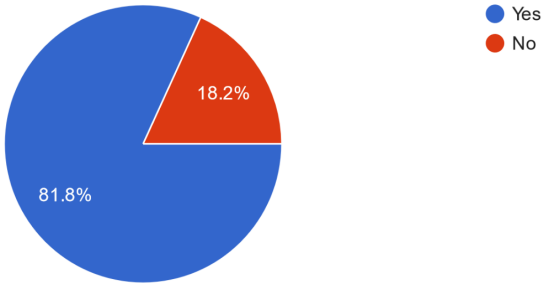


Do you agree that we should add more waste bins in the village



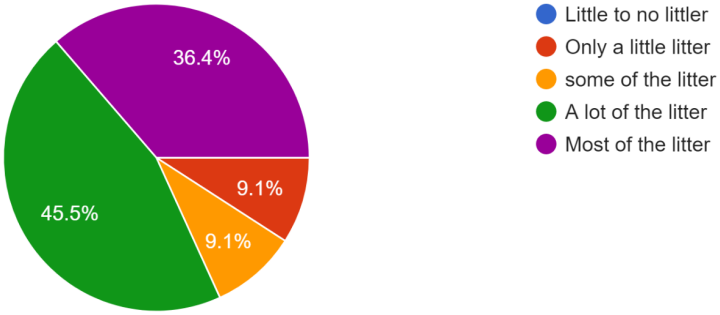
Should we provide the lid for cover the trash?

11 responses



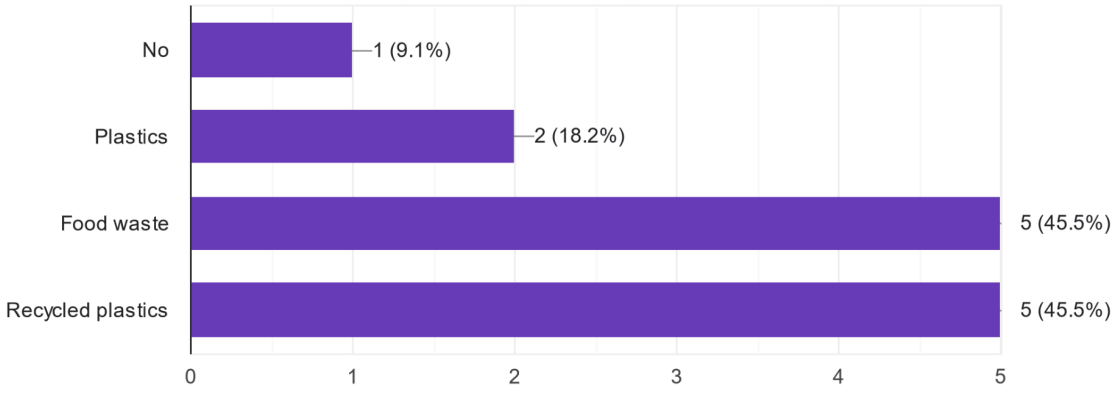
How much litter do you think is caused by animals rummaging through trash cans?

11 responses



Do you separate your waste by types of waste? If yes, how many and what types do you separate?

11 responses



Appendix D: Designated Interview Questions

D.1 Interview Questions for Local Elementary School Staff

1. Does the school teach the students about waste management?
   ในโรงเรียนได้มีการสอนเรื่องการจัดการขยะหรือไม่

2. Do they learn about pollution and its effects on the environment?
   นักเรียนได้เรียนรู้เกี่ยวกับมลพิษ และผลกระทบต่อสิ่งแวดล้อมหรือไม่

3. What(if yes to above question) do they learn about waste management and pollution? How is it taught? Lessons? Workshops?
   (ถ้าข้อ 2 ตอบใช่) นักเรียนได้เรียนเกี่ยวกับการจัดการขยะ และ มลพิษ หรือไม่ และสอนเนื้อหาอะไรบ้าง และได้มีจัดกิจกรรมหรือไม่

4. Do the students learn about composting? What do they learn?
   นักเรียนได้เรียนเกี่ยวกับการหมักปุ๋ยหรือไม่ และเรียนอะไรบ้าง

5. If we were to implement a workshop to teach the students about waste management, what would you like to see out of the workshop? What information do you think should be shared? How should it be shared?
   ถ้าทางทีมพวกเราได้จัดทำกิจกรรมเพื่อให้ความรู้นักเรียนเกี่ยวกับการจัดการขยะ คุณอยากเห็นพวกเราทำในรูปแบบไหน หรืออยากเสนอข้อมูลเพิ่มเติมหรือไม่

6. Do you think the students would be interested in learning waste management? Why?
   คุณคิดว่านักเรียนจะสนใจในเรื่องการจัดการขยะหรือไม่ เพราะเหตุใด

7. If not, how do you think the best way to engage them is?
   (ถ้าไม่) คุณคิดว่าวิธีไหนจะเป็นวิธีที่ดีที่สุด

D.2 Interview Questions for Local Elementary School Staff Responses

School details: 122 children, KG.2-G.6, school runs from 8.00 to 16.00
Spoke to Principal of school

- Zero waste School, she has enforced the zero waste plan with SAO each year (that's why can be used in the long term)
- She started the program by having students learn about recycle and reuse

Activities students participated in from zero waste plan

- School hosts volunteer activities to pick the trash at beach (once a month) by children, teachers, open to volunteers from the village

- Children made eco-bricks (put waste into plastic bottles to be used in building or construction). It is very useful technique to help create interest through creative ways to handle waste
- Teach habits in waste separation by providing different color bins (yellow is recyclable waste, blue is general waste, red is hazardous waste, and green is organic waste)
- How they teach kids to handle different types of waste
    - Organic waste (leaves): change to fertilizer
    - Plastic waste (snacks and milk containers): separate into 1 bin
    - Food waste: feed to animals

D.3 Interview Questions for Village Business Owners

1. Do you separate your waste into recyclables and disposables? Is organic waste separated?
   คุณได้แยกประเภทขยะที่สามารถรีไซเคิลได้ กับขยะทั่วไปหรือไม่ และขยะออร์แกนิคได้แยกด้วยหรือไม่

2. Do you compost your organic waste? Would you if there was a communal compost? Or if you were taught how to yourself?
   คุณได้นำขยะออร์แกนิคไปหมักปุ๋ยหรือไม่ คุณมีกลุ่มที่ช่วยกันทำหรือไม่ หรือคุณหาวิธีทำปุ๋ยด้วยตัวเอง

3. Does the garbage truck collect often enough to meet your businesses needs? If not, where does the excess waste go?
   รถขยะมาเก็บขยะในจำนวนวันที่พอดีหรือไม่ (ถ้าไม่, คุณจัดการกับขยะที่เกินมาอย่างไร)

4. Would you like for the trucks to collect more often? Would bigger or more trash bins be beneficial?
   คุณอยากให้รถขยะมาเก็บขยะเพิ่มหรือไม่ หรืออยากได้ถัง ขยะที่ใหญ่ขึ้นไหม

5. What would allow and encourage you and other business owners to dispose of waste correctly?
   อะไรเป็นสิ่งที่กระตุ้นให้คุณและ เจ้าของร้านอาหารอื่นๆเข้าใจในการทิ้งขยะให้ถูกประเภทมากขึ้น

D.4 Interview Questions for Village Head

1. We are wondering what your thoughts on waste management is and what do you think about the village's cleanliness? Do you do anything such as sorting your own waste and separating food waste? What do you think are the issues in the village?

2. We have been told that there have been workshops done in the past about keeping the village clean, however they only work in the short term. Why do you think that is, and how do you think we could create long term change?

3. We were thinking of creating a cooperative workshop to work with everyone in the village to come up with the best solution to keep the village clean. We think that involving the village will be the best way to create long term changes in keeping the village clean. Do you think people would want to participate in this (there would likely be free food and drink or something to draw people in) and if so when would be the best time and day to hold it?

4. How do you get information out to villagers? What do you think would be the best method of spreading information to them?

5. From the surveys we have done it seems that many of the villagers use facebook and TikTok. Do you have a facebook or tiktok account that you use to give information to the people of Baan Thung Noi? If not, do you think having a facebook page or tiktok account for the village would be feasible? In addition to giving updates to people, it could also spread information about how to keep the village clean, and the damage that pollution can cause to the environment. Do you think that this account could be maintained and updated in the long term? Why/Why not?

6. From what we have gathered from public opinion, the harbor seems to be the most problematic area. Why do you think that is? We noticed that there is a lack of trash bins in that area, do you think that is the reason? If so, would adding more trash bins to the harbor help?

7. FOR THE EVENT: If there has been any events in the village before and where? Was there food? How much food? How many people are in the village? What equipment was used?

D.5 Interview Questions for Local Elementary School Principal

1. We were thinking of creating a cooperative workshop to work with everyone in the village to come up with the best solution to keep the village clean. We think that involving the village will be the best way to create long term changes in keeping the village clean. Do you think the school children would like this kind of idea, and do you think they will want to help contribute ideas?

2. In addition we were thinking of tasking the children with designing a lid for the trash bins to prevent animals from rummaging through trash bins. We would hold a contest to see who could design the best lid and the winner's design would be implemented to prevent animals from spreading pollution. Do you think the children would want to participate in this idea?

3. We were wondering if the school would be willing to lend its reusable plates and utensils for the workshop event?

D.6 Non-structured Interview Notes with SAO Deputy

- On collection day, there is less than 1500 kg trash collected, 1000-1500 kg, from blue bins in total
- SAO Deputy's opinion on the current situation in the village
    - The harbor is mostly impacted by plastic bags, foam, and bottles. These come from waves, animals, and fisherman that litter while working
- Details about the previous workshop
    - There used to be no separation in the village
    - For some time there were separation bins at the harbor area but not every color; also only lasted for a short amount of time. People stopped using it so SAO got rid of them
    - Taught how to repurpose organic waste into fertilizer. Some houses did not want to be taught because they have less waste and do not separate anyway
    - They visited and taught 80 percent of total households
    - Aim of this effort was to reduce the smell by encouraging households to separate food waste out from general waste so it doesn't smell bad (food, fish waste/head)
- Other notes
    - Normally the trash does not overflow, but maybe on holidays (sudden increases in waste production)
    - Approximately 200 houses Baan Thung Noi
    - Dogs and animals, monkeys get into trash cans knocking them over

- How they get people to listen and participate
    - Previously thought walking to each house is better than trying to gather large amounts
- How they check that ppl are doing ทำได้นานไหม
- Result
    - Fish, food they collect and …trees?? Separate so its does not stinks
    - Nowadays municipality does not collect separate waste
    - Some houses still separate their organic waste and compost

- Any plans in the future from SAO
    - Bins separation- good to have but we have to inform the villagers and educate them (at sala is recommended)
    - Place the bins at sala chai talay, market ขายของชำ, separate in green (organic), yellow (recycle), red (hazardous)
    - For recycle they sell on their own bc they have a truck come and buy (Saleng)
    - Municipality collects 1-2 days a week (there are many truck)

- When we asked for their assistance in our community event
    - Deputy agreed to help, SAO wants to have more workshops
    - The issue is the incentive for keeping the village clean
    - Ask for help from head of village and K. Piya
    - Help clean the waste contaminating the water, educate them to bring their waste back to the land (do not throw in the sea)
    - Incentive is very important

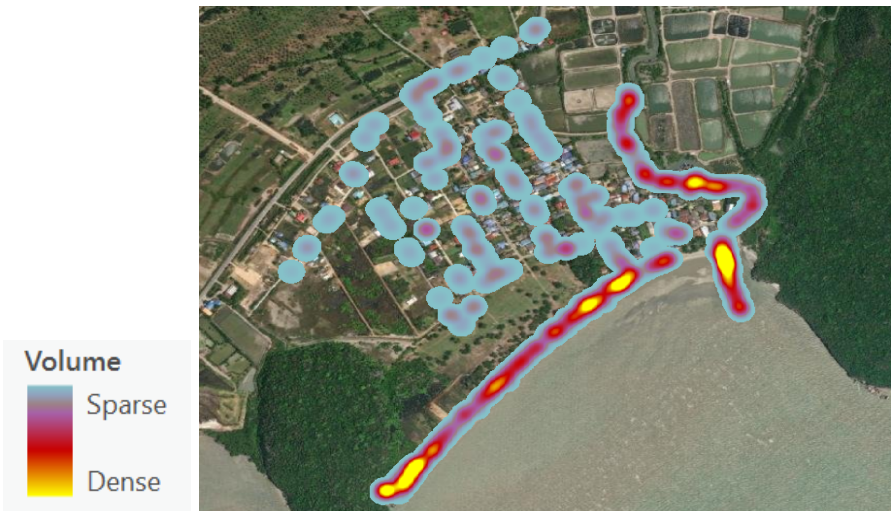
- Expectations
    - Incentive of the villager to be more responsible, not littering from มักง่าย, and the fishermans that are not Thai, focus on the boat owner to let them tell their employee,
    - The intention of the local dump sites in the village was for organic waste (e.g. seashells, crabs, fish, etc) but they did not intend for villagers to bring other waste (e.g. plastic). If it is full they will cover the soil เปลือกหอยเปลือกหนาม, no burning
    - Villagers bring their own waste such as trees. Which is not what they want?
- Biggest concern of SAO is the long-term plan and effect of these workshops
    - K. Piya and head of the village will continue to help organizing when we return to the village

D.7 Garbagemen Interview Notes

Garbageman Interview

Question or Topic	Response Notes
Types of waste collected in the village	Not much food waste, mostly mixed general waste, leaves, and plastic or glass bottles. SAO has a separate bin for hazardous waste.
When you pick up the trash, have you seen an issue with overflowing bins?	On a normal collection day, there is no overflow. During holidays or festivals, there will be more waste than normal.
Regarding the bin and litter maps in Figures 6 and 7	There is a hazardous trash bin placed at Moo.2, and the trash is picked up once a month. For this village, they collect from each house. SAO will gather and then destroy it.
Which places do you think lack bins?	There is not an issue of lack of bins or overflowing trash. During the holiday/festival, collection schedules are changed to meet the higher amount of waste so there is no overflow. Usually the resorts and tourist attractions produce more waste, but in the village there is not much.
Regarding the waste along the beach	This month, the sea level is high so the waves bring trash to the beach. When the sea level is low, the leader in this village will gather people as a group for collecting the trash on the beach.
Do you pour and mix everything in the truck?	No, I separate paper cardboard and bottles.
Regarding adding more collection days	Municipality cannot add any collection days because they collect trash for 3 villages, and 2 days per village per week
Amount of trash typically collected	This village has around 2000 kg of trash per collection day (collect 2 days per week)
Purpose of the landfill	For the trash that cannot be decomposed or combusted
Future plans for waste treatment	There are plans by municipality to build an Refuse Derived Fuel (RDF) factory (cleaning waste to be burned for fuel rather than going into the landfill)

Appendix E: ArcGIS Map



The web map is publicly accessible in the link found below, however in order to access the map an ArcGIS public account is required. This is a free account and can be signed up for at: https://www.arcgis.com/index.html# .

Web Map Link:

https://w-p-i.maps.arcgis.com/apps/mapviewer/index.html?webmap=51bcd73affd24a9c949de66cca4b3b67

Appendix F: Community Workshop Data

F.1 Event Observations (Field Note)

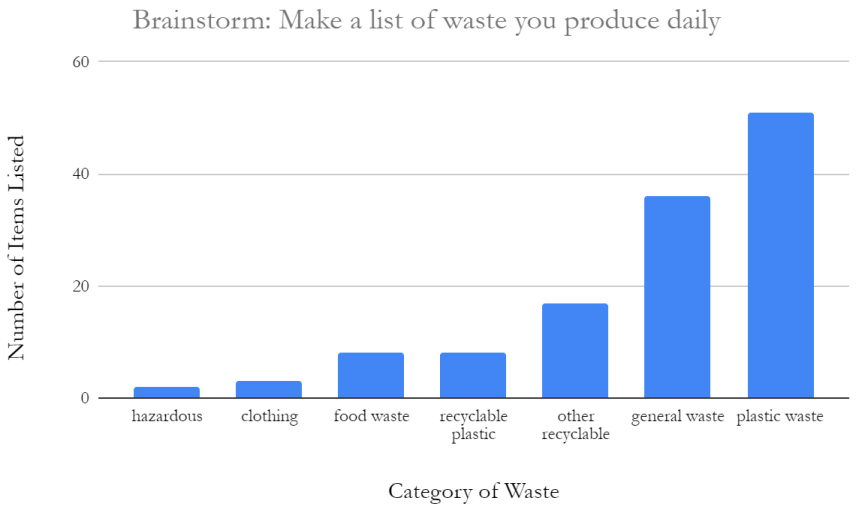
Observations from school event
The kids' design bins were creative. They enjoyed the activity.
The children were engaged and excited about the things they created. They also clearly wanted to win. The students in attendance who did not make a trash can were much less engaged than those who did.

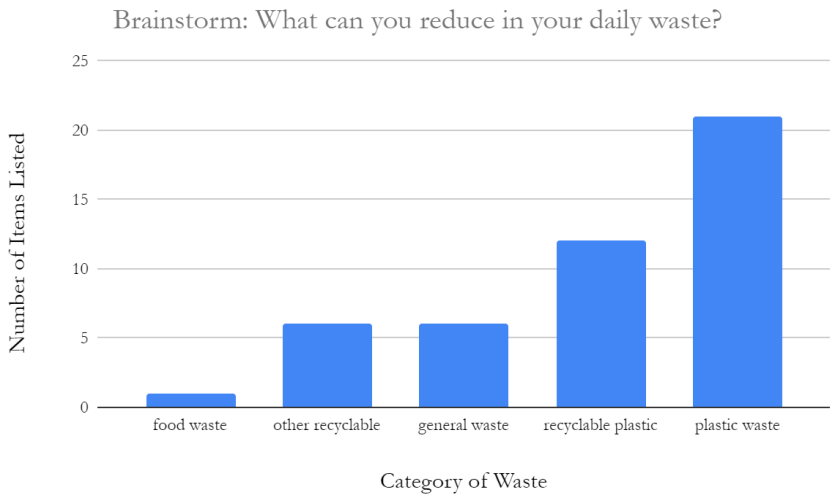
Observations from CU Zero Waste Event
Kids were engaged with the event. The groups were a bit too big, some kids on were on the outside of circles and not engaged in the content
Children were engaged with CU Zero Waste the speaker. Wanted to answer questions when presented with candy prize for answering in big group
The children were enthusiastic when the CU zero waste volunteer was talking about waste management.
For the observation from CU zero waste event, there were some children that answered the question. During the activity, a lot of children looked really happy and some children knew about the waste separation really well; some of them know how many types of bins there are and what kind of waste is supposed to be put in them. But there were also some groups that struggled. Moreover, they also looked really happy and enjoyed the reward announcements.
Students seem to be having fun and were at least somewhat engaged. Once they were involved, they were much more engaged than when they were just listening to a lecture.

Observations from Beach Cleanup
Kids were very motivated. They were excited about the competition and prizes. They enjoyed the competition. Younger kids tended to be more excited and engaged Students were very enthusiastic when picking up waste along the beach. Some were digging in the sand to get buried waste. Some were running around the beach, they filled up multiple bags. Children were competitive, eager to get results after picking up. When receiving the prizes, they were more enthusiastic about certain gifts (water bottles got more excitement than the reusable containers and bags)
Children enjoyed collecting the trash. After cleaning up, the beach became much cleaner.
The children seem to enjoy this activity. They were running everywhere and all of them participated in the activity very well.
The kids seemed to be really into this. Many students started before we said go because they wanted to win so bad. Having a competition seems to be a really good way to motivate these children.

F.2 CU Zero Waste Activity Data

Categorization of Brainstormed Daily Waste Items		
general waste	**plastic waste**	**clothing**
cigarette	bubble wrap	clothes
contact lens	candy wrapper	flower bracelet
cotton	condom	shoe
face mask	container	
fertilizer bag	fishing net	**recyclable plastic**
floss	ice cream bag	bottle cap
hair tie	plastic bag	plastic bottle
ice cream stick	plastic cup	water bottle
lunch box	plastic spoon	
milk box	plastic straw	**hazardous**
napkin	rice box	battery
pencil	snack bag	lighter
pin	straw	
rope	styrofoam	**other recyclable**
sanitary pad		can
tire	**food waste**	cardboard
tissue	food waste	glass bottle
toothbrush	fruit peel	paper
wooden skewer		





F.3 Post-Event Feedback: Interview Responses and Notes

Notes from interviews after the community event with teachers and community leaders (including the community activist, members of SAO, and head of the village)

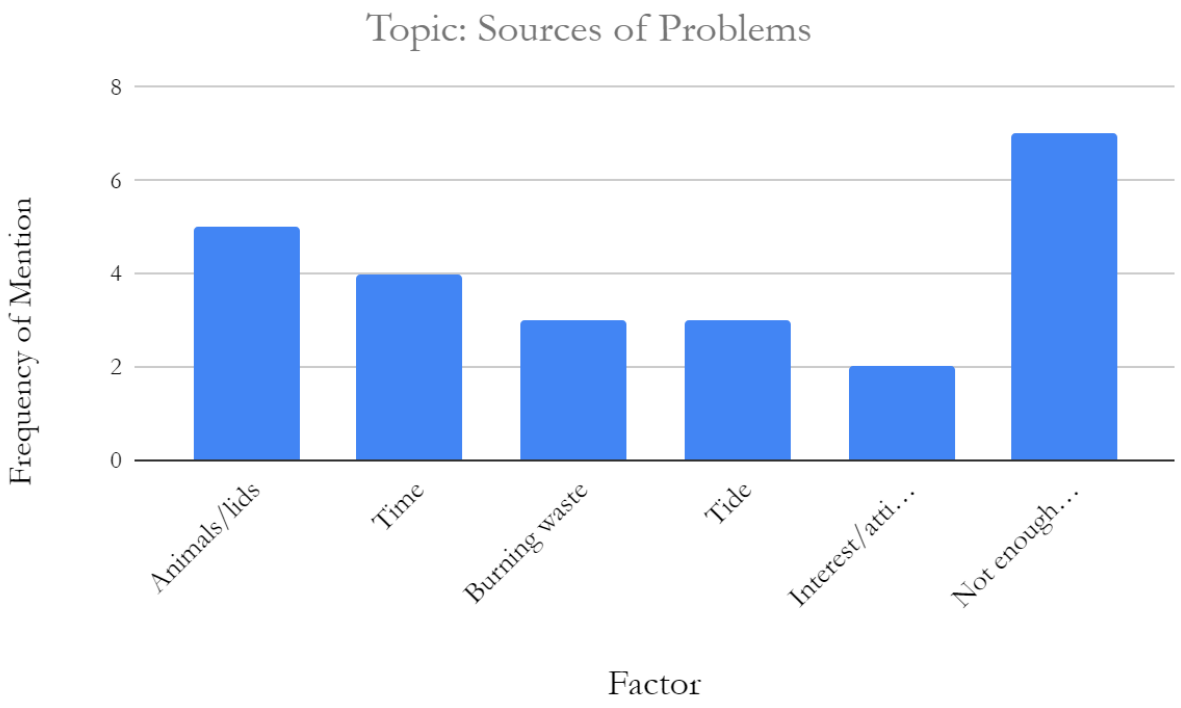
Did you find the activities and information provided in this event useful and informative?
- Responses ranged from moderately useful to very useful.
What was the most useful thing you learned today?
- Beach cleanup. - This activity is very useful, but we need to find someone to be the leader, so this activity can keep going continuously. - All activities are very useful. Should add more information about separation trash that can be applied in their real lives (e.g. why should we separate waste) - Overall activity was useful (e.g. 3R activity with CU Zero Waste and beach cleanup event) (from post-event interview, group of 5 people).
What aspect/activity did you enjoy the most during the event?
- Everyone named the beach clean-up event as the most enjoyable.
Was there any information or activities that you would have removed from this event? Is there anything you would have added?
- No removed and added but having the event more frequently in the future would be great. - No removed. - Everything was good in this event. Village should continue to do this kind of activity every month to give more information about waste management. Although, for the beach clean up contest, they want to add a new rule to pick up only plastic or dangerous trash.

- Nothing should be removed or added. Needs more promotion. Aiming for the school and educating the kids is the right track since nowadays the school doesn't educate as much about waste management. The event should occur more frequently too. Lastly, starting to form a small leadership group is a great starting point.
What kinds of changes do you want to make to your personal/household waste habits?
Separate more waste like food packages and glass bottles. I am going to make a sorting station in my house (e.g. glass bottle, plastic bottle, plastic wrap, and organic waste). Sorting more trash and trying to keep the area around the house clean.
If a waste management group is formed for the village, would you join it? Why or why not?
All said they would join.
Do children live in your household that attend the local school?
Three said yes, one said no.
Were you aware that the local school does monthly clean-ups of the beach?
One said yes, three said no. The one who said yes is the community activist who is directly involved in organizing many of the school clean-up events.
Were you aware of the local school's zero waste model?
All said yes, they are aware of it.
Would you be interested in getting involved with the local school's clean-ups? Why or why not?
Yes, as the head of the village, I have to be involved in the event. Yes, because it makes the village and the beach become clean, but I need financial support. Yes, they would. Local school's clean-ups are the one way that can raise awareness for the people who don't care and make them understand more about the magnitude of all trash in one day. If you pick up all around the village, it has more quantities. That tells everyone to give priority to putting trash properly into the trash bin to reduce the amount of waste in the village. Yes because SAO always participates in these events.

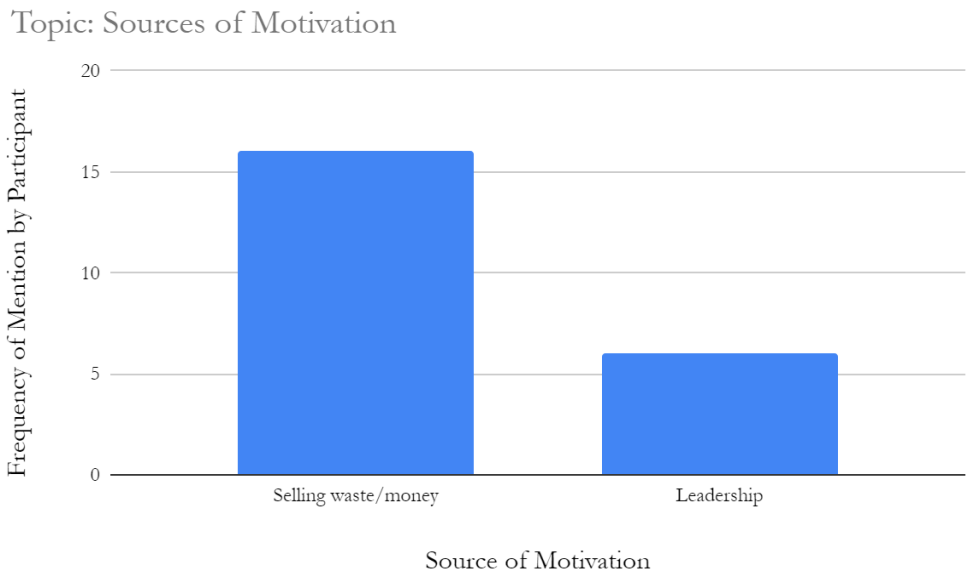
How effective do you think these methods will be in improving the village's waste management in the future? (Not useful, a little useful, moderately useful, very useful)				
	Not useful	**A little useful**	**Moderately useful**	**Very useful**
More community clean-ups and events				xxxx
Forming volunteer clean-up groups			x	xxx
Adding more general waste bins		xx	xx	
Adding more separation bins	x		xxx	
Increasing trash collection days	xxx	x		
Other (list)				

Appendix G: Qualitative Coding Data

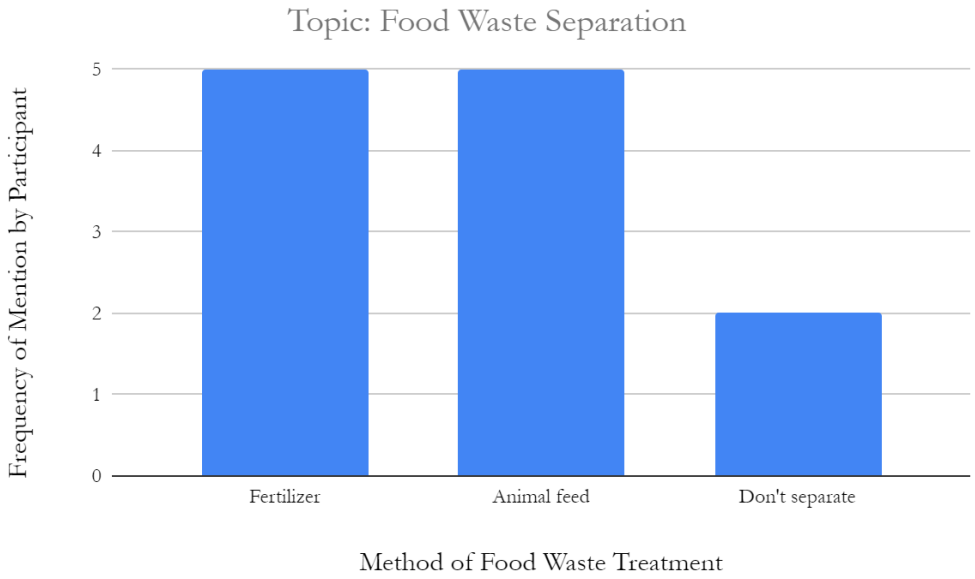
Topic: Sources of Problems	
Factor	**Frequency of Mention by Participant**
Uncontrollable/Environmental Factors	Animals (monkeys, dogs): 5 Environment (tide): 3
Socioeconomic Factors	Time requirement: 4
Low Motivation	Low interest: 2
Infrastructural Factors	Lack of Bins: 7



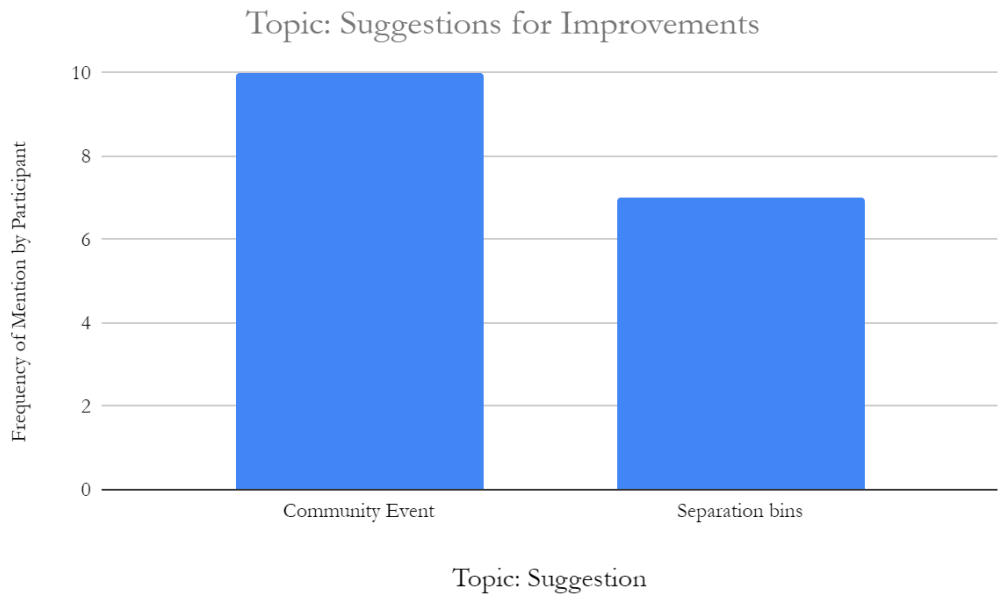
Topic: Sources of Motivation	
Factor	**Frequency of Mention by Participant**
Socioeconomic Factors (Selling Waste)	Plastic Bottles: 12 Fish Nets: 4
Leadership	Head of Village: 2 SAO: 4



Topic: Food Waste Separation	
Type of Food Waste Treatment	**Frequency of Mention by Participant**
Fertilizer	5
Animal Feed	5
Don’t separate	2



Topic: Villager Suggestions for Improvements	
Topic	**Frequency of Mention by Participant**
Community Event	Teach the villagers: 1 Assembly: 6
Adding Bins	Separation bins: 6 Adding general bins: 1



Appendix H: Event Flyers