Municipal solid waste management in a rapidly urbanising area in Thailand: Barriers and recommendations

by

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STATEMENT OF CO-AUTHORSHIP

The following people contributed to the publication of the work undertaken as part of this thesis. The co-authors are listed in the order that the co-authored publications appear in the thesis.

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All above listed contributions equated to no more than 25% of the work necessitated for publication of research manuscripts.

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PUBLICATIONS

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SUMMARY

Maintaining adequate municipal solid waste management (MSWM) is a challenge around the world, particularly in developing countries. The pressures of economic development in conjunction with rapid urbanisation have created a waste management emergency, with unofficial dumping grounds scattered around many areas. The Tha Khon Yang Subdistrict Municipality (TKYSM) in Maha Sarakham Province, Thailand, is at a crisis point for MSWM. There is a desperate need to respond to MSWM issues brought about by the rapid growth in the population, including a large transient student population, and responding commercial activity. The MSWM system adopted by the TKYSM is not effective as evidenced by the huge amount of accumulating waste.

This study assessed the current MSWM system in the municipality and identified the barriers to effective MSWM. The study also sought to develop recommendations to address these barriers to MSWM. The research question was 'What components are necessary for the successful implementation of Integrated Sustainable Waste Management (ISWM) in a rapidly urbanising area in northeastern Thailand?'. The researcher selected the ISWM framework for evaluation because this framework has been established as a useful tool for understanding sustainable waste management.

The issue is very complex and a variety of perspectives from stakeholders around waste management were sought to find solutions. It is well established that successful MSWM requires an understanding of the system in each area, including stakeholders' ideas and opinions. Each area is different, and approaches need to be tailored to the specific problems of the area. This study applied the triangulation method of research, which included interviews, focus groups and observations to identify the needs of local residents, gauge the capacity of the TKYSM to provide MSWM services and to examine input from external specialists to find opportunities for improvement in the region.

The outcomes of this study suggest that due to fiscal and capacity challenges, plans should focus on a range of issues, such as managing waste at the source (reducing waste and waste separation) instead of prioritising waste collection and transporting waste to landfill. Tha Khon Yang is similar in this regard to other areas – many municipalities experience financial pressures and often spend more than half of their waste management budget on processes of waste collection and disposal.

The recommendations for improving MSWM include developing an operational MSWM system that is appropriate for waste service users, developing both short and long implementation plans, establishing and educating a waste management team, developing a more rigorous system for monitoring and paying waste system fees and raising the awareness of residents to encourage people to manage waste properly at the sources.

Key outcomes of the study include identification of the barriers to MSWM in Tha Khon Yang, development of recommendations to address these barriers, a review of the application of the ISWM framework and recommendations for further research.

This thesis is based on published manuscripts, therefore, some repetition between chapters occurs.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Nachalida Yukalang
5th June 2019

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LIST OF ABBREVIATIONS

3Rs	Reduce, Reuse, and Recycle
4Rs	Reduce, Reuse, Recycling and Recovery
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
C&D	Construction and Demolition
CoP	Code of Practice
CSIR	Council for Scientific and Industrial Research (South Africa)
CWG	Collaborative Work Group
DANIDA	Danish International Development Agency
DGIS	Division for International Cooperation, Ministry of Foreign Affairs, the Netherlands
DTIE RIVU	Division of Technology Industry and Economics – Responsible Industry and Value Chain Unit (within the UNEP)
EAS	East Asia Summit
EIA	Environmental Impact Assessment
GDP	Gross Domestic Product
GIS	Geographic Information System
GTZ	German Technical Cooperation Agency
IGES	Institute for Global Environmental Strategies
ISWM	Integrated Sustainable (Solid) Waste Management
JICA	Japan International Cooperation Agency
LAOs	Local Administrative Organisations
MBA	Bangkok Metropolitan Administration (Thailand)
MDGs	Millennium Development Goals
MNRE	Ministry of Natural Resources and Environment (Thailand)
MoIND	Ministry of Industry (Thailand)
MoINT	Ministry of Interior (Thailand)
MoP	Ministry of Public Health (Thailand)
MSU	Mahasarakham University
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NCPO	National Council for Peace and Order (Thailand)
NEB	National Environmental Board (Thailand)
NEQA	National Environmental Quality Act (Thailand)
NGO	Non-Government Organisation

OECD	Organisation for Economic Cooperation and Development
PAOs	Provincial Administrative Organisations
PCD	Pollution Control Department of Thailand
PPE	Personal Protective Equipment
RCC	Regional Cooperation Centre, Bangkok, Thailand
SAOs	Sub-district Administrative Organisations
SBREC	Flinders University Social and Behavioural Research Ethics Committee
SDGs	Sustainable Development Goals
SES	Socioeconomic Status
SEZs	Special Economic Zones
SMS	Short Message Service
SW	Solid Waste
SWM	Solid Waste Management
TAOs	Tambon (subdistrict) Administrative Organisation
TKY	Tha Khon Yang Subdistrict
TKYSM	Tha Khon Yang Subdistrict Municipality
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UN-Habitat	United Nations Human Settlements Programme
US EPA	United States Environmental Protection Agency
UWEP	Urban Waste Expertise Programme
UWEP Plus	Sequel of UWEP

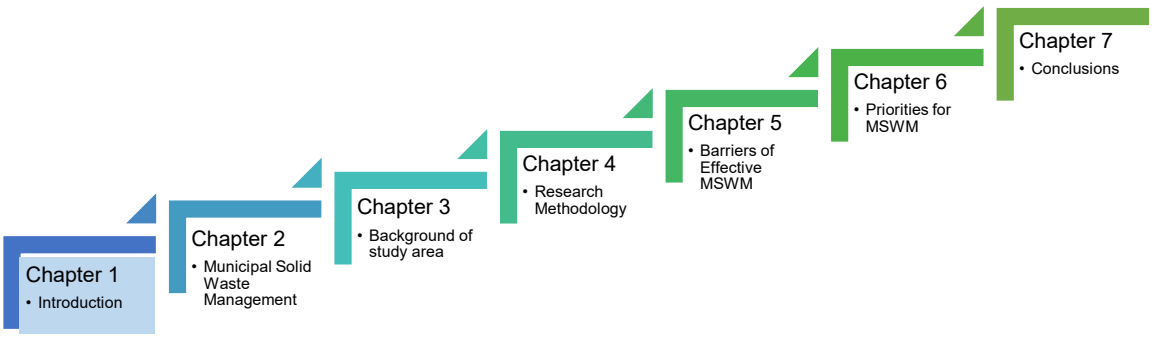
Notes:

Maha Sarakham [Province] is presented as two words throughout this thesis, which is the more correct spelling, except in Chapter 3, where the spelling used in the journal publication (Mahasarakham Province) is maintained. The Mahasarakham Province spelling is also used in some references, to maintain the original spelling used in those references.

Mahasarakham University has only one way of being spelled, and is presented this way through the thesis.

Australian English is used throughout this thesis, except in Chapters 3, 5 and 6, where American English is used, as these manuscript chapters have been published in American journals.

CHAPTER 1 INTRODUCTION



"A good solid waste management system is like good health: if you are lucky to have it, you don't notice it; it is just how things are, and you take it for granted. On the other hand, if things go wrong, it is a big and urgent problem and everything else seems less important."

(United Nations Human Settlements Programme 2010, p. xix)

1.1 Background (Rationale and Significance of the Study)

Inadequate management of municipal solid waste (MSW) is a global problem with enormous consequences, particularly for the world's developing countries, which have limited access to resources to deal with solid waste. The overall volume of global waste generation is increasing, with discarded materials currently estimated to be around 1.3 billion tonnes per year and by 2025 total MSW is estimated to rise to between 2.2 and 2.5 billion tonnes per year (World Bank 2018a; Worldwatch 2012). For millions of people the pressures now are extreme; the World Bank estimates that collection services cover only 40-70% of all urban solid waste, meaning that one to two thirds of discarded waste remains uncollected (United Nations Environment Programme 2016; Zurbrugg & Schertenleib 1998). The consequences of uncollected waste are serious. The outcomes for human health could be dire if this problem is not addressed, as more people are exposed to the environmental health impacts that poor solid waste management (SWM) creates. Human health is affected by waste through the spread of disease and also by threats to living resources and ecological systems (Atkin 2018; Giusti 2009; Hoornweg & Bhada-Tata 2012; United Nations Human Settlements Programme 2010; United States Environmental Protection Agency 2002; World Bank 2018a). Poor waste management is also a significant contributor to global warming (Hoornweg & Bhada-Tata 2012; World Bank 2018a), which, given the recent outcomes for global sea level rises and impacts on overall global temperature, has the potential to have additional destructive effects on human settlements, habitats and agriculture.

Ensuring effective and sustainable management of waste is a significant challenge; an often-intractable problem for national and local governments to resolve. Despite the fact that developing countries are likely to consume much less than developed countries, the end-of-life recycling and disposal methods are often less controlled and less effective than in developed countries (Atkin 2018). While waste management systems absorb a large portion of municipal governments' budgets, the amount of uncollected waste is vast.

There are many complex reasons for municipal solid waste management (MSWM) problems in developing countries, and these include inadequate coverage of collection services, inefficient operational services, limited recycling activities and ineffective landfill operations (Zurbrugg & Schertenleib 1998). There is also less awareness of waste management approaches and fewer clean-up campaigns than in developed countries (Atkin 2018). A key driver of MSWM system outcomes could be linked to the allocation of resources. Developing countries' expenditure on refuse collection and disposal, which is primarily open dumping and open burning, accounts for up to half of municipal average budgets (Schübeler, Christen & Wehrle 1996; United Nations Environment Programme 2016). Another problem of MSWM in developing countries is that the majority of MSW will end up in insanitary landfills (Kharat et al. 2016). As highlighted above, this has the potential to impact on the environment and human health.

Managing solid waste is intensified and more difficult in countries experiencing rapid urban population growth. The volume of solid waste in developing countries is increasing in areas of rapidly urbanising cities (Zurbrugg & Schertenleib 1998). In developing countries, many of the previously rural residents are moving to the cities and the World Bank expects the world's urban population to increase from 55% this year (2018) to 68% by 2050 (World Bank 2018b). This continuous urban population growth, coupled with economic growth and industrialisation in these countries, will exacerbate solid waste problems (Henry, Yongsheng & Jun 2006; Narayana 2009; United Nations Environment Programme 2016).

Thailand (a developing country) is suffering from MSW problems in both its rural and urban centres. This is because Thailand is experiencing economic, population and urban growth as well as changing consumption behaviour due to rising disposable incomes which have led to a significant increase in waste volumes. Disconcertingly, a recent Thai newspaper report was headlined "Thailand – becoming the garbage bin of the world" (Rujivanarom 2018).

In Thailand, managing MSW, the waste that comes from homes, schools, hospitals and businesses, is the responsibility of local government (Office of Decentralization Committee 2008). Solid waste has been a topic of heated debate in Thai local governments (Pharino 2017). The need for better waste management has become increasingly obvious as waste generation has increased annually. In 2005 the estimated amount of waste generated was 14 million tonnes per year. Within a decade it had almost doubled, reaching 27 million tonnes per year (2016 figures) (Ministry of Natural Resources and Environment 2016; Pollution Control Department 2017). Over

half of this waste remains unmanaged. Furthermore, MSW in Thailand contains organic waste (the largest proportion of MSW), recyclable items, electronic appliances and household hazardous waste which makes this difficult to manage when these items are not separated. Burning and dumping are the most common methods of managing waste, and accumulated waste in insanitary landfills is estimated to be 30 million tonnes. In rural areas especially, waste collection services are patchy and disposal sites are insufficient to accept the volume of solid waste produced (Royal Thai Government 2015).

The northeast part of Thailand produces the highest volume of total waste in Thailand (Pollution Control Department 2010). Maha Sarakham Province, the province in which the case study site is situated, is in this northeast region. This province consists of residential communities, markets, hotels, hospitals and education centres. A 2011 estimate indicated that this province was generating about 77 tonnes of waste per day (Grajam & Gaggaw 2011), but that amount is likely now to be considerably higher, given population growth and urbanisation.

Tha Khon Yang (TKY) subdistrict, the case study location for this research, is situated within the Maha Sarakham Province (Figure 1.1). TKY is predominately flat and, lies on a flood plain. The area is prone to flooding in the wet season, which has been beneficial for agriculture, however causes significant problems as rivers burst their banks and carry uncollected waste to other areas.

Figure 1.1: Location of Tha Khon Yang subdistrict in Maha Sarakham Province in the northeast of Thailand (Sources: Esri, USGS, NGA, NASA, CGIAR, N. Robinson, NCEAS, NLS, OS, NMA. Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community Boundaries: GISTA (Geo-Informatics and Space Technology Development Agency).

TKY is an example of a rapidly urbanising subdistrict. Over the past two decades, TKY has grown rapidly, mainly due to the development of the Mahasarakham University campus in the subdistrict (the University site can be seen in Figure 1.1). This was once a rural area but is now rapidly transforming into an urban one. Before the university campus was constructed in 1996, it was a rural zone with a very low population density. Now the same area holds 15 villages with a total population of over 38,000 people, approximately 75% of whom are temporary residents from other areas of Thailand (Tha Khon Yang Subdistrict Municipality 2015).

The population of TKY is experiencing a number of challenges related to inadequate MSWM. The volume of solid waste has increased. In 2010, TKY residents, student accommodation facilities, restaurants and commercial establishments produced approximately 10 tonnes of waste per day (Tongtiram 2011). By 2015, this amount of waste was estimated to have increased to between 15 to 20 tonnes of waste per day (Tha Khon Yang Subdistrict Municipality 2015) representing a significant increase (50-100%) over a five-year time frame. The increase in the quantity of waste produced in TKY has been influenced by a change in lifestyle of the population and the demographic characteristics of the population base. The large influx of students has been coupled with increased consumption of commodities including food and other consumables. Importantly, approximately one half to two thirds of waste per day in TKY is collected and transported to a landfill dumping site, leaving uncollected waste to accumulate in the municipality.

This is a crisis. The current MSWM system in TKY is unable to cope. Enormous amounts of waste are left in the municipality with no means to process it. This has a significant impact on both the local environment and the community. The key issue is that large amounts of waste are left unmanaged in the local streets and the ground (Figure 1.2, 1.3). This waste has created aesthetic problems, odours and leachate that attracts pests and possible pathways for the people of TKY to be exposed to pathogens and disease vectors. These problems have the potential to cause significant health problems for the local people and the environment as a whole. As noted above, floods are common during the wet season, and if flooding occurs this can facilitate the transportation of MSW throughout the district in an uncontrolled manner, blocking drainage systems and exposing an even greater proportion of the population to potential health problems associated with waste.

It was these visible signs of poor waste management and the associated environmental health issues that promoted the researcher to investigate the problem. This study was also prompted by the knowledge that urbanisation is likely to continue, exacerbating MSW problems. This combination of existing and growing problems drove the researcher to embark on a study of MSWM in TKY, exploring the current waste management system, in a bid to find solutions.

Figure 1.2: Waste bags dumped adjacent to a market place and beside a main road in Tha Khon Yang subdistrict in 2015 (Source: Researcher photographs)

Figure 1.3: Waste bags dumped beside minor roads in Tha Khon Yang subdistrict in 2015 (Source: Researcher photographs)

It is clear that the MSWM system in TKY is not successful. The accumulated waste problems indicate failure of the municipality to manage waste, which has been claimed to be the result of the absence of a waste separation system, lack of knowledge and understanding of MSWM by the general population, too few waste management specialists and a lack of municipal finance to support waste management (Grajam & Gaggaw 2011). However, these claims are, as yet,

unsubstantiated. It is likely that there are complex reasons for the failure of MSWM in Tha Khon Yang Subdistrict Municipality (TKYSM), associated with socioeconomic change and population growth.

If MSWM management in TKYSM is not improved, already serious problems will intensify. Better waste management is needed to improve the quality of life of residents in TKY. Suitable MSWM needs to focus not just on the technologies available to manage waste, but also to understand people's perceptions about waste, their attitudes to waste management and their behaviours in disposing of waste.

The researcher intends to use the TKY area and its associated MSWM problems as an example of a rapidly urbanising area in a developing country as a case study: the solutions which are identified might be applied elsewhere. While it is recognised that no one single 'one size fits all' solution to MSWM is possible, elements of this research are likely to be applicable to other areas around Thailand, and potentially other areas in developing countries elsewhere.

Over two decades ago, solid waste management (SWM) was recognised as an important issue globally. As such, Agenda 21, the sustainable development action plan arising from the United Nations (UN) 'Earth Summit', identified a hierarchy of objectives to waste management, with a focus on four key aspects (United Nations 1993):

a. Minimising wastes;
b. Maximising environmentally sound waste reuse and recycling;
c. Promoting environmentally sound waste disposal and treatment;
d. Extending waste service coverage.

Waste has continued to be on the global agenda for sustainable development. The *2030 Agenda for Sustainable Development Goals* (SDGs) recognised that sustainable urban development and management are important to the quality of life. The UN declared that this new agenda aims to minimise the impact of urban activities on human health and the environment, through environmentally sound management including the reduction and recycling of waste (United Nations 2015b). SWM is recognised in several of the SDGs. In Goal 11: *Make cities and human settlements inclusive, safe, resilient and sustainable* there is specific mention of waste management (United Nations 2015b), for example*,* Section 11.6: *Reduce the adverse per capita environmental impact of cities, by paying attention to municipal and waste management*. Additionally, Goal 12: *Responsible Consumption and Production* specifically includes: *Encouraging industries, businesses and consumers to recycle and reduce waste is equally important, as is supporting developing countries to move towards more sustainable patterns of consumption by 2030* (United Nations 2015a, 2015b).

The Integrated Sustainable (or Solid) Waste Management (ISWM) system is a framework that has been applied to evaluate waste management systems. It is a tool to work towards sustainable management of waste (Mwangi & Thuo 2014). The framework includes the whole waste stream,

from reducing the amount of waste generated through to final waste disposal (United Nations Environment Programme 2016). ISWM was developed to address common problems experienced in low and middle income countries, and also in countries in transition (United Nations Environment Programme 2016; Wilson, Velis & Rodic 2013).

Developing country reports on the application of this ISWM framework showed different problems being experienced in different situations (Mwangi & Thuo 2014; Woelandari 2016). Variations in challenges to waste management included available budget, legislative tools, quality of waste operations and collection services, existing waste practices in communities, and composition of wastes (Mwangi & Thuo 2014; Shekdar 2009; Woelandari 2016). This study used the ISWM framework to assess the MSWM problems in TKY, with the goal of determining the barriers to successful waste management and identify solutions.

1.2 Research Question

What components are necessary for the successful implementation of Integrated Sustainable Waste Management (ISWM) in a rapidly urbanising area in northeastern Thailand?

1.3 Purpose of the Study

This study evaluated MSW management by investigating the context and barriers to effective waste management in a rapidly urbanising area in Thailand, which as identified above, is currently not effectively managing its waste. The study seeks to identify the components necessary for implementation of successful MSWM in TKY. The study applied the ISWM framework in its evaluation.

The objectives of the study were:

To assess the current solid waste management system in the Tha Khon Yang Subdistrict, Maha Sarakham Province;

To evaluate the barriers to effective solid waste management in the Tha Khon Yang Subdistrict, Maha Sarakham Province;

To synthesise possible solutions for Municipal Solid Waste Management;

To prioritise actions for municipal solid waste management in the Tha Khon Yang Subdistrict.

1.4 Research Benefits/Significance

This study will help fill the gap in knowledge of effective MSW in a rapidly urbanising area in a developing country, using the ISWM framework and participants' perspectives to determine problems, context and solutions.The researcher selected the ISWM framework for evaluation because this framework has been established as a useful tool for understanding SWM (Anschütz,

IJgosse & Scheinberg 2004; Klundert & Anschütz 2001; United States Environmental Protection Agency 2002).

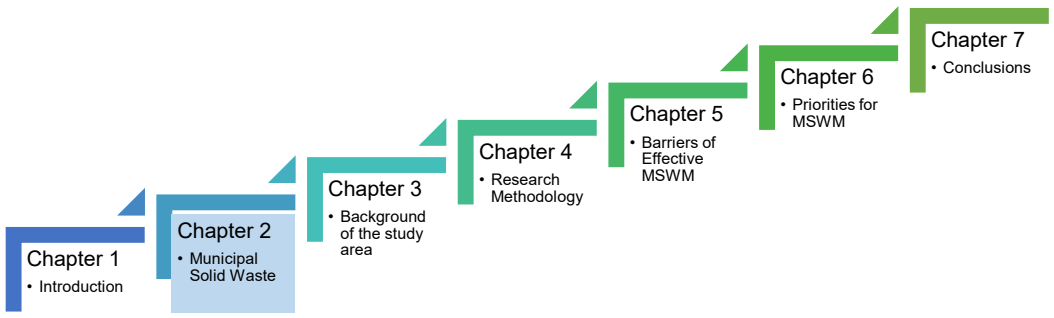
1.5 Structure of the Thesis

This thesis is divided into seven chapters.

The first chapter, this chapter, introduces the study and provides background to the research including the context of the research, with a general description of current solid waste problems in the study area. The chapter also presents the purpose and objectives of the study. Chapter 2 presents a review of the literature on MSW and discusses in greater detail the ISWM framework. Chapter 3 introduces an overview of SWM in Thailand. This chapter has been published, with the citation: Yukalang, N., Clarke, B.D. and Ross, K.E., 2017. Solid waste management in Thailand: an overview and case study (Tha Khon Yang sub-district). *Reviews on Environmental Health*, 32(3), pp.223-234. Chapter 4 presents the research methodology used in this study and discusses reasons for the approaches used. Chapter 5 discusses the barriers to effective MSW for the TKY area. This chapter has been published, with the citation: Yukalang, N., Clarke, B. and Ross, K., 2017. Barriers to effective MSW management in a rapidly urbanizing area in Thailand. *International Journal of Environmental Research and Public Health*, 14(9), 1013. Chapter 6 outlines the key findings and possible solutions to overcome those barriers presented in Chapter 5. This chapter has been published, with the citation: Yukalang, N., Clarke, B. and Ross, K., 2018. Solid waste management solutions for a rapidly urbanizing area in Thailand: Recommendations based on stakeholder input. *International Journal of Environmental Research and Public Health*, 15(7) 1302. Chapter 7 presents the conclusions of the study, based on the material from Chapters 5 and 6. Chapter 7 reviews the purpose and objectives described in this chapter (Chapter 1) and outlines recommendations for further research.

Note: As this thesis contains material that has been published, there is some unavoidable degree of repetition.

CHAPTER 2 MUNICIPAL SOLID WASTE



2.1 Introduction

Modernisation, with its economic development and increased consumption, has resulted in an overproduction of solid waste (Anschütz, IJgosse & Scheinberg 2004; Dhokhikah & Trihadiningrum 2012; Hoornweg & Bhada-Tata 2012; Khajuria, Yamamoto & Morioka 2010; Khan, Kumar & Samadder 2016). This has proved difficult for countries to manage. Inadequate or inappropriate waste disposal causes a number of environmental problems (Giusti 2009), exacerbates climate change (Menikpura, Sang-Arun & Bengtsson 2013; Shekdar 2009) primarily through the production of methane, a powerful greenhouse gas (Ackerman 2010; Hoornweg & Bhada-Tata 2012) and affects human health (Cocarta et al. 2009; Giusti 2009; Porta et al. 2009; United States Environmental Protection Agency 2002). Accumulated waste or uncontrolled landfill sites provide breeding opportunities for disease vectors such as insects or rodents, which cause health effects and aesthetic issues (United Nations Human Settlements Programme 2010).

Solid Waste Management (SWM) is directly linked to the economic, social and health aspects of both cities and rural areas (Anschütz, IJgosse & Scheinberg 2004).

Appropriate waste management is vitally important for protecting the environment and human health. There are a variety of approaches to managing waste applied in both developed and developing countries. The waste management process can be altered at many points, starting from managing waste at the source, changing the waste management processes at the point of collection, during transport, whilst undergoing treatment and at the point of final disposal.

This chapter examines the key literature and current paradigms in SWM, which have been used to develop the approach in this study.

Recognition of the urgency to develop appropriate SWM policies and programs has prompted a range of initiatives to be presented at conferences hosted by the United Nations (UN) over many decades. In 1972, the United Nations Conference on the Human Environment, also known as the ‘Stockholm Conference’, highlighted the inequality between the world’s wealthy and poor. The

conference prompted the formation of the United Nations Environmental Programme (UNEP) which has since played an important role in environmental protection. Subsequently, in 1992 the United Nations Framework Convention on Climate Change (UNFCCC) was established and in the same year at the United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro, Brazil, otherwise known as the 'Earth Summit 1992' or 'Rio Conference', an international environmental agreement was signed by participating countries. This summit produced 'Agenda 21', an action plan for sustainable development for the 21st Century (United Nations 1993). Overall 178 governments, including Thailand, adopted this agreement (Mohlenkamp 2003), which included developing effective ways of dealing with waste. This summit was successful in raising awareness of the need to balance environmental protection and socioeconomic development (United Nations 1993).

Outcomes of the Rio Conference led to the Kyoto Protocol, a key climate change agreement, ratified in 1997, with 192 parties signing up, including Thailand (which signed in 1999). The overarching aim was to work in conjunction with the UNFCCC to slow global warming by reducing the overall greenhouse gas concentration in the atmosphere: this included methane from landfill activities (United Nations 1997). In 2002, the 'World Summit on Sustainable Development' or 'Earth Summit 2002' or the Johannesburg Plan of Implementation reaffirmed the UN's commitment to the implementation of Agenda 21 (United Nations 2018).

Climate change has global effects and is especially of concern to Asian countries. These countries suffer from many natural disasters including drought and sea level rise (Association of Southeast Asian Nations 2018) which may be intensified by accelerated climate change. It has been forecast that Indonesia, Thailand, Vietnam, Myanmar, Malaysia and the Philippines are at significant risk from such impacts of climate change (Association of Southeast Asian Nations 2018).

The Association of South East Asian Nations (ASEAN) has recognised that there is a crisis and that Asia is vulnerable to the negative effects of pollution. A study by ASEAN and the Asian Development Bank (ADB) shows three contributing factors to ASEAN's vulnerability. These include a growing population, long coastlines, and a high concentration of people and economic activities in coastal areas. To address these issues, countries in the ASEAN region joined forces for climate action. At the Third East Asia Summit (EAS), in Singapore in 2007, ASEAN adopted the Kyoto Protocol as a part of its Declaration on Climate Change, Energy and Environment (Association of Southeast Asian Nations 2012).

From this, the broader international community also reaffirmed that environmental issues needed to be tracked. A third Earth Summit 'Rio 2012' or 'Rio+20' in Rio de Janeiro, Brazil, took place, reaffirming the economic and environmental goals of the global community (United Nations 2018).

In 2015, the *2030 Agenda for Sustainable Development* was produced by the UN in New York with continued focus on balancing the three dimensions of sustainable development: economic,

social and environmental development. This new agenda includes a suite of 17 Sustainable Development Goals (SDGs) to be met by 2030. Some of the goals and targets identify waste management as keys to sustainable urban development and important to quality of life. They highlight that if people reduce and recycle waste it can help minimise the impact on cities and on the overall global climate system (as stated in Goal 11). Goal 12 focuses on sustainable consumption and product patterns in food waste (United Nations 2015b).

The Paris Climate Change Agreement of 2015 stated that the rise of carbon emissions must be limited by the average temperature below 2 degrees Celsius globally (United Nations Framework Convention on Climate Change 2017). Also in 2015, the Regional Cooperation Centre (RCC), Bangkok, was established by the United Nations Climate Change and the Institute for Global Environmental Strategies (IGES). The aim of this centre is to support climate change mitigation efforts through empowerment, networks and technical assistance, with the aim of driving clean development in Asia and the Pacific (United Nations Framework Convention on Climate Change 2017).

Policies and intentions developed from these conferences and meetings have helped change frameworks and guidelines and raised awareness of the urgency of the issue of climate change, part of which identifies the need for waste management (Association of Southeast Asian Nations 2018). However, these initiatives are yet to translate into significant action (Ackerman 2010; Hoornweg & Bhada-Tata 2012).

Municipal Solid Waste (MSW) is a difficult and challenging issue to manage, especially in developing countries. Currently, more than half of the global population live in cities (World Bank 2018b) and the urban way of living has created significant amounts of waste because of changing consumption behaviours (Beigl, Lebersorger & Salhofer 2008; Lehmann 2011; Zaman 2015; Zaman & Lehmann 2011) related to living condition and incomes (Beigl, Lebersorger & Salhofer 2008). Urban dwellers tend to generate double the waste of people in rural areas (World Bank 2018a). Rapid urban expansion means that existing waste systems are often overwhelmed.

In developing countries, urbanisation and the number of cities is increasing rapidly through population growth, economic progression and industrial development. A consequence is an increase in the production of solid waste (Henry, Yongsheng & Jun 2006; Hoornweg & Bhada-Tata 2012; Narayana 2009). To protect human health and the local environment, there needs to be a Municipal Solid Waste Management (MSWM) system in place. A 'one size fits all' approach to waste management is not appropriate, as each city has its own individual set of characteristics and issues surrounding waste management (Schübeler, Christen & Wehrle 1996; Topic & Biedermann 2015). Even though drawing upon the MSWM experiences of developing cities can be helpful, due to every city being different, improvements need to be made by gathering a range of information about different local SWM perspectives.

2.2 Municipal Solid Waste (MSW)

It is important to examine and outline a clear definition of MSW and also define what MSWM entails. Projects and studies have used a range of definitions which were used as a guide to support the aims of this study as outlined below.

2.2.1 Definition of municipal solid waste

Municipal Solid Waste (MSW) has many definitions and is more commonly known as 'trash', 'garbage', or 'rubbish' (Cambridge Dictionary 2018; United States Environmental Protection Agency 2016).

The United States Environmental Protection Agency (US EPA) (2017, p. 1) states: "MSW consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses".

The Organization for Economic Co-operation and Development (OECD) (cited in Hoornweg and Bhada-Tata 2012, p. 4) says: "Municipal waste is collected and treated by, or for, municipalities. It covers waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, yards and gardens, street sweepings, contents of litter containers, and market cleansing. Waste from municipal sewage networks and treatment, as well as municipal construction and demolition are excluded".

The two definitions above are comparable, with the addition from the OECD indicating that waste from construction sites and human waste is not MSW, whereas Hoornweg and Bhada-Tata (1996, p. 6), in their 'What a Waste' report, include construction and demolition waste saying that: "MSW, as defined in this report, encompasses residential, industrial, commercial, institutional, municipal, and construction and demolition (C&D) waste". Similarly, Schübeler, Christen and Wehrle (1996, p. 9) says that "MSW is defined to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste and street sweepings".

From the definitions presented above, it could be stated that MSW is any waste that a municipality would collect from households, commercial, institutional and hospitality-based premises, and waste from yards and street sweeping. The types of waste the municipality would generally collect from the above locations would include food wastes, paper, plastic, clothes, wood, rubber and leather, glass, metal, stone, and other waste such as sand, dust, and ash. Other types of waste that a municipality might collect (but not as frequently) include construction and demolition waste, electronic waste and household hazardous waste such as dangerous chemicals, paint and batteries.

2.2.2 Municipal solid waste management (MSWM)

MSW is difficult to manage due to the fact that it is generally a mix of organic matter, recyclable and non-recyclable materials and often contains hazardous household waste including electronic waste (e-waste). As highlighted by Schübeler, Christen and Wehrle (1996), the primary aims of a MSWM program are to protect health, protect the environment and promote economic development via access to opportunity and income. Most local governments around the world play a major role in MSWM in their governed area (Borongan and Okumura, 2010, Hoornweg and Bhada-Tata, 2012, Schübeler et al., 1996, Tchobanoglous and Kreith, 2002). It is often extremely costly for local governments to manage MSW, as such management generally consists of collection, transportation and disposal (Solberg, 2012). Consequently, to deal with waste management problems, many solutions have been proposed to determine the most suitable approaches to solving these problems. Each of the activities within MSWM requires careful planning and financing, and collection and transport needs to be considered in conjunction with properly designed, constructed, and managed landfills. Local needs and conditions should always be considered, and then the most appropriate waste management programs for those conditions selected (United States Environmental Protection Agency, 2002).

The key activities for proper MSWM are waste separation, recycling, collection, transportation, treatment and disposal (Figure 2.1). Reduction in waste generation is also a key component in effective MSWM, although this is less often seen as a local government's responsibility (Borongan and Okumura, 2010, Guerrero et al., 2013, Schübeler et al., 1996, United States Environmental Protection Agency, 2002). Adequate MSWM is complex, and often requires comprehensive planning (United States Environmental Protection Agency, 2002).

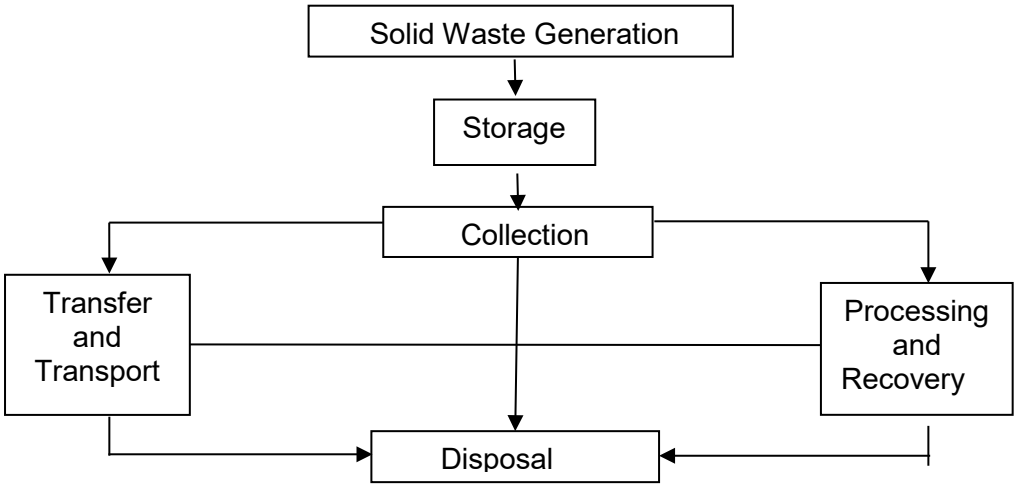


Figure 2.1: Municipal Solid Waste Management diagram (Adapted from Ramachandra et al., 2018) (Refer to <http://ismenvis.nic.in/Content/Copyright_166.aspx> for permission details)

A number of theoretical approaches have been created to deal with rising volumes of waste (Table 2.1). These include the 3Rs (reduce, reuse, recycling), the Waste Hierarchy, Zero Waste, Life Cycle Assessment, waste minimisation approaches and Integrated Sustainable Waste Management.

Table 2.1: Waste Management theories

Theory	History	Definition/explanation	Advantages/disadvantages
3Rs (Reduce, Reuse, Recycle)	Recycling has been a common practice since ancient civilisations. For example, records show that in the fourth century BC, Plato mentioned the importance of recycling in order to make the most of waste products (1). In the 1800s, there was no waste removal structures in a number of European countries, which resulted in enforced recycling, because of sanitary conditions. Around this time several beverage companies in Ireland and Great Britain established a system to return bottles from customers to the bottling companies (1). Metal materials were reused or moulded into new products, including for railroads throughout the US (1). In 1884, an official recycling system with refundable deposits on bottles was established for Schweppes, a Swiss beverage brand. In the 19th century, by World War I, in America, a “recycle post” was distributed to customers to return recyclable materials to the industrial manufacturer (2). By World War II, due to a materials shortage problem, reuse and recycling material became very important (2). The US government promoted the “Salvage for Victory” campaigns. In the UK, the National Salvage Campaign encouraged people to donate their metal, paper, rages and rubber as materials of patriotism (2). In the 1970s, the 3Rs as a concept was published by Garrett De Bell for Earth Day (3). During that time, investment in recycling occurred due to increasing energy costs. The 3Rs was supported until around 2000 by both Non-Government Organisations (NGOs) and governments of Europe and North America, who focussed on the development of recycling markets. Around a decade later the recycling of secondary materials started to become a global business (4)	The 3Rs encourage waste producers to take an interest in waste problems, to see the value of waste and to be aware that they should take responsibility for reducing waste or separating waste for recycling. However, it has remained a voluntary activity. Reduce is defined as preventing and reducing waste generation at sources. Reuse is defined as reusing for a second (or third, etc) time used products or materials before they become waste. Recycling is defined as waste material conversion process from old materials to the new materials or products. Recycled materials include glass, paper, cardboard, metal, plastic, rubber, textiles and electronics. Food or garden waste is considered recycling by composing.	The major advantage of the 3Rs approach is that it reduces the rising of volumes of waste. Reuse and recycling by this method reduces waste going to disposal, alleviates pollution from disposal processes and can reduce the use of fresh or raw materials (4, 5). Good waste separation is important to reduce the contamination of waste materials and enhance the quality of recycling. Waste pickers play an important role for waste recycling systems (4). However, many municipalities have (especially in developing countries) been facing problems with managing recycling systems. These problems include insufficient investment, poor public participation and lack of technical support (6).

Theory	History	Definition/explanation	Advantages/disadvantages
Waste Hierarchy	In 1975 the Waste Hierarchy was first introduced into European waste policy by the European Union‘s Waste Framework Directive. It highlighted the importance of waste minimisation to reduce the impact of waste on the environment and health. Later, the Waste Hierarchy was applied in waste policy and legislation in other nations including Australia and USA (7). In 2006, the European Commission, in the European Union Waste Framework Directive, proposed a 3-step hierarchy: 1) prevention and reuse, 2) recycling and recovery (with incineration) and 3) disposal. These steps were separated into 5 individual components (Prevention, Reuse, Recycle, Recovery, Disposal) in 2008 (8)	The Waste Hierarchy is a strategy to inform waste policy; to view waste from source to the end of the waste process (disposal). The hierarchy is based on sustainable development principles. It is presented as a pyramid diagram, which considers the maximum benefit waste management activities from the most favoured to the least favoured options. The Waste Hierarchy favours waste prevention, followed by waste minimisation. Reduce, reuse and recycling is seen as the ‘premium’ approaches, followed by waste recovery, with landfill being the least preferred approach (9) (Figure 2.2).	This strategy was created to flip the pyramid of waste practices, to emphasise that the least preferred method is disposal. Notwithstanding, landfill remains the largest component in the waste management pyramid. Due to simple technology and low cost, landfill disposal is very popular and is the largest component of waste management in most developing countries, especially in Asia and the Pacific (5, 10). There are practical challenges to the Waste Hierarchy, including delegation of tasks. For example, it is not clear form the hierarchy which level of government should take responsibly for individual components of the hierarchy model. These components include setting waste management strategies, collection of waste, and waste sorting systems There is a lack of co-operation between different levels of local government organizations, in addition to a lack of budget, baseline data, administrative capacity and technical expertise (11). All of these combine to make application of the Waste Hierarchy model difficult.
Zero Waste	In the 1980s, the Zero Waste concept was introduced in Berkeley, California (12). Early in the 1990s, a group called ‘The Zero Waste Recycling Movement of the Philippines’ was set up in Manila. This group created ways to use every scrap in the waste stream (12). In 1995, the idea of cutting consumption, recycling and reusing was expanded to include product design with the goal of Zero Waste. This expansion of the Zero Waste Concept was initially started in California and Italy (12). In 1996, similarly, the ‘No waste by 2010 law’ was passed by the Australian Capital Territory (ACT) Government (12). In 1997, the Zero Waste concept was adopted by the California Resource Recovery Association, Folsom, as part of its Agenda for the New Millennium (13).	Zero Waste is a waste prevention strategy for planning or managing waste, with the goal of reducing waste to disposal, particularly disposal of waste by burning, burying or dumping (13). The approach of Zero Waste is to encourage producers and consumers to consider the conservation of all products, packaging material, manufacturing processes and design for reusable or recyclable products or longer product life. It also has a focus on reducing discharges to the environment and impacts on human health (12, 13).	Zero Waste has many similarities to the 3Rs, but is a goal oriented rather than practice oriented. The concept of creating a waste management framework that limits opportunities for disposal can be useful because in theory, everything will be either recycled, reused or composted (12, 13). However as with other waste management approaches, Zero Waste does not address the problem of who should take responsibility for implementation of the concept.

Theory	History	Definition/explanation	Advantages/disadvantages
	In 2001, a Zero Waste goal was established by the California Integrated Waste Management Board and was added in their policy and In 2002, a goal of Zero Waste was established by the City and County of San Francisco's Department of the Environment (13).		
LCA (Life Cycle Assessment)	In the 1980s, consumers started to be interested in the environmental consequences of products. As a result, 'Life Cycle Assessment' was introduced as an analysis approach to evaluate the environmental impact of products (14). In the early 1990s, LCA was applied to evaluate the environmental components in waste management system (14). The LCA approach and associated tools are standardised, with well-defined procedures with detailed organizational guidance by ISO 14040:2006 (14). There are software tools for assessment to support LCA given the large amount of data LCA creates (14).	Broadly, the LCA approach has been applied in industry to protect human health and reduce environmental impact and is focused on resource consumption. This assessment is called "from cradle-to-grave" and assesses the environmental performance of products for the entire system. Products can include materials, goods, technologies and services. LCA has been used for evaluation of different waste processing technologies including ISWM (14, 15). On the other hand, ISWM has been used to describe the LCA approach to waste management system and facilities (16).	There has been significant criticism of the scope of the LCA approach. Specifically, it has been noted that if each activity within the entire product, process or system must be evaluated; this will create great complexity (14). Additionally, it has been noted that if there are any mistakes in data gathering, there is potential for LCA results to have significant errors. Due to these problems, it has been suggested that LCA should play a limited role only in waste management projects. However, SWM is a complex issue and requires information to be drawn from a variety of sources and should include environmental issues as well as economic and social impacts (14). Therefore there might be a role for LCA in SWM, although the issues with LCA highlight the need for significant monitoring during data collection, extensive training to use the system, and a high level of competency and know-how on the system users' behalf.
Waste Minimisation	In 2000, Waste Minimisation was defined by OECD (14). Waste Minimisation strategies have been promoted and led by the UNEP's Division of Technology, Industry and Economics – Responsible Industry and Value Chain Unit (DTIE RIVU) (17)	Waste Minimisation is a set of processes and practices to prevent waste entering the waste stream. This can be achieved by: 1. introducing upstream interventions, with a focus on reduction of waste at the source or by 2. minimising waste generation during production processes, 3. by reducing consumption habits, 4.by redesigning products and production processes (17).	Waste Minimisation can protect the environment and frequently, can return economic benefits (17). If companies or organisations adopt this strategy it can help reflect a positive environmental image. However, the Waste Minimisation approach does not include waste treatment or disposal. Therefore, it is missing an opportunity to consider an outcome for what is essentially a large portion of the waste stream (14, 17).
ISWM (Integrated Solid Waste	ISWM has been developed and undergone several reiterations over the past 30 years:	ISWM is a complete approach for all aspects of waste management that considers environment and health concerns for waste streams, from the waste generation level	ISWM is helpful for making suitable decisions around the most appropriate and achievable solutions, working within the conditions of a local area (19).

Theory	History	Definition/explanation	Advantages/disadvantages
Management or Integrated Sustainable Waste Management) or ISSWM (Integrated Sustainable Solid Waste Management)	It was first proposed in the 1980s by WASTE, a Dutch Non-government Organisation (18, 19) and was further developed in the mid-1990s, by the team Collaborative Working Group (CWG), a waste management practitioner group based in low- and middle-income countries. In 1995, the first conceptual framework of integrated municipal SWM in low-income countries was established from a workshop which was held in Ittingen, Switzerland (16, 20). (Figure 2.3)	(3Rs), collection and transport systems, sorting, treatment and recovery and final disposal. It also involves input of local conditions and needs into the evaluation system. ISWM covers solid waste management in term of technologies and environmental, economic and social dimensions (21). ISWM starts with three questions: What (is the scope)? Who (are stakeholders or actors)? and How (are the strategic objectives and aspects to be addressed)? (16) The program was specifically developed for poor cities.	
	In 1995 (later in the same year) to 2001, ISWM systems were further developed by the Dutch government and implemented by the UWEP. The program was carried out by Van de Klundert and Anschutz (Dutch NGO WASTE members) (Figure 2.4)	The ISWM framework was adapted and further details were added. These include integrating across all the elements of the waste hierarchy, all the stakeholders involved and all the 'aspects' of the 'enabling environment' (political, institutional, social, financial, economic and technical aspects), particularly in developing countries (16).	This framework provides details on each element, in order that it can be applied in differing areas with differing local governance. However, it has been criticised for this level of detail in that some users might consider that too many details make the framework's application confusing (22). **Note: This is version of the ISWM framework that was applied in this research**
	In 2012, ISWM framework was re-presented by Wilson, Rodic and Velisin (16, 22). (Figure 2.5)	ISWM framework was restructured into two overlapping triangles. The first triangle includes the physical elements which consist of public health (specifically, the waste collection system), the environment (the waste treatment and disposal process) and the 3Rs (reduce, reuse, recycle). The second triangle includes government strategies that support a well managed waste service: These are presented as firstly, inclusivity, including waste service users and providers; secondly, sound institutions and productive policies; lastly, financial sustainability.	It has been claimed that this more simplified version of the framework may not capture all the relevant details required to undertake a complete assessment (22).

Note:

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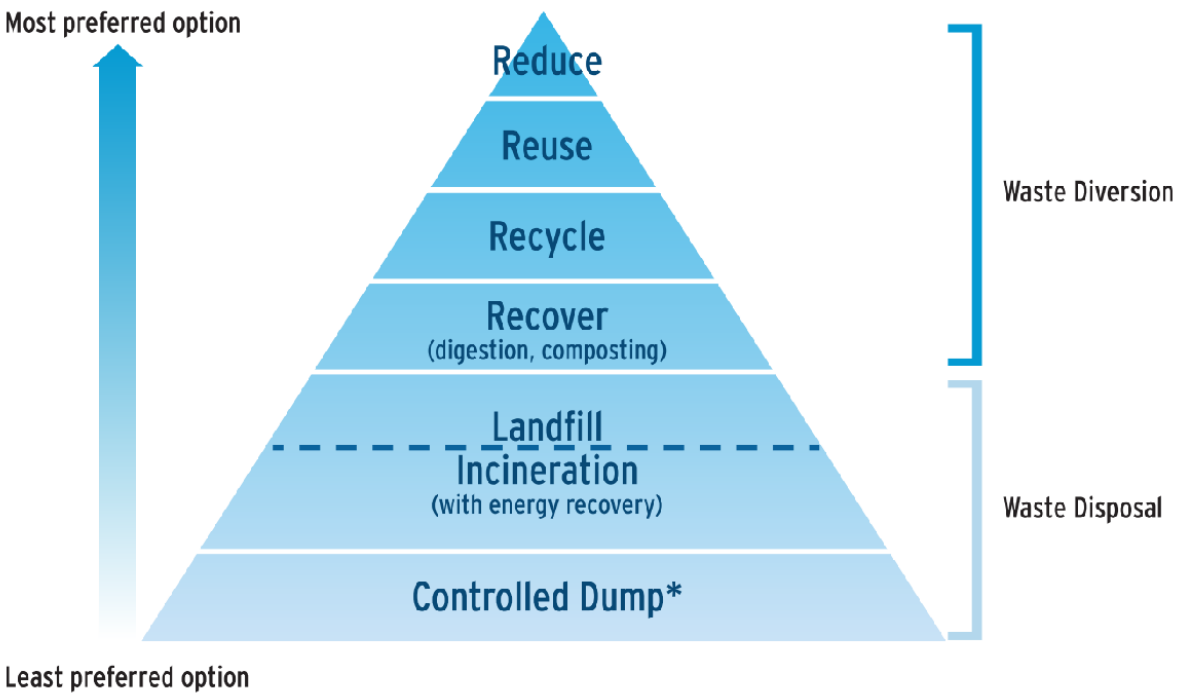


Figure 2.2: Hierarchy of waste management (Hoornweg and Bhada-Tata, 2012). Licensed under [CC BY 3.0 IGO]: https://creativecommons.org/licenses/by/3.0/igo/

2.2.3 Integrated sustainable waste management (ISWM)

ISWM is a complete approach consisting of three essential dimensions: waste system elements (with environmental and health concerns included from the beginning to the end of waste stream), related stakeholders (which encompasses waste producers, service-operators, government and non-government organizations as well as waste management professionals) and an additional six aspects (financial-economical, technical, legal, political, sociocultural and environmental/health). ISWM has the capacity to address the factors outlined above, because it prompts the user to consider all essential dimensions of the waste system. Figure 2.3 shows the original ISWM framework with three main questions 'what', 'who' and 'how' as dimensions (Figure 2.3) (Schübeler et al., 1996, Wilson et al., 2013). Figure 2.4 shows a newer version of the ISWM framework (Anschütz et al., 2004), which provides greater opportunity for stakeholders, and to which waste prevention and recovery have been added (Mwangi and Thuo, 2014, Klundert and Anschütz, 2001). Figure 2.5 shows the most recent version of the ISWM framework. As noted in Table 2.1, this framework might not capture all the relevant details required to develop an appropriate MSWM system. The second iteration of the ISWM (Table 2.1 and Figure 2.4) was considered most appropriate to use for this research. This is because this version was the clearest, most prescriptive and the most utilised of the three versions, and it is this iteration that was used in this research. There is a third version (Table 2.1 and Figure 2.5), however this version is a simplified version of the

previous two, and was considered as providing less guidance than the second version (this is discussed below).

There are several reasons that the researcher selected the ISWM approach as the framework for the study.

Firstly, there are many of factors associated with the overall waste management problem in the study site, a rapidly urbanising area of northeast Thailand. These include environmental and economic considerations and social dimensions, including a lack of understanding of the waste management system, which is exacerbated by the limitations of budget. As McDougall et al. (2001), note, no single approach can deal with complex waste management problems. No single method can manage the variety of materials in waste, and there is no single best collection system. The ISWM framework provides a solid starting point for waste examination, as it prompts the user to combine a variety of waste management methods with other aspects and input from stakeholders.

Secondly, developing countries are facing a dramatic rise in waste generation rates (Guerrero et al., 2013). Therefore the approach needed to consider the current and future needs of the area. It is currently difficult to manage MSWM in the study area, primarily because the waste is mixed and includes a large proportion of organic material, which makes up a much of the total municipal waste composition in many developing countries (generally, over 60 percent) (Hoornweg and Bhada-Tata, 2012). Separation of waste at the source, one of the components of ISWM, will reduce the waste going into the waste stream and also reduce the problem of mixed waste.

In recent years, the ISWM system has been acknowledged worldwide as the most comprehensive approach for managing waste (Marshall and Farahbakhsh, 2013). ISWM has been developed and improved by SWM specialists for more than four decades and is applied throughout many countries. ISWM has been applied as a long-term strategy for waste management in developing countries and applied to different situations around the world. Consequently, there are case studies available that share information about ISWM. In the UN-Habitat's Third Global Report on the World's Cities Water and Sanitation– 'Solid Waste Management in the World's Cities' a team of waste management experts from around the world examining case studies from 20 different cities across six continents. The report included low, middle, and high income countries and reported that "the ISWM framework has the goal to encourage a different kind of thinking and support every city to develop its own individual solution that is appropriate to its specific history, economy, demography and culture and to its institutional, environmental and financial resources" (Rodic et al., 2010).

Because ISWM has been applied in many cities and countries over a number of decades means that its application and resulting outcomes can provide examples for other cities to follow to help resolve their own waste management problems. This provides additional evidence that the ISWM approach is a useful framework which can be adapted to different waste scenarios. The existing evidence and case studies create opportunities for developing nations to learn and develop their own system and shape it to suit their own unique situation.

The US EPA (2002) notes that ISWM can effectively protect human health in communities and reduce greenhouse gas emissions which can protect the natural environment. ISWM encourages a comprehensive and systematic study of the intricacies of SWM systems (Anschütz et al., 2004), where emphasis is placed on integrating technical aspects of the waste hierarchy model, with more attention placed on waste prevention, recycling, and disposal (Wilson et al., 2013).

The requirement for appropriate solid waste management is intensified by the issue of global warming. Inappropriate or inadequate MSWM in many developing countries contributes to current global warming trends. As a result, a number of conventions and protocols have called for better MSWM, (including in the Stockholm Convention, Agenda 21, Kyoto Protocol and SDGs) (United Nations, 2015, Woelandari, 2016, United Nations, 1993, Wilson et al., 2013, Hoornweg and Bhada-Tata, 2012).

The success of the ISWM approach has prompted various international development agencies to provide the support and expertise required to implement ISWM systems. Support has come from a variety of sources including (but not limited to) the UNEP, the World Bank, Japan International Corporation Agency (JICA), German Technical Cooperation (GTZ), Danish funding by the Danish International Development Agency (DANIDA), and the Asian Development Bank (ADB) with aid arrangements including significant fiscal assistance and various grants from these bodies (Wilson et al., 2013, Woelandari, 2016, Lerpiniere et al., 2014). The majority of grant funding focuses on providing resources to improve local infrastructure and assist government capacity, while implementing change to MSWM in a systemic way (Lerpiniere et al., 2014). It has been suggested that the international support toward the development of MSWM capacity through implementation of systemic methods reaffirms that the commitment to ISWM systems is a global one (Woelandari, 2016). This is an important factor as SWM is not an easy issue to solve, however if local governments have a global knowledge and resource base to draw from, this can help to provide solutions through improved access to quality information sources and support.

There are a range of barriers around implementation of MSWM systems in developing countries. Early in the 1990s, many international agencies and NGOs started to recognise that effective MSWM is not only due to implementation of technology and infrastructure (Mwangi and Thuo, 2014, Wilson et al., 2013). This prompted consideration of elements including socioeconomic and environmental aspects that can influence the system outcomes (Klundert and Anschütz, 2001). Research undertaken by UN-Habitat (United Nations Human Settlements Programme) (2010) supports this. In 1995, UNDP, UN-Habitat and the World Bank designed a theoretical outline for ISWM to be utilised by developing nations at all levels, including municipal governments. This ISWM framework had the aim of being a complete, all-inclusive system that would identify gaps at all system levels (Wilson et al., 2013, Schübeler et al., 1996) by identifying the system's scope from operational requirements to the financial administration process, classifying participants and stakeholders, and finally

acknowledging implementation of the SWM strategy in areas such as political, social and institutional matters (Wilson et al., 2013).

The ISWM framework provides the tools for decision-makers to understand how to manage waste appropriately. It aims to develop and establish an approach to SWM using appropriate technology. Inappropriate technology has, in the past, regularly been used in SWM, particularly in developing countries and consequently has been unsuccessful (Woelandari, 2016). Rodic, et al (2010) mentioned that many cities of developing countries around the world have found that technology does not solves waste management problems (Rodic et al., 2010). It has been suggested that municipalities explore low technology, high labour intensive projects, which may not require a high capital investment (Council for Scientific and Industrial Research, 2011). Of the various frameworks and theoretical approaches to solid waste management, ISWM framework is best placed to ensure that inappropriate technology is not part of the MSWM system as it includes an examination of the area's needs and capacity.

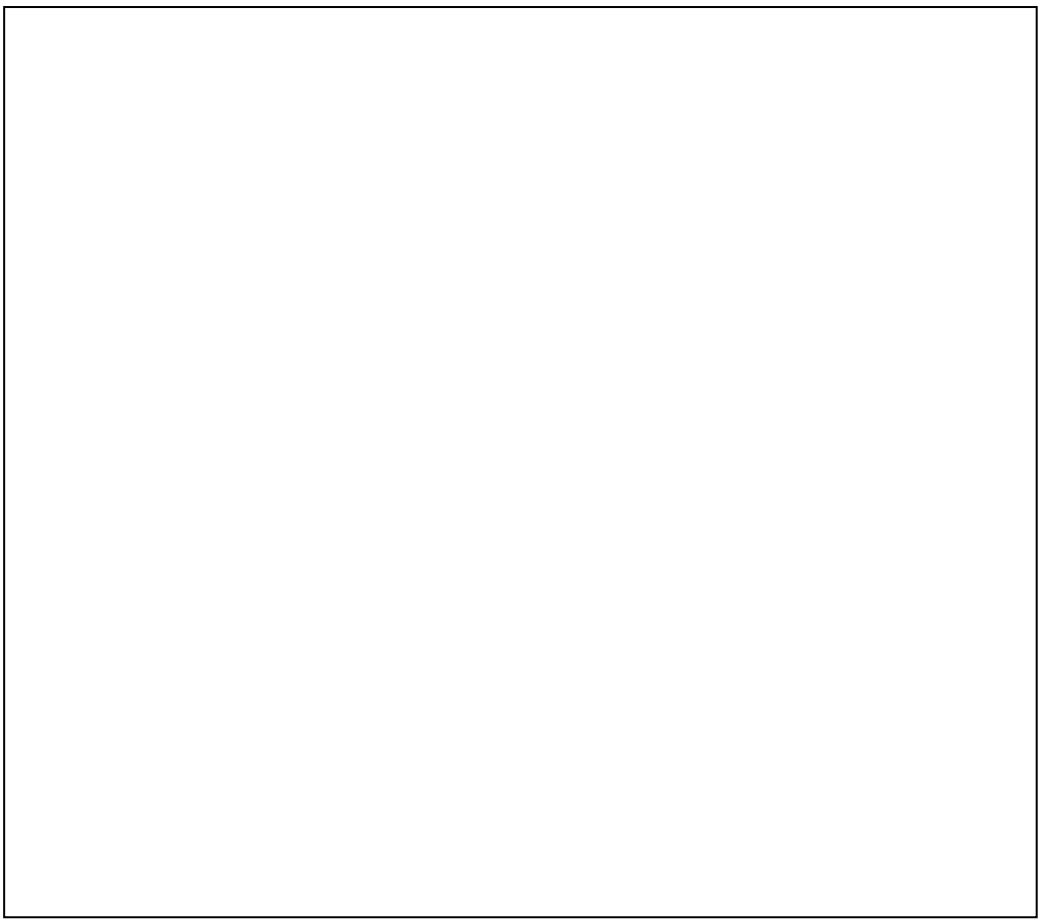


Figure 2.3: Integrated Sustainable Waste Management framework: the original framework (Schübeler et al., 1996 cited in Wilson et al 2013) (Available at https://www.icevirtuallibrary.com/doi/full/10.1680/warm.12.00005) ***Figure 2.3 has been removed due to copyright restrictions***

Figure 2.4: Integrated Sustainable Waste Management model: the second version, and the one used in this research (Anschütz et al., 2004). ***Figure 2.4 has been removed due to copyright restrictions***

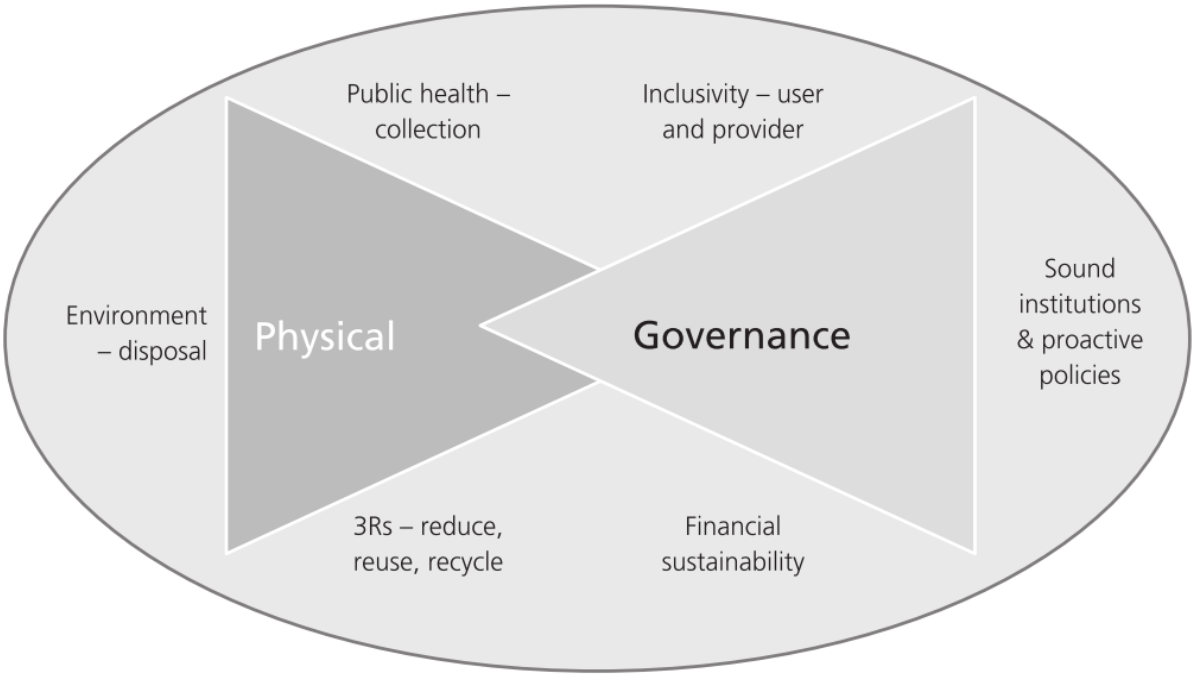


Figure 2.5: Integrated Sustainable Waste Management model: the third version (Wilson et al., 2013) (Permission obtained from ICE Virtual Library)

Further development of ISWM

In 1995, ISWM systems were further developed and implemented by the Urban Waste Expertise Programme (UWEP), a program that was supported by the Netherlands Ministry of Foreign Affairs, Division for International Cooperation (DGIS). The UWEP was applied for six years from 1995-2001 in four pilot cities in India, Honduras, Mali and the Philippines (Anschütz et al., 2004).

The first project which was called UWEP (now referred to as UWEP I), was continued with the UWEP Plus project from 2001 (Wilson et al., 2013, Anschütz et al., 2004). This program contributed to a better understanding of waste management in underprivileged cities. Notably, the program stimulated planning and improvement within the four pilot cities. UWEP Plus reexamined the ISWM system and built on UWEP I and formed the basis for evaluation and planning of SWM across nine cities in eight countries (India, Honduras, the Philippines, Mali, Bulgaria, Peru, Egypt and Costa Rica) from 2001 to 2003 (Anschütz et al., 2004).

Klundert and Anschütz (2001) considered that ISWM is able to meet the requirements of society, economy and the environment at a particular place, as it gives opportunities for all stakeholders to participate in the process and embraces waste prevention and waste recovery as a factor (Mwangi and Thuo, 2014, Klundert and Anschütz, 2001). The following discussion presents the three different dimensions of the ISWM framework including stakeholders, system elements and strategic aspects.

First dimension: Stakeholders

The first dimension of the ISWM refers to local authorities, nongovernment organisations and community based organisations, service users, private informal sectors, private formal sectors, and donor agencies. The ISWM framework requires both a degree of expertise in the area of solid waste supervisors, and an appreciation of the important role that the community, employees in MSWM, and local (and increasingly global) environments have in effective SWM. Therefore the stakeholders should include, for example, waste pickers, small-scale enterprises, and female heads of households (Klundert and Anschütz, 2001, United States Environmental Protection Agency, 2002).

Second dimension: Waste system elements

The second dimension of the ISWM refers to waste management elements. The ISWM framework is not just a waste management technique. It presents guidelines that cover the major components or elements in the waste stream, including waste prevention, recycling and composting, as well as combustion and disposal (United States Environmental Protection Agency, 2002). ISWM should be driven by clear objectives based on the hierarchy of waste management: reduce, reuse, and recycle (United Nations Environment Programme, 2009) often adding a fourth ‘R’ for recovery (Klundert and Anschütz, 2001). Each of these elements are described in turn below.

Waste Prevention

There are many ways to prevent or reduce waste at the source before it is generated including altering package design, engineering products that last longer, and reusing products and materials (United States Environmental Protection Agency, 2002). Waste prevention in the context of this research extended only to the reuse of products, which will be discussed in later chapters.

Recycling and Composting

Recycling and composting contribute significant environmental and economic benefits (Kaseva and Gupta, 1996, Barr et al., 2001). Waste can be turned into valuable resources by recycling processes. Recycling requires collecting and reprocessing and can include recovering certain waste materials such as metals, plastics, glass and paper to make new material or products. The process can occur at the source of the waste, as in household or businesses using waste pickers or scavengers, or waste collectors separating recyclable items that can be sold to scrap dealers, which is better than separation occurring at the landfill site (United States Environmental Protection Agency, 2002). Composting is another form of recycling as organic waste is often the greatest proportion of waste in the solid waste stream (United States Environmental Protection Agency, 2002). Some organic materials, like food waste, plant matter, or livestock waste contain high levels of nutrients that can be used to enhance the quality of soils (Thapa and Rattanasuteerakul, 2011, Pretty, 1995). Both recycling and composting can create jobs, and profits, and can also reduce the greenhouse gases that contribute to global warming, in addition to reducing the requirement for disposal, meaning less landfill space and fewer combustion facilities are required (United States Environmental Protection Agency, 2002).

Disposal (landfilling and combustion)

Disposal should be the last resort for materials which cannot be reused, composted or recycled and should therefore be the last method considered to manage waste. Disposal is generally through landfill and/or combustion.

For safety, health and environmental reasons, the landfill approach requires that the landfill be carefully designed, constructed and managed. Similarly, reducing the volume of waste by combustion also requires careful design, construction and management, and has the additional component of potentially toxic air emissions. Combustion can however reduce waste going to landfill, moreover, this technology can convert methane to energy (United States Environmental Protection Agency, 2002).

Third dimension: ISWM aspects

The third dimension refers to strategic aspects, which consist of technical, environmental/health, financial/economic, sociocultural, institutional, and policy/legal/political aspects. ISWM is a framework that can prompt the system user to approach solid waste in a broad sense via careful

selection and sustained application of suitable technology and working conditions, with emphasis on gaining social acceptance from the community and waste management authorities (most commonly local government) (Klundert and Anschütz, 2001). An ISWM system provides guidance across important aspects that need to be considered for MSWM planning (Klundert and Anschütz, 2001). These authors also argue that ISWM occurs through the use of four basic principles as a guide: equity, effectiveness, efficiency and sustainability (Klundert and Anschütz, 2001). These principles are included in the first, second and third dimensions of ISWM that were described above. These principles demonstrate the value of ISWM framework over the other theories. ISWM supports equity across all demographics within communities by encouraging multiple stakeholders to play a role in decision-making for waste management strategies. A range of different participants are involved across sectors including residential and commercial sectors, local institutions, the private sector, governments and SWM operations staff. All opinions and knowledge contribute to the development of the waste management system. This can support fairness in waste collection services in the community for the poor and rich, and in city or rural areas. Appropriate government services need a foundation of comprehensive research supported by frameworks that offer opportunities for a wide variety of stakeholders to participate. ISWM offers this. ISWM is concerned with the environmental and health issues that go into every process from waste generation to disposal. Combining waste management methods (from the table above); reduce waste at source, reuse and recycle cause a flow-on effect. Reduction of waste for example is initiated via using natural materials, which reduce the requirement to process new materials. This causes less energy and material use and the lowers the resulting pollutants. Improved waste collection coverage can reduce waste accumulation of waste. Effective waste transportation and disposal (sanitary landfill, incineration) also reduce water or soil contamination and air pollution, which is a key issue for developing countries where open burning a commonly used during the final and last stages of waste management.

An effective waste management system also protects humans through improvements around disease control and helps to lower the health and safety risk profile for waste handling staff. Additionally, ISWM promotes an efficient waste management system due to the ability to measure and allocate budget requirements, natural resource limitations and human resource issues to help solve problems and deliver the highest input / benefit ratio for the operation.

ISWM emphasises six aspects, which help to illustrate the sustainability of the waste management system (Klundert and Anschütz, 2001) (both environmental and economic sustainability) (McDougall et al., 2001). Local conditions are combined with present and future availability of local resources such as labour, natural resources, budget and public knowledge. However, a shortfall of the ISWM framework could be that it could require additional training of local government staff who may not be familiar with complex review systems and different methods of organization. Another criticism of ISWM is that the system can be used to focus on operational and tactical issues and these models are insufficient for long-term planning of waste management (Gopal et al., 2018). However, with

quality research and training of local government staff the impact of this issue could be reduced or eliminated. When working with this framework the meaning of what details are relevant can change – particularly when comparing the diverse requirements of developing and developed countries.

The study area is experiencing rapid population growth, which has gone relatively uncontrolled. This has put great pressure upon local government to find a solution to the problem. The quantity of valuable information this system can capture, the ability to develop the framework via review functions and the potential for positive outcomes in relation to the overall inputs makes ISWM frameworks attractive.

However, it must be stressed that implementing a successful ISWM framework requires thorough understanding and training of local government and organisational staff. Other strategies and approaches in Table 2.1 could also be added to an ISWM framework to support evaluation and decision making. Zurbrugg and Potting (2011) suggested that the LCA approach is also appropriate when assessing health and environmental issues around waste management (Zurbrügg et al., 2011). In addition, this study also applied the SWOT analysis for decision making. SWOT is a technique to show issues in the sphere of strengths, weaknesses, opportunities and threats which is useful in developing appropriate solutions. This approach provides information that is helpful in matching the case's resources and capacity to the environment in which it operates.

2.3 MSWM Challenges in Developing Countries

MSWM problems are widespread and can be seen in both developed and developing countries and governments are continually seeking solutions to these problems (Solberg 2012). Hoornweg and Bhada-Tata (2012) show that there are key differences in SWM practices between developing and developed countries that determine positive or negative SWM system outcomes. Developed countries often have access to finance (Hoornweg & Bhada-Tata 2012; Wilson, Velis & Rodic 2013), education, utilisation of technology, waste stream, disposal methods and community participation that developing countries do not have (Hoornweg & Bhada-Tata 2012). Cities in developing countries are often cited as having an unsatisfactory MSWM system (Hagos, Mekonnen & Gebreegziabher 2012), but it is argued that it is the most important service that a city provides (Hoornwe & Bhada-Tata 2012). This assertion is further supported by the United Nations where it is highlighted (in Transforming our world: The 2030 Agenda for Sustainable Development) that there is a basic human right to adequate sanitation (United Nations 2015b) and having adequate MSWM systems in place supports this.

ISWM is a method of implementing change and its implementation has assisted in solving MSWM problems around the world, but there have also been system failures in many developing countries (Aleluia & Ferrão 2016; Mwangi & Thuo 2014). A key issue behind many SWM problems is the fact

that problems are not consistent across the developed and developing world and the problems that many governments are facing are vastly different (Council for Scientific and Industrial Research 2011; Marshall & Farahbakhsh 2013).

Developing and developed countries often have dramatically different contemporary contexts to operate within. The following sections will explore these aspects and the challenges they present for MSWM systems in developing countries.

Developing countries experience low service coverage and irregular services, crude open dumping and burning (often with little or no air and water pollution control), additional insect and vermin issues, and informal waste picking or scavenging activities (Mwangi & Thuo 2014; United Nations Human Settlements Programme 2010). These conditions have caused inefficiencies and failures around MSWM in many of the urban areas of developing nations (Mwangi & Thuo 2014).

Mwangi and Thuo (2013) cite many barriers to implementation of a good MSWM system. They mention issues including lack of funding and the absence of institutional capacity. Marshall and Farahbakhsh (2013) go further by showing that SWM issues are exacerbated by the weakness of institutions, under-resourcing, limited budgets, rapid urbanisation, inequity, socio-cultural norms and consumption habits (Marshall & Farahbakhsh 2013; Wilson, Velis & Rodic 2013).

To respond to their own MSWM issues, many developed countries have undertaken ambitious environmental reforms and implemented changes for best practice in MSWM, but, in developing regions, like Sub-Saharan Africa for example, there are still significant barriers and problems around policy, institutions and system reforms (Ezeah & Roberts 2012). In developing countries, sociopolitical, technological, regulatory, financial, and human resources constraints have been cited as continuing problems around MSWM (Bufoni, Oliveira & Rosa 2016).

In developing nations, waste production is increasing and is often compounded by a cycle of poverty, rapid population growth, decreasing standards of living, poor governance, and the low level of environmental awareness (Ezeah & Roberts 2012). The ISWM model (Figure 2.4) takes these issues into account by providing six key aspects to be examined during MSWM system development. As noted above, these include technical, environmental/health, financial/economic, socio-cultural, institutional and policy/legal/political aspects: these are explored further below.

2.3.1 Technical aspects of MSWM

The technical aspects of MSWM are particularly challenging for developing countries. These issues come about through a wide range of factors that include urban planning and design, MSWM system design and implementation, type and size of plant or equipment used and adequate utilisation of plant and waste management staff. When examining technical aspects, it is important to note that many MSWM techniques and equipment are developed in countries with extremely different social and economic conditions compared with those in developing countries (Marshall & Farahbakhsh 2013).

Lack of urban planning and design is often an intractable problem. In a study looking at SWM in the developing world, many sources of waste were found to be only accessible by narrow roads or alleys. Access by waste collection vehicles may be blocked because of their width, congestion, or elevation. This is especially critical in unplanned settlements such as slums or low income areas and thus largely affects the selection of equipment (Nguyen, Zhu & Le 2015).

Due to inconsistent urban planning, roadway design and different waste stream profiles, plant and equipment capabilities must be considered. In developed countries, there exist standardised designs for vehicles and plants, consistent with normal waste characteristics and working conditions. In developing countries, waste from community bins is transported by various types of vehicles, ranging from general purpose vehicles (trucks) to highly mechanised compactors (Shekdar 2009), which is in contrast with the uniform approach of developed nations. Long term planning must take MSWM into account during the design and development of district areas to allow quick, safe and easy access to solid waste for the public and municipal workers.

Waste composition needs to be considered when choosing collection and treatment plant (i.e. machinery, equipment and apparatus used in MWSM e.g. vehicles) for MSW. Waste composition is different between developing and developed nations. Approximately 65% of waste in developing countries can be defined as organic (significantly higher than developed nations at 28%), which means that MSW in these countries is on average wetter and denser. As a consequence, transport and treatment plant type and design needs to be fully designed for the purpose it is needed for (Wilson, Velis & Rodic 2013).

An important aspect to consider during the procurement of plant is its application and use. The knowledge required around MSWM and its technicalities is often considerable and it is essential for municipalities to employ the correct staff or engage consultants throughout the process. For example, in Myanmar, it was reported that MSWM problems include insufficient technical knowledge around the plant, improper collection and management of disposal sites (Borongan & Okumura 2010).

Governments in developing countries have been known to use cheap, inferior vehicles and plant that are difficult to get spare parts for, which can also make spare parts very expensive (Ezeah & Roberts 2012; United Nations Human Settlements Programme 2010; Wilson, Velis & Rodic 2013). Due to weak maintenance systems and lack of capacity, there can be a shortfall in a waste collection fleet where waste will not be collected as quickly as required (United Nations Human Settlements Programme 2010; Wilson, Velis & Rodic 2013). For example, many municipal governments in Nigeria have struggled with the changes required to match MSW collection requirements (Ezeah & Roberts 2012). In India, it was found that equipment such as bins and waste transport vehicles were removed from service due to inadequate maintenance. This lack of access to functioning MSWM facilities led to behaviours such as littering and illegal dumping by citizens who felt they could not properly dispose of trash because proper resources were unavailable (Hazra & Goel 2009; McAllister

2015). This shows that the upkeep of SWM plant is very important. If plant reliability is compromised, good community waste disposal habits can quickly decline. In developing cities such as Mekelle, Ethiopia (also a rapid growth area), due to poor solid waste collection, haphazard dumping of waste in open areas from the public being unable to access rubbish containers is common. Waste is consequently often dumped around inadequate landfill sites (Hagos, Mekonnen & Gebreegziabher 2012).

2.3.2 Environmental/ health aspects of MSWM

A major driver of MSWM system development is concern for environmental and public health. According to the UN-Habitat (2010) report, if MSW is not managed properly there are opportunities for diseases to develop and be transported (mosquitos, rodents, insects) and in extreme cases there is also potential for human waste to come into contact with solid wastes creating a new range of health issues. In response, when resources are limited, such as in developing countries, management has primarily focussed on open dumping and burning methods of disposal (United Nations Human Settlements Programme 2010; Wilson, Velis & Rodic 2013), which can and do cause severe environmental impacts.

MSWM issues are prevalent in many countries with unsanitary landfills and poor management such as Vietnam, Nigeria, and Egypt (Aleluia & Ferrão 2016; ElSaid & Aghezzaf 2017; Luong et al. 2013). These have been identified as beginning to have severe environmental and human health impacts due to the pollution of soil, air and water resources (Karagiannidis & Kontogianni 2012; Khan, Kumar & Samadder 2016; Luong et al. 2013).

2.3.3 Financial/economic aspects of MSWM

Guerrero, Maas and Hogland (2013) and Shekdar (2009) show that waste quantities are influenced by the economic status of a society, with the quantity of waste generation being higher in countries with a higher GDP. Economic development and change is a significant driver of increased solid waste, Hoornweg and Bhada-Tata (2012, p. 3) also note that “Waste is mainly a by-product of consumer-based lifestyles that drive much of the world’s economies”.

The increase in developing countries’ consumption is matched by their increase in waste production, as Dhokhikah and Trihadiningrum (2012, p. 332) noted “The improvement in living standards [in Asian countries] has changed lifestyle and SW [solid waste] composition. In high income residential areas in some developing countries recyclable material (i.e. plastics, metal, glass and others) tend to increase, because of the consumption of more packaged products”. Advances in development in many developing countries have been rapid, and the quantity and compositions of solid wastes across many countries have changed (Dhokhikah & Trihadiningrum 2012; Krause & Townsend 2014). This rapid change of waste volume and waste composition requires changes to be made to MSWM systems.

Allocation of finances for SWM could be the greatest challenge for waste management, especially as it is a key barrier for low income countries (Wilson, Velis & Rodic 2013). Hoornweg and Thomas (1999) compared MSWM budgets and found that the lower income countries consumed most of their budget on waste collection, while the high income countries concentrated their budgets around waste disposal. A decade later, this trend had changed and high income countries were observed to use most of their waste budget on waste minimisation schemes including education, waste treatment and developments in recycling technology. In lower income countries however most of the budget is still put toward collection and disposal (Hagos, Mekonnen & Gebreegziabher 2012).

As a result, the developed countries spend only 10% of their budgets on waste collection, but with a service efficiency close to 100%, while the low income countries spend 80-90% of their budgets on waste collection but the total efficiency is only around 50% at best (Hoornweg & Bhada-Tata 2012). In developing countries, there needs to be greater emphasis for budgeting and accounting, as well as capital investment, cost recovery and cost reduction. Notably, ineffective fee collection systems have been raised by a number of authors (Hoornweg & Bhada-Tata 2012; Klundert & Anschütz 2001). Some suggestions to ameliorate this issue from the World Bank include securing loans from financial intermediaries and special central government loans or grants to use for SWM (McAllister 2015; Schübeler, Christen & Wehrle 1996).

It is important to note that financial costs can be a primary barrier to MSWM projects because economic benefits are not immediately realised, but if further examination is carried out it becomes obvious that the cost is worth the welfare benefit to society (Bufoni, Oliveira & Rosa 2016).

Correct application of finance is important in MSWM settings. For example, it has been found that in Kenya's municipal budget for MSWM is directed to pay for an over-staffed and under-qualified workforce (Henry, Yongsheng & Jun 2006) and not allocated to make improvements within their own infrastructure (McAllister 2015). Collection of revenue to support MSWM is a problem in many developing countries (McAllister 2015; Schübeler, Christen & Wehrle 1996) which increases difficulties around system and capacity improvement, which can in turn lead to waste of financial resources. As shown above, MSWM absorbs a significant portion of government revenue (Borongan & Okumura 2010).

Many developing countries are experiencing rapid economic development. Within rapidly urbanising areas, additional financial resources are required to support municipalities through periods of rapid change. Population growth in developing countries needs planning, adequate facilities and good MSWM systems to be successful (Hagos, Mekonnen & Gebreegziabher 2012). Inadequate financial support is a significant barrier to developing MSWM systems in rapidly urbanising, or high population growth areas (Hagos, Mekonnen & Gebreegziabher 2012).

Equipment and facilities are required quickly and in large quantities. Hagos, Mekonnen and Gebreegziabher (2012) analysed factors that affected the household waste in Mekelle city, Ethiopia. The result highlighted a requirement for adjustments in sanitation fees determined in consultation

with local residents to help secure proper MSW coverage in their area. This method could be a way forward for many rapidly urbanising areas, and could be helpful, as there are often problems around official funding strategies and application. If fees were collected directly and consistently from residents this could alleviate financial pressures and help change MSW issues (Ezeah & Roberts 2012).

2.3.4 Sociocultural aspects of MSWM

Sociocultural aspects are an important component in MSWM system development. Zaman and Lehmann (2011) showed that education and moderating human behaviour is an important part of waste management and is a catalyst that will help develop sustainable societies in the future. Appropriate government communication strategy is important to MSWM, according to McDougall et al. (2001) people need to understand the part they play in the MSWM system, and follow the law for it to work.

Moh and Abd Manaf (2017, p. 11) consider that “Education and individual upbringing contribute significantly towards environmental awareness, how society perceives the issue, as well as how they decide on their daily behaviour, particularly in managing solid waste”. There are limitations in public knowledge and education about SWM in developing countries. In Thailand, lack of community awareness and confidence around SWM technologies have led to problems amongst government organisations and their local communities (Sharp & Sang-Arun 2012). It has been reported that Nigeria and Myanmar have also had difficulties including lack of public knowledge and cooperation toward SWM (Borongan & Okumura 2010; Oguntoyinbo 2012; Olukanni, Adeleke & Aremu 2016).

However, some sources show that even if people know the requirements for actions around MSW matters, poverty can influence their choices. Ezeah and Roberts (2012) demonstrate that the requirement for economic survival far exceeds environmental considerations for most people. This displays that the basic need to ensure day to day survival can override a person’s willingness to participate in good SWM practices. This is a significant challenge for SWM in developing countries. Schübeler, Christen and Wehrle (1996) highlights that that the overall success of MSWM systems relies on community engagement with the SWM system.

It is very important that solutions to MSWM problems are tailored to amalgamate with cultural norms. Sharp and Sang-Arun (2012) have found that waste separation programs in Thailand have been a lot more successful when local residents were engaged as a part of the consultation process. Klundert and Anschütz (2001) showed that in Pakistan, waste bins were never put out properly for collection. It was found that cultural expectations and norms were an issue. Men would not touch the waste and women were not permitted to leave the house, so placing a waste bin outside the home was not possible. After an NGO conducted interviews an agreement was reached where children would take the waste bins to the correct locations.

2.3.5 Institutional capacity aspects of MSWM

The policy and financial aspects of MSWM are key areas that must be examined when implementing MSWM plans, however the role that institutions play in the successful implementation of MSMW systems is crucial. Hagos, Mekonnen and Gebreegziabher (2012) show that many governments lack the institutional capacity to develop a good MSW system.

Institutional MSWM capacity is frequently cited as an important factor behind MSWM system success. It has been stated that the local authority always holds the responsibility for ensuring the quality of the service (Mwangi & Thuo 2014). In many developing countries, the greatest impediments to efficient and effective handling of solid waste are managerial rather than technical (McAllister 2015). For example, it has been found that in Myanmar institutional problems include a lack of personnel, and available human resources (Borongan & Okumura 2010).

Pressures could be alleviated through the education or upskilling of the workforce. There are significant knowledge gaps around MSWM for municipal staff. Ezeah and Roberts (2012) also show that lack of expertise and emphasis on the importance of MSW education waste issues are left to people who do not have the right skill sets. McAllister (2015) reaffirms this by showing that lack of education leads to valuable MSWM approaches being discounted, leading to unnecessary pressures on landfill and significantly boosting waste management costs.

2.3.6 Policy/legal/political aspects of MSWM

Policy support needs to be a primary consideration during the development and implementation of MSWM systems (Schübeler, Christen & Wehrle 1996). Godfrey et al. 2013 (cited in Bufoni, Oliveira & Rosa 2016) show that an adequate waste management service is dependent upon provision of sufficient budgets and argues that politics influences everything; including MSWM policy content and budget allocation, down to the job description and wage of SWM collection personnel.

A study carried out in Guatemala showed that MSWM coverage was inadequate because it was not a priority for policy makers and planners (McAllister 2015). Additionally, lack of policy enforcement is a major issue. For example, in Kenya, although there is legislation covering MSWM, local authorities lack the capacity to enforce policy (Henry, Yongsheng & Jun 2006; McAllister 2015). Some developing countries such as Nigeria have cited policy issues including lack of strategy which weakens legal framework around waste management and this is compounded by weak waste management institutions with loosely defined roles, unclear legislation and poor policy strategy (Ezeah & Roberts 2012).

In Thailand, there have been policy barriers around waste management due to investment in certain technologies. For example, if investors and governments favour landfill gas recovery or waste to energy processing methods, useful recycling initiatives such as the 3Rs may be overlooked because investors or government officials may wish to have more garbage to process in their new project rather than reducing the waste stream (Sharp & Sang-Arun 2012).

2.6 Challenge of MSWM in Developing Countries Experiencing Rapid Urbanisation

As shown, many developing countries are experiencing issues in MSWM. Within this context there is also the rapid urbanisation paradigm characterised by rapid population and economic growth (Dhokhikah & Trihadiningrum 2012; Marshall & Farahbakhsh 2013), which has led to massive growth in the amount of MSW and a change in the qualities of the waste stream (Solberg 2012). Additionally Marshall and Farahbakhsh (2013) also indicate that changes around urbanisation; inequality, economic growth, cultural change, socioeconomic policy, governance, institutional issues and international influences have shaped MSWM and complicated it in developing countries. This is further explored in Chapter 3.

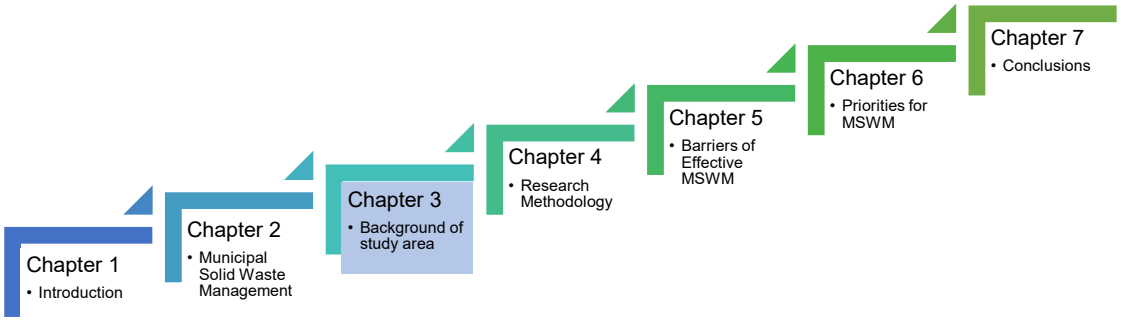
2.7 Summary

The ISWM framework has been successfully applied in many low and middle income countries (Klundert & Anschütz 2001). It is unique in the fact that it looks at SWM from a broad range of perspectives. Waste problems are due to a range of factors and the use of ISWM guidelines align with this. Waste management is not only about having technical options such as transport, treatment and disposal. If long term successful MSWM outcomes are to be developed, a wide range of elements and aspects need to be considered, which the framework provides guidance to identify.

The ISWM framework used in this research was developed to guide the researcher to achieve the objectives of this study. The framework requires the identification of the status of local conditions and the needs of the area in order to develop appropriate solutions for MSWM. The research framework principles aimed to use straightforward techniques to gather data. The research framework was also important to evaluate themes from each area of data collection, which included focus groups, and in-depth interviews (explained in Chapter 4). The research framework provided the themes under which the data were analysed. As presented above, there are six aspects described within the ISWM framework that should be considered, namely; technical, institutional, social, financial, economic, and environmental aspects (Anschütz, IJgosse & Scheinberg 2004).

MSW has become a major problem in the study area in Thailand. This area is facing significant MSWM problems resulting primarily from its rapid urbanisation. This statement is based on the gap between the rapid growth of population and the capacity to pay for, plan for and effectively manage MSWM. The population of this urbanising area produces a high volume of waste that is not currently managed appropriately. The ISWM framework was chosen to evaluate the factors as it highlights the complexities associated with the implementation of the MSWM, and has the flexibility to be supported in the local context of the MSWM system in the study area (Tha Khon Yang subdistrict, Maha Sarakham Province, Thailand).

CHAPTER 3 BACKGROUND OF STUDY AREA



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Solid Waste Management in Thailand: an Overview and Case Study (Tha Khon Yang Sub-district)

Abstract

Due to rapid urbanization, solid waste management (SWM) has become a significant issue in several developing countries including Thailand. Policies implemented by the Central Thai Government to manage SWM issues have had only limited success. This article reviews current municipal waste management plans in Thailand and examines municipal waste management at the local level, with focus on the Tha Khon Yang sub-district surrounding Mahasarakham University in Mahasarakham Province. Within two decades this area has been converted from a rural to an urban landscape featuring accommodation for over 45,000 university students and a range of business facilities. This development and influx of people has outpaced the government's ability to manage municipal solid waste (MSW). There are significant opportunities to improve local infrastructure and operational capacity; but there are few mechanisms to provide and distribute information to improve community participation in waste management. Many community-based waste management projects, such as waste recycling banks, the 3Rs (reduce, reuse and recycle), and waste-to-biogas projects have been abandoned. Additionally, waste from Tha Kon Yang and its surrounding areas has been transferred to unsanitary landfills; there is also haphazard dumping and uncontrolled burning of waste, which exacerbate current pollution issues.

Introduction

Municipal solid waste (MSW) refers to waste in a solid form, produced in the daily life of a society, such as packaging, food scraps, grass clippings, clothing, paper and electronics (1). Over 50% of the global population does not have access to regular waste collection, which makes managing solid waste easily, one of the key challenges of the 21st century (2). Furthermore, it has been shown that inadequate municipal solid waste management (MSWM) leads to hazards for human beings such as risks to health, living resources and ecological systems, adding to global warming, causing damage to infrastructure, and increasing waste management and disposal costs (3–5).

The number of rapidly urbanizing cities in developing countries is increasing. This has led to increased opportunities to consume pre-packaged consumer products which have resulted in the creation of enormous amounts of waste from daily life; from homes, offices, institutions and commercial establishments (6). The by-products of an urban lifestyle, including MSW, are higher than that of a rural lifestyle. Urban dwellers generate approximately double the waste of a rural resident.

According to Hoornweg and Bhada-Tata, high income countries tend to generate the highest amount of waste (46%), with lower middle income countries generating more (29%) than upper middle income (19%) and lower income countries (6%) (7). In 2003, 2.9 billion urban residents generated an average

of 0.64 kg of MSW per person per day. This amount increased to 1.2 kg per person per day by 2012; by 2025 this will likely increase to 1.42 kg per person per day (7).

The number of urban residents has increased dramatically around the world (7). The amount of solid waste in developing countries is increasing as a result of continuous economic growth, urbanization and industrialization (8–10). It is becoming more difficult for national and local governments to ensure the effective and sustainable management of waste. This situation will continue unless every level of government takes active steps to address the serious issue of waste management.

Hoornweg and Bhada-Tata show that the wealth of a country has a direct influence on its MSWM system. Recently, collection services in middle income countries have been developed and increased for many residential areas, and some processing equipment had been imported and used for recycling; but this was usually run by the informal sector and had high operating costs (7). Waste incineration has also been used but suffers from budget and operational capacity limits, with older incineration methods also likely to cause pollution with limited attention paid to monitoring of air quality. Moreover, while some landfill sites have environmental management and control systems open dumping is still very common (7).

At a policy level the allocation of funding to different streams of a MSWM program between high, medium and low income countries is very different (Table 1). The lower income countries tend to allocate the bulk of their MSW budget to collection, and a very small amount to disposal (7); with the coverage rate for waste collection usually reaching about 50% (7). Collection expenditure in middle income countries will consume about 50–80% of MSWM budget (7, 11) and the collection rate will be anywhere from 50 to 80% (7). However, high income countries have the budget capacity to allocate around 10% to collection (7, 11) and still meet collection rates > 90% (7, 11). The greater success of the high income countries is due to a number of factors, including organized education programs that highlight the 3Rs (reduce, reuse, and recycle). There is also greater producer responsibility via closer focus on product design (7).

In regard to the content of MSW, the biggest proportion of waste in low income countries is organic materials. As a proportion of the total MSW, organic waste is approximately 41% of the global total, while it is 65% of the total waste in East Asia and the Pacific (7). This is in contrast with high income countries where paper, plastic and inorganic material make up the bulk of MSW (7). The increase in inorganic waste is a result of the purchase of packaged consumer goods. In an effort to control this increase, several MSWM projects have been run throughout developing countries including Thailand. The projects are often not straightforward as they are frequently influenced by issues including politics, culture, institutional dominance and public participation (12).

Thailand is located in Southeast Asia; it has a total land area of approximately 514,000 km^2 and its population is just over 68 million (2016), making it the world's 20th most populous country. The population increased 0.38% from 2015 to 2016 (13), and population density in 2014 was 133 people

per km^2 with 51.1% of population being urban (34.8 million) (13, 14). Administratively the country is divided into six main regions: north, northeast, central, west, east and south consisting of 77 provinces overall.

Thailand is classified as a developing country (8). Over the last four decades Thailand has moved from a low income country to being categorized as an upper middle income country in 2011 (14), with the average wage being 13,777 baht (US$386) per month in early 2016 (15). In 2014 economic growth slowed to 0.9% per annum although positive trends are expected for 2015– 2017 (with growth rates of 2.9% per annum) (16). Past economic growth has helped to improve the quality of public services across the country, stimulating domestic consumption and creating more opportunities for expenditure (14). This rising income and urbanization has led to massive amounts of consumer waste developing throughout the country.

The national budget from 2007 to 2015 has increased by more than 55%; from 1,566,200 million baht to 2,575,000 million baht (approximately US$45.2 billion to US$74.3 billion). However, the proportion allocated to addressing pollution issues and environmental management was very small when compared to other developing countries. For 2015 it was only 9205 million baht (US$266 million) or 0.36% of Thailand's annual Government expenditure. Of this, 623 million baht (US$18 million) was used to fund 21 waste management projects around Thailand (17). For many other middle income countries, as well as low income countries, MSWM is normally the largest single budget item for cities (7); and it can absorb anywhere from 20 to 50% of a city budget in developing counties (18). It is believed that the comparatively small allocation in Thailand is stopping the development of good SWM systems (19).

Table 3.1: (Manuscript Table 1) Comparison of MSW collection and budget allocation by income level

	Low income	**Middle income**	**High Income**
Costs of collection	Collection cost 80-90% of MSWM budget	Collection cost 50-80% of MSWM budget (1999)	Collection cost <10% of MSWM budget
The biggest proportion of spending budget	Waste collection (small amount for disposal) (2012)	Waste disposal (e.g. open dumping and open burning) cost 50-80% (2009)	Intermediate waste treatment facilities (e.g. recycling and composting)
Collection service rate	<50%	50-80% (2009)	>90%

Adapted from What a Waste, World Bank (7), and Developing integrated solid waste management plan, UNEP (5).

Research methodology

This paper is based on a literature review of SWM and policies in Thailand with a focus on Tha Khon Yang sub-district, Mahasarakham Province. The research technique followed included locating relevant literature on a number of search databases and uploading this to the Endnote data management system for easy extraction and retrieval.

Municipal waste in Thailand

The average waste volume in Thailand has increased over the past decade. Between 2008 and 2015 the amount of waste for Thailand increased by almost 3 million tons to 26.85 million tons per year or 73,560 tons per day (Figure 1). The average generation rate of MSW in Thailand in 2008 was 1.03 kg per person per day, which then increased to 1.13 kg per person per day by 2015 (17, 19).

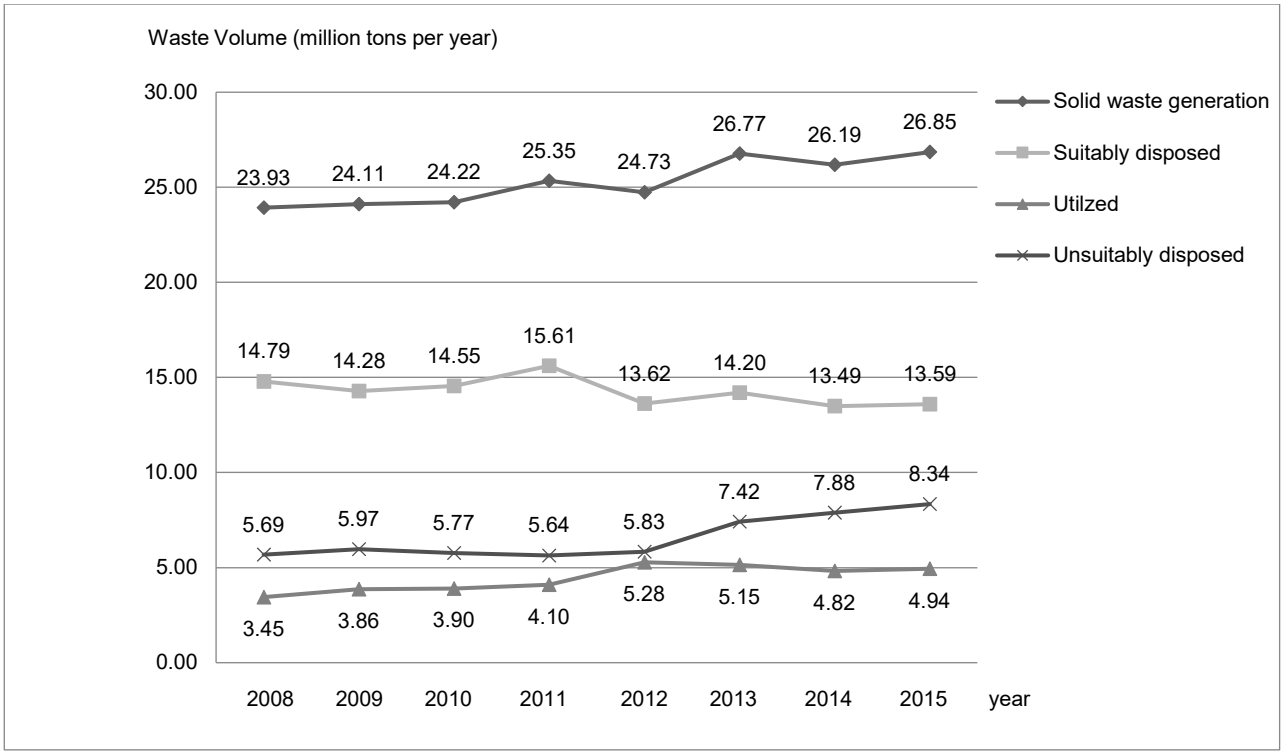

Figure 3.1: (Manuscript Figure 1) The average volume of solid waste generated, waste utilization, suitable and unsuitably disposed in Thailand from 2008 to 2015 (Source: adapted from Thailand State of Pollution Report 2015) (17)

However, there are differences in waste generation rates in different geographical locations. Factors including lifestyle, living standards and population density vary which has an influence on waste generation rates; in major cities and tourism areas, it was 1.0–1.4 kg per person per day, 0.7–1.0 kg per person per day in municipality areas, and 0.4–0.6 kg per person per day in sub-district administrative organizations (SAOs) areas (12, 20).

A dramatic increase in accumulated waste occurred during flooding across several provinces in late 2011. The shortage of solid waste treatment facilities under emergency conditions impaired the

waste collection and disposal capacity in the affected areas during this disaster (21, 22). Moreover, by early 2015, the amount of accumulated waste around Thailand had reached 30.4 million tons (17).

Waste collection, transportation and disposal

Based on the Thailand State of Pollution Report (2013), almost 54% of the waste generated was unsuitably disposed of by open burning or dumping and only 54% of local administrative organizations (LAOs) provided waste transport services (19). A survey undertaken by the Pollution Control Department (PCD) of Thailand in 2013 reported that residual waste was discovered and illegally disposed of in abandoned ponds or wastelands. Engineered landfills were also found, but these would be considered small by most standards at a total capacity of 50 tons per day. Incinerators (with air pollution control systems), waste-to-energy technology, composting, and mechanical biological treatment systems were also used in some areas (19).

It was also found that the total number of unsuitable waste disposal sites came to just over 2000 (19); with some sites at overloaded capacity and some not yet starting operations since completing construction. A few had even halted operations as LAOs were not ready and some sites had faced public protests (22). There were several fires that occurred at legal and illegal disposal sites in 2014 (23), which led to a number of pollution incidents. One of the worst examples was a fire at a landfill in Samut Prakan Province which had over 10 million tons of accumulated waste; resulting in toxic smoke being detected around the landfill. It was established that there was an increased risk of lung cancer for people living near the area based on sulfur dioxide levels measured at the time of the incident (24, 25).

Municipal waste utilization

The process of utilizing recyclable waste is often undertaken by collection crews and scavengers at disposal facilities; leading to buying and selling the recyclables through junk shops, material centers, community recycling centers, recycling banks and take-back programs for recycling of product packaging by entrepreneurs. Within Thailand's total solid waste amount of 26.8 million tons per year, about 5.2 million tons or 19% was utilized, and total recyclable waste utilization was 3.9 million tons (76%). This volume of recyclable waste can be further divided into recyclable waste from community recycling centers (46.6%), while the other 53.4% was collected from a waste exchange system (19).

For the organic waste, a PCD survey in 2004 found that it was the biggest proportion in waste disposal facilities at 63.6% (20). Using this can include transformation into organic waste (compost) for agricultural purposes or turning it into biogas where it can be used as an alternate energy source (Figure 2). However, with average moisture content of 40–60% the organic waste may need to be processed before it is suitable for conversion to biogas (12, 19).

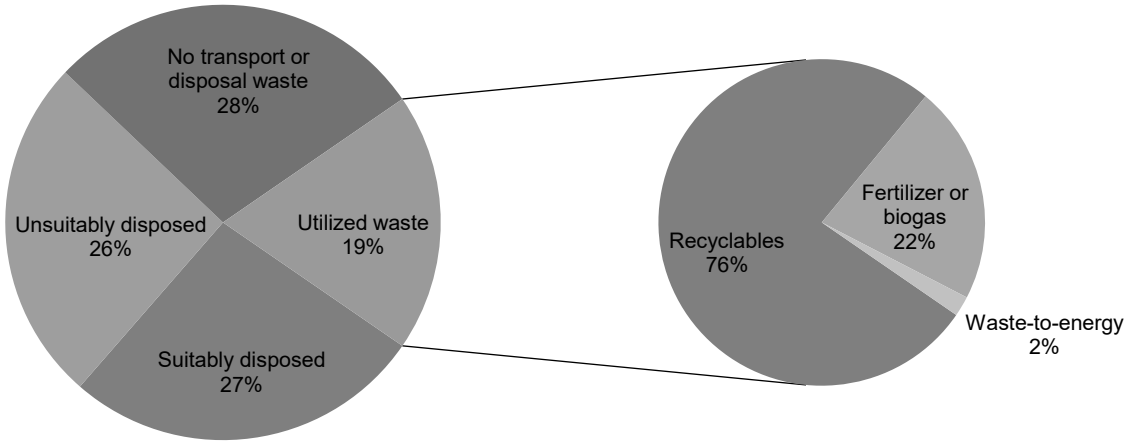

Figure 3.2: (Manuscript Figure 2) The proportion of waste municipal solid waste in Thailand in 2013 (19)

Responsibilities for municipal waste management

Thailand has a constitutional monarchy with a King as Head of State; with official power resting with the Thai Government, headed by the Prime Minister and the Parliament. The Ministry of Interior (MoINT) has plans to overhaul Thailand's waste management system to deal with the rapidly increasing amount of waste across the nation (26). The Central Government also supports and promotes LAOs to establish their own MSWM plans. They are encouraging the local government and private sector to establish and promote environmentally friendly processes and products. Institutions involved in SWM are organized into three administrative levels: National, provincial and local under the National Government Organization Act, B.E. 2534 (1991) (27).

National level

At the national level, the National Environmental Board (NEB) was formed to oversee the management of the country's natural resources and environmental quality through the implementation of the National Environmental Quality Act B.E. 2535 (NEQA, 1992). There are four ministries that are responsible for MSWM, namely, the Ministry of Natural Resources and Environment (MNRE), MoINT, Ministry of Public Health (MoP) and Ministry of Industry (MoIND) (28). The Central Government plays supporting roles to solve problems. For example, the MNRE set the national environmental policy; and the departments and agencies under the ministries are responsible for implementing the provisions of the law through regulations and technical guidelines; while the MoINT plays coordinating roles to local administrations (20).

Provincial and local levels

In many developing countries, SWM is ultimately the responsibility of the local government (7). Thailand is no different in this case; it is stated under Section 18 of the Public Health Act B.E. 2535 (1992) that “Disposal of sewage and solid waste in the area of any Local Government shall be the power and duty of such Local Government” (29, p. 5). The concept that local issues are handled at a local level was reinforced further in the Determining Plans and Decentralization to Local Government Organization Act B.E. 2542 (1999); It highlighted that under Section 17 “Provincial Administrative Organizations shall give powers and duties to systemize the public services for the benefit of local communities” (17, p. 5), this includes to “manage the environment and pollution” (17, p. 6).

The Department of Local Administration was established in 2002, to act as an authority over Thailand’s 7853 Local Governments, 76 Provincial Administrative Organizations (PAOs), 2440 municipalities and 5335 Tambon (subdistrict) Administrative Organizations (TAOs). There is also an extra two Municipal Governments for Pattaya and Bangkok Metropolitan Administration (MBA) (30). All of these have some responsibility for handling MSW occurring in their own areas, mainly waste collection, transport, treatment, and disposal; with the option to engage the private sector to manage MSW in their area as required (20).

Additionally, the Central Government has also applied the Decentralization Action Plan to transfer functions and extra personnel from the Central Government to all local governments (28). Waste management problems in each area do vary and the capacity of each local government branch is different. But generally the waste management capacity including collection and transportation in urban areas is better than most rural areas (12).

Thailand’s MSW policies and plans

MSW has been a serious problem in Thailand for several years (19). MSWM is ranked as the highest priority for capacity-building and MSW is the largest proportion of the total waste in Thailand. This is increasing annually (31) and a sustainable solution must be developed as soon as possible.

Under the Enhancement and Conservation of National Environment Quality Act B.E.2535 (1992), the disposal of hazardous waste was addressed but there was no law to manage waste disposal and urban waste. Then the Enhancement and Conservation of National Environment Quality Policy and Plan of 1996 established a set of 20 year targets for general waste (to be completed by 2016). The targets included: waste generation rates shall be < 1 kg per person per day, waste recycling rates in Bangkok and in municipalities will increase by more than 15%, all waste in municipalities should be managed and unprocessed waste around the borders of municipalities should be < 10% of total waste (32).

According to the MNRE, there were two primary national policies to achieve proper waste management. The first was to promote the 3R hierarchy of Reduce, Reuse and Recycle among the

community and recycling businesses. The second was to encourage local administrations to establish central solid waste disposal facilities with integrated concepts of modern technology and utilizing instant composting and waste-to-energy plants (20).

The Eleventh National Economic and Social Development Plan of Thailand was developed to "ensure that all Thai people and all segments of society have equal opportunity and access to resources and will share the benefits from development fairly" (26, p. 2). Covering the period from 2012 to 2016, it contains the following framework relevant to SWM: Social strategies linking public and private sectors with public awareness to reduce waste and increase the utilization of organic and recyclable waste. Economic strategies to promote investment from the private sector into clean technology for goods production waste treatment and disposal management. In addition, a taxation strategy may be used (if necessary) as a tool for reducing waste generated during production processes. Legal strategies to establish laws and revise existing laws and regulations highlight the use of law enforcement to make various steps of waste management more effective. And lastly, supportive strategies are recognised that help research and development of appropriate technology for producing environmental friendly products and products made from recycled materials (26).

Despite the strategies outlined above the amount of waste is still at crisis levels in every province throughout Thailand. In 2013 half of all LAOs did not provide waste transport services and only 466 of 2490 landfill sites were suitable to be used for waste disposal; highlighting that a staggering 81% of disposal sites were unfit to be used for their intended purpose. Additionally much of the MSW at these sites consisted of hazardous and infectious waste (23% of 2.65 million tons of hazardous waste comes from municipal areas) (19, 33). That so many landfill sites are unfit for use highlights that MSW has not been managed efficiently in Thailand in the past; it also shows that there is a huge amount of untapped resource to support a proper MSWM system.

Reasons for the causal roots of the problem have been put forward. Siriratpiriya (12, p. 337) notes that "the society has suffered from waste mismanagement as a result of insufficient know-how, a lack of realistically applicable technology that is suited to circumstances, and weakness in process of public participation, policy implementation and institutional support" (12). This is supported by Chinda et al. (34), showing that in Thailand there are several key issues that hinder efficient waste management systems which include: "1) there are no clear and direct regulations for residents to follow, 2) people in the community create a large amount of improper dumps, 3) amount of waste disposal is less than that generated, 4) lack of cooperation between the community and government" (p. 7). MSWM presents a huge challenge for the Thai Government. To be successful, it will require the combination of a suitable waste management system and increased public awareness and participation.

The National Policy and Plan – from 2014: the 'Comprehensive Waste Management Plan of Thai Government, 2014'

During 2013 and 2014 Thailand had a significant political crisis that eventually prompted large groups of anti- Government protestors to demand the dissolution of parliament. In 2014, it was ruled that the previous government (Yingluck Shinawatra's government) would step down; this was replaced by the army with Chief General Prayut Chan-o-cha as the head of the National Council for Peace and Order (NCPO). Thailand has since remained under this military government and these political changes and uncertainty have affected public and private investment across all sectors (35).

The NCPO has drafted a national waste management strategy (35) with a focus on systematic garbage management and the production of alternative energy using waste (36, 37). To support this, the NCPO proposed a 'road map' as a master plan for the disposal of garbage and hazardous waste which was approved by the NCPO Government on the 26th of August 2014 (35). This road map relates to the Eleventh plan of National Economic and Social Development Plan of Thailand, and considers issues including gas emissions from waste sectors, waste management among communities as well as proper waste disposal (38).

The head of the MNRE, delivered the SWM policy to the Governors in every province on the 18th of September 2014 (38, 39). The MNRE submitted the plan to the PCD where it was scrutinized and then forwarded to the cabinet (37). The steps in the road map include: Disposal of accumulated waste in crisis zones, developing a model for solid waste and hazardous waste management, enforcement of procedures for managing solid and hazardous waste and lastly, the promotion of public compliance and awareness via education and application of law (35). The primary target of this road map is for waste management facilities to be introduced across all 77 provinces over three stages: 10 provinces in the short term (6 months), 20 provinces in the middle term (1 year), and 47 provinces in the long term (40).

During the implementation of this road map there were significant changes to MSWM policy and practice across several provinces. There is a sense of urgency among many Thai people at the ground level when it comes to MSWM. But, there has been backlash over the waste-to-energy plant projects backed by the Thai government – plans are in place to build 53 waste-to-energy plants within 5 years (35). The government is dedicated to their goals but if full environmental impact assessment (EIA) is undertaken the road map has the potential to fall short of its target.

To fast-track implementation of the road map, in 2016 the head of the NCPO used authority under Section 44 of the Interim Constitution to issue order numbers to grant exemptions. The orders (3/2016 and 4/2016) stipulated that the construction of buildings around special economic zones (SEZs) (41) as well as power plants, waste disposal, collection, gas processing and recycling plants would be exempt from the regular framework of the Town and City Planning Act (1975) (42).

In such situations a code of practice (CoP) will be used instead of EIA which can expedite the application of the road map plan. Many environmental and legal experts have criticized this as it is

believed that the CoP will not prevent environmental problems. Importantly, ignoring or not undertaking proper EIAs has the potential to cause long-term damage to the environment and human health. Moreover, a CoP does not allow for public input and participation processes that are usually included as a part of an EIA.

At this point the road map has provided decent results. The 30.4 million tons of accumulated waste around Thailand was reduced by 66% within a year. However, this still leaves a gap of appropriately 10.46 million tons in unprocessed waste. This is because some unsanitary disposal sites had been closed and therefore are unable to provide any waste processing capacity. A part of the success can be put down to the fact that only 54% of LAOs had waste transport services before the road map was implemented – this was improved to 76.23% (17).

Even with the successes of the road map it must be recognized that some members of the public may not be ready for the anticipated rate of change. Protests from local people can be a barrier to establishing waste-to- energy plants or landfills. It must also be noted that waste segregation rates need improvement. A part of this could be attributed to the fact that Thailand has many pieces of legislation that relate to MSWM but no single legislative article that links to waste management directly. This contributes to confusion at several levels including policy implementation.

Municipal solid waste in Tha Khon Yang sub-district, Mahasarakham Province: a case study

The changes in focus, funding and governance arrangements have influenced SWM across Thailand. This section has a special focus on changes at a local government level in the Tha Khon Yang sub-district of Mahasarakham Province.

Mahasarakham Province is located in the Isan region of Northeast of Thailand. Isan is divided into 20 provinces, with around a quarter of the Thai population living there. The average monthly wage of a Thai household in 2015 was 26,915 Baht ($US754) (43). In 1996 households in Mahasarakham Province had the lowest monthly income for the Isan region (44, 45); today Mahasarakham is the fourth richest province in the region (44, 45) with the average monthly wage at 13,774 baht ($US386) per household per month (2016) (15). Access to education facilities is readily available, with Mahasarakham being known as the “Town of Education”; there are two growing universities and several colleges and schools throughout the province. The influx of students has been a major driver of population growth and urbanization leading to the creation of high volumes of MSW.

As noted, the quantity of waste in Mahasarakham Province has been influenced by the education sector, especially the expansion of Mahasarakham University (MSU) (the biggest university in the northeast in terms of student numbers) (46). The university is located in both the Tha Khon Yang and Kamrieang sub-districts in the Kantharawichai district. In addition to growth in student numbers, there has been significant development in the community business activity to service the university, with the overall result being a rapid change from a rural to an urban culture for many people.

Municipal solid waste in Mahasarakham Province

Mahasarakham Province is developing quickly. In 2015, the province generated 960 tons of MSW per day. Of which, 330 tons was transferred to landfill sites while 630 tons was left behind as accumulated waste (47). The biggest landfill in this province is managed by Mahasarakham Municipality and the landfill site is located near Nong Pling village, Waeng Nang sub-district – approximately 12 km far from Mahasarakham city center. The site covers 49 Rai (7.84 hectares) (47).

As well as the MSW from Mahasarakham city the landfill also acquired waste from 14 other areas (Figure 3). This landfill site was designed for disposal of 955 tons MSW per month or 33 tons per day; but in reality it received 103 tons per day. Only 58 of the 103 tons in received waste could be disposed of, and severe overload was caused reducing the expected lifespan of the landfill from the original 20 years to just 10 (48).

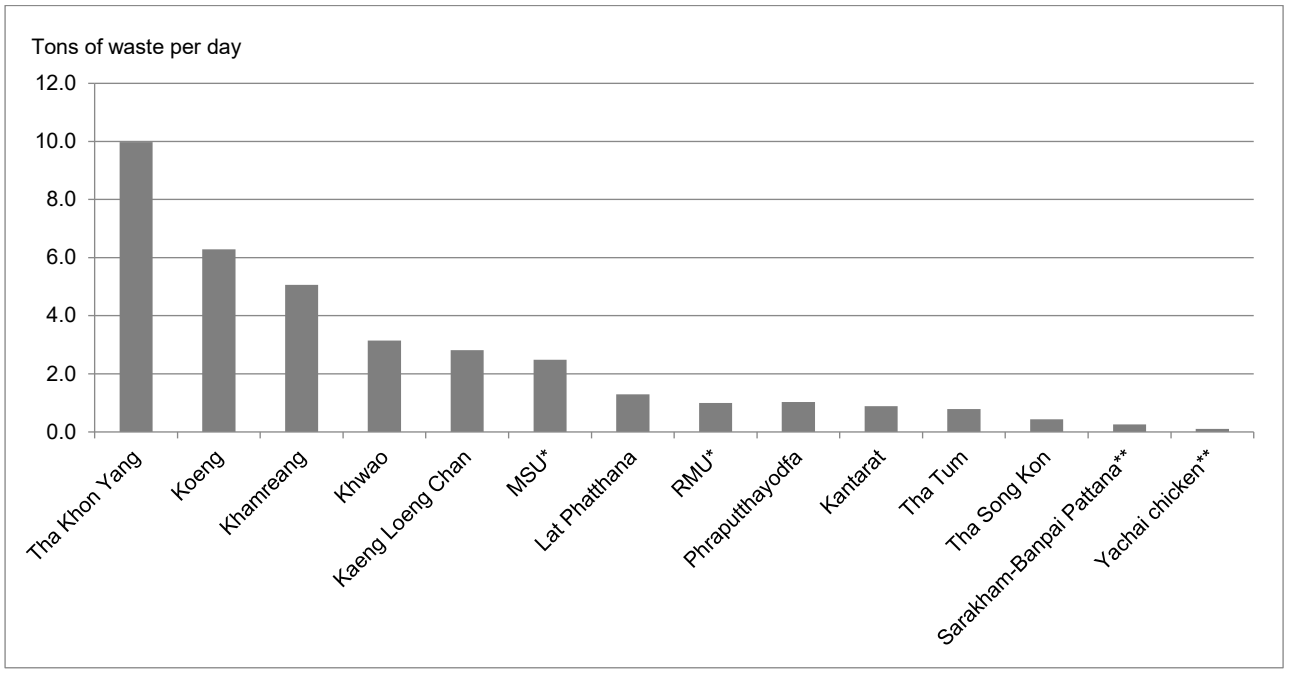

Figure 3.3: (Manuscript Figure 3) Proportion of municipal solid waste from 14 other areas that was transferred to Mahasarakham Landfill site (Nong Pling site) (Source: Mahasarakham Municipality, September 2015) (47)
* University
** Private company

Open dumping and burning were the management techniques at the site (49); and instead of being a sanitary landfill using the standard technique of covering waste with a layer of earth each day, (or more frequently) (50), this landfill was covered only a few times per year (51). The unsanitary methods of disposal have caused an increase in accumulated waste and created nuisance and health hazards to Nong Pling villagers (52). In the study "Quality of life of people living near the waste disposal center of Mahasarakham Municipality" (2006), it was cited that there are air, water and soil pollution issues (52). Strong odors from waste, problems with flies and leachate liquid seeping into

sites surrounding the landfill are also issues of concern. Reports of surface and groundwater contamination are coming from both the general public and official data (52). Until a management plan is ratified reducing or stopping waste being trans- ported to this site should be a top priority. Moreover, scavenging at collection points and dumping sites is still common which is consistent with the high level of informal economic activity that occurs among the poor in this area (53).

The Mahasarakham Municipality received funding to improve this landfill site from the MNRE, as a result of a recent policy of the Central Government disallowing open dumping throughout the country and due to special local requirements for waste disposal facilities. The Mahasarakham Municipality had attempted to enhance public interest in reducing waste at the source; however, the volume of waste that fed into this landfill was still the same. As a result, the Nong Pling landfill site stopped receiving waste from other areas in August 2015. This lasted for approximately two months and significantly affected MSW in areas that previously transferred their waste to this landfill. This includes Tha Khon Yang, which created a huge volume of waste, but now had no access to a landfill location. In response to the changes, people were informed via megaphone to manage household waste by themselves. This method of providing information was not effective and the majority of people did not understand the details of what they were being told. In the middle of 2016 due to significant buildup of accumulated waste throughout the Tha Khon Yang sub-district an agreement was reached where the sub-district have access to the Nong Pling landfill site where for a fee, a limited amount of waste can be dumped.

Municipal solid waste in Tha Khon Yang sub-district

The Tha Khon Yang sub-district is located in what was a rural area around two decades ago; waste creation was low and people managed their own MSW. Food waste was fed to livestock or composted and often used for farming– other rubbish was disposed of through open burning or dumping (9). But when the population increase occurred, the lifestyle of many people changed to an urban one.

Tha Khon Yang is a good example of the impacts of urbanization with several issues occurring due to increasing numbers of student accommodation, restaurants and commercial enterprises. In just 38 km^2 there are 15 communities with a total population of 38,016 people; of these about 30,000 are people from other areas; mainly fulltime students of Mahasarakham University (MSU) (in 2008 MSU had 26,000 students, by 2015 this increased to 45,000 students); there are also more than 3000 academic and support staff at MSU (54, 55). Solid waste has been a hot topic for a decade in the sub-district and the need for better waste management has become increasingly obvious with the rise in population.

The waste management system in Tha Khon Yang can be separated in two parts: collection and transport to the disposal site. Collection of MSW is the responsibility of the Division of Public Health and Environment of Tha Khon Yang sub-district municipality. In the past the number of staff included

two officials with three part time and three full time staff in operational roles (street sweeping and waste collection) (55). In 2015 staffing levels were altered. Now there is one director and an officer dedicated to public health and environmental issues. Additionally, there are three waste collection teams (one team for one truck). A team consists of a driver and two collectors and they also have other staff for street sweeping. Even though people are assigned responsibility for health promotion, there are still knowledge gaps when it comes to specific expertise in MSWM. Many other municipalities across Thailand (and cities around the world) are experiencing the same issue – this is one of the great barriers for MSWM (56).

The volume of MSW has also increased annually. According to Tongtiram's study, in 2010 280 tons of MSW was collected per month from residential and commercial areas in Tha Khon Yang (55). In 2015, data from the Mahasarakham Municipality shows that the amount of MSW transferred to disposal sites has increased to over 300 tons per month. Most residents have garbage bins outside of their houses (84%) with 65% of these garbage bins being uncovered baskets (55). Some community waste containers were provided to Tha Khon Yang residents by the sub-district municipality – other containers were donated by people in the community. A resident could also bring their garbage to public bins placed at points throughout the community, but these were often inadequate as they were not large enough for the volume of waste being generated (55).

Another issue is that the collection points changed frequently and people did not want a community waste collection point in front of their house, so this result in residents leaving waste in random locations. In some situations there were different colored bins (blue, yellow, red and black) for segregation, but often no attempt was made by the user to separate their waste. Factors that have caused people to not separate their waste included absence of local knowledge and lack of promotion for MSWM policy (46, 56). Further investigation into waste segregation at a local level is warranted.

The municipality cannot provide full or consistent coverage for MSW collection, even though there are three waste collection trucks required to follow seven routes and collection zones. The municipality does have a basic plan for collection; however, the operations staff must develop their own route based on the daily needs of each area. As Siriratpiriya shows, the frequency is dependent on the average waste quantity in each area and urban areas are generally better resourced and more efficient than rural areas (12).

As shown, a stationary container system had been used for MSW collection in the sub-district (55) and while vehicles are supplied to collect and transport waste, there are no tools to support waste collection or personal protective equipment (PPE) (such as rubber gloves) to protect collectors from hazardous waste. Throughout collection two staff members gather recyclable waste for private sale and put saleable items into bags that hang on the side of the truck (this is not one of the direct duties that they were employed for) to on-sell to various buying agents. After collection and additional sorting the collected waste is transported directly to the waste disposal site (55).

The Tha Khon Yang sub-district Municipality has several expenses to manage in regard to MSWM. Total wages for all waste collection staff combined was 837,242 baht (US$23,800) per year. This does not include items such as the cost of fuel, bins or trucks. Tha Khon Yang sub-district Municipality has to pay a tariff 400 baht per ton of waste. The amount of waste that was transported for disposal was on average 280 tons/month or about 3300 tons per year in 2010; so this municipality had to pay tariffs totalling 1,339,248 baht (US$38,000) per annum for waste disposal (55). Therefore, the total cost of waste management in Tha Khon Yang could be as high as 2–3 million baht ($US57,000–85,000) per year if all expenses are included. Remarkably, this municipality does not have a clear system for any cost recovery or relief strategy for waste collection fees.

The Tha Khon Yang Local Government Board has not evaluated options and opportunities or made decisions about actions with relation to the future of SWM in this community. The Board has requested assistance in developing its leadership and decision making processes, to develop a MSWM scheme and to implement a waste minimization policy.

MSWM in Tha Khon Yang sub-district, Mahasarakham Province during the changing period of the road map

Preliminary research regarding MSWM problems in Tha Khon Yang sub-district, Mahasarakham Province conducted during 2015 and 2016 is described in the following section, examines MSWM issues in the Tha Khon Yang sub-district, during the implementation period of the “road map” plan outlined by the Central Thai Government.

The “Disposal of Garbage and Hazardous Waste Road Map” was applied to every province in Thailand at the end of 2014. The Mahasarakham Municipality has responded to this plan by supporting the “no open dumping strategy” disbursed by the Central Thai Government. Changes have been implemented rapidly and the Mahasarakham Municipality has been unable to find a new area to establish a new landfill site in such a short period of time. Pollution around the landfill site is increasing and issues like visual pollution, odor and leachate are out of control. This is particularly the case during the wet season, with leachate run off commonly entering rice farms around the disposal site causing water and soil pollution.

Due to limits in the amount of waste that could now go into landfill, the Mahasarakham Municipality decided to dispose of waste mainly from Mahasarakham town center. For other areas, only one truck per day was allowed to use the landfill. This has affected the other 14 areas, especially the Tha Khon Yang area which transferred waste of over 10 tons a day to this landfill site. When it lost access to its landfill site the Tha Khon Yang sub-district Municipality tried to find solutions for its MSWM problems. The Chief Executive of Tha Khon Yang sub-district municipality and Environmental Sanitary Officers attempted to develop a cooperative plan by holding public meetings in each community but few people attended. From the information collected at these events some key topics stood out. A crucial finding was that facilities must be allocated to allow for proper waste segregation; because Tha Khon

Yang has no local landfill site and easing pressure on landfill sites could provide part of the solution to MSW problems. A potential difficulty lies in access to space where a waste segregation site can be established.

While locals agreed that waste segregation is a part of the overall solution, no one will sell their land for this use; and public space cannot be used because people are afraid of pollution that could be released into the local environment. These fears are compounded by the fact that this location is very flat and flooding is common in the wet season – and land in Tha Khon Yang is extremely expensive as MSU is located in this area. Other issues in MSWM were cited including: waste left beside the main roads is collected only when requested; food waste is collected from villages just once a week and people manage their own recyclable waste by selling it.

A lack of adequate record keeping is also an issue. The amount of waste in the area can only be estimated from the recorded data of waste that has been sent for disposal. This means that the vast quantify of accumulated waste that is not taken away is not counted in the total volume. Further to this, some recyclable and compostable material is removed before disposal and is not included in waste disposal statistics. These incomplete and inaccurate estimates of waste make management even more difficult. Better reporting and estimates of volume and composition of waste is needed to prepare plans and budgets for SWM. When a lack of accurate MSW data is mixed with an inadequate legal framework this makes it difficult to build a functional MSWM system; couple this with a small budget and a lack of staff it becomes obvious that there are several opportunities to improve the current arrangement. Overall in Thailand, societal awareness and interest in MSW management is low and waste problems are often simply neglected and good environmental values are absent. There is potential for political and community interference around waste management projects, this also needs to be studied to ensure maximum efficiency is maintained during SWM projects.

Conclusions

The Thai Government is starting to pay close attention to MSWM, but swift action must be taken to develop robust strategies to tackle the issue. The development of a national waste agenda is a great step to support every branch of government to follow the “road map for the disposal of garbage and hazardous waste”. This agenda can usher in a significant period of change in MSWM for the whole of Thailand – where local government autonomy is improved and there is freedom to deal with local issues and tailor plans to meet specific needs.

Tha Khon Yang is facing a problem with MSW so large that it cannot continue to be ignored. Developing a culture of community and personal responsibility and building the capacity for residents to participate in MSWM are among the big issues for the Tha Khon Yang Sub-district Municipality. In this situation input from different disciplines are needed to design an appropriate MSWM system. Better technical capacity will be required as well as a clear framework addressing waste segregation, collection, transportation, disposal and monitoring. If this is combined with transparent policy

implementation and a continued focus on community involvement and consultation there can be positive outcomes regarding MSWM in the Tha Khon Yang sub-district.

This review article will be helpful in providing the next step for finding solutions to waste problems in Tha Khon Yang or other areas facing waste problems resulting from rapid change.

Author Statement

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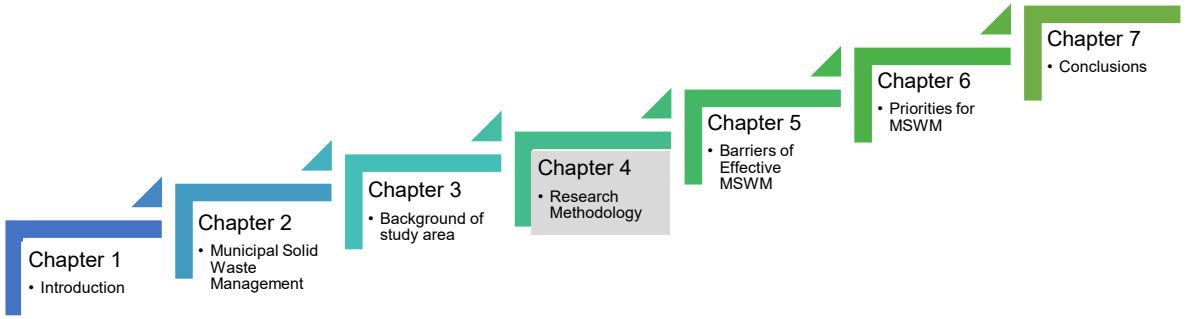
CHAPTER 4 RESEARCH METHODOLOGY



Chapter 4 presents the theoretical approach and conceptual design for this research. The methods used in this research and the reasons for adopting the approaches chosen are described. The purpose of this research was to determine the barriers to municipal solid waste management (MSWM) and to provide solutions towards a suitable MSWM system for the study area – a rapidly urbanising area in Thailand.

Understanding people's perspectives on waste is recognised as a factor that significantly impacts on the success or effectiveness of waste management and managing waste problems (Anschütz, IJgosse & Scheinberg 2004; Tenopir 2003). According to the Integrated Sustainable Waste Management (ISWM) framework, appropriate representation and input from stakeholders is important in developing successful waste management plans (Anschütz, IJgosse & Scheinberg 2004; Klundert & Anschütz 2001; United Nations Human Settlements Programme 2010). Therefore, this research focussed on understanding stakeholders' ideas and perspectives about the existing MSWM system in the Tha Khon Yang Subdistrict (TKY). In this research, stakeholders included the residents, or end users of the MSWM system, staff from Tha Khon Yang Subdistrict Municipality (TKYSM) (the local government), and experts in MSWM from government and the local university. Understanding the experiences, practices and attitudes of participants allows insight into the functioning of the municipal solid waste (MSW) system in the TKY area.

The research area is the TKY, in Kantharawichai District, Maha Sarakham Province, Thailand (see Figure 1.1). This area was chosen because, firstly, TKY is experiencing rapid population growth and because the current MSWM programs are not meeting demand. Secondly, TKY is situated adjacent to the Mahasarakham University (MSU) allowing ready input from the university into the study, and potentially for future assistance with implementation and monitoring of a revised system. The MSU is a key university in the region as it offers an Environmental Science major, which means that there are students and researchers who can learn from and contribute to the development of the MSWM programs for TKY in the future. The background of the researcher was the final reason for choosing this area. The researcher lived in TKY between 2006 and 2015 working at MSU, and in that time saw changes in the region resulting from the growth of the university since its establishment in 1996.

Waste problems in that time visibly increased, and the researcher had opportunities to discuss these problems with the staff of the TKY municipality.

This chapter describes the research approach, including the research planning and preparation and the methods for collecting data in the field which included focus groups, interviews, and site visits. Research instruments and data analysis are described. Ethical considerations in the research process are also presented.

4.1 Qualitative Research

This study used a qualitative approach. Qualitative research has been used widely to understand social policy fields including complex behaviour, needs, systems and cultures (Ritchie & Spencer 2002). Green and Thorogood (2014 p. 5) explain that qualitative research typically tends to use written or oral data compared with quantitative research, which in contrast, uses numerical data. They also state that "The most basic way of characterising qualitative studies is to describe their aims as seeking answers to questions about the 'what', 'how' or 'why' of a phenomenon". This research sought to understand the barriers to MSWM – the "why" of the problems of solid waste management (SWM). Qualitative research involves a variety of different approaches (Silverman 2013, p. 15) and is suitable for exploring human or social problems by analysing emerging issues. Data are gathered from sets of participants and then analysed by building themes (Creswell 2014). In this research, the themes were based upon the ISWM framework, which divides waste management into a number of 'aspects' (described below). Qualitative research is valuable for measuring "what people want or say they want and for answering why they behave in a certain way" (Tenopir 2003, p. 16), and for understanding social phenomena in a specific context and setting, but notably, accepting the complex and dynamic quality of the social world (Babbie 2013).

4.1.1 Triangulation

Research that uses a variety of approaches (triangulation) avoids bias. Triangulation "works metaphorically to call to mind the world's strongest shape – the triangle" (Patton 2002, p. 555). No one approach can ever adequately explain problems, therefore, triangulation, using a variety of theories, sources of data, or methods for collecting data and analysing data provides a stronger understanding of the research problem (Patton 2002). Triangulation offers strategies for cross-checking findings and can reduce and avoid biases resulting from reliance on one method of data collection and weaknesses inherent in each method (Babbie 2013; Patton 2002). Patton (1990) describes four types of triangulation. These include: methods triangulation (different kinds of data collection methods); triangulation of sources (different sources are examined following a single method); analyst triangulation (using a number of analysts to view findings); and theory or perspective triangulation (application of different viewpoints (theories) to understand a set of

information) (Patton 1990). In this study, triangulation of methods (Figure 4.1) and triangulation of sources were used (Figure 4.2).

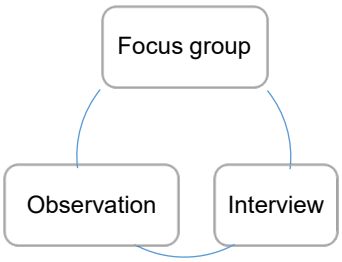


Figure 4.1: Triangulation of methods

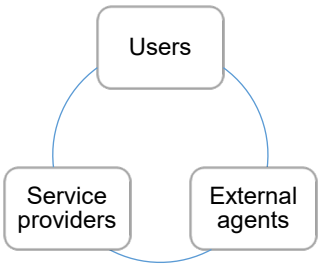


Figure 4.2: Triangulation of sources

4.1.2 Rationale for focus groups

Focus groups are designed to encourage participants to share experiences or to discuss the same issue (Dawson 2009). It has been argued that focus groups are a quick and useful method adopted to find out the views of a wide range of participants (Krueger 1994). Focus groups typically comprise participants who share specific key characteristics.

Focus groups require a moderator who asks questions, prompts for more details in response to answers, and makes sure that every participant contributes to the discussion and that no one participant influences the conversation by dominating the discussion (Dawson 2009). A moderator is required to take responsibility for leading the group discussion (Krueger & Casey 2009). Moderators should practice, or have experience in being able to ensure the smooth running of the session and to ensure the participants feel comfortable in the focus group. They also need to try to avoid interruptions from participants when others are speaking (Dawson 2009; Krueger & Casey 2009).

Some participants may feel nervous or be unwilling to answer questions, and therefore the moderator needs to start with easy questions and give gentle encouragement (Dawson 2009). To develop an effective focus group approach, the moderator should hold a practice pilot focus group to ensure successful moderation (Dawson 2009).

The size of the focus group needs to be large enough to provide a variety of perceptions and small enough for everyone to get the chance to share their opinions (Krueger & Casey 2009). The ideal number of participants has been suggested to be between five and ten but the size can start from four and be up to 12 (Krueger & Casey 2009), although there are varying 'ideal' sizes, (Dawson 2009; Green & Thorogood 2014; Krueger 1994). Focus groups usually last from 1 to 2 hours (Green & Thorogood 2014).

It is important to use good quality visual or audio recording equipment to ensure all the discussion is captured and it is recommended that an additional recorder be used in case one fails (Dawson 2009). It is better that note taking is undertaken by someone other than the moderator, as the moderator needs to pay attention to the conversation (McIntyre 2005).

4.1.3 Rationale for interviews

Interviews are an important data collection tool in qualitative research to investigate human experiences via personal interaction between researchers and interviewees (Kvale 2006). It is argued that qualitative research interviewing has become a "sensitive and powerful method for investigating subjects' private and public lives and has often been regarded as a democratic emancipating form of social research" (Kvale 2006, p. 480). An in-depth interview can be semi-structured or unstructured (Liamputtong 2013). The semi-structured interview is the most frequently used format for qualitative research, and normally has open-ended questions (Dicicco-Bloom & Crabtree 2006). Semi-structured interview questions are sometimes combined with additional questions that interviewers spontaneously employ during the interview (Dicicco-Bloom & Crabtree 2006).

Interviews use open-ended questions and probes that yield in-depth responses to elicit information about people's experiences, perceptions, opinions, feelings and knowledge (Patton 2002). Open-ended questions can allow the researcher to elicit greater detail than closed questions (Dicicco-Bloom & Crabtree 2006). In-depth interviews tend to be one-on-one with the interviewer and the interviewee, and can be conducted face-to-face, by telephone or email. There are significant advantages in face-to-face interviews in that the interviewees can be observed, and body language and expressions noted (Dawson 2009; Dicicco-Bloom & Crabtree 2006; Liamputtong 2013).

4.1.4 Rationale for observation

Observation is an instrument associated with qualitative research that is considered to be "the 'gold standard' of qualitative methods", as it allows the researcher to record what people actually do (Green & Thorogood 2014, p. 152). Observation involves collecting data on phenomena (including behaviour) (Green & Thorogood 2014) by observing people and places in the field. Patton (2002). described observation as including activities, behaviours, actions, interpersonal interactions, organisational or community processes.

4.2 Research Process

The research for this thesis was carried out in three phases – planning, data collection and analysis. Each research step and process was planned carefully. Planning consisted of reviewing documents, identifying stakeholders, developing questions for interviews and focus groups, and acquiring and examining other essential documentation. The planning process also included writing an ethics application for submission to the Flinders University Social and Behavioural Research Ethics Committee (SBREC). Data collection consisted of two separate field trips (Fieldwork trip 1 and trip 2). Fieldwork trip 1 consisted of observation, selecting participants, testing the interview schedule and the focus group questions with a pilot group, arranging and conducting interviews, and conducting the focus groups. Fieldwork trip 2 consisted of further observation, more interviewing and additional data collection from attendance at meetings and participation in a conference.

4.2.1 Document review

At the outset, the researcher gathered and reviewed any available primary and secondary written material about MSWM including journal articles, official publications and reports from national and provincial levels, and any available plans and policies for the TKY area. Published information about waste problems and waste management practices in developing countries and information specific to Thailand and TKYSM was reviewed, including material available online, books, articles, and government documents.

Prior to the commencement of fieldwork, a number of activities were completed including preparation of research instruments, receipt of ethics approval to conduct research and identification of study participants.

4.2.2 Research instruments

Research instruments were prepared for both focus groups and interviews (See Appendix for both instruments A1, A2, B1, B2). Focus group questions consisted of engagement questions, key questions and exit questions. Interview schedules combined a mix of closed and open-ended questions. Questions were first written in English and then translated to Thai by the researcher. Both English and Thai questions were pre-tested in Australia with three Thai-English speakers to ensure the questions were readily understood.

Letters of introduction, information sheets for participants, introductory email text, consent forms and letters of cooperation were also developed in English and translated to Thai language (copies of this paperwork are available in Appendix C1, C2, D1, D2, E1, E2, F1, F2, G1, G2).

4.2.3 Ethics approval for the study

As this research involved people as participants in the fieldwork data collection, it required approval by the SBREC. Approval determined that the research was considered to be low risk research on 21

April 2015 (SBREC Project Number 6784). Because this research was to be carried out in Thailand, it was also necessary to ensure approval to conduct fieldwork from the Mahasarakham University Ethics Committee. Permission was granted on the basis of the SBREC approval (See Appendix H1, H2).

4.2.4 Selection of participants

To identify representative participants for the study the advice of UN-HABITAT was followed (United Nations Human Settlements Programme 2010; Zaman & Lehmann 2011). A broad spectrum of people was needed to provide a balanced set of perspectives. Participants were chosen to represent three main groups, namely: service providers, service users and some external agents.

The first group included a range of MSWM providers responsible for the local waste management service. TKYSM is the only organisation that provides MSWM services in TKY. This group of participants included people from different positions within the MSWM system, including directors involved with the decision-making; official staff, who take part in developing plans for MSWM, and communicate and disseminate waste management information to residents in TKY; and operational staff, responsible for the waste collection service in TKY.

Service users comprised three groups of residents in TKY, including tenants (university students) living in off-campus accommodation, villagers, leaders of villages, and entrepreneurs (owners or managers of local restaurants, off-campus accommodation, markets or minimarts). This group included permanent and temporary residents who live in TKY in both urban and rural areas, representing a range of socioeconomic groups.

External agents (from organisations beyond the TKYSM), included academics from MSU and Mahidol University, and experts from the Provincial Natural Resources and Environment Office, Maha Sarakham Province, the waste operator of Maha Sarakham Town Municipality, who could provide knowledge and experience in regard to MSWM in TKY (Figure 4.3).

4.2.5 Sampling method

Due to time and cost limitations, a nonprobability sampling approach was determined as the appropriate sampling method for this study. With this approach, the researcher decides who to select for the sample, which allows a degree of flexibility (Neuman 2012). Nonprobability approaches include purposive and snowball sampling. Snowball sampling, where the researcher “get[s] cases using referrals from one or a few cases, and then referrals from those cases, and so forth” (Neuman 2012, p. 147), was used whereby key contacts were asked to suggest possible participants, who were then approached to ask whether they would be willing to participate (voluntary participants). In this study, key contact people were primarily persons who could guide the researcher in seeking potential participants who held the criteria required to be participants in either interviews or focus

groups. Purposive sampling identified participants from publicly available lists (such as employment records or websites).

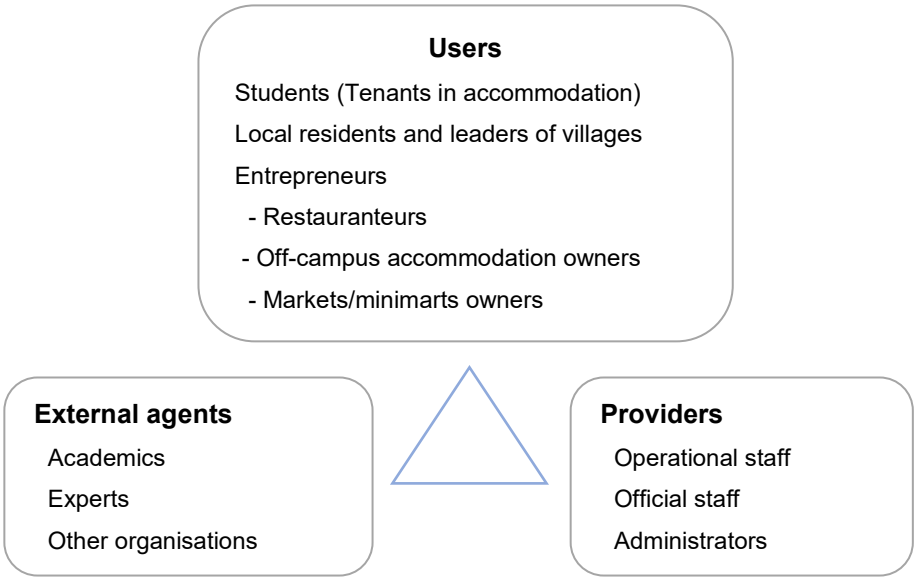


Figure 4.3: Stakeholder groups represented in the study

4.2.6 Participant selection for focus groups

Each group of participants was selected based on the purpose of the study and their social and cultural backgrounds. As noted above, key informants were necessary to provide suggestions regarding participant selection. Staff of the local municipality provided lists of local residents, and entrepreneurs; the researcher could then select the participants from the list by area zone and different size of businesses without any bias. Another key contact person was a student of MSU who was able to contact students who lived in different dormitories of the university, and in off-campus accommodation.

Focus group participants for this study were selected on the basis of their interaction with MSWM. Initially, there were four groups of stakeholders; students (tenants of off-campus accommodation), TKY villagers, operational staff of the TKYSM waste management operation and entrepreneurs of local businesses in TKY. However, on the advice of the Director of the Environmental and Sanitation section of the TKYSM, who noted that it would be difficult to invite entrepreneurs to all participate at the same time, this group was changed to individual in-depth interviews.

4.2.7 Participant selection for interviews

Participants for interviews were selected for their involvement in waste management, or their expertise in a particular area. Thirty four interviewees were selected, including lecturers from education sectors involved in SWM, waste management specialists, local governors and deputies, leaders of the villages and entrepreneurs in TKY including the owners or managers of campus

student accommodation (dormitories), owners of restaurants, and owners of minimarts. The process of contacting potential interviewees from each group was different, based on the characteristics of participants.

Academics with expertise in MSWM were initially identified by accessing their profile on the internet. These academics were then contacted by email and asked whether they would be willing to participate in an interview and when might be convenient for the researcher to visit. The email also contained information about the study and the relevant SBREC documents. This meant that the academic had time to read through the documentation and consider whether they would like to be involved in the study. The replies were either by email or by phone (the phone number was provided in the email). Six university lecturers, a school teacher and two specialists with expertise in waste management participated in the study, and were interviewed in their work places.

Local governors and external experts were contacted initially by getting in touch with their secretary at their workplace. The researcher phoned the secretary of the specialists and then went to their work place to give the information sheet and consent form to the secretary. This is common organisational practice in Thailand. Then the researcher waited for a response by phone or email. If invited participants had not replied within two weeks, the researcher followed up with a phone call to the secretary. Three local governors and three external experts subsequently agreed to participate in the study.

Leaders of villages were initially contacted by the researcher after a meeting in TKY community (25 May 2015) at Charoen Phon Temple, Tha Kon Yang subdistrict, Maha Sarakham Province. Attendees at this meeting included the Chief Executive of the TKYSM, leaders of every village in TKY (15 villages) and others in key leadership positions in the TKY community. The meeting was held to discuss development in their villages. Four leaders of villages agreed to participate in the research as interviewees.

Entrepreneurs were contacted as suggested by the Director of the Waste Management section of the TKYSM. The Director was a key person and knew the area and all of the entrepreneurs very well. The Director was able to provide guidance about who to contact from the list of entrepreneurs; the researcher was then able to select participants from the list based in the urban zones and different size of businesses. Three groups of entrepreneurs were selected within TKY. The two main roads leading to MSU show the urban zones of TKY, which contain many commercial shops, restaurants and minimarts (Figure 4.4). There are more than 250 off-campus student residential apartments in this area (Maha Sarakham Governor's Office 2012). Three groups of entrepreneurs were owners or managers of off-campus student accommodation (private dormitories), restaurant owners or managers, and owners or managers of minimarts or markets.

Figure 4.4: Aerial photograph showing urbanising area in Tha Khon Yang (Google Maps 2018)

4.2.8 Informal site visits, meetings and observation

Two fieldwork visits were undertaken, the first visit between 12 May 2015 and 23 September 2015 (19 weeks) for observation, face to face interviews, and focus groups. The second visit between 3 July 2016 and 29 August 2016 (8 weeks) was for observation (attending meetings) and undertaking three unstructured interviews.

The researcher, having previously lived in TKY for ten years, was familiar with the area. This helped in developing the fieldwork. Both informal and organised site visits ensured that the researcher was familiar with key sites in the study area. A series of meetings, during which observations and notes were recorded, was also attended (Table 4.1).

4.2.9 Site visits

Site visits to the many alleys in 15 villages (Mubaan) within TKY were used to gather background information about TKY waste management practices. This took place between 15 and 24 May 2015 (Table 4.1). The researcher observed unmanaged waste, and took photos and notes. The researcher also visited the landfill disposal site operated by Maha Sarakham (Province) Municipality on 30 August 2015 in Waeng Nang subdistrict, to observe the waste disposal site. Informal discussions with villagers provided the researcher with a deeper understanding of the MSWM system. Photos were taken to capture images of the huge waste piles and leachate, and observational notes about

odour and pollution around this site were recorded. The researcher also talked to people who picked through waste to collect saleable items (scavengers or waste pickers).

Additional observations focussed on determining whether there had been any change in the waste problems or in the strategy of waste management of the TKYSM. Accumulated waste along the roads in TKY was observed.

4.2.10 Informal and formal meetings

The researcher attended a number of meetings, some spontaneous and others as a guest at a prearranged meeting (see Table 4.2).

Informal meetings assisted in the gathering of publicly available and unpublished documents to assist in the assembling of information related to waste management in TKYSM. This included information about the current waste management system, population demographics and distribution of functions of waste management responsibilities within the organisational structure. They were also very helpful for developing a relationship between the researcher and municipality officers. A formal letter of cooperation and all SBREC information were given at this time to the TKYSM director. The researcher met with the Director of the Environmental and Sanitation section of TKYSM and other departmental staff on 15 and 18 May 2015. After initial discussions about the focus of the research, contact details were exchanged. Subsequently, the researcher visited the TKYSM on 13-14 July 2015, 17 July 2016, and 1-3 August 2016.

Table 4.1: Site visits (Fieldwork trip 1)

Date	Place	Description of Area	Description of Activities
15/05/15	Mubaan 11 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to restaurateurs and waste collectors
16/05/15	Mubaan 1 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to restaurateurs
17/05/15	Mubaan 3 Baan Tha Khon Yang Mubaan 4 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to restaurateurs
18/05/15	Mubaan 2 Baan Tha Khon Yang Mubaan 6 Baan Wangwa	Mixed rural and urban area	Observed waste, took photographs and notes, talked informally to restaurateurs
19/05/15	Mubaan 5 Baan Goodrong	Rural area	Observed waste, took photographs and notes, talked informally to restaurateurs
20/05/15	Mubaan 12 Baan Donsuan	Rural area	Observed waste, took photographs and notes, talked informally to local shops owners and managers
21/05/15	Mubaan 7 Baan Don Yom	Rural area	Observed waste, took photographs and notes, talked informally to local residents
22/05/15	Mubaan 8 Baan Don Wiang Chan	Rural area	Observed waste, took photographs and notes, talked informally to local residents
23/05/15	Mubaan 10 Baan Khrai Nun Mubaan 14 Baan Khrai Nun	Rural area	Observed waste, took photographs and notes, talked informally to local residents
24/05/15	Mubaan 9 Baan Hua Khua Mubaan 15 Baan Hua Khua	Rural area	Observed waste, took photographs, and notes, talked to local residents
30/08/15	Waeng Nang subdistrict	Waste disposal site	Visited waste disposal site, observed waste, took photographs and notes, talked informally to waste pickers

Table 4.1: Site visits (Fieldwork trip 2)

Date	Place	Description of Area	Description of Activities
14/07/16	Mubaan 3 Baan Tha Khon Yang Mubaan 4 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to local residents and restaurateurs
15/07/16	Mubaan 1 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to local residents
16/07/16	Mubaan 2 Baan Tha Khon Yang Mubaan 6 Baan Wangwa	Mixed rural and urban area	Observed waste, took photographs and notes, talked informally to local residents
18/07/16	Mubaan 12 Baan Donsuan	Rural area	Observed waste, took photographs and notes, talked informally to local residents
25/07/16	Mubaan 5 Baan Goodrong	Rural area	Observed waste, took photographs and notes, talked informally to local residents
26/07/16	Mubaan 7 Baan Don Yom	Rural area	Observed waste, took photographs and notes, talked informally to local residents
27/07/16	Mubaan 8 Baan Don Wiang Chan	Rural area	Observed waste, took photographs and notes, talked informally to local residents
28/07/16	Mubaan 10 Baan Khrai Nun Mubaan 14 Baan Khrai Nun	Rural area	Observed waste, took photographs and notes, talked informally to local residents
29/07/16	Mubaan 9 Baan Hua Khua Mubaan 15 Baan Hua Khua	Rural area	Observed waste, took photographs, talked informally to local residents, local shop owner/manager
30/07/16	Mubaan 11 Baan Tha Khon Yang	Urbanising area	Observed waste, took photographs and notes, talked informally to local residents
31/07/16	Waeng Nang subdistrict	Waste disposal site	Visited waste disposal site, observed waste, took photographs and notes, talked informally to waste pickers
22/08/16	Waste separation plant Mahasarakham University	Waste separation plant	Visited waste separation plant, observed, took photographs and notes, talked informally to waste operators

Table 4.2: Formal meetings attended (Fieldwork trip 1)

Date	Place	Duration Time Taken	Description of Activity
15/05/15	Tha Khon Yang Subdistrict Municipality	9.00am-12.00 pm 3 hours	Informal meeting to TKYSM: Research project explained, made plans for fieldwork activities (interview and focus groups), took notes
18/05/15	Tha Khon Yang Subdistrict Municipality	9.00-11.00 am 2 hours	Informal meeting to TKYSM: Took notes, collected available information about MSWM
25/05/15	Charoen Phon Temple, TKY	9.00-11.00 am 2 hours	Community meeting organised by administrative staff of TKYM
13/07/15	Tha Khon Yang Subdistrict Municipality	9.00-11.00 am 2 hours	Informal visit to TKYSM: Planned site visit, took notes
14/07/15	Tha Khon Yang Subdistrict Municipality office	1.00-4.00 pm 3 hours	Formal meeting with the District Chief Officer and prefects of TKYSM, Administration staff of TKYM, Leaders of villages: took notes and made audio recording
17/08/15	Charoen Phon Temple	8.00-10.00 pm 2 hours	Attended a Community Meeting with residents from villages and leaders of villages organised by administration staff of TKYM: took notes and made audio recording
20/08/15	Don Wiang Chan Temple	8.00-9.30 pm 1.30 hours	Attended a Community Meeting with residents from villages and leaders of villages organised by administration staff of TKYM: took notes and made audio recording
26/08/15	The City Hall Maha Sarakham Province	1.30-4.30 pm 3 hours	Attended a City Meeting with the government officers of Maha Sarakham Town Municipality organised by administration staff of Maha Sarakham Town Municipality: took notes and made audio recording

Table 4.2: Formal meetings attended (Fieldwork trip 2)

Date	Place	Duration Time Taken	Description of Activity
17/07/16	Tha Khon Yang Subdistrict Municipality	1.30-4.30 pm 3 hours	Informal meeting to TKYSM: took notes, collected information about MSWM
1/08/16	Tha Khon Yang Subdistrict Municipality	9.00-11.00 am 2 hours	Informal meeting to TKYSM: took notes, collected information about MSWM
2/08/16	Tha Khon Yang Subdistrict Municipality	9.00 - 11.00 am 2 hours	Informal meeting to TKYSM: took notes, collected information about MSWM
3/08/16	Tha Khon Yang Subdistrict Municipality	9.00-11.00 am 2 hours	Informal meeting to TKYSM: took notes, collected information about MSWM
4/08/16	Elderly School in Tha Khon Yang subdistrict, Maha Sarakham Province	10.00am-2.00 pm 4 hours	Attended a Community Meeting with locals and local organisations and met key people from TKTSM. This was organised by administration staff of TKYM. Took notes and made audio recording

On the 25 May 2015 a meeting about waste management and other issues relating to community development in the area was organised by TKYSM. After this meeting, the researcher was able to meet the leaders of communities and was also able to observe the way community leaders work together and how they participate in meetings. The researcher used these observations to compare what people said in interviews or focus groups with what was happening in practice. Observations were recorded by taking notes and photographs (Table 4.1).

When attending meetings the researcher was a non-participant observer, and did not interrupt meeting activities, as described by Green and Thorogood (2014). In addition, being present at the meetings had an indirect benefit of establishing rapport between the researcher and the participants. The researcher attended five meetings about waste management in different villages in the TKY area on 25 May, 14 July, 17 August, 20 August 2015, and 4 August 2016 (Table 4.2), which allowed observation as to how the villagers respond to the waste problem in their area and discussions about waste management issues. On the 26 August 2015 the researcher also had the opportunity to attend a meeting with the Mayor of Maha Sarakham Province, the study area town, to discuss waste management in Maha Sarakham Province. This provided information about the policy and strategy of MSWM at the provincial level. During meetings conversations were recorded, and notes taken to ensure the details of the discussion were captured.

In August 2015 Maha Sarakham Town Municipality stopped receiving waste from other areas. The researcher attended and observed community meetings with locals and local organisations and met with key people of TKYSM to find out more about the effect of the landfill closure and the waste crisis that followed from August 2015 (discussed in Chapter 5).

4.2.11 Conduct of focus groups and interviews

Empirical data collection was conducted between 25 May and 23 September 2015 with a combination of focus groups and interviews. Some unstructured interviews were undertaken during the second phase of fieldwork, between 31 July 2016 and 22 August 2016. A summary of this activity is provided in Table 4.1. Details of the focus group and interview methods are explained in detail in the following discussion. All participants were Thai and over 18 years of age.

4.2.12 Focus groups

To test the focus group process a pilot was held on 25 August 2015 with six undergraduate students from the Faculty of Public Health, MSU. The students were tenants living in MSU dormitories. The pilot focus group session took place in a meeting room of the Faculty of Public Health, MSU and took approximately 90 minutes. The session ran well, and participants responded to all questions, however some participants talked more than others. In response, the researcher intervened to guide some answers from participants. There were other interruptions including background noise that

occurred during the pilot. The researcher discussed these problems with the team to ensure successful moderation for the following three meetings.

The research team for the focus groups consisted of the researcher who took the role of moderator, two note takers (both university academics), an audio recording assistant (a university student) and an organiser (this was a university student for two focus groups of students; the pilot group and off-campus university accommodation, and was the director of the waste management section of TKYSM for the focus groups of operational staff of TKYSM and the focus group of local residents) (Table 4.4).

An accessible, quiet and comfortable area was chosen for the three focus group discussions. Different places were arranged for the focus groups, based on convenience for participants. For the operational staff of the waste management section of TKYSM, the focus group was held in the meeting room of the TKYSM office on 31 August 2015. For students (tenants), who live in off-campus accommodation in TKY area, the focus group was held in a classroom of the Faculty of Public Health, MSU, on 1 September 2015. The session for the local residents who live in TKY, was held in a village leader's house in Baan Hua Khua village, TKY, on 15 September 2015. Before the day of each focus group, the researcher contacted participants to check that they were able to attend and confirmed the location and meeting time. Prior to each focus group meeting, the research team arrived earlier than the scheduled meeting to check the focus group places and to test the recording equipment. Drinks and appetisers were provided for participants, as suggested by Dawson (2009). Care was taken to provide a non-threatening environment and ensure that all participants felt comfortable to share their opinions (Krueger & Casey 2009).

Thirty four in depth interviewees and 24 participants for three focus groups were selected based on their relationship to MSWM and the objectives of the study (Table 4.3).

Following recommendations from the literature, the number of participants in each of the three groups for this study varied between six and ten participants (Table 4.4). The focus groups commenced with a greeting, the research team was introduced, and an overview of what was expected of the participants explained to each group (Dawson 2009). An assistant took notes and managed two digital recorders for each meeting. A digital sound recording was made of each focus group meeting. To ensure the privacy of participants no photos were taken.

The focus groups lasted for approximately one and a half hours. Notably, after focus groups had finished, some participants wanted to continue giving information. These individual conversations were also noted.

Table 4.3: Focus groups and in-depth interviews

List of participants	Number of participants	
	In-depth interview	Focus group
Providers		
Administrators of the TKYSM	3	
Operational waste management staff of the TKYSM		10
Users		
Leaders of villages	4	
Restaurateurs	6	
Off-campus student accommodation owners	5	
Minimart owners	4	
Local residents living in Tha Khon Yang area		8
University students, living in off-campus student accommodation in Tha Khon Yang area		6
External agents and experts		
Academics		
University lecturers of Mahasarakham University	3	
University lecturers of Mahidol University, Bangkok	3	
School teacher from primary school, Tha Khon Yang subdistrict, Maha Sarakham Province	1	
Other organisations related to MSWM		
Director of the Provincial Natural Resources and Environment Office, Maha Sarakham Province	1	
Waste operator of Maha Sarakham Town Municipality	1	
Waste operator of Mahasarakham University*	1	
Recycling trader*	1	
Scavenger in Landfill site of Maha Sarakham Town Municipality, located in Waeng Nang subdistrict, Maha Sarakham Province*	1	
Total	**34**	**24**

*An unstructured interview was used for this interview

Table 4.4: Details of the pilot group and three focus groups

Date/Time	Focus Group Sessions	Place for Running Focus Group	Number of Participants
25/08/15 1.30 hours (6.00-7.30 pm)	Students (tenants), who live in dormitories of Mahasarakham University (pilot group)	Mahasarakham University	6
31/08/15 1.30 hours (1.00-2.30 pm)	Operational staff of waste management section in Tha Khon Yang Subdistrict Municipality	Tha Khon Yang Subdistrict Municipality office	10
1/09/15 1 hour (6.00-7.00 pm)	Students (tenants), who live in off-campus accommodation in Tha Khon Yang area	Mahasarakham University	6
15/09/15 1 hour (10.30-11.30 am)	Residents (villagers) who live in Tha Khon Yang area	Hua Khua village, Tha Khon Yang subdistrict	8

4.2.13 Interviews

There were a number of different groups of people interviewed including official staff and directors of TKYSM and external agents (academics, experts and entrepreneurs and leaders of villages) (Table 4.5). As noted above, the method of selection differed for the different groups of interviewees. Before conducting the interviews, the researcher read aloud the information sheet and gave the participants time to read and sign the consent form before the interview commenced. Interviews ran for between 20 to 40 minutes. The researcher had an assistant who took notes and made audio recordings of the semi-structured interviews.

Unstructured interviews were also conducted. These were used to gain an understanding of some of the grey literature, or additional data from the TKYSM on an ongoing basis, undertaken in conjunction with observations. For example, unstructured interviews were undertaken with extra participants who were identified as holding useful information. These included staff from waste management areas from MSU, recycling traders and scavengers. For these unstructured interviews (Table 4.3), the researcher made notes and audio recordings. Unstructured interviews also were used when some participants wanted to continue talking after interviews or focus groups were completed. It has been noted that more can often be achieved when a relaxed environment for conversation has been created and can result in the researcher gaining fuller ideas from interviewees (Dicicco-Bloom & Crabtree 2006).

Table 4.5: Details of the interviews

Date	Place	Start time	Finish time	Duration Time Taken	Description of Activity
25/05/15	Charoen Phon Temple, Tha Kon Yang subdistrict, Maha Sarakham Province	11.00 pm	1.00 pm	2 hours	Four leaders of villages Semi structured interview
25/05/15	Tha Khon Yang Subdistrict Municipality	3.00 pm	3.38 pm	38 minutes	Administrator of TKYSM Semi structured interview
10/06/15	Tha Khon Yang Subdistrict Municipality	10.00 am	10.38 am	38 minutes	Administrator of TKYSM Semi structured interview
11/06/15	Mahasarakham University	3.00 pm	3.30 pm	30 minutes	Academic Semi structured interview
17/06/15	Mahasarakham University	2.00 pm	2.30 pm	30 minutes	Academic Semi structured interview
6/07/15	Mahidol University, Bangkok Thailand	8.00 am	9.00 am	1 hour	Academic Semi structured interview
6/07/15	Mahidol University, Bangkok Thailand	3.00 pm	4.00 pm	1 hour	Academic Semi structured interview
6/07/15	Mahidol University, Bangkok Thailand	4.00 pm	5.00 pm	1 hour	Academic Semi structured interview
23/07/15	Waste separation plant of Mahasarakham University	9.00 am	10.30 am	1.30 hours	Operator of waste separation plant of MSU Unstructured interview
4/08/15	The Provincial Natural Resources and Environment Office (Maha Sarakham Province)	10.30 am	12.00 pm	1.30 hours	External expert Semi structured interview
27/08/15	Mahasarakham University	1.30 pm	2.08 pm	38 minutes	Academic Semi structured interview
30/08/15	Tha Khon Yang, Maha Sarakham Province	9.30 am	10.00 am	28 minutes	Restaurateur Semi structured interview
30/08/15	Landfill site, Waeng Nang subdistrict, Maha Sarakham Province	12.00 pm	1.00 pm	1 hour	Scavenger Unstructured interview
31/08/15	Tha Khon Yang Subdistrict Municipality office	3.00 pm	3.34 pm	34 minutes	Administrator of TKYSM Semi structured interview
2/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.30 pm	3.00 pm	32 minutes	Restaurateur Semi structured interview
3/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	3.00 pm	3.30 pm	30 minutes	Restaurateur Semi structured interview
4/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.30 pm	3.00 pm	32 minutes	Off-campus accommodation owner Semi structured interview

Table 4.5: Details of the interviews (Continued)

Date	Place	Start time	Finish time	Duration Time Taken	Description of Activity
04/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	3.30 pm	4.15 pm	46 minutes	Off-campus accommodation manager Semi structured interview
04/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	5.00 pm	6.00 pm	52 minutes	Off-campus accommodation owner Semi structured interview
5/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.00 pm	3.00 pm	50 minutes	Restaurateur Semi structured interview
5/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	3.30 pm	4.00 pm	32 minutes	Restaurateur Semi structured interview
5/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	4.30 pm	5.05 pm	35 minutes	Off-campus accommodation owner Semi structured interview
5/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	6.00 pm	6.30 pm	30 minutes	Restaurateur Semi structured interview
6/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.30 pm	3.00 pm	17 minutes	Minimart owner Semi structured interview
7/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.00 pm	2.30 pm	30 minutes	Minimart owner Semi structured interview
07/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	6.00 pm	6.30 pm	15 minutes	Minimart manager Semi structured interview
08/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	2.00 pm	2.20 pm	21 minutes	Market owner Semi structured interview
11/09/15	Tha Khon Yang subdistrict, Maha Sarakham Province	10.00 am	10.30 am	30 minutes	Off-campus accommodation owner Semi structured interview
15/09/15	Hua Khua School, Tha Khon Yang subdistrict, Maha Sarakham Province	2.00 pm	3.00 pm	1 hour	Academic Semi structured interview
23/09/15	Maha Sarakham Town Municipality	10.30 am	11.30 am	67 min	External expert Semi structured interview
31/07/16	Landfill site, Waeng Nang subdistrict, Maha Sarakham Province	1:00 pm	2:00 pm	1 hour	Scavenger Unstructured Interview
22/08/16	Waste separated plant of Mahasarakham University	12:00 pm	13:00 pm	1 hour	Operator of waste separation plant of MSU. Unstructured interview
23/08/16	Recycling trader shop, Maha Sarakham Province	13:00pm	13:30 pm	30 minutes	Recycling trader Unstructured Interview

4.2.14 Data analysis

The data collected about MSWM was based primarily around conversations – interviews and focus groups. Babbie (2010) notes that exploring conversations requires appropriate methods to ensure validity and reliability and to ensure the issues of concern are identified. Content analysis is a method in qualitative research or social science that studies the content of communications, including information, symbols, words or sentences within material that will provide the key elements of data useful for responding to research questions (Babbie 2013; Green & Thorogood 2014). It is suggested that the researcher needs to analyse the structure of materials, and pull together generic ideas, concepts and themes and categorise contents into specific viewpoints (Green & Thorogood 2014; Neuman 2012).

To do this, data were transcribed from audio recordings into text, uploaded to NVivo, and subsequently coded into themes. Emerging themes were analysed to develop an understanding of the barriers and solutions to MSWM in TKY. Analysis of qualitative research data evaluates, interprets and explains the phenomena under investigation (Green & Thorogood 2014). In this study, data from all focus groups and interviews were transcribed from the audio files into Microsoft Word documents. Transcription turns oral conversations into written text (Liamputtong 2013). Kyale 2007 (cited in Liamputtong 2013) suggests that the researcher or the interviewer should be the person who does the transcribing, because they will be the person who best understands the situation and the interviewees. Therefore, all recordings both Thai language and Isan (Isan, a local language is only a spoken language) were transcribed into Thai in Microsoft Word by the researcher.

Word documents were later transferred into the NVivo program, qualitative data analysis software designed to assist in the management, and organisation and analysis of imported data. NVivo assists the researcher by bringing data together from a variety sources of information (such as documents and audio files), to organise and conceptualise data by coding into themes. This provides mechanisms to visualise the data, which is very helpful for the final write-up (Edhlund & McDougall 2012).

Coding was used to classify conversations from the 34 interviewees' in-depth interviews and the three focus group discussions. Neuman (2012) proposes three steps to develop themes for qualitative data. First, 'open coding' which involves reading and reviewing all data notes and looking for critical terms, then identifying concepts and themes and drafting a code. Second, 'axial coding', which involves organising all codes into a structure, then identifying major and sub themes and concepts by looking for categories of concepts that group together or third, 'selective coding', where the researcher finishes the data collection process and then develops themes.

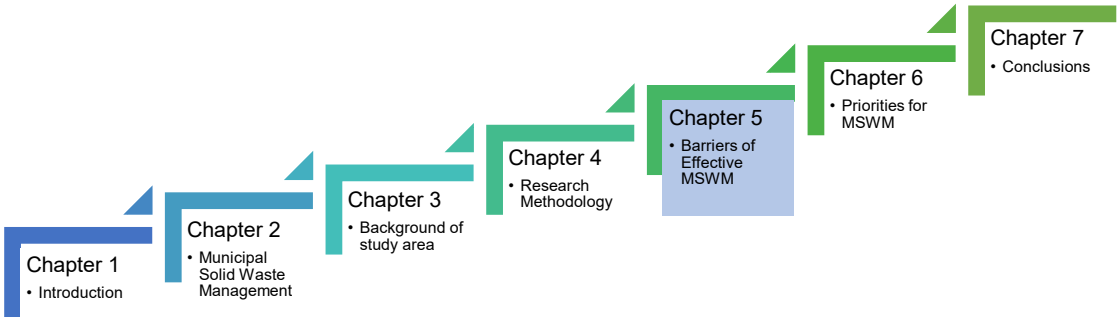
During this research, the researcher used the themes presented in the ISWM framework as a guideline for axial coding. The six 'aspects' of ISWM technical, environmental, financial-economic, socio-cultural, institutional and policy/legal/political, provided the main codes (Anschütz, IJgosse &

Scheinberg 2004; Guerrero, Maas & Hogland 2013; United Nations Environment Programme 2009). Sub-codes were added within the main themes. This enabled the researcher to capture the key ideas within the main themes. Sub-themes or codes were added – selective coding – as they became apparent throughout the process.

4.3 Conclusions

The combination of qualitative methods (primary and secondary document reviews, observations, face-to-face interviews and focus groups) presented in this chapter were chosen to ensure an understanding of stakeholders' perspectives around MSWM in TKYSM. The ISWM framework provided the basis of analysis to structure the qualitative data. Key findings are presented in the results sections of the thesis in Chapters 5, 6 and 7.

CHAPTER 5 BARRIERS OF EFFECTIVE MSWM



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(See Appendix I2)

Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand

Abstract

This study focused on determining the barriers to effective municipal solid waste management (MSWM) in a rapidly urbanizing area in Thailand. The Tha Khon Yang Subdistrict Municipality is a representative example of many local governments in Thailand that have been facing MSWM issues. In-depth interviews with individuals and focus groups were conducted with key informants including the municipality staff, residents, and external organizations. The major influences affecting waste management were categorized into six areas: social-cultural, technical, financial, organizational, and legal-political barriers and population growth. SWOT analysis shows both internal and external factors are playing a role in MSWM: There is good policy and a reasonably sufficient budget. However, there is insufficient infrastructure, weak strategic planning, registration, staff capacity, information systems, engagement with programs; and unorganized waste management and fee collection systems. The location of flood prone areas has impacted on location and operation of landfill sites. There is also poor communication between the municipality and residents and a lack of participation in waste separation programs. However, external support from government and the nearby university could provide opportunities to improve the situation. These findings will help inform municipal decision makers, leading to better municipal solid waste management in newly urbanized areas.

1. Introduction

Municipal Solid Waste Management (MSWM) refers to waste in a solid form, produced in daily life from households and non-hazardous solid waste from commercial, industrial, and institutional establishments including hospitals, markets, yard and street sweeping [1,2]. Globally, the amount of solid waste is increasing due to population expansion, continuous economic growth [3,4], urbanization and industrialization [5]. In developing countries, high population growth and urbanization, together with rapid economic growth accelerates consumption rates [6]. These patterns have increased the generation rate of municipal solid waste and changed the composition of waste [7]. It is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste. In rapidly urbanizing cities, local governments need to consider the key activities of MSWM including; waste generation and separation, appropriate solutions for recycling, collection, transfer and transport, treatment and proper final disposal [2,3,8]. Inadequate MSWM processes can lead to impacts on human health, living resources and the environment, including water contamination, rodents and insect attraction and flooding due to blocked drainage [3,9–14]. Impacts on human health include infection transmission, physical injury, non-communicable diseases, and emotional and psychological effects. In particular, pollutants from landfill can increase the risk

of cancer, birth defects, reproductive disorders and respiratory diseases [15]. In addition, inadequate solid waste management systems substantially increase management and disposal costs [4,16].

Many municipalities in low and middle income countries use integrated solid waste management (ISWM) as the ideal principal concept for their MSWM [16–20]. However, different regions have different conditions that require them to determine the best ISWM approach for their situation. ISWM has been described as the integration of sustainable management options, for example: waste minimization, recycling, composting and other recovery options [19,21].

In Thailand, for many years solid waste management has been a topic of heated debate. Solid waste management presents practical management challenges for local government. The need for better waste management has become increasingly obvious with the rise in population. Many potentially good MSWM solutions have been suggested and applied, even if temporarily, in many areas around Thailand, such as waste sorting and recycling [22–26]. However, whilst some have met with success, most have not achieved their objectives.

Tha Khon Yang, a sub-district of Kantharawichai, Maha Sarakham Province, in northeast Thailand is rapidly changing from a rural to an urban culture. This change has been encouraged partly by the presence of the Mahasarakham University which has a large and rapidly expanding staff and student body [27,28]. Urbanization has resulted in increased waste production, due to new commercial enterprises, accommodation and restaurants. For more than two decades, MSWM has been a serious problem for Tha Khon Yang and the problem is escalating. Between 2009 and 2017 the volume of waste generated in Tha Khon Yang was estimated to double from 4204 tonnes/year to 8004 tonnes per year [29].

In 1999, the Thai government formally decentralized many functions from central to local government [30]. Consequently, the Tha Khon Yang Subdistrict Municipality (TKYSM) has primary responsibility for MSWM within its governed service area as identified in the Public Cleaning Act B.E.2535 (A.D.1992) and the Public Health Act B.E.2535 (A.C.1992) [30,31]. The TKYSM receives revenue from the central government via the Provincial authority, and manages waste through its Division of Public Health and Environment. The MSWM system includes collection of waste from stationary waste bins by trucks via a municipal ‘kerb-side’ system that then deliver their waste to a landfill site [29,32]. In Tha Khon Yang there is only limited recycling of materials that hold value (glass, paper, plastic and steel) and this activity is separate from the government’s MSWM system [33]. Residents place their waste bins or plastic bags (of mixed waste) in front of their houses or at unfixed waste collection points along main roads. There are three waste collection trucks in TKYSM that follow a route covering seven waste collection zones [29,32] twice daily from Monday to Saturday (4:00 a.m. to 8:00 a.m. and 1:30 p.m. to 4:30 p.m.). Each truck employs three staff; a driver and two waste collectors who lift waste bins and bags and empty them into the trucks [33].

Around 10 tonnes of waste per day is transferred directly from Tha Khon Yang to a landfill site 25 km away in the same Province. TKYSM pays a disposal fee of 400 baht (US$11.60) per ton of waste to the Province [33].

At the time of this study the Thai Government released a national waste initiative that included a 'No open dumping' clause [34]. This clause resulted in the closure of the Maha Sarakham landfill site in August 2015. The landfill refused to accept waste from 14 areas outside the Maha Sarakham Municipality [33] and Tha Khon Yang was one of these areas. Tha Khon Yang became very polluted [35] resulting in a state of emergency. Ironically, the closure of the landfill site resulted in the unauthorized dumping of large volumes of roadside waste.

During this time, TKYSM tried to encourage people to manage waste at the source. A public meeting was organized to inform and seek cooperation from the community. However, not many people attended the meeting. In a further bid to inform people about the changed service the TKYSM delivered a message, using a megaphone, from a moving vehicle. This method failed to reach people living in multi-story-complexes or apartments. People were told to manage their household waste by separating recyclables, composting organic waste or, disposing of their waste by burning it. The outcome of the closure and the failed community engagement effort resulted in a dramatic increase of accumulated waste. To reduce waste going to landfill the TKYSM attempted to find space to separate recyclable waste. However, the low-lying topography, lack of private land or civic space for use or purchase has made this a significant and ongoing challenge [33].

The theoretical framework applied in this study follows that of the model of Integrated Sustainable Waste Management (ISWM) [36], a model that "allows studies of the complex and multi-dimensional systems in an integral way" [8]. This approach incorporates three key dimensions by which to analyse a waste management system: first; inclusion of the stakeholders who have an interest in solid waste management, second; an understanding of the flow of waste materials from generation points until final disposal, and third; identification/selection of aspects that frame the analysis (such as technical, socio-political, financial aspects). Application of the model has assisted in isolating barriers to effective MSWM in Tha Khon Yang. Clearly defining the barriers may contribute to development of solutions to waste problems both in this region and in other in newly urbanized areas in places suffering similar problems, leading to better MSWM.

2. Materials and Methods

To understand the experiences and attitudes of participants with respect to MSWM in the Tha Khon Yang area, and to avoid bias, data was gathered from a variety of sources using a variety of techniques [37] including focus groups, in-depth interviews, observation, and site visits. Research was conducted entirely in the Tha Khon Yang Sub-district.

This study represents the views of various stakeholders, including both MSWM service providers and users of the service, and some external agents. Stakeholders were chosen according to

recommendations from the literature [7,38]. All participants in the study were Thai and over 18 years of age. Service providers were selected from the TKYSM, the local authority providing the waste management service, including directors, official staff and operational staff. The users of the service were people from Tha Khon Yang, including residents (university students, villagers and village leaders), and entrepreneurs (owners or managers of businesses in the immediate area). External agents included other organizations, academics and experts.

The Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784) approved this study on the 21 April 2015. Approval was granted on the English versions of the research instruments. These were later translated into Thai language.

Fieldwork was undertaken between May and September 2015, and July and August 2016. Firstly, the primary researcher met informally with the Director and members of the

Environmental and Sanitation section of the TKYSM. The Mayor of the municipality was informed about the research project. A formal letter and all related documents were sent to him.

Between May 2015 and August 2016, the primary researcher received invitations to attend six meetings concerning waste management in Tha Khon Yang. These meetings had a number of purposes; some were high-level managers meetings (e.g., with the Provincial Governor, and District Chief Officer) while others were community information sessions. The researcher made audio recordings, took written notes, and observed participants. Attending meetings provided the opportunity to establish rapport with study participants.

The primary researcher visited many roads and alleys in villages and communities around the study area to view and take photos of waste piles, bins and waste collecting points. The waste collecting points were also observed, over days, weeks and months. The researcher also visited the landfill site. Figure 1 presents some evidence of pollution.

(**a**) (**b**)

Figure 5.1: (Manuscript Figure 1) (**a**) Typical scene of road-side waste in Tha Khon Yang; (**b**) Landfill site of Maha Sarakham Municipality.

Between May 2015 and August 2016, the primary researcher conducted 28 face-to-face, semi-structured interviews with residents, academics, administrators and other organizations related to MSWM of Tha Khon Yang (Table 1).

Interviews took between 20 and 40 min per person. Times differed between stakeholder groups to accommodate social and cultural backgrounds of interviewees. On deciding to participate, interviewees contacted the researcher and made an appointment. Nonprobability sampling [39] was used for participant selection approaches and techniques that are explained below:

Village leaders: The primary researcher attended a meeting as an observer in Tha Khon Yang community. Attendees of this meeting consisted of the Chief Executive of the TKYSM, leaders of every village in this sub-district (15 villages) and other leaders in this community. The researcher was introduced to attendees at the meeting by the Director of the TKYSM. Volunteer sampling [39] was used and four leaders volunteered to participate.

Entrepreneurs: First, the researcher made an appointment with the Director of the waste management section of the TKYSM who knew the area and its entrepreneurs very well. Then the researcher and the Director selected three groups of entrepreneurs, namely restaurants, dormitories and markets. Purposive sampling [39,40] was used for selecting participants from the list of entrepreneurs in Tha Khon Yang which met the criteria of two urbanized zones and three sizes of businesses (small, medium and large). The researcher visited these entrepreneurs and administered the research instruments.

Academics: The primary researcher sent an invitation to one to two academics from a university and a school ask them to contribute them to participate in the study. The email administered the research instruments. A Snowball technique [39] was used. A key academic referred the primary researcher to other academics who might be willing to participate.

Waste Management Administrators: The primary researcher made appointments with Waste Management Administrators and other external organizations via workplace secretaries. The researcher made a phone call to their secretaries to arrange the administration of the research instruments.

Three focus groups were run, comprising of different stakeholders (waste management operation staff, residents, and students from dormitories in the Tha Khon Yang) (Table 2). The three focus groups were arranged to be held on separate days and in different places, depending on the stakeholder group. Voluntary sampling [39] was used to select local residents from different villages, students (tenants) from different dormitories and waste management operation staff of TKYSM. There were no more than ten participants in each focus group. Focus group sessions lasted for 60 to 90 min. In each focus group session, the research team consisted of the researcher, moderator, note taker, audio recorder and organizer. An audio recording of the focus group conversation was made for later review. During focus group discussions, participants were guided by the moderator who kept the

discussion focused, ensured that everyone participated, and encouraged participants to explain their answers.

Table 5.1: (Manuscript Table 1) In-depth interviews.

In-Depth Interview Participants	Number of Participants
Residents	**19**
Leaders of villages	4
Restauranteurs	6
Dormitory owners	5
Minimart owners	4
Academics	**4**
University lectures of Mahasarakham University	3
School teacher of Ban Hua Khua School, Tha Khon Yang Sub-district, Maha Sarakham Province	1
Administrators	**3**
Administrators of Tha Khon Yang Subdistrict Municipality	
Others organization that related to municipal solid waste management	**2**
Director of the Provincial Natural Resources and Environment Office, Maha Sarakham Province Waste operator of Maha Sarakham Town Municipality	
Total	**28**

Table 5.2: (Manuscript Table 2) Timetables for conducting focus groups.

Date	Time	Focus Group Participants	Number of Participants
31 August 2015	(1.30 h)	Waste management operational staff of the TKYSM	10
1 September 2015	(1 h)	Students, living in private dormitories in Tha Khon Yang	6
15 September 2015	(1 h)	Residents living in Tha Khon Yang	8
		Total	**24**

The audio files generated from the 28 face-to-face semi-structured interviews and three focus groups were transcribed by the researcher onto a word processor and later uploaded and analysed for thematic content using NVivo software [41].

Analysis was undertaken in Thai language to prevent bias or loss of nuance that might arise from translated terms or expressions. Salient quotes were translated into English for use in publication. The analytical framework for this study was constructed of factors or aspects reported in the solid waste management literature and applied by the US EPA (May 2002) [3,42] and Guerrero et al.'s 2013 cross-national study focusing on developing countries [8]. Thematic aspects of the framework include technical, institutional, socio-political, and financial matters.

3. Results

The following discussion includes findings from interviews and focus group discussions.
The results present the most frequently cited issues.

3.1 Technical and Physical Barriers

A well-functioning waste management system allows residents to dispose of their waste in an appropriate manner. Components of a waste management system include the facilities and equipment used to temporarily store waste (collection bins) or transfer collected waste to its final disposal site [16]. The majority of participants' comments point to problems with the waste management system in TKYSM. The following sections explain the key technical and physical challenges to MSWM identified by participants.

At least six waste management issues were raised by survey participants that express how current infrastructure is insufficient including; lack of waste collecting points, irregularity of waste collection, inadequate waste collection vehicles, limited access to waste bins, alternative to final waste disposal and improper waste separation facilities. Also physical challenges including; large volume of waste and space limitations.

3.1.1 Lack of Waste Collecting Points

The most frequently cited barrier to effective waste management identified by 15 interviewees (54%) and all three focus groups (100%) was a problem with non-fixed waste collection points. TKYSM does not provide obvious waste collection points for local people. Participants in this study complained that they could not find an appropriate location to put their solid waste, that there were an insufficient number of collection points, or, points are not sited appropriately, or, that collection points are not fixed.

> *"We don't know where waste is to be collected from."* Operational staff of TKYSM F3 [Focus group].

> *"People do not know where to put garbage. When they see bins or black plastic bags somewhere, they will put their waste there too. The problem is that there is no obvious waste collection point."* Restaurateur R4 [In-depth interview].

> *"People who are concerned about waste want to put their garbage in the right place, if there are no waste bin points, they probably cannot do the right thing."* Leader of village ID01 [Interview].

> *"Now, the waste collection points have been changed to another area; [collection points] are always changing."* Market owner M2 [In-depth interview].

Many residents refuse to have a bin in front of their home because they fear others will bring their

garbage there too, thereby establishing a neighborhood waste collection point, rather than a household one:

> *"If we leave bins outside, others throw their garbage here too, for example restaurants and dormitories. It becomes a very untidy place. And sometimes, some pickup trucks bring their waste to this point too . . . Some waste collecting points are too close to a community or people. That is not very good."* Restaurateur R5 [In-depth interview].

3.1.2 Irregularity of Waste Collection

Waste collection routes in Tha Khon Yang are divided into seven zones; trucks will collect waste in each zone from Monday to Saturday. Even though there is a system of collection routes for each truck; they struggle to complete their set tasks each day. The waste collectors are unable to adhere to their collection schedule. Waste collection services were a common issue of concern for most participants. Not only residents, but staff at the TKYSM also recognized this problem. The second most commonly cited issue given by 13 interviewees (46%) and three focus groups (100%) was infrequency of waste collection:

> *"It is an embarrassment, we could not tell [the residents] the exact day of collecting. We have tried to collect every day though."* Operational staff of TKYSM F3 [Focus group].

> *"It smells very bad. So I called them (the municipality) to ask when they could collect the waste and how often. They said they were unable to tell me how often that they could offer a waste collection service for this dormitory. If it is a severe problem, I can call them. It is kind of like they will collect randomly. They cannot tell me the exact day."* Dormitory owner D2 [In-depth interview].

> *"Oh! When will they [waste collection truck] come? The waste pile is higher than my head already. Sometimes they leave it for 10 days. That is too long. The highest frequency is three collection times a month. Especially these days, there is the huge waste pile because they have not come to collect. We have a trolley to take it away. It takes about 2–3 trips a day to move the waste."* Dormitory owner D3 [In-depth interview].

> *"I used to put my garbage bags in front of my restaurant but they weren't collected. It happened again and again."* Restauranteur R1 [In-depth interview].

3.1.3 Inadequate Waste Collection Vehicles

The landfill site is about 25 km from the TKYSM and there is no waste transfer station to take waste for sorting. This travelling distance in conjunction with the volume of waste generated each day means that waste collection trucks make a few trips per day to the landfill site. Thirteen interviewees (46%)

and three focus groups (100%) stated that deficiencies in waste collection trucks (too few or poorly maintained) were barriers to effective waste management. Participants claimed that each day waste collection trucks are always full before the trucks reach the end of their routes.

> *"There are not enough trucks or they are out of order."* Operational staff of TKYSM [Focus group].

> *"It seems like one waste collection truck could not collect all of the waste from some single dormitories."* Restauranteur R3 [In-depth interview].

> *"They [TKYSM staff] said they have only one truck . . . There was an inadequate number of waste collecting trucks to collect [all of the waste from] the route."* Dormitory owner D3 [In-depth interview].

> *"Currently I have heard that the municipality has the budget but they still don't have ability to buy the truck."* Dormitory owner D1 [In-depth interview].

3.1.4 Inadequate Access to Waste Bins

In TKYSM waste bins are placed at the kerb-side ready for collection by the waste trucks. Eleven interviewees (39%) and three focus groups (100%) cited inadequate access to these waste bins as one of the main barriers to effective waste management. Waste bins pose a problem for both public and private use. The TKYSM in the past provided kerb-side waste bins for public use in the Tha Khon Yang community but problems developed (for example, some people took the bins away because they were unsightly and smelled bad) and so the TKYSM ceased to provide bins. In the absence of a TKYSM waste bin service most waste bins are now provided by private business (in dormitories) or by households. These private bins are simple receptacles, such as plastic baskets or bins made from old tires. Many people simply use plastic bags. Many respondents mentioned the inadequacy of the capacity of the bins placed in dormitories.

> *"There are no waste bins [on the kerb-side]. There are only black plastic waste bags. When people put them [on the side of the road], waste becomes scattered [because dogs and scavengers tear open the bags]. Also, in dormitories the [owner] provides one big waste bin on the ground floor. It always overflows; it is not enough."* Operational staff of TKYSM F3 [Focus group].

> *"They [the TKYSM] have not provided waste bins for many years. We have to buy them by ourselves."* Dormitory owner D1 [In-depth interview].

"We separated waste from our room but there is only one bin downstairs . . . It is a mixed bin and it is collected every day but it is full every day and overflows everyday too." F2 Student [Focus group].

3.1.5 Alternatives to Final Waste Disposal (Burning and Illegal Dumping)

When the landfill site limited their intake of waste (on the introduction of the Thai government's no opening dumping regulations) TKYSM had no option but to reduce its daily waste by more than 10 tonnes. Minimizing waste at the source was the only solution. Residents were required to manage their waste reducing and reusing, as well as disposing of their own waste by burning or burying rubbish on their own land. Four interviewees (14%) talked about alternative methods of final waste disposal, as compared to sending waste to the landfill final. Some TKYSM staff suggested that people dispose of their waste by themselves by open burning or dumping it on their land. However, not everyone can burn or compost their waste (e.g., people living in multi-story complexes or townhouses).

"Sometimes residents want to [compost or burn waste] but the problem is they have no space. It is difficult for them, especially if they live in townhouses." Restauranteur R2 [In-depth interview].

"They [the TKYSM staff] suggested that we have to dispose our waste; like burning it ourselves." Dormitory owner D4 [In-depth interview].

3.1.6 Improper Waste Separation Facilities

Waste separation is an important strategy to reduce the amount of solid waste going to landfill. It is a goal of the managers of the TKYSM to reduce the amount of waste going to the Maha Sarakham Municipality landfill site because dumping is costly. In addition, the operators of the landfill are limiting the amount of waste they will accept from TKYSM. This means waste separation is an important element of waste management for this local government. However, there is no formal waste separation process in place. Rather, informal systems have emerged:

"They (waste collectors) try to select recyclable waste on the truck too, after our house keepers have already taken some." Dormitory owner D3 [In-depth interview].

Participants in this study were cynical about going to the effort of separating their own waste.

"I have noticed the waste collectors throw the waste bags to the truck, then every waste type [recyclables and landfill] are put together anyway." Market owner M4 [In-depth interview].

3.1.7 Volume of Waste

Nine interviewees (32%) and three focus groups (100%) stated that the sheer volume of

accumulated waste is a primary barrier to effective waste management for the TKYSM.

> *"Sometimes the waste pile is suddenly high, about my waist, within only a day. I guess it comes from the alleys around here."* Restauranteur R6 [In-depth interview].

> *"Now we just collect waste to take it to the disposal site. Sometimes people leave their waste bags after the waste collection truck has already gone (laugh) . . . There is a lot of waste. Sometimes there is a big pile of waste in front of the dormitory. Each pile is around 2–3 tonnes. We could not collect all of it, we collected it but people dispose of waste again. It's like a cycle, repeated again and again. It is a lot of waste."* Operational staff of TKYSM F3 [Focus group].

3.1.5 Space Limitations

Seven interviewees (25%) and one focus group (33%) mentioned the lack of space for waste disposal. The Tha Khon Yang area is flat land with the Chi River running through it. There was a significant flood in 2011 that covered much of the sub-district, indicating that most of the land is not appropriate for a landfill site. Some people said that the limitation of space is an obstacle for managing waste near their residence or place of work.

The TKYSM nominated public places such as the small forest close to the Chi River, a larger forest in the Tha Khon Yang region, and public open spaces as possible sites for a transfer station for waste sorting prior to final disposal. However, the public rejected these suggestions.

> *"We worked very hard to find a place for a yard for a recycling program. We wanted to use the public space for this project and we organized public hearings many times but people refused it."* Administration staff ID06 [In-depth interview].

Until recently, Tha Khon Yang was a rural area comprising several small villages. Now it has an increased population density and several main roads connecting a web of smaller roads and alleys. It can be difficult for waste collection trucks to collect waste due to growing traffic congestion. In addition, some of the alleys are inaccessible to the trucks. Therefore, trucks collect rubbish only from the main or easily accessed roads. This problem contributes to the accumulation of waste.

One interviewee (4%) and one focus group (33%) mentioned the inability of trucks to easily access collection points due to poor condition of roads, limited access to narrow sites such as alleys, and traffic congestion.

> *"There are dormitories located in small alleys. We have tried to collect the waste there, however the truck could not get in. That causes the [waste accumulation] problem."* Administrator staff ID05 [In-depth interview].

"Traffic is the obstacle; [the waste collectors] went [to collect waste] in the morning. [This makes it hard for the waste trucks to stop to collect kerb-side waste]. There is a lot of traffic. This is the same every day. Small alleys are especially difficult, because they are narrow." Operational staff of TKYSM F3 [Focus group].

3.2 Organizational Barriers

Many participants indicated that organizational barriers stand in the way of effective waste management. Five key organizational barriers to effective MSWM in TKYSM include problems for the local authority such as lack of planning, strategic direction, and management (including lack of training) and poor communication between TKYSM staff and the community.

3.2.1 Lack of Planning and Strategy

Planning is normally the first step for designing or developing MSWM [3]. Many participants mentioned poor planning when they talked about challenges to waste management in TKYSM. The director of TKYSM knows that MSWM is a challenge for this area. TKYSM tries to follow the plan from the Maha Sarakham (Provincial) Administrative Organization, however some experts, academics and entrepreneurs suggest that good planning and a strategy for MSWM is absent in TKY. Eleven interviewees (39%) and one focus group (33%) mentioned "lack of planning and strategy".

"The policy [of waste management] needs to be clear and earnest, and immediately able to be applied. Action [from the] top down, [and] from the bottom up. Why doesn't the operator [management of waste in TKYSM] think about this and implement the cycle (of MSWM) from the beginning?" Academic ID13 [In-depth interview].

"Here, there is no [waste] management. The municipality needs a new vision for waste management. For example, waste as energy, waste is a resource. The municipality must think outside of the box. They could build a biogas plant from the organic waste. I asked the administrator 'why don't you do it?'" External organization ID12 [In-depth interview].

3.2.2 Inadequate Policy

Respondents at the highest levels from within the TKYSM and business people identified policy inadequacy as a challenge:

Four interviewees (14%) but no focus group talked about "inadequate policy". One of entrepreneurs said that the TKYSM should have an obvious policy of waste management. Another suggested that an appropriate approach to solve the landfill problem was burning waste from the households. Two others talked about the policy of waste management from the entrepreneur's perspective.

"I heard from a person who attended the waste management meeting that we need to burn rubbish by ourselves." Dormitory owner D4 [In-depth interview].

"The TKYSM needs to have policy from the top. Like, we have to do this, we have to do that." Market owner M4 [In-depth interview].

"It is difficult [to create waste management systems [in dormitories], some dormitories, managers are employed to look after the dormitories. They think about the benefit only. That's it." Dormitory owner D1 [In-depth interview].

However, three interviewees from the TKYSM (10% of all interviewees) and a focus group (33%) mentioned that the administrators of the TKYSM pay attention to waste problems and claimed that they have good policy for MSWM. In addition, the provincial administrative organization also puts MSWM as a high priority policy.

"Policy is not the problem." Official staff of the Municipality ID14 [In-depth interview].

"We (TKYSM) have tried to make a good plan for MSWM and tried to collect waste and invite entrepreneurs for the [MSWM] meeting. So we worked so hard." Administration staff ID06 [In-depth interview]

Poor management/lack of leadership.

MSWM is a challenge for local governments especially in developing countries. TKYSM is no exception. Many participants made comments about the inability of the local authority to manage the municipal solid waste of TKYSM. Some comments refer to the ability of the Director, and some to administrators or staff of the TKYSM. Some participants explained that the political challenges associated with these roles, or that staff did not understand their duties or that staff were over worked. Nine interviewees (32%) and one focus group (33%) mentioned lack of staff capacity and staff numbers as a barrier to MSWM. Lack of staff capacity was relevant to all levels from the performance of senior management down to street workers.

"The staff don't understand their duties clearly, because they have to respond to so many issues . . . health, [supervising] public health volunteers, Health Promotion Hospital and so on." External organization ID12 [In-depth interview].

"Our operational staff for waste collection and cleaning need to do other jobs too. Moreover, they are also responsible for managing many cases of waste and wastewater problem. They also need to manage the budget, procure, bla, so many things, but there are only two employees [two official staff of the Division of Public Health and Environment of TKYSM]. As a director, I have to look after all of this. . . Inadequate staff and vision of the administrator are the problem. Policy is not the problem." Official staff of the Municipality ID14 [In-depth interview].

3.2.3 Lack of Engagement with Programs

To teach people that waste has a value, the TKYSM arranged some practical programs to assist its community to manage MSWM. These programs included earthworm composting and a waste bank (the buying and selling of recyclable waste in schools). However, the programs were introduced only to a few households or schools and are no longer active. When asked about programs for MSWM, TKYSM staff and villagers responded that there were some programs provided by TKYSM but that these were not helpful and that the programs offered were not what was expected. Some residents and the administrator from the TKYSM indicated that there were also some programs designed to develop waste management capacity by taking members of the community to visit and see good practice examples of for waste management facilities in other local organizations. Three interviewees (11%) and all three focus groups (100%) mentioned that the community were disengaged from these programs.

> *"Yes, yes, we went to Rayong Province and we visited waste projects that cost 20, 200, 300 million [baht]. It is impossible to build those plants in our area. I prefer to see projects in villages that are similar to our villages; projects that could feasibly be applied."* Residents F1 [Focus group].

> *"We used to have earthworm compost project in our community. Eventually, villagers didn't add food waste to the pit but they add some leaves instead. It is incorrect. Then those earthworms die. There are some places that villages still have earthworm projects."* Administration staff ID05 [In-depth interview].

> *"The waste bank project in our school has stopped, we could not run it."* School teacher ID15 [In-depth interview].

3.2.3 Poor Communication

A year prior to the closure of the waste disposal site in a bid to prepare the TKYSM, Maha Sarakham Municipality announced that closure could happen at any time. When the landfill site did close the TKYSM tried to inform its community about the repercussions. However, disseminating information to the urban community in Tha Khon Yang using outdated methods such as inviting people to public meetings or transmitting messages by megaphone from a moving vehicle were not successful.

Poor communication was the most commonly cited problem raised by entrepreneurs. There were two major issues within poor communication, which are as follows:

- Lack of information

Eleven interviewees (40%) and three focus groups (100%) mentioned that "lack of information" is an issue for effective MSWM for this municipality.

"We need to have an explanation, we need some information to inform us how to discard waste and how can we manage waste." Restaurateur R1 [In-depth interview].

- Inappropriate media

Nine interviewees (32%) and one focus group (33%) mentioned that "inappropriate media" was used to inform residents about how to manage their waste in TKY. The information dissemination methods proved ineffective in reaching households and residents.

"I heard that [the announcement] but I didn't understand what they said. Because it was the announcement by the car and it was driving past . . . The announcement might not be heard. They only came one time, and so quick . . . What are they talking about? About the waste, maybe". Restaurateur R4 [In-depth interview].

3.3 Social-Cultural Barriers

Community participation and awareness are linked directly to MSWM problems. The literature suggests that encouraging people to participate will increase awareness, input and reception [3]. Here, socio-cultural barriers—those social and cultural factors that determine people's activities—refer to lack of participation, poor co-operation and negative attitudes of residents.

3.3.1 Lack of Participation

Participants in this study claimed that the community was not disposing of rubbish appropriately (e.g., failing to separate waste) and failed to engage in government initiated special meetings designed to instruct people how to manage their own waste to reduce the amount taken to landfill. Participants also claimed that the public ignore instructive kerb-side signs evidenced by the wide-spread practice of rubbish dumping. Respondents claimed this lack of engagement is a barrier to waste management in the TKYSM.

- Lack of engagement with waste separation activities

Seventeen interviewees (61%) and all three focus groups (100%) mentioned a lack of engagement with waste separating activities.

"[Everybody] including students in the dormitories- they do not separate waste. They just throw garbage away." Restaurateur R3 [In-depth interview].

"I used to provide separate bins for students [tenants] but they did not separate their waste. Now housekeepers [in the dormitories] separate the waste." Dormitory owner D1 [In-depth interview].

- Lack of attendance at community meetings

The TKYSM ran a series of meetings for different villages on the topic of managing domestic waste.

Six interviewees (21%) and two focus groups (67%) talked about people not joining these TKYSM meetings. Many entrepreneurs did not participate in the meetings for different reasons such as being "*too busy*" or considering that "*it is useless to attend*" or for "*no reason*".

> *"When the municipality invited us for the meeting, we could not go because it was scheduled for 9 a.m. Many shop owners and employees could not go. At that time, every shop is busy and we have to get our shops ready to open."* Restaurateur R6 [In-depth interview].

> *"I didn't go [to the meeting], let them [the TKYSM staff] think by themselves. Even if we attend the meeting, they won't follow our suggestions. They [the TKYSM staff] just need us to attend. They will do what they want anyway."* Dormitory owner D1 [In-depth interview].

- Failing to observe signs

Two interviewees (7%) and a focus group (33%) suggested that many people in the community ignore [locally constructed] signs instructing, "do not litter" or "do not put your garbage here".

> *"Lack of participation of entrepreneurs is a significant problem: restaurants, dormitories, especially dormitories. This morning I have just put up the sign ['Please do not litter in this area']. I also cleaned the scattered waste around the kerbside not far from my restaurant] after the waste collection truck had collected. Then, by late morning, there were some people who had put the waste there [the same place]. Also some waste pickers had scattered the waste there [the same place] again."* Restaurateur R4 [In-depth interview].

3.3.2 Lack of Co-operation

Some participants talked about the conflict between the TKYSM and the Mahasarakham University and who should take responsibility for waste collection along the main roads leading to the University. Some participants mentioned a lack of participation by private businesses. Twelve interviewees (43%) and three focus groups (100%) mentioned poor cooperation.

> *"The cause of problem is that there is a conflict between the university and this municipality, which is a barrier. If the municipality [TKYSM] cooperated with the university, this problem would have been solved a long time ago . . . there is a public area, but the municipality said it belongs to the University. But the municipality has the responsibility to look after this area. So if the municipality [TKYSM] doesn't want to do it, they have to transfer this authority to the University."* Dormitory owner D1 [In-depth interview].

Some mentioned poor cooperation between dormitory owners and residents.

"We provided the separate waste bins but they are useless, residents don't separate their waste; all the bins are used for mixed waste. So it doesn't matter which color they are." Dormitory owner D2 [In-depth interview].

3.3.3 Negative Attitudes

Participants mentioned that a barrier to MSWM in the Tha Khon Yang area was related to the negative attitudes of people including residents (and students), entrepreneurs and local municipality staff. Lack of concern; blaming others; and believing waste management is unsolvable are examples.

- Lack of concern for waste management

Answers given by study participants illustrate a lack of understanding of how individuals contribute to MSWM. Common perceptions were: that business owners do not contribute a significant amount of waste (18%), that people don't care about pollution (14%) and that people have no time to manage waste (11%).

"Even through people were educated about waste management they were not concerned about it. That is because the habit of Thai people is just 'take it easy'. Most Thai people are like that. We do not exactly love our environment, I think. Unlike some countries that have experienced a disaster, like Japan, for example. They are really concerned about their environment." Market owner M1 [In-depth interview].

"I cannot do that [dispose of my waste thoughtfully], I do not have time. And there is not a lot of sellable waste. For others [waste pickers], that is their job, let them have their job." Market owner M2 [In-depth interview].

- Blaming others

Eleven interviewees (39%) and two focus groups (67%) blamed others for bad behavior with respect to waste management. In response to the question about who should be responsible for making the changes for the better MSWM some participants replied as follows:

"Our waste is dry waste. Nowadays it smells because of waste from others, for instance the noodle shop, they will throw their waste here around 1 am. The smell is not because of our market waste." Market owner M2 [In-depth interview].

"It is because the big dormitories, they produce a lot of waste. There is not a lot of waste generated from our village." Restaurateur R3 [In-depth interview].

- Insolubility of the problem

Seven interviewees (25%) indicated that they thought that the waste problem is too difficult to solve because it is not possible to change the behavior of people.

"Waste producing behavior cannot be changed. This is Thailand. We always discard waste. But if it is about waste separation, we can do that." Market owner M4 [In-depth interview].

"It is difficult to change children's behavior. They have no discipline. For example, if there is a bin, they will throw their rubbish to the side, not in the bin. This is the habit of children now-a-days." Teacher ID15 [In-depth interview].

- Insufficient communication

Nine interviewees (32%) mentioned communication problems between entrepreneurs and their staff or between tenants and owners of dormitories. If entrepreneurs do not set rules or provide guidance for staff, it is difficult to control the waste management practice in these places. Communication problems emerged between the restaurateurs who generate organic waste and farmers who want to use it. There were allegedly agreements made between some restaurants and farmers but farmers were reneging on their deal.

"Many people used to ask me for my food waste [for example, farmers who would feed their livestock]. But they didn't come to get it." Restaurateur R1 [In-depth interview].

"Last year the town [Maha Sarakham] municipality stated that the waste management system has to be prepared because the disposal landfill will be closed whenever. That was a warning. About a month before the landfill was closed, the TKYSM was informed about the closure again. But the TKYSM didn't tell any [local] entrepreneurs. We got a letter about one day before the landfill was closed. We have to manage our waste by ourselves, they won't collect the waste. And the day after, 12 August they [TKYSM] distributed an invitation letter at 5:00 a.m. to attend a meeting about waste at 9:00 a.m. the same day. I don't know how many people attended the meeting. I didn't go." Dormitory owner D1 [In-depth interview].

"The staff usually peeling the fruits here and they didn't care. But I cannot do anything about this sometimes, I tried to tell them. Sometimes, we need to let it be." Restauranteur R2 [In-depth interview].

"If I tell them [tenants] to [separate waste], will do it or not? Hmm . . . I am not sure. (Laugh)" Dormitory owner D2 [In-depth interview].

3.4 Financial Barriers

To create a MSWM system it is necessary to consider financial factors. This refers to waste fees, including the public's ability and willingness to pay and the ability for the collection of fees by the

municipality; and it also refers to the public's attitude to the value of waste. The majority of participants indicated that financial constraints are one of the major barriers to effective solid waste management of TKYSM. There are three main financial barriers; waste management fees; the assumption that waste has no value; and that overall, there is insufficient external funding.

3.4.1 Waste Management Fee Collection

TKYSM does not have a clear fee system for waste collection services. Normally, commercial businesses pay a fee (tariff) at the TKYSM office annually or monthly with different rates that depend on the type of business. Every household pays a tariff to the TKYSM of 10 to 30 baht (US$0.29 to US$0.87) per month (depending on the size of the household). In this study fees were the most commonly cited financial issue. Nine interviewees (32%) and one focus group (33%) stated that fee collection was a barrier for effective MSWM. Most participants said that they were willing to pay the waste collection service fee and that the price of the fee was reasonable. However, some people refuse to pay the waste management service fee because they claim to manage their own waste and do not use the service provided by the TKYSM. Alternatively, some restaurants and dormitories paid additional fees to a private waste collector. These respondents said they gave extra money (300–1000 baht (US$8–$28), per month) to waste collectors to clear waste from their dormitories.

> *"In the past the authority [TKYSM] collected 50 baht [waste collection fee], I think . . . They [the authority from TKYSM] hardly come now, it's hard to get the authority to come. Some authorities collected the fees and did not hand them to the council. I heard that sometimes no authority collect fee! . . . Some people throw their waste in the field or into someone else's property. Some people have different thinking, they are afraid to pay so they decide to throw the waste elsewhere."* Restauranteur R3 [In-depth interview].

> *"I give them [waste collectors] 500 baht a month and give them beers [personally] plus the tips . . . If you charge per unit, 5 baht per unit, and 10 units. We [normally] pay 50 baht per month [to the TKYSM]. I was asked why I paid that much? Some big apartments only paid 30–40 baht; I don't know why, I just gave . . . The fee collector has changed several times. They're scared to come now. 'They're afraid they will get scolded."* Dormitory owner D5 [In-depth interview].

> *"We had paid 10 baht per month, no problem. And we paid for the bins that are alright . . . But, some families have said that they didn't use the waste collection service; so they do not pay the fees as it is not worth it . . . It's okay if the authority was collecting for the fees."* Residents F1 [Focus group].

For this issue, the administrator of the TKYSM has said that the normal fee rate is reasonable.

"The rate of waste collection fee is normal, so people did not suffer, just 10 baht per household." Administration staff ID05 [In-depth interview].

3.4.2 Insufficient Funding

TKYSM currently pays for the rubbish trucks, maintenance, fuel, collection, and waste disposal. Individuals are responsible for providing their own bins. Six interviewees (21%) mentioned that insufficient funding is a barrier to the effective waste management for the TKYSM. Some residents responded that they thought that the TKYSM might not have adequate funds for effective waste management. However, the TKYSM indicated that there was enough funding for MSWM. Funds come from the annual payments for waste management from the central Thai government, together with the fees paid by residents and businesses. In addition, the Department of the National Resources and Environment Office of Maha Sarakham, can provide further funding if requested.

"There might be limitations on the budget [of the TKYSM]. The large number of nonregistered population [not being included in the budget]; not enough money. It is because the expected volume of waste [that is calculated] is not covered by the budget." Dormitory owner D4 [In-depth interview].

"It is difficult to encourage villagers to participate. We [waste administration of the TKYSM] have arranged waste projects every year, but it seems like we wasted money." Administration staff ID05 [In-depth interview].

Two staff from TKYSM (67%) claimed the budget was sufficient for MSWM:

"We have enough money [for MSWM]." Administration staff ID06 [In-depth interview].

A number of business people indicated they have considered providing different types of bins for their apartments. However, they have not yet because they are waiting for [general] local economic improvement.

"The business is not good so this [changing the bins] cannot be done now because the economy is terrible. We want to do it [change the bins' color]; but we need to wait for the right time." Restauranteur R2 [In-depth interview].

3.4.3 Waste Has No Value

Waste is valuable if there is a demand for discarded materials. Waste separation is the first step. For example, waste is of value to waste pickers who sell recyclable materials, and to farmers, who can turn organic waste into compost or feed for their stock. However, some participants from commercial businesses do not separate waste because it has no value to them, and waste separation takes time. Five interviewees (18%) suggested that "waste has no value". Such a perspective is another

barrier to the effective waste management for the TKYSM.

> *"I do not have time to collect it [recyclable waste], I rarely do it. There is not much to collect. For others [waste scavengers], that is their job; they have to make a living."* Market owner M2 [In-depth interview].

> *"The value [of recyclable waste] is little. It could be 30 baht to 40 baht, it is cheap. Five bottles, two baht per a kilo. They are light and it takes a long time to collect. There are not many of them, so I let the housekeeper take them. I don't want them."* Dormitory owner D3 [In-depth interview].

3.5 Legal and Political Barriers

Many participants indicated there were legal-political barriers to effective solid waste management. Inadequate and weak legislation and conflicting interests were cited as such barriers.

3.5.1 Inadequate and Weak Legislation

Four interviewees (14%) and a focus group (33%) mentioned that "inadequate legislation" was a barrier to effective waste management for the TKYSM. One entrepreneur noted that there are no rules for waste management in some dormitories. Another mentioned the weakness of the regulation. Some villagers highlighted that because punishments for dumping rubbish are inadequate or weak, this behavior continues.

> *"The TKYSM needs to have rules [about waste management], more obvious rules to guide the residents. What do they want us to do? We need to help each other. They need to set the rules and we must follow the rules."* Market owner M3 [In-depth interview].

> *"For example, even they [the TKYSM] have the rules, however people still do the same [wrong thing]. People are not afraid to be fined . . . 'If you discard the garbage here, you will be fined for 500 baht'; nobody follows that because the writer just wrote the sign but has never fined anyone. Don't be afraid, you will never be fined."* Restauranteur R5 [In-depth interview].

3.5.2 Conflicting Interests

Interviewees noted that political problems could be as barriers to effective waste management. Individuals elect to fill administrator positions in local organizations and residents vote. Four interviewees (14%) but no focus group suggested that the elected administrator in order to protect their position avoid conflict. This holds true for politicians too. Respondents thought politicians were afraid to make decisions about waste disposal sites that were unfavorable with residents or the community because they will not be re-elected.

3.6. Population Growth

With the increasing size of the TKYSM population there is a concomitant increase in the amount of waste. There are permanent and non-permanent residents complicating this matter. The budget TKYSM receives from the Thai central government covers only permanent residents. This anomaly was noted and that TKYSM's budget needs to be supplemented for non-permanent residents who put pressure on the existing system. Nine interviewees (32%) and a focus group (33%) talked about "population growth" as a barrier to effective waste management for the TKYSM.

> *"There were too many non-registration populations (temporary population), so the budget would not be enough. Also the amount of waste would not be calculated correctly."* Dormitory owner D4 [In-depth interview].

4. Discussion and Recommendations

The in-depth interviews, focus groups, observations and secondary data, all point to participants not being satisfied with the waste management service from the TKYSM. A SWOT analysis of the results, highlight two main factors for the TKYSM to consider, internal factors and external factors [43,44]. Table 3 presents an overview of the SWOT analysis.

4.1 Internal Factors

Internal factors including technical aspects of MSWM, organizational aspects (staff, policies, plans and strategies), and funding relating to what is happening within the TKYSM.

4.1.1 Insufficient Waste Management Infrastructures

The first internal barrier to overcome is the ineffective MSWM system, the service provided by TKYSM including the waste collection, transfer and disposal.

Infrastructure for of waste operations is lacking (not enough waste bins, waste collection services, and waste collection vehicles). No separation bins are provided; people leave waste in plastic bags beside roads. Some households purchased waste bins but then others used these bins too. People do not know where to put their garbage because there are no fixed waste collection points or times for garbage collection. The TKYSM tries to solve the problem on a day-to-day basis. The waste collection staff collect waste every day but there is still an accumulation of waste. This causes pollution and nuisances such as odor, an increase in disease vectors (flies and dogs) and unsightliness. While the TKYSM has a plan for waste collection routes; waste collectors or staff do not follow the plan because the trucks are usually full before the end of the routes, or the trucks cannot enter some of the route.

Table 5.3: (Manuscript Table 3) SWOT analysis for MSWM in Tha Khon Yang Subdistrict Municipality

	Positive	Negative
Internal	**Strengths**	**Weakness**
	Good policy Enough budget Location is not too far from the disposal site (25 km approximately)	Weak strategy Weak and inadequate regulation Lack of planning Insufficient waste infrastructures (waste bins, waste collection points, waste infrequency waste collection, waste collection and transfer vehicles) Waste fees collection system Lack of information system and training program Lack of staff capability Staff have too great a workload Lack of systems to ensure that staff are rotated through a range of job roles Political influence at the organization level
External	**Opportunities**	**Threats**
	Funding from central government National and provincial levels have policies that support waste management and also be the driver for the TKYSM to develop better MSWM Mahasarakham University could support training or knowledge Peoples' concern about waste problems	Lack of control over operation of disposal site (the TKYSM did not operate or control the waste disposal site, it is owned and operated by another organization) Flat land and flooding location Poor cooperation from residents (especially entrepreneurs) People are unwilling to separate waste at source Increasing population and economic growth may increase consumption and waste Low value (price) of recyclable waste

4.1.2 Organizational Barriers

Opportunities for improvement in organizational structure to create more effective MSWM are discussed below.

4.1.3 Communication

The TKYSM needs communicate more effectively by providing clear information to people encouraging them to take some responsibility for waste management in their households and businesses. Additionally, people need to understand that actions of individuals influence how the system works. TKYSM should communicate using methods that will reach different groups in the community.

4.1.4 Staff

The directors of the TKYSM have policies to support better MSWM. However, strategies to put these policies into action are weak. It is important for organizations to work together to improve implementation of strategies. Staff numbers and capacity within the TKYSM is a weakness. MSWM is but one responsibility in the sanitation and environmental section of the Public Health Division of TKYSM. There are only two official staff with too many responsibilities; their roles also cover environmental sanitation, health promotion, and occupational health. They fulfil roles of sanitation inspector, public awareness trainer, they attend to administrative tasks in the office and do fieldwork [45]. Employees have insufficient education to conduct their work. The operational staff are also required to respond when other sections of the TKYSM call on their assistance.

4.1.5 Information

It is difficult to make reliable decisions on an appropriate waste management system without appropriate information. There is little data collected. Details of waste collection was being recorded in handwritten notebooks that are not considered to be of high importance. For example, when asked for these records, staff could not find one of these notebooks. There are other missing records, including historical records and reports. There is limited data upon which to base decision-making. It is not possible currently to identify trends in change of volume of waste, seasonal variations, type of waste and so on. There is no database to inform managers. Related databases are scattered across institutions that have conducted relevant studies, such as Mahasarakham University and Maha Sarakham Town Municipality, suggesting that a cooperative strategy to collate this data would be successful.

4.1.6 Financial Barriers

Finance is an important issue for MSWM [3]. It was found that financial problems were common among waste processing facilities, including imbalances between revenue and expenditure [16]. Like many Asian cities, TKYSM MSWM budget is spent on collection and disposal rather than supporting waste minimization at the source [46]. Troschinetz and Mihelcic found that finance is one of the three biggest barriers for developing a recycling system in developing countries; on the other hand, household economics is one of the smallest barriers [47].

Many residents are willing to pay for waste collection. Some people said that they would still be willing to pay more if the service improved. TKYSM has a problem with irregularity of collecting fees complicated by variation in price charged to different users of the service. The TKYSM needs to develop an appropriate rate and a payment system that is convenient for residents.

Notably, the staff of TKYSM said that they think that there is enough money for waste management. However if the MSWM system is to be improved, staff consider that waste management demand more of budget. Funds allocated by the Thai government could be used to undertake training projects

within the community. However, accessing these funds requires staff capacity to draft and submit and successful proposals. The problem is reflected elsewhere; Kotuta and Sobhanaboon found that lack of staff capacity in Maha Sarakham Municipality is a cause of waste management and waste collection problems. They also reported that a fee system needs to be developed there as well [48].

4.2 External Factors

External factors – those factors not in the control of the TKYSM but that affect MSWM include social and public participation and cooperation from other related organizations and policy, legal, political barriers, and physical barriers are included.

4.2.1 Social-Cultural Barriers

Negative attitudes and behavior of residents could be seen as social and cultural barriers; limited waste separation by residents, students and entrepreneurs is a barrier to effective waste management. This is a difficult problem because it is only partly controlled by the TKYSM, and is compounded by the rise in population, including large numbers of temporary residents.

In general, people think the value of recyclable waste is very low, so there insufficient incentive to separate waste materials. Business people had varied ideas about the value of waste. Some suggested that while waste might have value, they still see collection and reuse of waste as not worth doing. Mostly, they leave the recyclable waste to housekeepers to collect. The waste then becomes worth money to those who collect and/or sell the waste. However, most people think that is the quick and easy solution for taking their waste away.

Implementing successful recycling and composting programs is important work for the local government. Getting people to consider the value of waste and think before throwing things away can significantly reduce waste volume. “Valorisation” of materials is the basis for all private-sector recycling activity, meaning that even if the owner of an item throws it away, it still has some retained value [7]. Separating waste into recyclable waste, organic waste, and general waste has been successful elsewhere [7,16,23]. Composting particularly is likely to be a good investment in Tha Khon Yang because there is much agricultural land. This would require building better facilities to compost organic waste. However, researchers have indicated that farmers in Maha Sarakham were concerned about inadequate nutrient in organic compost [49].

“*It is hard to solve the problem*” was a common sentiment. “*This is the habit of Thai, it is impossible to change*”. Addressing these attitudes requires input from many sections and the TKYSM needs to organize training or education programs to encourage people to be concerned about their waste problems and to change their habits, particularly with respect to waste separation. Promotion of public participation or education campaigns is needed to encourage residents to separate waste at source and to increase the recycling rates [7]. TKYSM needs to understand their residents’ culture and

determine suitable solutions to develop a new system that covers the whole process of waste management.

There is a lack of communication between local government and public. Provision of information about waste management is insufficient and the format of disseminating information needs modification so that people can understand. Lack of awareness of the population was a concern for the entrepreneurs. However, based on the students (tenants) and other residents' focus group, it seems there is awareness within some groups about the value of waste separation. These groups indicated that they are ready to separate waste if the separating waste system is easy to understand and follow. From observations made during the community meetings, the researcher witnessed that villages leaders are both willing to participate and are very concerned about waste management.

4.2.2 Legal and Political Barriers

There are good policies for MSWM in TKYSM but poor strategies to solve waste problems in the area. This makes it difficult for people to understand how to participate or follow the policies of the TKYSM. For example, from the attitude of participants it was clear that consideration of waste management by businesses is still poor; many businesses have not developed or implemented waste management systems.

The TKYSM claimed they had tried to encourage people to separate waste; however they failed to enforce this. This suggests that legal implementation is required. Tightening of laws may encourage waste separation, and the TKYSM should establish their own rules to support their system and encourage people to participate in the waste management system.

The political context of local government affects MSWM in many ways [2]. Because the Director of every municipality is elected by the public, there is pressure on the Director to make popular decisions that will help them retain their role for as long as possible. This makes the implementation of change that will affect peoples' lives challenging, and encourages a status quo.

4.2.3 Physical Barriers

Tha Khon Yang area is flat land and flooding is common. It is difficult to find suitable space for waste recycling and disposal both because of the geography and opposition from local people who are afraid of pollution and who do not trust that waste will be managed correctly. This lack of space is identified in the waste management and hazardous waste plan for the Maha Sarakham Province (2015–2019); and the requirement for large areas of land for new waste disposal in this area [50].

In addition, Malaysia [51] and Vietnam [52] are experiencing population increases in immigration and large numbers of unregistered population, and an increase of visitors places like in Bang Saen, popular beach in Thailand [53] or in Bali, Indonesia [54], making it difficult to create waste management plans.

Principally, planning is the first step in designing or improving a waste management system [3]. Proper waste collection is an essential function of government authorities. Waste collection is one of the key components of an integrated sustainable waste management system and it is one of the main functions of urban services [7,55]. Therefore, the TKYSM needs to overhaul its waste collection system with a clear plan for MSWM including minimizing waste generation, more efficient and effective waste collection, transfer, and transportation to a final disposal site. With the centrally managed budget, the TKYSM needs to have a plan to spend money on waste management for the long term. Purchase of additional trucks was a common suggestion from residents; however, this option will be very costly. Redesigning waste collection routes with increased frequency of waste collection or waste transfer points and a waste separation system, together with residential or waste separation at source, might mean that the additional truck purchase is not necessary in the short term. More immediately, the TKYSM needs to prepare an emergency plan for situations such as when the landfill disposal site closes. Currently, methods used to deliver information are inappropriate or ineffective. Using appropriate technology (e.g., creating brochures, use of internet, emails, etc.) to improve information transfer will require training and human resource development.

5. Conclusions

This study has found the waste management system of the Tha Khon Yang Subdistrict Municipality cannot support the current increase in waste generation. Opinions from various stakeholders provided significant insight for the TKYSM to consider. There are many barriers that the TKYSM must overcome including: technical, organizational, social-cultural, financial, legal-political and population growth.
The findings of this study will help the TKYSM policy makers develop an effective and appropriate MSWM for Tha Khon Yang. This study may lead the way to develop a new waste management approach and a new waste management system. This new approach could be adapted to other local areas in Thailand or other developing countries that are facing similar problems.

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Author Contributions

Nachalida designed the research proposal, undertook fieldwork and transcribed conversations from interviews and focus groups. She also undertook translation from Thai to English. Beverley and Kirstin provided guidance through the fieldwork and throughout the manuscript preparation. All authors contributed to the methods design and drafted manuscript and the framework for the coding process. Kirstin checked the manuscript and edited the English language and grammar.

Conflicts of Interest

The authors declare no conflict of interest. The sponsors (Mahasarakham University and Flinders University) for the study had no role in the design of the study, collecting data, and writing of manuscript or in the decision to publish this manuscript, and in the decision to publish the results.

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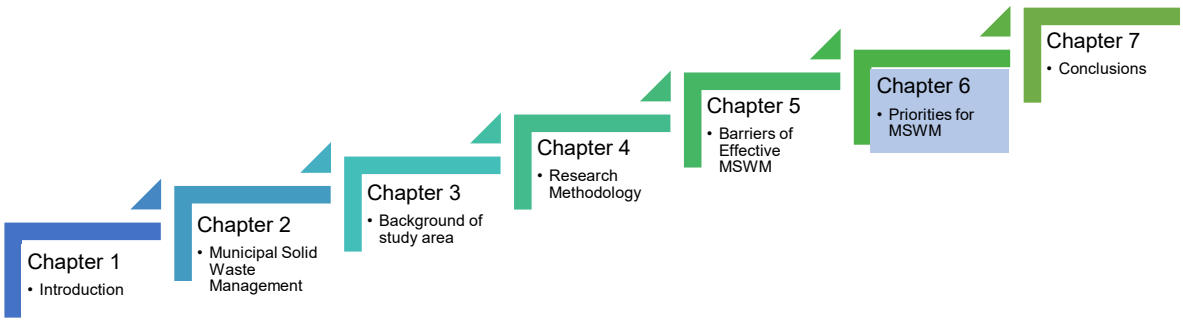
CHAPTER 6 PRIORITIES FOR MSWM



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(See Appendix I3)

Solid Waste Management Solutions for a Rapidly Urbanizing Area in Thailand: Recommendations Based on Stakeholder Input

Abstract

Municipal solid waste is a significant problem, particularly in developing countries that lack sufficient infrastructure and useable land mass to process it in an appropriate manner. Some developing nations are experiencing a combination of issues that prevent proper management of solid waste. This paper reviews the management of municipal solid waste in northeast Thailand, using the Tha Khon Yang Sub-district Municipality (TKYSM) in Maha Sarakham Province as a case study. The combination of rapid population and economic growth and its associated affluence has led to an increase in the use of consumer items and a concomitant increase in the production of municipal solid waste. In the TKYSM there is pressure on local government to establish a suitable waste management program to resolve the escalating waste crisis. The aim of this study is to provide viable solutions to waste management challenges in the TKYSM, and potentially to offer guidance to other similar localities also facing the same challenges. It is well established that successful changes to waste management require an understanding of local context and consideration of specific issues within a region. Therefore, extensive community consultation and engagement with local experts was undertaken to develop an understanding of the particular waste management challenges of the TKYSM. Research methods included observations, one-on-one interviews and focus groups with a range of different stakeholders. The outcomes of this research highlight a number of opportunities to improve local infrastructure and operational capacity around solid waste management. Waste management in rural and urban areas needs to be approached differently. Solutions include: development of appropriate policy and implementation plans (based around the recommendations of this paper); reduction of the volume of waste going to landfill by establishing a waste separation system; initiation of a collection service that supports waste separation at source; educating the citizens of the municipality; and the local government staff, and for the local government to seek external support from the local temples and expertise from the nearby university.

1. Introduction

Globally, population growth, together with economic growth and associated consumption behaviour, has resulted in a significant increase in solid waste production [1,2]. In developing countries, managing municipal solid waste (MSW) is a serious problem [2,3]. Urbanisation and increasing affluence have resulted in a significant increase in volumes of discarded materials [4–6].

The problem of MSW is particularly challenging for large cities in developing countries [7,8] and for local levels of government that are typically responsible for managing waste [3,9].

MSW is defined as local waste generated by households and commercial and governmental enterprises. It includes packaging, food waste, grass clippings, clothing, paper and other solid forms

of waste, but does not include hazardous and infectious waste or sewage [3,9,10]. It is estimated that the volume of MSW could double from current levels of 1.3 billion tonnes annually to 2.6 billion tonnes by 2025 [10].

In developed countries, MSW is usually well managed. Often the highly technical and complicated methods of dealing with MSW used effectively in developed countries are brought to developing countries. However, these solutions are often not sustainable due to lack of capacity and the incongruity of trying to establish systems in dissimilar situations [11,12].

Municipal solid waste management (MSWM) in developing countries accounts for between 20% and 50% of local government budgets [3]. Studies show that more than 50% of developing countries' populations lack consistent access to waste collection services [5,6]. Disposal methods often include open dumping and open burning [5]. The World Bank reports vast amounts of uncollected waste in urban areas; estimates suggest between 40% and 70% of discarded materials remaining uncollected [6]. This pollution leads to significant impacts on human health and the environment [4,13].

In keeping with global trends, waste generation in Thailand is increasing. From 2008 to 2016, waste generation increased from around 24 million tonnes per year in 2008 to over 27 million tonnes [14,15]. The Thai Government in recognising the problem released its Roadmap for Municipal and Hazardous Waste in August 2014 [16]. The Roadmap was coupled with a devolution of responsibility for MSWM from central to local government [17]. The central Thai government transferred functions, budget, and personnel to local governments, which means local governments now play a lead role in the management of solid waste within their jurisdictions [18]. There is limited data about the specific amount of waste generated in individual districts Thailand; however, the Pollution Control Department of Thailand reports that the northeast Thailand is generating of highest volume of waste in the country [19].

However, there are many issues preventing the implementation of a successful MSWM system in Thailand. Thai municipal governments are focused on other pressing problems such as water and sewage infrastructure, road maintenance, public amenities, and disaster response. Waste management is often not the priority [3]. In 2016, it was estimated that of the 7777 Thai local governments, only 60% provided a waste collection service. Of this 60%, only two-thirds is transferred to sanitary landfill sites [14]. An absence of a functioning MSWM service leads to open burning and open dumping and environmental pollution and health issues. There have been public protests in Thailand about such insanitary conditions [20].

This paper focusses on the Tha Khon Yang Sub-district in the Maha Sarakham Province in the northeast of Thailand (Figure 1). Tha Khon Yang (TKY) comprises 15 villages. Maha Sarakham city has become an education hub with several universities and colleges, the largest being the Mahasarakham University. In the last two decades, five of the 15 villages of TKY have transitioned from rural to urban settlements. In the TKY, there are 8400 permanent and approximately 25,000

Figure 6.1: (Manuscript Figure 1) Location of Tha Khon Yang Sub-district in the Maha Sarakham Province in the northeast of Thailand. (Sources: Esri, USGS, NGA, NASA, CGIAR, N. Robinson, NCEAS, NLS, OS, NMA. Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community Boundaries: GISTA (Geo-Informatics and Space Technology Development Agency).

temporary residents (students or workers) [21]. As a result of the expansion of the Mahasarakham University accommodation and commercial enterprises have spread into the adjacent Khamriang Sub-district as well as the TKY. Urbanisation has had the combined effect of increased consumption of goods and concentrated the waste that is generated. In 2010 administrators of the Mahasarakham University, concerned with the increasing volume of waste produced within its campuses, created a zero-waste policy and implementation plan. This plan included additional waste management facilities and promotion of awareness of solid waste management approaches for their staff and students [22]. The Mahasarakham University introduced recycling banks, waste separation sites, and bio-fertilizer production from compost [23]. This reduced the volume of waste going to landfill by several tonnes per day. In 2015, the University was recognised by the Green University campaign for its commitment by achieving a place in the UI Green Metric World University Ranking [24].

The Department of Public Health and Environment in the Tha Khon Yang Sub-district Municipality (TKYSM) has responsibility for municipal solid waste. The Department has no formalised or articulated policy or plan to guide waste management; nor is there a published strategic plan or vision for future waste management. In addition, the TKYSM waste collection team has responsibilities outside of waste management. The TKYSM Department of Public Health and Environment, in addition to MSWM, is responsible for assisting in the delivery of health promotion initiatives, food safety, vector control and emergency response. These functions are carried out by a team of 10 operational and 2–3 managerial staff.

The annual revenue for the TKY raised from the contribution from the central Thai government, together with fees paid by residents and businesses for waste management is approximately 3 million baht (US$94,800—based on 2015 figures). This revenue funds waste collection (the purchase and maintenance of trucks, fuel, salaries of staff), and landfill fees for final waste disposal. The TKYSM pays a significant proportion of its budget in landfill fees (400 baht (US$11.60) per tonne of waste).

Currently, the TKYSM provides some large ‘community’ bins, while some residents provide their own bins or bags, which are placed randomly on curbsides. There are no fixed waste collection points. Twice daily from Monday to Saturday, three waste collection trucks (each with one driver and two collectors) service seven zones in TKY. This collection service covers 76% of the TKY municipality [25]. Each truck services a different zone. One collects from the off-campus dormitories, the second covers rural areas and the third covers the urban area. Each truck follows its own standard route. The trucks are not always able to complete one collection cycle in a day because trucks, when filled to capacity before their round completion, must go to the landfill site 25 km away. The trucks recommence their collection cycle where they left off. However, in the meantime, waste accumulates throughout the municipality on curbsides, where it is placed continuously for collection because residents have no notification of a fixed collection time. During the collection process, to generate extra money for personal profit, the waste collectors try to select and separate sellable items. Of the

estimated 15 tonnes of waste generated [26], only 10 tonnes are collected and transferred to the landfill. The rest remains in situ as pollution.

In a bid to reduce the volume of waste going to landfill, TKYSM encourages households to separate recyclables and compost organic waste and, at times, has encouraged citizens to burn their waste. To date, these approaches have not been successful. The challenges of waste management for TKYSM, as identified by a broad stakeholder group ranging from government staff to residents and entrepreneurs, are detailed in Yukalang et al. [27]. This study is novel because it presents an overview of engagement with stakeholders from a wide range of levels in MSWM. This approach, while strongly recommended by UN-HABITAT in Solid Waste Management in the World's Cities [2], is still often overlooked [6,28–30].

The aim of this paper is to present solutions based on an understanding of the region and its particular waste management challenges. The solutions for this study might be useful for other municipalities facing similar problems.

2. Materials and Methods

Following the Integrated Sustainable Waste Management (ISWM) framework, this study evaluated the current solid waste management system in TKY. The framework recognizes the importance of evaluating local conditions and needs and creating place-appropriate solutions [4].

ISWM theory recognizes three key components: the stakeholders affected by or engaged in waste management, physical or practical elements of the waste management system and an array of 'aspects' that directly affect waste management including political and cultural influences (Figure 2) [31].

To gain an understanding of the MSWM system, the waste management processes from point source to final disposal were observed, and primary and secondary reports and data scrutinised.

In conjunction with site visits, observations, and secondary data analysis to determine the specific waste management issues facing the TKYSM, semi-structured, one-on-one interviews and focus groups were conducted to further investigate and understand the perspectives of local stakeholders [32].

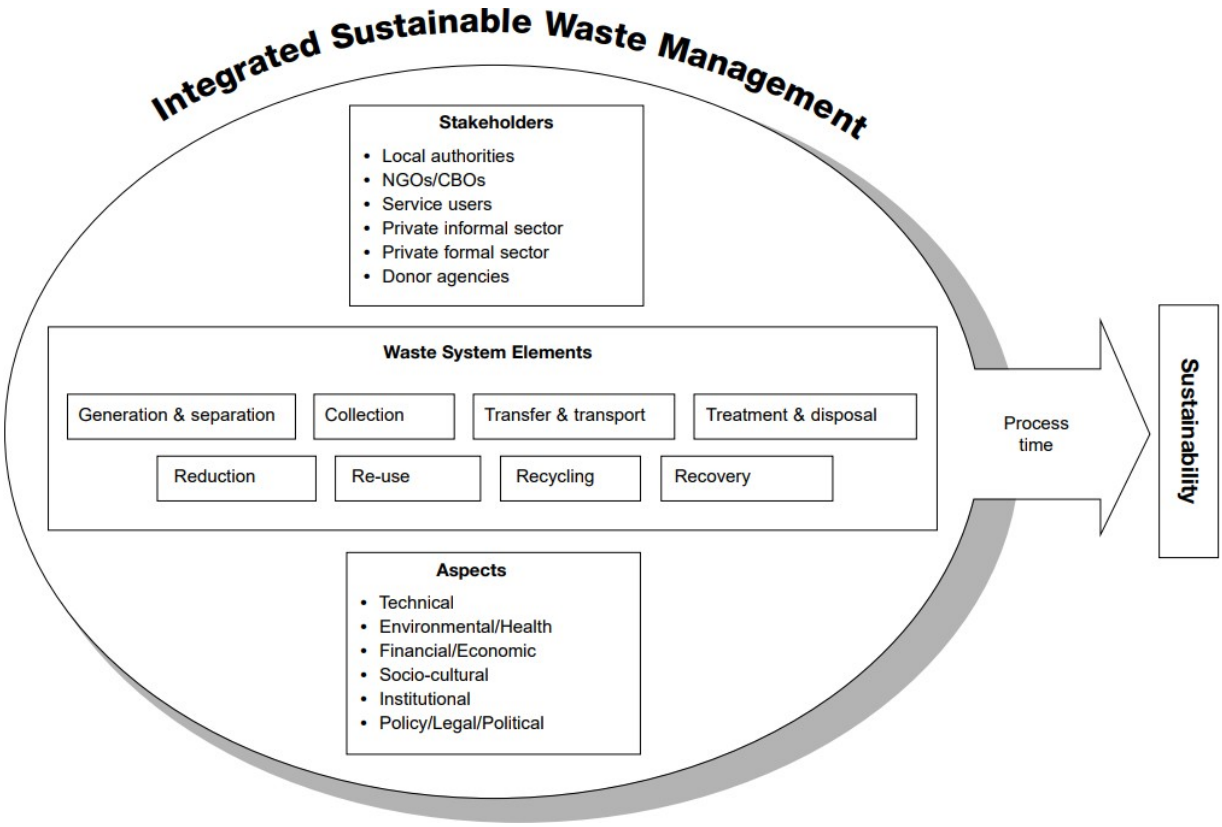

Figure 6.2: (Manuscript Figure 2) Integrated Sustainable Waste Management model (Source: Putting Integrated Sustainable Waste Management into Practice, 2004) [31].

Following the framework and criteria described by UN-HABITAT stakeholders were identified, including service providers, citizens, external agents or experts) [2]. Research instruments, for the focus groups and interviews were approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784) in April 2015. Purposive sampling and snowball sampling (nonprobability sampling approach) [33–36] were used to select 34 in-depth one-on-one interviewees and 24 participants for three focus groups. All participants participated voluntarily [36]. Data collection was carried out between May 2015 and August 2016 in the TKYSM, Kantharawichai, Maha Sarakham Province.

In this study, participants were selected to represent a broad cross-section of Thai society across a range of different socio-economic groups, including low, medium and high status (Table 1). The defining characteristics of participants was employment and education (because they are related to income) [37]. Participants with tertiary education and in white collar employment or business ownership were classified as high socioeconomic status (SES). Those on low incomes doing more menial work were classified as low SES, this includes operational staff and waste pickers. Villagers and village leaders are mostly farmers, and although some of them have leadership positions in their villages, they do not receive a high income and were therefore classified as middle income. Students

were also classified as medium because they have a high education, although low incomes. A number of different strategies were employed to identify, contact, or approach potential participants.

Purposive sampling was the main technique used to identify participants for the structured and non-structured interview [36]. Interviewees were selected by four different strategies. First, at community meetings a senior delegate introduced the research project and invited village leaders to participate. Second, the researcher created a listing of establishments (e.g., restaurants, markets and dormitories) from two urbanised zones and selected a sample from three different-sized businesses (small, medium and large). The researcher visited selected entrepreneurs and delivered the research instruments. Third, emails were sent to some known academics asking them to participate in the study. The email invitation encouraged these first contacts to forward the invitation to other relevant academics with expertise in waste management (snowball sampling). Finally, the researcher called secretaries of waste management administrators, inviting the participation of the senior staff. On deciding to participate, all invited participants contacted the researcher and made time for appointments. The waste operator for MSU was contacted as were the academics, and the recycling trader and scavenger. Unstructured interviews were conducted with the recycling trader, the operational staff within the university, and the waste picker. To do these, the researcher visited them at their workplace and the landfill site, and could interact with them onsite. The strategy used to select focus group participants was purposive sampling. Key contacts were asked to suggest possible participants who were then approached to ask whether they would be willing to participate. Residents from different villages, students (tenants) from different off-campus dormitories and waste management operation staff of TKYSM volunteered to participate in the focus groups. Three focus groups were run, with up to ten participants each (Table 1).

Key questions asked of interviewees and focus group participants are shown in Tables 2 and 3.

Interviews took from 20 to 40 min. Focus groups took from 60 to 90 min. Conversations from both interviews and focus groups were recorded using digital audio recording devices. During the focus groups, the researcher moderated, and assistants took notes and managed the recording device. Audio files were transcribed in Thai language onto a word processor and then uploaded to NVivo, qualitative data management software, for coding and analysis [38]. Quotes presented here are well articulated responses to questions and represent themes raised by multiple respondents.

Table 6.1: (Manuscript Table 1) In-depth interviews and focus group participants.

List of participants	Number of participants		Socio economy status
	In-depth interview	Focus group	
Providers			
Administrators of the TKYSM	3		High
Operational waste management staff of the TKYSM		10	Low
Users			
Leaders of villages	4		Medium
Restaurateurs	6		High
Off-campus student accommodation owners	5		Medium
Minimart Owners	4		High
Local residents living in Tha Khon Yang area		8	Medium
University Students, living in off-campus student accommodations in Tha Khon Yang area		6	Medium
External agents and experts			
Academics			High
University lecturers of Mahasarakham University	3		High
University lecturers of Mahidol University, Bangkok	3		High
School teacher from Primary School, Tha Khon Yang Sub-district, Maha Sarakham Province	1		Medium
Other organizations related to MSWM			
Director of the Provincial Natural Resources and Environment Office, Maha Sarakham Province	1		High
Waste operator of Maha Sarakham Town Municipality	1		High
Waste operator of Mahasarakham University[1]	1		High
Recycling trader[1]	1		Medium
Scavenger in Landfill site of Masasarakham Town Municipality, located in Waeng Nang Sub-district, Maha Sarakham Province[1]	1		Low
Total	**34**	**24**	

[1] An unstructured interview was used for adding missing information and to avoid bias

Table 6.2: (Manuscript Table 2) Key questions for interviews (note: these interviews were semi-structured, and 3 unstructured interviews were also conducted).

Number	Key Questions for Interviews
1	How effective do you think the municipal solid waste management is in the TKY (a scale of 1–5 where 1 is very ineffective and 5 is very effective)?
2	What are the most successful or best aspects of solid waste management in TKY?
3	In your opinion, what are the main challenges or worst aspects of solid waste management in this area?
4	What are the causes of, or obstacles for, municipal solid waste problems in this area?
5	What improvements need to be made in regard to MSWM in the TKY?
6	Do you think the waste problems affect (a) the environment (b) health of people (c) operational costs of waste management (d) other aspects in this area? (these were asked as four separate questions)
7	What technologies do you think are needed to improve solid waste management in the TKY?
8	What improvements could be made to the MSWM system?
9	What is the most important aspect that should be addressed?
10	What improvements could be made to help you undertake your own role (in the MSWM sector) more effective?
11	Who should be responsible for making these changes?

Table 6.3: (Manuscript Table 3) Key questions for focus groups.

Number	Key Questions for Focus Groups
1	What are the most successful or best aspects of solid waste management in TKY
2	In your opinion, what are the main challenges or worst aspects of solid waste management in this area?
3	What are the causes of, or obstacles for municipal solid waste problems in this area?
4	What improvements need to be made to overcome these problems?
5	What is the most important aspect that should be addressed?
6	What is the first aspect that you think it could be done as soon as possible?
7	Who should be responsible for making these changes?

3. Results

The results presented here largely reflect respondents' ideas for solutions to waste management challenges in TKY. These are preceded by a brief overview of the site visits and observations made by the researcher, which confirm the scale and impact of uncollected and unmanaged municipal waste.

3.1 Observations

Site visits along the streets of TKY confirmed that pollution from open dumping is widespread and common. The photographs show that the population of TKY dispose of their waste onto curbsides in

plastic bags, which break apart, and litter scatters into the streets and adjacent spaces. These temporary waste disposal sites are unsightly and generate strong odours (Figure 3).

(**a**) (**b**)

Figure 6.3: (Manuscript Figure 3) Typical scene of road-side waste in Tha Khon Yang.
(**a**) Urbanized zone 1 (Observed 2/09/2015); (**b**) Urbanized zone 2 (Observed 25/07/2016)

3.2 Participants' Responses

The majority of participants in this study agreed that solid waste management is a problem for TKY. The results suggest that socioeconomic status (SES) (defined here by education and employment) had very little influence on attitudes of respondents to waste management. All participants regardless of their SES were very concerned about waste management and gave detailed feedback about how to improve the MSWM system for TKY.

When asked, "what improvements need to be made in regard to the municipal solid waste management in TKY?", the most common response across all stakeholder groups related to ineffective collection processes that lead to waste accumulation. In other words, there was an emphasis on the technical aspects of MSWM (Figure 4). Lesser consideration was given by participants to the institutional and organisational, social-cultural, legal and political, financial and environmental and health aspects of MSWM. All quotes presented here are coded from answers from the semi structured and unstructured interviews and focus groups.

The results presented below are organised according to the structure of the ISWM framework in Figure 2. The remainder of this section presents the recommendations of participants as to how to improve the MSWM system of TKY, arranged according to the Integrated Sustainable Waste Management (ISWM) framework.

3.3 Technical Recommendations

The technical components (Figure 2), provide a guideline by which to consider the practice of waste management. The technical components of an efficient waste system are two tiered. The first tier

includes the process for collecting and transferring waste (facilities and equipment). The second tier corresponds to waste reduction techniques such as composting, recycling or reusing waste [4]. Technical solutions associated with MSWM were the primary focus of participants. Each of the three focus groups and 25 (81%) interviewees gave 147 individual quotes dedicated to technical solutions (Figure 4). Participants cited solutions about the need for facilities to support waste separation, waste containers, waste collection points and more or modified waste collection vehicles. Technical solutions also included increasing the frequency of waste collection days, and changes to collection routes. Second tier solutions of waste reduction through recycling and composting were also mentioned.

> *"I am interested in waste disposal and sustainable management systems ... having a truck collecting waste every day, different types of waste bins and having junk shops buying recyclable items."* ID13 [In-depth interview]

A restaurateur suggested that changing packaging products was an efficient way to reduce waste entering the waste stream, but that this had knock-on effects.

> *"Foam [for packaging take-away food items] poses the same problem as plastic, they are not bio-degradable. But they are cheaper than the bio-degradable products like [containers] made from bagasse [sugarcane]. If we want to use bagasse for food containers, we need to raise the price of the food we sell."* R6 [In-depth interview]

According to Figure 2, 'waste generation and separation' is the starting point of the waste management system. Many participants (three focus groups and 11 (35%) interviewees), thought that a simple and convenient waste separation system for the community was an important solution for waste management in TKYSM. The provision of colored or labelled bins to assist waste separation would assist people to undertake waste separation at the source.

> *"How can we [off-campus student accommodation owners] help? First, we have to provide different kinds of bins with attractive signs, and then announce it to tenants. The tenants will be then able to understand which bin is for recycling, garbage or food waste."* D4 [In-depth interview]

Compartmentalised trucks allowing for waste separation at the collection point or multiple runs for different waste types (e.g., one run landfill, one run recyclables) were also suggested as mechanisms to assist in waste separation.

> *"Waste collection trucks could have separate boxes for different types of waste."* F2 [Focus group]

"The TKYSM needs to administer an appropriate waste separation system and process using separate waste collection trucks for different waste types; also, there needs to be waste separation bins for people." ID11 [In-depth interview]

"If people separate their waste then trucks could collect food waste one day; and another day collect paper or recyclable waste." ID11 [In-depth interview]

A number of different ideas about 'collection' and 'transfer and transport' (Figure 2) were suggested by respondents including: clearly identifying waste collection points, improving the frequency, efficiency and effectiveness of waste collection; increasing the number of trucks and/or improving truck capacity or design. It was also noted that Geographic Information Systems (GIS) modelling could help improve the efficient design of waste collection routes.

"Effective waste collection routes will save time and could expand the system to collect waste in every area." D4 [In-depth interview]

'Waste treatment and disposal' is the final element in the waste management system (Figure 2). Currently, TKYM has limited facilities to process its own MSW.

In terms of tier two solutions to reduce waste, participants identified the need and potential for the construction of a waste separation facility, recycling centers and/or community or household composting facilities. Several participants and entrepreneurs (from restaurants) saw the benefit of changing organic waste to compost and utilising food waste to feed animals. This would result in a reduction of waste being processed through the system and lower the volume of waste going to landfill.

"TKYSM should establish a recycling center for buying recyclable waste." ID03 [In-depth interview]

"Some communities might have a small composting plant. TKYSM could encourage the villagers to make composting on site for each household." ID11 [In-depth interview]

According to a staff member from the TKYSM, the municipality plans to develop a pilot waste separation and composting project in two villages. Each village will have their own waste separating site and local people will be hired sort the waste. This respondent concluded that setting up MSWM programs and encouraging local people to separate waste in rural areas would be easier than in the urban areas where space is limited. If this pilot project is successful, it could be used as a model to apply in other villages.

"I would start the pilot project with two rural villages. Rural communities will have black bins for organic waste and other colored bins for general waste. People could learn to manage and separating waste by themselves." ID05 [In-depth interview]

A few participants (4 (13%) interviewees) suggested the Provincial government should identify and develop a new landfill site specifically for the TKY.

> *"Find space and develop a landfill site for TKY."* ID06 [In-depth interview]

3.4 Financial-Economic Recommendations

The technical solutions described above require funding. Two academics and one external expert stressed the importance of a suitable budget for further development of the system. The 'financial/economic' aspect of Figure 2 refers to costs inherent in the operation of a waste management system as well as sources of revenue including fees and income generated from the sale of recyclable items.

A number of ideas were offered by study participants to increase the funds available for advancing waste collection and management.

> *"Why don't they [the municipality] collect fees via taxes [like] organizations such as water, electricity or other services?"* ID11 [In-depth interview]

Collection of fees from households towards their waste management in TKYSM is ad hoc (see Yukalang et al. [27] for details). A solution suggested to improve revenue raising was to give the community more power to manage their own waste collection fees.

Another participant noted that money from selling recyclable waste could be collected and funnelled back into MSWM—perhaps via a village waste fund. The potential value of waste, through recycling and reuse, was noted by a number of participants.

> *"We have to see value in waste; it is a resource; [scavenging] is the kind of work that can earn money. In a municipality, if someone knows how to manage [sale of recyclables] well, that is money. . . However, to have this, [appropriate management of MSW], available space and a proper budget is necessary."* ID10 [In-depth interview]

> *"Waste from the newer [wealthier] communities can make more money-people there dispose of larger quantities of valuable recyclable waste. On the other hand, people in older villages usually separate recyclable waste to sell it anyway."* ID05 [In-depth interview]

3.5 Social and Cultural Recommendations

Participants identified 'socio-cultural' aspects of MSWM in terms of raising public awareness and enhancing participation in waste management. Socio-cultural aspects were the second most commonly cited solutions. Social and cultural solutions were generated by the three focus groups and 21 (68%) interviewees, resulting in a total of 76 individual quotes (Figure 4).

When asked, "who should take responsibility for waste management?" most participants replied that 'everyone' should take responsibility. In order for improved practices and changes in behaviour,

participants explained that a change attitude of TKY citizens to waste and its management is essential. Solutions for changing attitudes included increased education, making use of important cultural places, implementing rewards and increasing social pressure to do 'the right thing'.

> *"We need to educate people to think that waste can be precious things to change their attitudes."* ID01 [In-depth interview]

> *"It takes time to install or use social pressure to make people know that it is wrong to dispose of waste . . . if someone knows how to manage it well, that is a resource and money."* ID10 [In-depth interview]

With the exception of operational staff and market owners, every stakeholder group suggested that education is the mechanism by which to change attitudes. There is potential for the Thai education system as a whole to help usher in change, but other key leaders and influential people were also identified as playing a role.

> *"A person that can reach people such as village health volunteers and staff from primary health care centres could educate people. Leaders of villages could inform people using basic knowledge."* F2 [Focus group]

> *"The [national] Education Department could set waste management as a national issue; with every school separating its waste."* ID08 [In-depth interview]

Some participants were already involved in waste management education, and others (village leaders, school teachers and academics) indicated a willingness to be involved in the future.

> *"Now, I [school teacher] am starting to train students about waste separation. There will be discussion in the classrooms. I will focus on the students by building discipline in them."* ID15 [In-depth interview]

> *"As I am a leader of a village, I have a special responsibility for waste management by informing local residents to separate their waste."* ID02 [In-depth interview]

Some villages' host training programs (such as composting, biogas fermentation and establishing recycle banks where waste materials are bought and sold) run by municipality staff and academics from Mahasarakham University. Through these projects, people learn the value of waste, and as a result, reuse, recycle and reduce waste going to landfill.

Thailand is going through a transitional period where the culture of older Thai people (particularly in city areas) is quite different to younger generations. Several university students said that education about waste management needs to have impact.

"To inform people about waste, it needs to be something interesting. What about a short film contest? This would ensure that information can easily reach and inspire students to be concerned about waste." F2 [Focus group]

A restaurateur (and a dormitory owner) highlighted that temples are an important hub for the people of TKY. Ninety-five percent of Thais are Buddhist [39]. Temples provide a meeting place for the community and as such can provide a place for learning.

"I used to write waste management songs for singing in a temple." D5 [In-depth interview]

Temples receive recyclable waste as donations and the monks sell on these goods. A participant suggested that this practice could be encouraged and expanded. As the monks are respected it is likely citizens would bring high quality recyclable items.

"The TKYSM should ask a temple to be a recycling center. People will bring good recyclable waste there." R2 [In-depth interview]

Some participants suggested financial rewards and praise as methods as encourage people to participate in waste management.

"How about giving a reward for people who separate waste? If we give recyclable waste to the owner of accommodation and in return, they reduce the electricity cost for us, it would be nice." F2 [Focus group]

"We can also promote it as beneficial for student accommodation to get a five-star award. The benefit of sorting waste is earning money back and it is also easier to manage by making rules for tenants." ID09 [In-depth interview]

3.6 Institutional/Organisational Recommendations

Solutions for the 'institutional/organisational' aspects (Figure 2) are focused on the TKYSM, around organisational structure, planning and decision-making, and staff capacity for managing waste. Two focus groups and 19 (61%) interviewees mentioned institutional or organisational solutions, with a total of 48 quotes focussed largely upon improving municipal staffing matters (Figure 4). For example, staff duties are often split across portfolios and waste management is not always the priority; employees need to have a better understanding of their roles and responsibilities; staff capacity needs to be improved through training or education programs; and there are too few staff.

Participants identified the need for defined duties within the TKYSM. A mechanism is also required to ensure that individual staff fully undertake their specified role:

"They [the municipality should] require staff to work seriously." ID10 [In-depth interview]

The municipality would benefit from a strong and clear MSWM implementation plan to guide staff at all levels, from the director to the collectors, including a clear mandate about staff duties and responsibilities. It was also suggested that staff responsible for MSWM should not have other responsibilities that take them away from their primary role.
Developing staff capacity will improve MSWM. It may be that the TKYSM needs to invest in staff training. One expert suggested:

> *"Private consultants may need to be engaged to train staff appropriately."* ID10 [In-depth interview]

According to some participants, TKYSM is not entirely responsible for finding solutions for its waste management problems. One focus group and 14 (41%) interviewees indicated that stronger relationships with higher tiers of government and with other organisations is important. For example, there is potential for TKYSM to seek support and advice from the Mahasarakham University which has implemented a good waste management system. The University could be a model of MSWM efficiency and provide expertise to design improved system operations, such as more efficient waste collection routes and to build municipal staff capacity.

> *"The Mahasarakham University can design and offer new systems for the TKYSM. I do understand that the TKYSM has a limited budget, [so, for example] if the university helps by giving some suggestions about effective waste collection routes to suit a budget, this should include staff requirements and routes required per day."* D4 [In-depth interview]

In addition to TKYSM's responsibilities, participants indicated that they thought that higher tiers of government should play a role in MSWM because they have a responsibility to assist subdistricts to work and plan together. An example of how institutional cooperation might help was suggested by the director of the TKYSM, who referred to establishing a new landfill site.

> *"We need help from the Provincial Administrative Organisation and the District Office. They have power to find space and develop a landfill site. They have more authority to create cooperation between sub-district municipalities. How can this happen?"* ID06 [In-depth interview]

3.7 Policy, Legal and Political Recommendations

'Policy, legal and political' aspects are those supporting conditions that help regulate the proper management of waste. Twenty-two opinions from one focus group and 7 (23%) interviewees indicated that legal and political factors influenced MSWM and that laws and regulatory frameworks should be strengthened.

"If they [TKYSM] don't hurry up and develop municipality law, waste will be difficult to manage and control. The best solution is to let people follow the law. Law is important; it can do everything. People love laws." ID08 [In-depth interview]

"Actually, the law [the Public Health Act A.C. 1992] under Section 3: Waste and sewage disposal, the municipality has the authority to dispose of waste in an authorized area. So, they need to set rules for waste management. They need to consult lawyers from the Public Health lawyer center for establishing the municipality law. And [TKYSM] has to follow it seriously and continually." ID10 [In-depth interview]

One participant commented on the potential for policy in provincial and sub-district level to bring credit to the area:

"Making a provincial policy might be a remarkable campaign for this province." R4 [In-depth interview]

Several academics gave suggestions to push politicians to engage with MSWM projects, including:

"We need to encourage them [politicians] as it will help them get votes. Don't talk about environment. Because the politicians will care only about their [re-] election . . . we can say 'If you can keep the town clean, within the next 10 years, people will vote for you.' " ID10 [In-depth interview]

Figure 4 presents a summary of the focus of all of the quotes emerging from the unstructured and semi-structured interviews and the focus groups, categorised according to the categories of the ISWM.

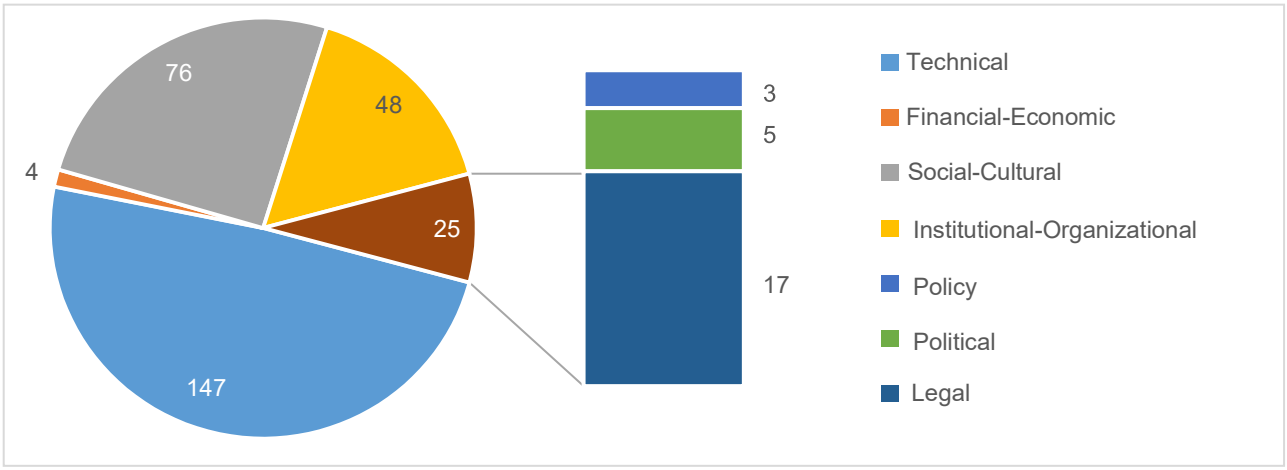

Figure 6.4: (Manuscript Figure 4) Thematic content of all of the quotes emerging from the unstructured and semi-structured interviews and the focus groups, categorised according to the categories of the ISWM (policy-legal-and political-based quotes are presented together in the pie chart and separated for clarity).

Measurable, sustainable indicators are presented in Box 1.

Box 1: Measurable sustainable indicators for MSWM in TKYSM.

Measurable sustainable indicators for MSWM in TKYSM (adapted from the ISWM framework for six target aspects) could include:

Technical aspects:

- Volume of waste going to landfill is decreased within a short and long term.
- Facilities for waste separation system are established, including waste containers and waste collection points.
- A waste separation plant, recycling centre and composting plants are established.

Financial-economical aspects:

- Cost of waste disposal to landfill site is reduced compared with previous years.
- Income is generated from selling recyclable items.
- Locals or scavengers are hired in the new waste management system.
- Implementation of a waste collection fee-paying system that easy to understand and complied with.

Social and cultural aspects:

- Engagement with, and support from, the community in MSWM (measured by survey).
- Development of a waste management team or network for monitoring, which consists of local residents, entrepreneurs, students with help of TKYSM, schools and university.

Institutional/Organisational aspects:

- Production of a well-developed, articulated MSWM strategy and implementation plan.
- Hiring of adequate staff and implementation of training courses for MSWM. Policy, legal and political aspects:
- Production of well developed, articulated MSWM policy, municipality laws and associated rules.

Environment/Health aspects:

- Implementation of an environmental health assessment and monitoring system (longer term).
- A decrease in the number of people complaining about the MSWM.

4. Discussion

Observations indicate that the MSW in TKY is not being managed appropriately. Tha Kong Yang has experienced rapid population and economic growth. It is becoming more affluent [21,40]. This growth and prosperity have led to an increase in the use of consumer items which has resulted in a substantial increase in the production and volume of solid waste. This presents the difficult task of dealing with unmanaged and accumulated waste that is causing environmental, health and aesthetic problems. In TKY there is pressure on local government to improve its existing waste management program [21,27,40].

This study aimed to identify viable solutions to TKY's MSW problems that may potentially provide guidance to other localities in developing countries also facing waste problems resulting from rapid change. To do this, the ISWM evaluation framework proposed by US EPA (2002) [4] was used to structure the evaluation and help identify solutions to both waste accumulation and waste management. It is well established that successful changes to waste management require an understanding and consideration of local context [2,41]. Therefore, extensive community consultation and engagement with experts was undertaken to develop an understanding of the region and its waste issues. Study participants identified an array of different strategies and solutions to respond to the equally diverse set of problems associated with waste management. This discussion provides an overview of the strategies and ideas (from structural and procedural to practical actions) towards

an improved system and a reduction of unmanaged solid waste currently accumulating in the municipality.

There are many opportunities to improve local infrastructure and operational capacity around solid waste management. There is recognition that the current system cannot be sustained, with its focus on landfill as the current sink for waste [40]. Waste management strategies need to differentiate between rural and urban areas. Strategies emerging from this study are not necessarily highly technical or complicated and as such may be implemented with some careful thought and good planning. It is important that appropriate technologies are developed for and implemented in developing counties. There is compelling evidence that it is ineffective to transpose complicated or expensive technology designed for developed countries to developing countries [12,13,41].

Presented below in order of importance and urgency are key solutions. Aspects demanding immediate attention are presented first, followed by longer-term targets. Key findings are based on the outcomes of this study. The key solutions are: development of a municipal waste management policy and an associated implementation plan; reduce the need for the landfill by generating a waste separation program (including education, infrastructure and economic policy), improving the existing waste collection system, and improving the financing of waste management.

4.1 Key Solution 1: Develop a Locally Relevant Waste Management Policy and Implementation Plan

The TKYSM does not yet have a strategic vision or associated policy for waste management. Clear policy for waste management is needed to address both immediate and long-term goals. Daichai et al. [42] (p. 1) noted, when referring to another municipality in Thailand, that "the municipality has to set a clear policy goal of municipal waste management, short-term, and long-term action plans." Overarching policy should be developed in conjunction with an implementation plan. The US EPA "Solid waste management: A local challenge with global impacts" notes that when it comes to ISWM, government plays an important role in planning, developing, and managing day-to-day operation of solid waste management activities [4]. The TKYSM has a duty and the power to manage is own waste management system [43,44], and is therefore responsible for developing both policy and plans. However, as observed by Amornvivat (2004), many local administrations around Thailand are poorly prepared to take on these responsibilities, as many of them are "considerably too small with regard to mandatory services" [45] (p. 18). This includes problems with "efficiency of service deliveries, absorptive capacity, local autonomy, and financial adequacy" [45] (p. 3). Direction could be taken from the Thai Government's Roadmap [16], and local policy be developed in conjunction with partners such as academics from the Mahasarakham University, who can provide both legal and technical expertise [3]. A workable implementation plan to address the MSWM problem can be based on the key findings outlined below.

4.2 Key Solution 2: Reduce the Volume of Waste Going to Landfill by Establishing a Waste Separation System

The Thai Government's Roadmap states, "communities and municipal authorities are encouraged to reduce waste, implement waste sorting at source and dispose of waste in an appropriate manner" [17] (p. 14). There is an urgent need to reduce the amount of waste going to landfill from TKY. The landfill site currently used by TKYSM is costly and not sustainable in the long term (TKYSM currently pays the Mahsarakham provincial municipality to leave waste at this landfill. It is estimated to be more than half of the TKYSM's budget). Establishing a new landfill site is a complex, expensive process and likely to be opposed publicly [46]; isolating a suitable site will be challenging [11], as land close to the TKYSM is prone to flooding [40].

A cheaper, more sustainable option would be to reduce the amount of waste going to landfill. Respondents in this study identified enthusiasm for such an initiative.

It is estimated that in TKY, organic waste (primarily food waste) contributes 60% of waste volume, and recyclable waste (resalable waste products including cardboard, paper, plastics and metals) almost 40% [21,25]. Therefore, waste sorting and separation and the diversion of organic waste and recyclables will almost eliminate the need for landfill dumping.

There are two possible approaches to waste separation. Separation can be accomplished at the source, then collected and taken away for reuse or recycling; or, unsorted waste can be collected and taken to a waste separation site facility for sorting. An administrator of the TKYSM and other respondents in the study prefer the second option. However, finding space to site such a facility will be the first hurdle. TKYSM residents are opposed to siting a waste separation facility close to the municipality due to concerns over environmental and aesthetic impacts [27].

Perhaps a more acceptable approach will be to separate organic waste at the source and for it to be transferred directly to end users. However, organic wastes from rural and urban areas will need to be approached differently (as illustrated in Figure 5). Smaller facilities for sorting non-organic recyclable waste might be accommodated throughout the municipality.

Should a coloured bin system be implemented to encourage waste separation, it would need a companion public information roll-out (Figure 5). Tai et al. [47] indicated that at-source separation was significantly improved when accompanied by multimedia advertorials (radio, television, newspapers and the Internet). This contrasts with Nixon and Saphores [48], who found that face-to-face communication between friends or colleagues was the most effective method of encouraging people to recycle.

In TKY waste accumulation is seasonal. It varies according to the University timetable (e.g., it reduces during semester breaks when students vacate), to special events, and with farming calendars. TKYSM should also include in any new plans contingencies for emergencies, such as during floods, or landfill closure.

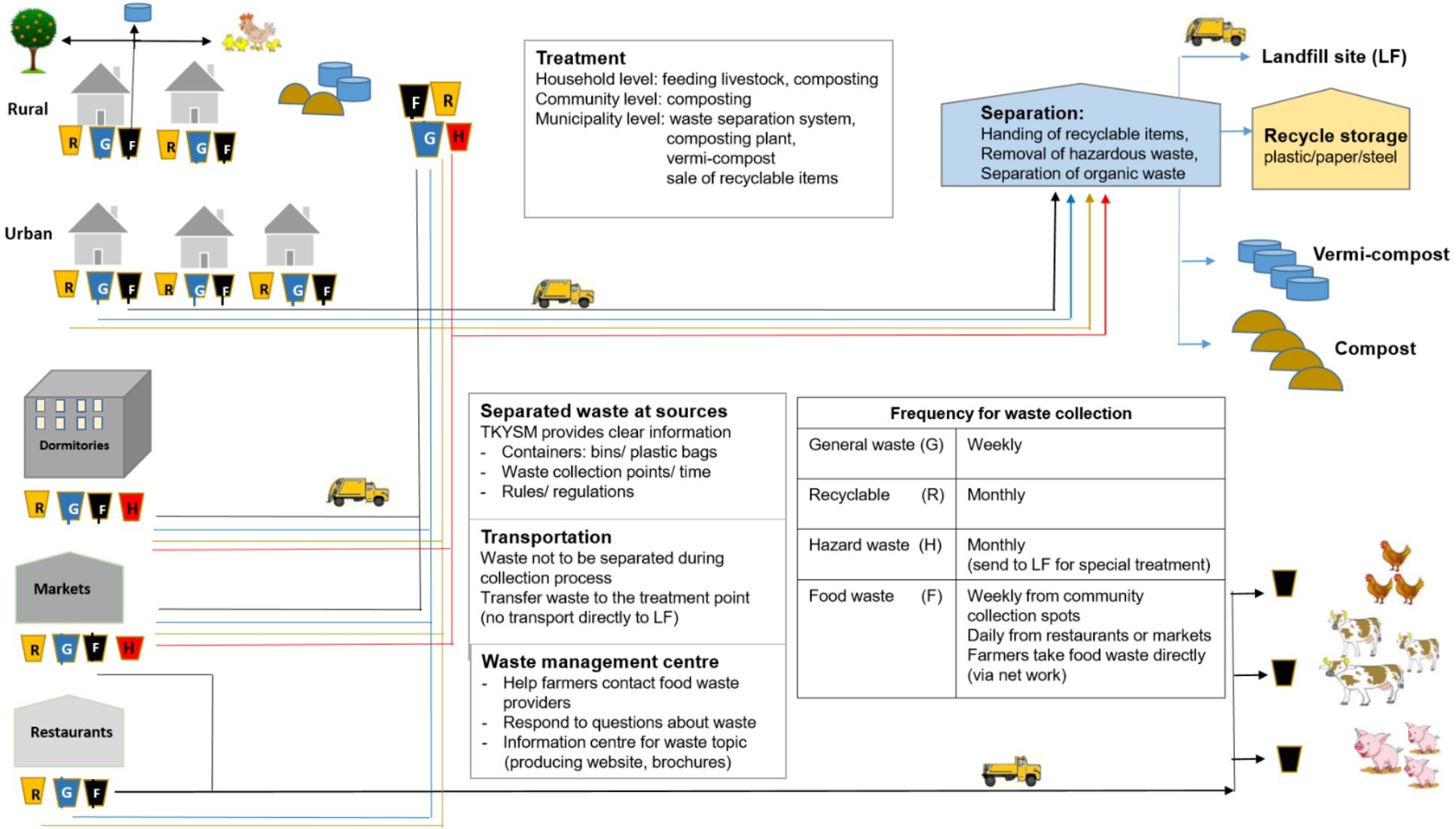

Figure 6.5: (Manuscript Figure 5) A schematic approach to waste separation components.

4.3 Key Solution 3: The Need to Initiate a Collection Service That Supports Waste Separation at Source

Facilitating waste separation at the source has the potential to drastically reduce landfill requirements. Viable suggestions for encouraging at-source waste separation included truck modifications (creating separate compartments within collection trucks to receive and segregate different types of waste). The potentially more efficient suggestion is to collect different types of waste on different days (Figure 5). The advantage of this second approach is the use of existing trucks rather than requiring investment in expensive modification or extra collection trucks. Food waste from restaurants could be delivered directly to farmers. In this scenario, the municipality may have a role to pay in providing a small truck to transport food waste (Figure 5). The use of restaurant food-waste as livestock feed has been successful in other countries either directly [49], or after processing through fermentation [50] or dehydration [51]. Given the added expense of processing food waste, it is suggested that direct transfer to farmers is the preferred approach.

Collection routes need to be optimised to assist TKYSM meet collection schedules and to reduce costs. Collection and transport of waste is generally the most expensive aspect of MSWM. Das and Bhattacharyya (2015) have shown that route optimisation could reduce the collection path length by more than 30% [52]. This is supported by the work of Son and Louati [53] who modelled collection scenarios using GIS to and substantially reduced collection paths. TKYSM could engage with the Mahasarakham University to apply modelling technology to improve local collection routes.

4.4 Key Solution 4: The Need for Support and Education of the Waste Producers

Improved citizen behaviours such as waste separation at source and following collection schedules requires their engagement and commitment. Respondents in this study perceived a lack of engagement resulting from disinterest in the environment [27]. It is clear from the literature that at-source waste separation only works if the necessary infrastructure is provided [48], and if the system is convenient and readily understood [54–56].

A common reason given as to why citizens of TKYSM did not separate their waste was the inconvenience of the task (e.g., having no time or space for recycling) [27]. This is supported by other research which showed that space for storage or distance from recycling centres results in reduced recycling behaviour [48]. Therefore, TKYSM should make separation facilities accessible (Figure 5). Making available the necessary infrastructure to undertake waste separation will be essential [56].

It is also important that residents understand what is required of them and that they are engaged in the process [3]. To date, efforts to change behaviour have experienced limited success for the municipality, the owners off-campus student accommodation and entrepreneurs [27]. A variety of communication tools tailored to end-users' needs and level of understanding is essential [55]. The municipality will need to educate its citizens about any changes to the collection system and service (such as the introduction of different-coloured bins or community collection points).

Engaging citizens in the development of waste policies and planning may increase engagement in the uptake of new strategies [57].

To reduce food waste entering the waste stream participants in this study suggested that the TKYSM should arrange training for households or businesses about how to compost so as to encourage the practice.

Awarding good waste management behaviour as a strategy to encourage people to engage in waste separation activities was an idea proposed by students and some experts. TKY has more than 250 off-campus student accommodation facilities which are proving to be points of pollution [58]. Awards could include a recycling star-rating for dormitories, or fee reduction for tenants. The use of rewards—incentives as regulatory instruments—has been assessed in a number of evaluations including Garbosky (1995) [59], and Wilson and Balkau (1990) [60]. The use of 'carrots and sticks' to manage waste needs to be thoroughly investigated to ensure that the means justifies the required end.

Participation in separation of recyclables is likely to be more successful in low income communities who can generate income from the sale of recyclables through buy-back centres or waste banks. Around Thailand, waste bank projects have been successful in schools, communities and universities [61,62]. A challenge might be to encourage wealthy communities or big businesses to undertake proper waste separation of recyclables. A reduced waste collection fee resulting from reduction of waste going to landfill might be a mechanism to ensure uptake by higher socio-economic communities or businesses [11].

TKYSM would benefit from the help of external agencies, primarily the Mahasarakham University, seeking assistance from experts in the areas outlined above. The TKYSM directors indicated that local people would prefer to listen to the opinions and guidance of new people, possibly because it may make the subject matter more interesting or because there is a belief in the expertise offered by University staff. Therefore, support from the Mahasarakham University would be very helpful in many areas, including the development of a communication strategy to inform people about new waste management plans and systems. The benefit of engaging with the local University is that being situated adjacent to TKYSM staff will understand the local context.

There are currently public health volunteers living in TKYSM. These volunteers usually work with the primary health care centre (a local government organisation that is separate from TKYSM), sharing health information with villagers. Having already established relationships with villages, these volunteers could provide a conduit between the TKYSM and village communities.

A communication breakdown between the municipality and wider community exists. The community feels uninformed and complained about methods of communication as being inadequate [27]. To ensure better communication between residents and the municipality, local waste management teams or centers could be established, overseen by the TKYSM, but staffed by villagers. Such centers may help establish a mutual understanding of MSWM between citizens and the municipality. Any planning for MSWM in TKYSM should engage the community. There have been many recommendations from

participants about improvements to communication between the TKYSM and people in the community. These methods include written information (letters or brochures), online technologies (mobile device applications), and visual media (short films), all of which would guarantee widespread distribution of information.

4.5 Key Solution 5: The Need for Support and Education of the TKYSM Staff

There were a number of staffing related suggestions. Respondents thought waste management would be more effective if more TKYSM staff were employed. In addition, a clearer staffing structure and identification of roles and responsibilities need to be developed. TKYSM should prepare appropriate staff training for MSWM.

The technical skills of personnel employed by municipal governments significantly influence waste management systems [63]. It is one of many factors that influence waste collection and transportation waste [64]. Waste pickers may potentially staff recycling centres as they already use separation techniques seeking out high value recyclable items [65]. Waste scavengers have been successfully incorporated as part of recycling programs in other countries, including. Brazil, Colombia, India, South Africa [66], Nigeria [67], Tanzania [68], Indonesia [69], and China [70].

It was clear from site visits that the TKYSM needs to develop a system for monitoring waste. For example, records of waste volume are missing data for some days, and some years the waste volume reports are missing. Therefore, changes to the volume of waste overtime and changes to the waste stream are incomplete or unavailable. Easy-to-use, reliable monitoring [41] and recording systems are imperative to support long-term decision making in MSWM.

4.6 Key Solution 6: Financial Considerations

The proposed new MSWM system will require a sufficient budget. The TKYSM should consider several ways to enhance its budget. An immediate step would be to introduce (and strictly adhere to levies) for residents and commercial enterprises in receipt of waste collection services. Second, the implementation of a functioning waste separation system, focused on recycling and composting, will generate an income from the sale of such products [71]. Simultaneously with a waste separation scheme is the need to introduce appropriate infrastructure to assist households. Residents could be required to buy their coloured waste bins from the TKYSM or use the ‘prepaid bag’ system that has been successful in South Korea [72]. Third, TKYSM spends more than half of its MSWM budget on disposal of waste to landfill. Diversion of waste away from landfill will result in substantial savings. Finally, the TKYSM could research ways to reduce total expenditure for waste management, such as waste-to-energy production.

4.7 Key Solution 7: Cultural Considerations—Engaging the Use of Temples

Most Thais follow the Buddhist faith, and as such, their temples are important social and cultural meeting places [39]. They are also places for contemplation and learning. Quality recyclables are

already brought to the temples as donations. As temples are kept clean, they could potentially provide sites for recycling. Engaging with monks may provide an important strategy for MSWM, particularly in Thailand.

4.8 Unanticipated Outcomes

Despite the Thai Roadmap's focus on waste reduction [17] this was rarely mentioned by study participants as a strategy for solving MSWM in TKYSM. One person (a mini-mart owner) mentioned that he asks customers whether they need a plastic bag in a bid to reduce bag use. One of the contributing factors to the MSWM problem in TKY is rising affluence and the associated increase in consumer goods [40]. Waste reduction is an obvious and much-cited solution to waste management; however, most MSWM plans focus on reuse and recycling [73]. The introduction of fees for waste collection and disposal has seen reductions in waste generation [74].

The ISWM framework (Figure 2) has a 'health and environment' aspect. Participants in this study did not offer solutions about how to better protect the environment and human health from MSW. This was despite many comments about such problems. It is noted by the authors that the key findings listed above are in themselves inherent solutions to environmental and health problems.

Conclusions

This study has identified simple, logical solutions to both the waste accumulation and waste management problems in TKYSM. This was achieved by engaging with the MSW stakeholders, including waste generators, staff from the TKYSM, academics and administrators.

Pressure to establish a successful MSWM system in TKY is increasing due to costs associated with the current approach of taking waste to a landfill outside of the TKYSM area, which is expensive and not sustainable. To achieve effective MSWM in TKY, establishing technical and expensive solutions are not recommended. Establishing a new waste disposal site is not a feasible option because it is not sustainable nor suitable. Instead, a simple system based around recycling and reusing is proposed. The primary component of the plan requires appropriate waste separation, which takes into account the lifestyles of residents in urban, rural and commercial areas. The focus should be on food waste and recyclable materials, which together comprise almost all of the waste stream. Appropriate separation containers must be provided, and regular collections initiated. The management facilities that is readily understood by the residents and businesses and also by the operational staff involved in MSWM.

Ensuring of awareness and uptake of waste separation by local citizens is a significant challenge for the local municipality. Information must be provided across the public domain in a way that is direct and reduces confusion while increasing awareness among local citizens.

Rules and regulations have to be clear and be developed with a bottom up approach to ensure that the changes match cultural and distinct local needs in the area. This also includes the revenue collection processes.

Overall, a common theme has emerged that shows input from the local population into the development of the MSWM system will be vital to its success of the project. This target needs significant cultural shift in government policy and human behaviour, including the way people think about waste, which will assist in the development and implementation of robust MSWM systems for TKY.

Further Research

Establishing an appropriate monitoring system to determine the types, volumes and seasonality of waste production in TKY will guide future research. Engagement between the TKYSM and the Mahasarakham University will provide opportunities for further research and evaluation. Other potential research areas include an evaluation (cost, benefits and outcomes) of the new waste separation system in the TKYSM to inform decision making, applying GIS to determine better waste collection routes for the TKYSM, assessing the level of community engagement and waste management in the TKYSM, establishing a coaching and mentoring program for the waste management team, undertaking an Environmental and Health Impact assessment in the waste management system in TKY and research into the application of this model in other rapidly urbanizing areas in Thailand.

Author Contributions

N.Y. designed the research proposal, undertook fieldwork and transcribed conversations from interviews and focus groups. She also undertook translation from Thai to English. B.C. and K.R. provided guidance through the fieldwork and throughout the manuscript preparation. All authors contributed to the methods design and drafted manuscript and the framework for the coding process. K.R. checked the manuscript and edited the English language and grammar.

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Conflicts of Interest

The authors declare no conflict of interest. The sponsors (Mahasarakham University and Flinders University) for the study had no role in the design of the study, collecting data, and writing of the manuscript or in the decision to publish this manuscript, and in the decision to publish the results.

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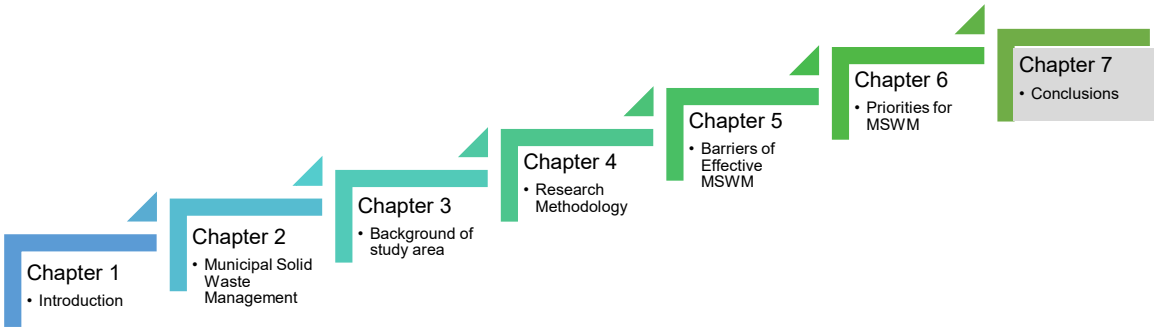
CHAPTER 7 CONCLUSIONS



7.1 Introduction

Inadequate municipal solid waste management (MSWM) is causing significant impacts on the environment and human health locally and globally. MSWM in developing countries is seen as an important issue by government leaders, but despite that acknowledgement the problem of proper management is still increasing dramatically. This study commenced with an overview of MSWM and the impacts of inadequate management in global, national and local settings, with a focus on the examination of contemporary MSWM issues and challenges for Tha Khon Yang (TKY) subdistrict, Maha Sarakham Province, Thailand.

This study makes an important contribution in several areas of MSWM. It contributes toward the development of MSWM theory by examining the application of a modified Integrated Solid Waste Management (ISWM) framework to a rapidly urbanising municipality in a developing country. This development trend is not unique to the study area and there is potential for other researchers to draw ideas and knowledge from this research in the future. Additionally, this study aimed to examine current local MSWM practices and trends within TKY, to formally identify opportunities for improvement. Waste problems in developed countries have been supported by a range of waste management system frameworks. These system models have been used both as decision-support tools during the planning processes and during implementation for MSWM systems. Here, a modified ISWM framework provided a starting point for Tha Khon Yang Subdistrict Municipality (TKYSM) to review past failures as well as guide decision-making regarding MSWM in the future.

It intended that the results of this study become a part of a pilot project in TKY, and that the national government of Thailand can draw on knowledge to help solve MSWM issues in other provinces around Thailand. This should begin with aligning policy outcomes with the sustainable development goals outlined in Agenda 21. The 2030 Agenda for Sustainable Development Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) published by the United Nations in 1993 and 2015 respectively (United Nations 1993, 2015b) intend to reduce the negative impact of population growth, including human consumption activities. These goals include strategy development and planning for resolving waste management problems (United Nations 2015b). This

study contributes to the part that Thailand can play in this by adding important information to the current pool of knowledge.

There are many principles and strategies around waste management that have been applied effectively in developed countries. These include the 3Rs, waste hierarchy, and waste minimisation. Most cities in developing countries have ineffective MSWM systems (Klundert & Anschütz 2001) and many of these countries are still struggling with implementation of waste management programs, particularly in the major cities (Selin 2013). Due to a range of factors, the waste management methods that local governments are facing are vastly different between developed and developing countries, particularly the rapid urbanisation occurring in developing countries (Council for Scientific and Industrial Research 2011; Marshall & Farahbakhsh 2013). A major benefit of the ISWM framework is the inbuilt review function, which acts as a prompt for system development and change. Because of this review element, municipalities around the world that have changing needs around MSWM can use ISWM framework to capture problems in an accurate, measured way, and alter approaches accordingly.

This study was designed to examine MSWM in a developing country in the rapidly urbanising area in TKY, Maha Sarakham Province, Thailand. This place has a small local government, with villages transitioning from rural to urban settlements. It is experiencing a rapidly changing community and culture, with a growing population, many of whom are transitory students who come for study and leave when they finish their education. The current MSWM system in TKY is failing, with a huge amount of uncollected waste accumulating in the local streets, reserves, sports fields and school grounds. This has been a problem for more than two decades and has not been resolved. For the wellbeing of the population of TKY, and to prevent further problems, this predicament cannot be ignored. Left unresolved, there will be serious consequences in the near future for public health and the environment.

This study sought to identify factors that affect the efficiency of the MSWM system of the TKYSM, to examine the current waste management system and waste management practices of the people of TKY and to identify improvements to the MSWM system.

This study tried to find answers to the question “What components are necessary for the successful implementation of Integrated Sustainable Waste Management (ISWM) in a rapidly urbanising area in northeastern Thailand?”.

7.2 Empirical Findings

This section synthesises the empirical findings in response to the specific objectives of the study;

To assess the current solid waste management system in the Tha Khon Yang
Subdistrict, Maha Sarakham Province;

To evaluate the barriers to effective solid waste management in the Tha Khon Yang Subdistrict, Maha Sarakham Province;

To synthesise possible solutions for Municipal Solid Waste Management;
To prioritise actions for municipal solid waste management in the Tha Khon Yang Subdistrict.

7.2.1 The current solid waste management system in Tha Khon Yang

In trying to resolve the waste management problem, information was needed about the system itself. The TKYSM does not have current records about waste generation, accumulated waste that has been left behind, or reliable records of waste volumes transferred to landfill. At the local level, this study has produced the first detailed snapshot and analysis of MSWM at the TKYSM case study site, which can act as a foundation for ISWM framework development.

There were three significant outcomes presented in Chapter 3 regarding the current situation for MSWM in TKY. Firstly, the overall volumes of municipal solid waste (MSW) in TKY have been rapidly increasing. Secondly, accumulated uncollected waste is reaching crisis levels. Finally through poor communication, the public in the district do not have any guidelines to align with regarding MSWM and are confused about issues, including where to actually dispose of their waste. Due to this, accumulated waste is a common sight around roadside areas. If municipal workers do not collect the waste, animals are often attracted to the area which leads to waste being scattered further from dumping points where it can carry disease vectors to another area. Residents also noted that leachate and odour in the TKY is a significant issue.

The Division of Public Health and Environment of the TKYSM has tried to take responsibility for managing MSW. However, the Division mainly focuses on collecting waste, then transferring it to a landfill site and paying disposal costs. The staff capacity and facilities available (three officers who also have other portfolio responsibilities, ten operational staff, and three waste collection trucks) are inadequate and cannot fully service the daily collection routes or meet MSW collection requirements.

Fiscal management in the TKYSM needs improvement. The municipality receives funds from several sources. At this time, the Thai central government provides a budget to the TKYSM, and it receives taxes from businesses and fees from households. However, the collection of fees is *ad hoc* and unsuccessful largely due to the inconsistent and outdated method of door-to-door fee collection. Providing a solution to this issue is important as better fee collection would provide another revenue stream to support the development of a robust MSWM system in TKY. Further investigation needs to be directed toward this. For example instead of a door-to-door collection process, it may be more efficient to use the TKYSM offices as a collection point or to use mobile phone technology to collect more from the users.

Overall, the current situation of MSWM in TKY is very ineffective across multiple areas, meaning that a number of these areas should be reviewed and developed to improve the current MSWM system.

7.2.2 Barriers to effective solid waste management in Tha Khon Yang

The main barriers for MSWM within the TKYSM are outlined in Chapter 5. There is a combination of reasons for ineffective MSWM in TKY. Six main barriers were identified and categorised using the

ISWM framework. These barriers were: technical, organisational, social-cultural, financial, legal-political and demographic issues.

Technical limitations were regularly cited. Lack of facilities for MSWM was the primary issue identified by study participants. Understandably, if the MSWM system does not have appropriate services; inadequate facilities, no bins, no schedule or limited waste collection points, it is difficult or impossible to have an effective MSWM system. This is compounded by a lack of information and poor communication between the TKYSM and people living in the area. It is not reasonable to expect people to use good practices for waste management in their households if waste is not collected, or if they do not know when to expect collection.

Within the TKYSM organisation there are opportunities to develop policies, plans, strategies and staff capability. There are also political issues which influence the overall MSWM approach. There is no formal policy outlined from the TKYSM meaning that MSWM is developed via *ad hoc* short-term planning and changes are often produced as annual projects. The report, *Solid Waste Management: A Local Challenge with Global Impacts* shows that adequate planning is essential to the proper development of good MSWM systems (United States Environmental Protection Agency 2002).

Current MSWM operations in TKY also lack appropriate information management, which hinders or removes the ability to monitor trends and developments around MSWM. For example, the data available from TKY about MSW is unusable for system development. This is due to data inconsistencies about waste collected, where it is collected from, the amount of waste that is taken to landfill and the volume of waste that is not collected. Moreover, the benefits of any waste recycling programs are not monitored or measured, which leads to program abandonment with wasted revenue and resources.

Building municipal staff capacity was also found to be an important issue during the study, where it was found that improvements can be made in a number of areas, including formal education, training, clearly defined job requirements of staff and number of staff. Guerrero, Maas & Hogland (2013) in *Solid waste management challenges for cities in developing countries* note that technical capacity of municipal staff can have major influence on MSWM system outcomes.

Additionally, building an appropriate communication strategy between the municipality and local people was found to be a key issue. It was found that there was a lack of programs for providing workshops, education or information to residents about good waste management practices, including health and environmental considerations. Using old methods to communicate to people was, and still is unsuccessful in this mixed and quickly developing culture. The lifestyles of the younger and older generations are very different. In the past a megaphone has been used to provide information about waste management. Now the target area is simply too large for this to be effective, and the majority of inhabitants work or study in sealed buildings and sound does not travel well in this environment. This megaphone method has been used in conjunction with community meetings which may be effective around small rural villages, but is ineffective when attempting to reach the

urban population of TKY. The way that information is conveyed must reach younger residents and business people, using communication methods that engage the majority of the modern target audience. Communication methods such as mobile phone Short Message Service (SMS) or social media applications will be more effective.

Enhancing the MSWM system capacity through an adequate budget was also examined. The TKYSM staff suggested that the budget was sufficient to manage MSW at the time; however, if the issue is examined in a holistic sense, significant changes need to be made to the way the budget is allocated. During the study, it was found that the allocation of the annual budget that TKYSM receives directly from the central government does not take into account the transitory student population (accounting for over 25,000 temporary residents). If these 'invisible' residents are accounted for in the budgeting formula the total amount may be increased. Importantly, the mechanism by which fees are collected from residents is ineffective. The current door knock approach is not consistent and this causes a shortfall in funds reaching the TKYSM. There are more appropriate methods for fee collection, which are presented below.

Additionally, the behaviour of residents is a barrier to effective MSWM. Waste reduction or waste separation requests are ignored. People do not separate waste at its source. Mixed waste with recyclable items, organic waste or household hazardous waste is contaminated and cannot be recycled. Notably, the dormitories have a high volume of unseparated waste. Unseparated waste, once it enters the waste management stream, is very difficult to separate, and poorly separated waste contaminates any separated waste to which it is added. Most people do not see the value of waste separation and the problem of mixed waste. Responsibility for waste separation is usually given to housekeepers, scavengers or the poor who want to make money from recyclable items, which is an inadequate response to the problem.

Other physical issues making it difficult to manage waste include the fact that space in TKY is very limited. People refused to have a waste separation plant because they are afraid of possible associated pollution, and the land is expensive and prone to flooding, which makes it very vulnerable. Waste management has been a problem for TKY for decades. With little communication between residents who use the service and the TKYSM, the service provider, there has been no clear way to resolve the problem.

7.2.3 Possible solutions for municipal solid waste in Tha Khon Yang

Solutions for MSWM within the TKYSM are outlined in Chapter 6. To overcome the barriers of MSWM, this study brought together the perspectives of various stakeholders. Based on the barriers identified in Chapter 5, stakeholders suggested ways to overcome these obstacles to good MSWM. Recommendations for MSWM in TKY came from three groups of stakeholders; users, providers and external agents. The most frequently heard suggestions from stakeholders were summarised as key solutions including improving the technical side of the waste management system, addressing the financial system, raising the awareness of people, developing staff capability at the TKYSM,

developing an appropriate MSWM policy and plans, and addressing the political issues related to waste management problems.

The MSWM system for TKYSM needs to be designed for both the current situation and the future. Instead of focussing on collection and disposal of waste to landfill, the TKYSM should focus on addressing waste at its source. The TKYSM needs to improve the waste collection and transfer system, using techniques of waste reduction such as waste separation, recycling, and composting, to prevent waste from having to go to landfill. People require a clear system to allow them to separate waste, such as coloured and signposted bins and clear points to dispose of waste. The TKYSM needs to establish different waste management services in the rural and urban areas. Reduction of food waste via composting is appropriate in the rural and agricultural areas and would reduce the waste volume by 60%. Additionally, food waste from many restaurants in urban areas should be taken to farms which are located around TKY. The TKYSM will need to support and manage this by providing the links between the restaurateurs and farmers. Transfer of waste for animal feed, composting and recycling will reduce the total cost of disposing waste to landfill. Some participants noted that a good waste separation and recycling system will return funds to the waste management system. However, to establish this system, the TKYSM requires a budget for setting up facilities. Most participants were willing to pay waste collection fees because they need a good waste collection service. Therefore, the municipality needs to develop the fee paying system, with a collection approach that is convenient for both users (residents) and providers (TKYSM). Some suggestions from participants included that they might be able to pay it at convenience stores (as it is also the way that people usually pay for electricity) or using mobile phone internet banking. Another alternative is the use of the already operational TKY tax collection system.

Once the MSWM system is planned, participation from residents is a critical component in its success. A number of participants in the study mentioned the negative attitudes towards waste management activities from residents, but because the current MSWM system in TKY is unclear, difficult to follow or non-existent, that is unfair. Some participants suggested that the TKYSM needs to encourage people in a number of ways, through community engagement, education, advertising, and rewards. Communication strategies across mixed cultures of older and younger residents needs to be appropriate for both new and permanent residents.

In the TKYSM, some people think having more staff will be the solution for MSWM, however it is clear that improving staff capability rather than only the number of staff is necessary. Academics suggested that clear direction for the staff is important, with training and education programs required for every level of staff. Politically, it was clear that residents would support politicians that support good waste management policies as nobody feels comfortable living in a littered environment.

7.2.4 Priorities for municipal solid waste in the Tha Khon Yang

The priorities for MSW in TKY can be explained in the follow steps:

Firstly it is important that the TKYSM set clear policies, and from these develop good plans to meet the immediate and long-term targets for sustainable MSWM. Reducing waste volumes going to landfill is the first vital target for the TKYSM. Reduction of waste needs to be managed at the source (from users), at the collection system (waste collection points and transport) and at the waste separation point (waste transfer point or separation plant).

Secondly, improvements need to be made to the waste fee collection system. The TKYSM needs an adequate budget to support implementation of the plans. To do this, the TKYSM needs to change the waste fee collection system. The easiest way to do this would be to apply the already operational TKY tax collection system to waste collection fees.

Thirdly, the TKYSM needs to establish a MSWM team and build the capability of the staff of the MSWM. This should be done via workshops and other educational programs to increase the capability of the staff of the TKYSM. Workshops should focus on understanding and being able to use necessary technologies such as computer programs and smart phone applications for recording and reporting waste management data or communication. This might need a coaching and mentoring program, which will need engagement with people from the community, experts from the university and staff from the TKYSM.

Additionally, establishing cooperation and participation within the community is important. Developing education and community engagement campaigns might be a good way to encourage people to engage with good MSW practices. The TKYSM and the waste management team should provide appropriate information for the community. People need clear and sufficient information that is easy to follow, receive and understand. Additionally, cooperation with other organisations could support the establishment of a successful MSWM program. Mahasarakham University provides an excellent opportunity for collaboration, as it is a nearby university that has established a good MSWM system, and it has academics with expertise in areas of waste management.

Additionally, the waste management elements of the MSWM system need to be improved so that they are convenient and easy for people to use. These elements include collection facilities such as waste containers, fixed appropriate waste collection points, and regular, predictable waste collection.

Finally, MSWM need a monitoring system which can be used to evaluate the system to monitor the existing system and to provide information to be used for improvements in the future.

7.3 ISWM Framework

Several Solid Waste Management (SWM) systems have been developed and trialled with the success of these systems attributed to the capacity of countries to operate and develop these systems. When SWM systems have been applied in developing countries there has often been a failure due to system breakdown. Very few models considered the social aspects of SWM, focusing solely on the economic and environmental spheres (Morrissey & Browne 2004). None considered involving all relevant stakeholders (government officials, industry and formal private sector services

providers, local communities) or considered the full waste management cycle from prevention to disposal (Morrissey & Browne 2004).

The ISWM (Integrated Sustainable Waste Management) framework is unique in the fact that it has a control within the framework that means it is 'live' and allows the user opportunities to improve and develop the system. This is particularly attractive for this study as the area is rapidly urbanising and seeing significant changes in population density, human living conditions and arrangements, along with the types of waste being generated.

There are three main dimensions within ISWM framework which allow a well-rounded approach to collection of system inputs. The first is *stakeholders* which accounts for system users, providers and consultation or engagement with experts and external agencies. The second dimension is *ISWM aspects of concern*, which includes technical, financial-economic, socio-cultural, institutional-organisational, policy and environmental aspects. The final dimension is *waste system elements*, which takes account of operational issues; including waste generation and separation, waste collection, waste transfer, and final treatment or disposal, in conjunction with the 4 Rs (Reduction, Reuse, Recycling, Recovery) (Klundert & Anschütz 2001).

There are many gaps between the developed and developing countries when it comes to the success of SWM systems. These include financial resources, capability of municipalities to obtain staff with adequate skill sets, cultural and social habits of people living in the area, and local demography and current urban planning and development practices. The ISWM framework is advantageous in this area, due to the fact that even when 'foreign' principles have been utilised it offers several opportunities to review and assess system gaps, where the significant issues can be identified as described above.

However, sources show that application has failed in many developing countries in the past, where private consulting firms have implemented ISWM systems in conjunction with local government agents, particularly after the initial implementation stage the projects became unsustainable. It was found that the local governments could not continue to manage it independently.

When applying the ISWM framework to investigate MSWM in TKY, this study found a number of disadvantages within the framework.

Firstly, knowledge gaps will make it difficult for TKYSM staff to examine all aspects of the ISWM framework and develop a robust MSWM system. There is a need to improve the human resource processes, to develop strategies to apply the budget in an appropriate manner and improve awareness of ISWM systems via education and staff development. Applying the ISWM framework without assistance and management from external agencies or appropriate budget support could be a problem, and an obvious weakness of ISWM is the fact that without training, education and initial system support it may be difficult to implement.

Within the current setting TKYSM has limited ability to apply the ISWM framework to solve the waste crisis problem alone. At the time of this study, the capacity of TKYSM needs to improve for an ISWM

system to be properly implemented. The barriers are from both internal factors within TKYSM and external factors around TKY residents, as well as issues unique to the local area.

Secondly, there also are issues that are not included in the ISWM framework that need to be considered. The MSW in TKY contains a high proportion of organic waste which is usually mixed with household hazardous wastes (as in many other developing countries). This aspect is particularly important when dealing with rural zones converting to urban living areas; in this case the ISWM framework should consider organic waste and hazardous waste issues and build this clearly into the *waste system elements* section of the framework.

Lastly, whilst using the ISWM framework as a guide to investigate key findings for each objective of this study, it was found that when responding to each objective there was a need to consider aspects that were not included or outlined clearly within the system. Using the standard aspects of concern from the ISWM framework does not directly link with the requirements and objectives of the TKY area. When using the standard six aspects outlined in *ISWM aspects of concern* to explain the four objectives of this study (highlighted in section 7.2), there is a lack of direct links or indicators that assist with finding the MSWM system barriers or improvement opportunities. As found in this study, in the case of TKY it is necessary to consider physical impediments such as population growth, flooding and urban design.

However, the ISWM framework is an excellent starting point for evaluating issues around waste management, and can provide guidance during the development portion of MSWM systems. It must be noted that the definition of 'integrated' in ISWM means to be linked or coordinated. In this study the SWOT analysis approach to evaluate the internal and external factors of TKY's MSWM system aided in understanding system strengths, weakness, threats and opportunities. The 'sustainable' within ISWM means this system can be used long term, and it is obvious that no system can be sustainable without using an evaluation and monitoring system which identifies shortcomings. Reviewing the results, and evaluating problems, is absolutely vital so the system can develop and move into the next stage. This is particularly true for TKY (and in any cases of transitioning or urbanising areas) where situations can change quickly.

An advantage of the ISWM framework is that it will help TKYSM staff see waste management in a wider context, and give clear opportunities to consider information that could have been overlooked if a different system was utilised. Overall, this can lead to better decisions around MSWM system planning, leading to better strategy and policy development. The ISWM framework is flexible enough to suit circumstances around waste management and will help the TKYSM see the strengths, opportunities and weakness of the system as it evolves and allow methods to manage them appropriately. Furthermore, as noted above, newly developed and small municipalities like TKYSM need quality training, agencies and teamwork to support MSWM system implementation. An appropriate budget allocation is required to establish these. Given that the waste problem in TKY is at a crisis stage, TKYSM could request funding and support from international agencies.

Importantly, waste projects using ISWM need to have appropriate timelines where results of the project can be seen across long-term implementation models. For sustainability, a system of monitoring and evaluation is imperative to make sure that the system can essentially run itself under the control of TKYSM and the local community.

7.4 Limitations of the Study

The immediate limitations of this study are based around the research time frame and budget limitations. The researcher in this study had a limited time frame to collect information from the study area, and information needed to be gathered from a broad range of participants across community and government settings. Participants were not always available for interviews and focus groups, appointments were often changed. Additionally, having a limited time frame created limitations in the quantity of data able to be collected.

After information was collected the researcher would then return to her home university in Australia to translate and collate the data as required, meaning that the researcher did not have immediate access to the study area.

Another limitation found was around access to local data. During the study it was found that local data surrounding MSWM in TKY was inconsistent and inadequate. This is not unique to TKY. In developing nations a lack of information around local MSWM data is quite common. Initiating systems for accurate data collection is a key step that TKY must take to make positive improvements around MSWM.

The final limitations of the study are language and cultural issues. The translation of languages can sometimes be very difficult. The difference between the Thai and English languages are vast. Translation requires the input of an interpreter and when languages are translated from one to another there is potential to gain or lose meaning. In this case, interviews were carried out in the Thai language (national dialect) and local Thai Isan dialect (recorded and transcribed). Translation to English occurred post-coding as the final step in the process to minimise loss of nuance, however some meaning will inevitably be lost.

Cultural norms can lead to limitations around data collection. It is important to note that Australian ethical policies undertaken and implemented during studies have the potential to make people from other cultures feel uncomfortable during interview processes. Even though taking steps to protect the identity of participants (photographs of participants and names were not used in the study), due to collectivist based cultural norms in Thailand information can be withheld due to participants feeling uncomfortable with sharing negative information. Having to sign official documentation before starting a conversation or focus group, and not being able to take photos (which Thai people like to do) during this time, can create a feeling of apprehension for Thai people and could cause information gaps in the study.

7.5 Recommendations for Further Study

The findings from this study will guide future studies, both in terms of research and development, to develop sustainable MSWM systems for both the study area and possibly be a model for other municipalities.

The results from this study could be used as a guide for other local governments in Thailand, or elsewhere in developing countries, that have MSW problems similar to those faced by the TKYSM. This is particularly the case for areas that have a rapidly increasing population, and mixed culture.

Specifically, in this case, Mahasarakham University could provide support for research in the future. Research areas include monitoring engagement between the TKYSM and the community, an evaluation of the MSWM system (the cost, benefit and outcomes), assessing the effectiveness of waste separation, and developing efficient waste collection routes using GIS programs. Other developments should include coaching and mentoring programs to build and develop the waste management team in TKYSM.

7.6 Conclusions

The issue of MSWM is a major global problem and for developing countries MSWM is increasingly complicated. Efficient MSWM cannot be established using fiscal increases and technical solutions alone. During the development stages of a modern MSWM system, TKYSM must consider cultural and social trends pertinent to the target area, update its communication strategy and distribute information that aligns with demographic trends.

This study highlights that a key contributor to the disruption of the current MSWM strategy is a lack of access to quality information. With all stakeholders communication must be relevant, transparent and direct if improvements are to occur. A foundation where all people are encouraged to participate and contribute to the development and application of a new MSW system must be created. Here it is important to acknowledge that MSWM is not only a civic duty and responsibility for local people, but it is also important for TKYSM to provide opportunities to participate in the system.

It is vital to recognise that TKY is a rapidly urbanising area and extremely fluid at this time. This shows the importance of having a framework for MSW that can follow trends and enable TKYSM to manage the present and accurately plan for the future. An ISWM framework can provide the conduit for this. If communication and information propagation around MSWM is done correctly, the quality of the ISWM framework inputs will be high, so the outcome of the implementation of the system will have a greater chance of tracking a positive curve.

The TKYSM needs to ensure that it uses education and information to engage personnel with appropriate skillsets during this process to ensure that the correct foundations for the system are implemented and gaps are understood and managed appropriately.

Information, education and consistency in application are fundamental to quality outcomes during the application of a new MSWM system in TKY. If the importance of this is not stressed and

understood by TKYSM staff and people living in the study area, no MSWM system will ever be successful. There are many opportunities to improve, and through the will of the people it is possible for TKYSM to be a leader in applying sound foundations for MSWM that other municipalities can follow. The methodology used in this study could be applied elsewhere, and the suitability of applying the ISWM framework has been established by this study.

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APPENDICES

Appendix A1: Focus group questions (English)

Focus Group Introduction and Ground Rules

Focus Group Introduction and Ground Rules Introduction for every focus group of participants

Good morning/ good evening and welcome to our session.
Thanks for taking the time to join our discussion on municipal solid waste management in Tha Khon Yang subdistrict.

My name is Nachalida Yukalang. I am a PhD student of Flinders University. I will serve as the moderator for today's focus group discussion.

My assistants are……

The purpose of today's discussion is to get information from you about the involvement in the new municipal solid waste management plan for your community.

We have invited people with similar experiences to share their perceptions and ideas on this topic. You are representing others in your respective villages. There are no right or wrong answers but rather differing points of view. We expect that you will have differing viewpoints. Please feel free to share your point of view even if it differs from what others have said. If you want to follow up on something that someone has said, you may want to agree, disagree, or give an example, feel free to do that. Don't feel that you have to respond to me all the time. Feel free to have a conversation with one another about these questions. I am here to ask questions, listen and make sure everyone has a chance to share. We're interested in hearing from each of you. So if you're talking for a long time, I may ask you to give others a chance. And if you are not sharing much idea, I may ask for your opinion. We just want to make sure we hear from all of you. Feel free to get up and get more refreshments if you like.

My team and I will be audio recording and taking notes to help us remember what is said. We guarantee the confidentiality of your responses; no transcribed comments will be attributed to any one individual. If any question is confusing or ambiguous, please let us know. Everyone's views and opinions are important, that is why we ask that everyone participate in the discussion.

Please keep in mind that we are very interested in both positive as well as negative comments.

The session will last about 2 hours, and we will take a formal break after one and a half hours.
Do you have any questions before we begin?

Ground Rules

Each participant is encouraged to participate in the conversation. Each participant's input is valuable, and should be respected by all. Only one person should talk at a time. Keep in mind that we are only here to lead the discussion, feel free to discuss amongst yourselves. Please remember we are here to develop some constructive ideas for making improvements to solid waste management in this community.

Let's begin with each person in the room, by please telling us their name and some brief information about themselves.

Questioning Route

Outline of Focus Group Questioning Route and Protocol

Opening comments

Welcome and statements regarding the purpose of the study, focus group procedures and ethical issues.

Opening question

Please tell us a little bit about yourself.

Introductory question

Does anyone know what the current waste management system involves in this subdistrict?
(This is only an introductory question, no need for any exact answer.)
Let's look at this summarised system of solid waste management. (Then, I will give the feedback information that is related to municipal solid waste management in this area briefly.)
Do you agree with this information that I have said?

Participants will be separated for 3 groups as follows;

Pilot Group Tenants (students) who live in Mahasarakham University accommodation
Group 1 Tenants (students) who live in off-campus accommodation
Group 2 Operational waste management staff
Group 3 Villagers

Engagement questions

1) What do you think when you see the huge amount of unseparated waste?
2) What is “good municipal solid waste management” in your opinion?

Exploration (Key) questions

3) What are the most successful or best aspects of solid waste management in Tha Khon Yang subdistrict?
4) In your opinion, what are the main challenges or worst aspects of municipal solid waste management in this area?
5) What are the causes of municipal solid waste problems in Tha Khon Yang subdistrict?
6) What are the obstacles to overcome the challenges for the good municipal solid waste management in Tha Khon Yang subdistrict?
7) What improvements need to be done (How) to overcome these problems?
8) What improvements could be made to help you undertake your own role (in the MSWM sector) more effectively?
9) What is the most important aspect that you think it could be made in regard to the municipal solid waste in Tha Khon Yang subdistrict?
10) What is the first aspect that you think it could be done as soon as possible?
11) Who should be responsible for making these changes?

Exit questions

12) Is there anything else we have not talked about, that you feel we need to address?

*In this grey highlight is used for waste management operational staff of TKYSM.

Thank you

Appendix A2: Focus group questions (Thai)

คำถามสำหรับการประชุมกลุ่มย่อย

คำชี้แจง
คำกล่าวเปิดการประชุม

สวัสดีผู้เข้าร่วมประชุมทุกท่านและยินดีต้อนรับสู่โครงการการจัดการขยะมูลฝอยในตำบลท่าขอนยางของเรา ก่อนอื่นดิฉันขอพระขอบพระคุณท่านที่สละเวลาในการเข้าร่วมโครงการการจัดการขยะมูลฝอยในตำบลท่าขอนยางในวันนี้

ดิฉัน นางสาวณัชชลิดา ยุคะลัง, นักศึกษาปริญญาเอกของมหาวิทยาลัย Flinders ประเทศออสเตรเลีย รับหน้าที่เป็นผู้ดำเนินรายการในวันนี้

และดิฉันขอแนะนำผู้ช่วยดิฉันคือ .....

วัตถุประสงค์ของการประชุมในวันนี้คือการอภิปรายร่วมกันเกี่ยวกับการมีส่วนร่วมในการสร้างแผนจัดการขยะมูลฝอยชุมชนของเทศบาลตำบลท่าขอนยาง

ทุก ๆ ท่านที่นั่งอยู่ ณ ห้องประชุมแห่งนี้ มีความเชี่ยวชาญ หรือมีความคิดเห็นเรื่องเกี่ยวกับการจัดการมูลฝอยที่อาจจะคล้ายกัน หรือแตกต่างกัน ขึ้นกับประสบการณ์มีท่านมี เพราะฉะนั้นวันนี้เราจะมาร่วมกันการแบ่งปันประสบการณ์และความคิดเห็นของท่านเกี่ยวกับการจัดการมูลฝอย ท่านเป็นตัวแทนของคนอื่น ๆ ในหมู่บ้าน ในสังคมของท่าน ทุก ๆ สิ่งที่ท่านกล่าว จะไม่มีคำตอบที่ถูกหรือผิด แต่เราจะเคารพถึงมุมมองที่แตกต่างกันของทุกท่าน กรุณาอย่าลังเลที่จะแบ่งปันมุมมองของท่าน แม้ว่าท่านจะมีมุมมองที่แตกต่างจากสิ่งที่คนอื่นได้กล่าว ดังนั้นท่านมีสิทธิที่จะแสดงความคิดเห็นได้เต็มที่ ดิฉันและทีมงานจะร่วมอยู่ในการประชุมกลุ่มย่อย เพื่อที่จะถามคำถาม ฟัง และเพื่อเปิดโอกาสให้ทุกคนมีโอกาสที่จะแบ่งปันความคิดเห็น เราจะให้ความสำคัญกับทุก ๆ ความคิดเห็นจากทุกท่าน ถ้าหากมีบุคคลบางท่านใช้เวลาพูดนานเกินไป ดิฉันอาจขอให้บุคคลท่านนั้นได้เปิดโอกาสให้ท่านอื่น ๆ ได้แสดงความคิดเห็นบ้าง และหากท่านไม่แสดงความคิดเห็นมากนัก ดิฉันและทีมงานอาจจะมีการขออนุญาตถามคำถามเพื่อกระตุ้นให้ท่านแสดงความคิดเห็น เราเพียงแค่ต้องการที่จะได้ยินความคิดเห็นจากทุกท่าน หากท่านรู้สึกเหมื่อย ท่านสามารถที่จะเดินไปรับเครื่องดื่ม หรือรับประทานอาหารว่างได้ทุกเมื่อ

ดิฉันและทีมงานขออนุญาตทำการบันทึกเสียงและการจดบันทึกบทสนทนาต่าง ๆ และในสิ่งที่ท่านกล่าว เราจะรักษาคำตอบของท่านเป็นอย่างดี โดยบทสนทนานี้จะถูกบันทึกในรูปแบบเอกสาร โดยจะไม่ระบุชื่อ หรือแสดงตัวตนของท่าน บทสนทนานี้จะถูกนำมาประกอบการแสดงความคิดเห็นของแต่ละบุคคลเท่านั้น หากท่านไม่เข้าใจคำถามใด ๆ หรือคิดว่าคำถามไม่ชัดเจนกรุณาแจ้งให้เราทราบ มุมมองและความคิดเห็นของทุกท่านที่ได้มีส่วนร่วมในการอภิปรายในวันนี้ รวมทั้งข้อคิดเห็นในเชิงบวกหรือเชิงลบล้วนมีความสำคัญทั้งสิ้น

ในการประชุมในวันนี้ จะใช้เวลาประมาณ 2 ชั่วโมง และจะมีเวลาพักรับประมาณอาหารว่างในระหว่างประชุม ก่อนที่เราจะเริ่มประชุม ท่านมีคำถามใดๆ ที่จะสอบถามดิฉันหรือไม่

คำชี้แจง

ผู้เข้าร่วมแต่ละท่านจะได้รับการกระตุ้นให้มีส่วนร่วมในการสนทนา เราเคารพและให้ความสำคัญในการให้ข้อมูลของผู้เข้าร่วมประชุมทุกท่าน ข้อมูลที่ได้รับจากการอภิปรายในแต่ละกลุ่มจะนำไปสู่การพัฒนาและปรับปรุงการจัดการขยะมูลฝอยในชุมชนแห่งนี้

เริ่มต้นด้วยการแนะนำตัวท่านพอสังเขป

ประเด็นคำถาม

กล่าวเปิดการประชุม

ดิฉันขอชี้แจงวัตถุประสงค์ของการศึกษา, วิธีการและประเด็นในการสนทนากลุ่ม, ประเด็นด้านจริยธรรมในการวิจัยในการปกป้องความเป็นส่วนตัวของท่าน

เริ่มคำถาม

กรุณาแนะนำตัวท่านพอสังเขป

คำถามนำ

ท่านทราบข้อมูลอะไรบ้างเกี่ยวกับระบบการจัดการมูลฝอยในปัจจุบันของพื้นที่ตำบลท่าขอนยาง

คืนข้อมูล

ดิฉันขอสรุปให้ข้อมูลที่เกี่ยวข้องกับการจัดการขยะมูลฝอยในพื้นที่ตำบลท่าขอนยางคร่าว ๆ ท่านเห็นด้วยกับข้อมูลที่ดิฉันได้กล่าวไปหรือไม่ ?

คำถามเพื่อเชื่อมโยงไปสู่การประชุมกลุ่ม

1) ท่านคิดว่าข้อดีหรือประโยชน์เกี่ยวระบบการจัดการขยะมูลฝอยที่มีอยู่ในเทศบาลตำบลท่าขอนยางในปัจจุบันคือ อะไร?

2) อะไรคือปัญหาของระบบการจัดการขยะมูลฝอยของเทศบาลในปัจจุบัน?

3) จะทำอย่างไรเพื่อที่จะแก้ไขปัญหานั้นได้?

4) ท่านคิดว่าใครควรจะมีบทบาทรับผิดชอบในการแก้ไขปัญหาเหล่านี้?

คำถามสำคัญ

ในความคิดของท่าน การบริหารจัดการขยะมูลฝอยเทศบาลที่ดีควรจะเป็นอย่างไร?

คำถามปิด

ท่านมีอะไรจะเพิ่มเติมอีกหรือไม่?

แบ่งกลุ่มย่อย ผู้เข้าร่วมประชุมจะถูกแยกประชุมกลุ่มย่อย เป็น 3 กลุ่ม ดังนี้

กลุ่มทดลอง นักศึกษาที่อาศัยอยู่ในที่พักในหอพักของมหาวิทยาลัยมหาสารคาม

กลุ่มที่ 1 นักศึกษาที่อาศัยอยู่ในที่พักเอกชน

กลุ่มที่ 2 เจ้าหน้าที่ปฏิบัติการการจัดการขยะมูลฝอยจากองค์กรส่วนท้องถิ่น

กลุ่มที่ 3 ประชาชนผู้อยู่อาศัยในพื้นที่เทศบาลตาบลท่าขอนยาง

คำถามสำหรับการประชุมกลุ่มย่อย

คำถามนำ

1. **ท่านคิดอย่างไรเมื่อท่านมองเห็นกองขยะมูลฝอยขนาดใหญ่ที่ไม่ได้รับการแยกขยะ**
2. **ท่านคิดว่าการจัดการขยะมูลฝอยที่ดีเป็นอย่างไร**

คำถามหลัก

3. **ระบบการจัดการขยะมูลฝอยที่เป็นอยู่ในปัจจุบันของเทศบาลตำบลท่าขอนยางมีข้อดีอย่างไรบ้าง**
4. **ระบบการจัดการขยะมูลฝอยในปัจจุบัน มีปัญหาอย่างไร**
5. **สาเหตุของปัญหา หรืออุปสรรคของการแก้ปัญหาการจัดการขยะมูลฝอยของเทศบาลตำบลท่าขอนยาง คืออะไร**
6. **อุปสรรคของการแก้ปัญหาการจัดการขยะมูลฝอยของเทศบาลตำบลท่าขอนยาง คืออะไร**
7. **จะแก้ปัญหาระบบการจัดการขยะมูลฝอยได้อย่างไร**
8. **ในบทบาทของท่าน ท่านจะสามารถช่วยพัฒนาการจัดการขยะมูลฝอยให้มีประสิทธิภาพมากขึ้นได้อย่างไร**
9. **การจัดการขยะมูลฝอยของเทศบาลตำบลท่าขอนยางเรื่องใดเป็นเรื่องที่สำคัญมากที่สุดที่ควรได้รับการแก้ไข**
10. **ในการจัดการขยะมูลฝอย เรื่องใดเป็นเรื่องเร่งด่วนที่ควรถูกแก้ไขให้ได้เร็วที่สุด**
11. **ใครบ้างที่ควรมีบทบาทที่จะทำให้เกิดการเปลี่ยนแปลงนี้**

คำถามปิดท้าย

12. **ท่านมีข้อคิดเห็นอื่นๆ เพิ่มเติมอีกหรือไม่**

*** คำถามในข้อ 8 ใช้สำหรับการประชุมกลุ่มย่อยเฉพะเจ้าหน้าที่ผู้ปฏิบัติงานการจัดการขยะมูลฝอยของเทศบาลตำบลท่าขอนยางเท่านั้น**

ขอบพระคุณทุกท่านที่ให้ความร่วมมือ

Appendix B1: Interview questions (English)

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Interview Questions

(For administrators, academics, leaders of villages, experts and entrepreneurs)

Instructions:

Please answer the questions to the best of your knowledge or in your opinion. There are no right or wrong answers. I am interested in your opinion on the issues.

1. What is your role in waste management?

   _____
   _____
   _____

2. How effective do you think the municipal solid waste management is in the Tha Khon Yang subdistrict? (a scale of 1-5 where 1 is very ineffective and 5 is very effective)

1	2	3	4	5	6
Very Ineffective	Ineffective	Neither effective nor ineffective	Effective	Very Effective	Don't Know

   Could you please give me a reason for your choice?

   _____
   _____
   _____

3. In your opinion, what are the successful or best aspects of solid waste management in this area?

   _____
   _____
   _____

4. In your opinion, what are the main challenges or worst aspects of solid waste management in this area?

   _____
   _____
   _____

5. What are the causes of municipal solid waste problems in this area?

_____
_____
_____

6. What are the obstacles for municipal solid waste problems in this area?

_____
_____
_____

7. In your opinion what improvements need to be made in regard to the municipal solid waste management in the Tha Khon Yang subdistrict?

_____
_____
_____

8. Do you think waste problems affect the environment in this area?

□ Yes
□ No

Could you please give a reason for your choice?

_____
_____
_____

9. Do you think waste problems affect the health of people in this area?

□ Yes
□ No

Could you please give me a reason for your choice?

_____
_____
_____

10. Do you think the operational cost of waste problems have any effect to people in this sub-district or the Tha Khon Yang municipality?

□ Yes
□ No

Could you please give a reason for your choice?

_____
_____
_____

11. Do you think the waste problems affect any other aspects in this area or not?

□ Yes
□ No

Could you please give a reason for your choice?

_____
_____
_____

12. What technologies do you think are needed for the improvement of solid waste management in in the Tha Khon Yang subdistrict?

_____
_____
_____

13. What alternative improvements/models could be made to the municipal solid waste solutions?

_____
_____
_____

14. What is the most important aspect that should be addressed

_____
_____
_____

15. Given your answers above, what improvements could be made to help you undertake your own role (in the solid waste management sector) more effective?

_____
_____
_____

16. Who should be responsible for making these changes?

_____
_____
_____

17. Do you have any other comments you wish to add?

_____
_____
_____

Thank you for your time

Appendix B2: Interview questions (Thai)

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คำถามสัมภาษณ์

(สำหรับ เจ้าหน้าที่จากองค์กรปกครองส่วนท้องถิ่น ผู้เชี่ยวชาญ ผู้นำชุมชน และผู้ประกอบการ)

คำชี้แจง:

กรุณาตอบคำถามที่ตรงกับความคิดเห็นของคุณของท่านมากที่สุด ไม่มีคำตอบที่ถูกหรือผิด

1. ท่านมีบทบาทเกี่ยวข้องกับการจัดการขยะอย่างไรบ้าง?

2. ท่านคิดว่าการจัดการขยะมูลฝอยของเทศบาลตาบลท่าขอนยางมีประสิทธิภาพมากน้อยในระดับใด?

(โดย เรียงจากน้อยไปมาก ระดับที่ 1 ถึง ระดับที่ 5 ดังนี้)

1 หมายถึง ไม่มีประสิทธิภาพมาก

2 หมายถึง ไม่มีประสิทธิภาพ

3 หมายถึง มีประสิทธิภาพระดับปานกลาง

4 หมายถึง ประสิทธิภาพ

5 หมายถึง มีประสิทธิภาพมาก

6 หมายถึง ไม่ทราบ

กรุณาให้เหตุผลในการเลือกคำตอบ?

_____
_____
_____

3. ท่านคิดว่าการจัดการขยะมูลฝอยในพื้นที่เทศบาลตาบลท่าขอนยางประสบความสำเร็จมากที่สุดในกระบวนการหรือด้านใด?

_____
_____
_____

4. ท่านคิดว่า การจัดการมูลฝอยในกระบวนการใดที่ควรได้รับการแก้ไขมากที่สุด?

_____
_____
_____

5. อะไรคือสาเหตุของปัญหาสำหรับเทศบาลในการจัดการปัญหาขยะมูลฝอยในพื้นที่นี้?

_____
_____
_____

6. ท่านคิดว่าอุปสรรคในการจัดการปัญหาขยะมูลฝอยในพื้นที่นี้คืออะไร?

_____
_____
_____

7. ท่านคิดว่าจะแก้ปัญหาระบบการจัดการขยะมูลฝอยได้อย่างไร

_____
_____
_____

8. ท่านคิดว่าปัญหามูลฝอยส่งผลกระทบต่อสภาพแวดล้อมในพื้นที่นี้หรือไม่?
   □ มี
   □ ไม่มี
   กรุณาให้เหตุผลประกอบ

_____
_____
_____

9. ท่านคิดว่าปัญหามูลฝอยส่งผลกระทบต่อสุขภาพของประชาชนในพื้นที่นี้หรือไม่?
   □ มี
   □ ไม่มี
   กรุณาให้เหตุผลประกอบ

_____
_____
_____

10. ท่านคิดว่าค่าใช้จ่ายในการดำเนินงานของปัญหาขยะมีผลกระทบใด ๆ กับคนในตำบลหรือเทศบาลท่าขอนยาง?
    □ มี
    □ ไม่มี
    กรุณาให้เหตุผลประกอบ

_____
_____
_____

11. ท่านคิดว่าปัญหามูลฝอยส่งผลกระทบต่อด้านอื่น ๆ อีกหรือไม่?
    □ มี
    □ ไม่มี
    กรุณาให้เหตุผลประกอบ

_____
_____
_____

12. เทคโนโลยีใดที่ท่านคิดว่ามีความเหมาะสมที่จะนำมาประยุกต์ใช้ในการปรับปรุงการจัดการขยะมูลฝอยในตำบลท่าขอนยาง?

_____
_____
_____

13. ท่านมีข้อแนะนำเกี่ยวกับวิธีการ หรือ รูปแบบทางเลือกอื่น ที่เทศบาลควรนำมาใช้ในการจัดการมูลฝอยในพื้นที่ หรือไม่?

_____
_____
_____

14. ท่านมีข้อแนะนำเกี่ยวกับวิธีการ หรือ รูปแบบทางเลือกอื่น ที่เทศบาลควรนำมาใช้ในการจัดการมูลฝอยในพื้นที่ หรือไม่?

_____
_____
_____

15. ท่านคิดว่าจากบทบาทของท่านจะสามารถเพิ่มประสิทธิภาพการจัดการมูลฝอยในพื้นที่ได้อย่างไร

_____
_____
_____

16. ใครบ้างที่ควรมีบทบาทที่จะทำให้เกิดการเปลี่ยนแปลงนี้

_____
_____
_____

17. ท่านมีข้อเสนอแนะเพิ่มเติมอีกหรือไม่?

_____
_____
_____

ขอบพระคุณในความร่วมมือ

Appendix C1: Letter of introduction (English)

School of the Environment
GPO Box 2100
Adelaide SA 5001
Tel: +61(0)8 72218584
Kirstin.ross@flinders.edu.au
http://www.flinders.edu.au/people/kirstin.ross
CRICOS Provider No. 00114A

LETTER OF INTRODUCTION

Dear Sir,

This letter is to introduce Miss Nachalida Yukalang who is a PhD student in the School of Environment at Flinders University. She is undertaking research leading to the production of a thesis on the subject of "Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand". The purpose of this research is to identify the components that are necessary for successful implementation of integrated sustainable waste management in this area. This research will be carried on in Tha Khon Yang Sub-district, Kantharawichai District, Mahasarakham Province.

I'm writing on behalf of Flinders University, Australia to ask for your cooperation. Miss Yukalang would like to invite you to assist in this project, by granting cooperation in **focus group** session with **local government staff and residents, owners of local businesses and students**. Moreover, she would like you to provide information that is related to waste management in this area. This project will be conducted between April 2015 and October 2017. The focus group meeting would be conducted about two hours at the faculty of Public Health, Mahasarakham University. Focus group is a necessary method of this research. Therefore, the participants could read more information in the information sheet and will be asked to sign the consent form before participation as attached files.

This research will help to build an appropriate system for municipal solid waste management in Tha Khon Yang sub-district. By produce a sustainable waste management model which is based on community participation and can be integrated with the Integrated Sustainable Waste Management (ISWM) plan.

Be assured that any information provided will be treated in the strictest confidence and none of the participants will be individually identifiable in the resulting thesis, report or other publications.

Any enquiries you may have concerning this project should be directed to me at the address given above or by telephone on +61(0)87 72218584, or by email (kirstin.ross@flinders.edu.au).

Thank you for your attention and assistance.

Yours sincerely,

[redacted]

Dr Kirstin Ross
Lecturer

School of the Environment

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix C2: Letter of introduction (Thai)

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CRICOS Provider No. 00114A

หนังสือแนะนำตัว

เรียน

เนื่องด้วย นางสาวณัชชลิดา ยุคะลัง นักศึกษาปริญญาดุษฎีบัณฑิต สำนักวิชาสิ่งแวดล้อม คณะวิทยาศาสตร์และวิศวกรรมศาสตร์ มหาวิทยาลัยฟลินเดอส์ ประเทศออสเตรเลีย ได้ทำการศึกษาในหัวข้อวิจัย เรื่อง "รูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็ว ในภาคตะวันออกเฉียงเหนือของประเทศไทย" โดยมีวัตถุประสงค์ของงานวิจัยเพื่อค้นหาแนวทางการจัดการมูลฝอยอย่างยั่งยืนในพื้นที่ที่ศึกษา ซึ่งการศึกษาครั้งนี้จะดำเนินการในพื้นที่ ตำบลท่าขอนยาง อำเภอกันทรวิชัย จังหวัดมหาสารคาม ในนามของมหาวิทยาลัยฟลินเดอส์ ประเทศออสเตรเลีย ข้าพเจ้าขอความร่วมมือจากท่านในการให้ สัมภาษณ์เกี่ยวกับการจัดการมูลฝอยในพื้นที่เขตเทศบาลตำบลท่าขอนยาง โดยท่านสามรถอ่านข้อมูลเกี่ยวกับ โครงการวิจัยนี้ได้ ในเอกสาร "ข้อมูลเกี่ยวกับโครงการวิจัย" และหากท่านยินดีให้สัมภาษณ์ โปรดลงนามใน "เอกสารแสดงความยินยอมในการให้ความร่วมมือในการวิจัย" ดังเอกสารที่แนบมาพร้อมนี้ ทั้งนี้ระยะเวลาการดำเนิน โครงการ เริ่มตั้งแต่เดือนเมษายน 2558 ถึง เดือนตุลาคม 2560 ข้าพเจ้าหวังว่างานวิจัยนี้จะเป็นประโยชน์ในการพัฒนาระบบการจัดการมูลฝอยชุมชนในพื้นที่เทศบาลตำบลท่าขอนยาง โดยการสร้างแผนการมีส่วนร่วมของประชาชน บูรณาการณ์ร่วมกับการจัดการมูลฝอยอย่างยั่งยืน ข้อมูลที่ได้รับจากท่านจะถูกรักษาอย่างดี โดยข้อมูลที่จะระบุถึงตัวท่านจะถูกเก็บเป็นความลับข้าพเจ้าหวังเป็นอย่างยิ่งว่าจะได้รับความร่วมมือจากท่านเป็นอย่างดียิ่งและขอขอบพระคุณมา ณ ที่นี้

หากมีท่านประสงที่จะทราบข้อมูลเพิ่มเติม ท่านสามารถติดต่อข้าพเจ้าได้โดยตรงตามที่อยู่ที่ให้มาพร้อมนี้
โทร +61(0)87 72218584 หรือ อีเมลล์ kirstin.ross@flinders.edu.au
หรือ ติดต่อผู้วิจัย นางสาวณัชชลิดา ยุคะลัง โทร 085- 643 0403 หรือ อีเมลล์ yuka0004@flinders.edu.au

ขอแสดงความนับถือ

ดร. เคริ์สทิน รอสส์
School of the Environment School

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix D1: Information sheets for participations (English)

MISS NACHALIDA YUKALANG
SCHOOL OF THE ENVIRONMENT
FACULTY OF SCIENCE AND ENGINEERING
HEALTH SCIENCE BUILDING, 5.26
GPO BOX 2100 ADELAIDE SA 5001
TEL: +61 8 72218587
YUKA0004@FLINDERS.EDU.AU
CRICOS PROVIDER NO. 00114A

INFORMATION SHEET

Title: "Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand"

Investigators:

Miss Nachalida Yukalang
School of the Environment
Faculty of Science and Engineering
Flinders University
Ph: +61 8 72218587

Supervisor(s):

Dr Kirstin Ross
School of the Environment
Faculty of Science and Engineering
Ph: +61 8 72218584

Dr Beverley Clarke
School of the Environment
Faculty of Science and Engineering
Ph: +61 8 82012760

Description of the study:

This study is part of the project entitled '**Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand**.

Purpose of the study:

General Aim of the study

To identify the necessary components for successful implementation of ISWM

Specific aims of the study

1) To assess the current solid waste management system in the Tha Khon Yang sub-district, Mahasarakham Province
2) To identify barriers to effective solid waste management in the Tha Khon Yang sub-district, Mahasarakham Province
3) To identify the priorities for municipal solid waste management plan of a rapidly urbanizing area
4) To develop a municipal solid waste management plan of rapidly urbanizing area

What will I be asked to do?

You are invited to attend a focus group with a researcher who will question you about your views about municipal solid waste management that in the study area. The focus group will take about 2 hours. The conversation during focus group meeting will be recorded by using a digital voice recorder to help with looking at the results. Once recorded, the conversation will be transcribed (typed-up) and stored as a computer file and then destroyed once the results have been finalised. This is voluntary.

What benefit will I gain from being involved in this study?

The sharing of your experiences will improve the planning and delivery of future solid waste management. We are very keen to deliver a service and resources which are as useful as possible to people in the study area.

Will I be identifiable by being involved in this study?

We do not need your name and your information will be given by you will remain confidential. Once the interview has been typed-up and saved as a file, the voice file will then be destroyed. Any identifying information will be removed and the typed-up file stored on a password protected computer that only the researcher (Miss Nachalida Yukalang) will have access to. Your comments will not be linked directly to you.

Are there any risks or discomforts if I am involved?

The researcher anticipates few risks from your involvement in this study. If you have any concerns regarding anticipated or actual risks or discomforts, please raise them with the researcher.

How do I agree to participate?

Participation is voluntary. You may answer 'no comment' or refuse to answer any questions and you are free to withdraw from the interview at any time without effect or consequences. A consent form accompanies this information sheet. If you agree to participate please read and sign the form and send it back to Miss Nachalida Yukalang, researcher (Phone Number: +66(0)43 754353 or +66 (0) 85 6430403) or e-mail yuka0004@gmail.com.

- Participation in the study is voluntary and refusal to participate will have no effect on your job/ study;
- A sound recording will be made of your participation, which will be transcribed;
- Any information that identifies people will not be transcribed;
- Participants can withdraw from the study at any time, without consequence; and
- Participants can ask for any part of their participation to be omitted from the study.

Please note: Anonymity cannot be guaranteed within the focus groups (the other focus group members might recognise you).

How will I receive feedback?

Copies of the participant's transcript could be made available.

Thank you for taking the time to read this information sheet and we hope that you will accept our invitation to be involved.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix D2: Information sheets for participations (Thai)

MISS NACHALIDA YUKALANG
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FACULTY OF SCIENCE AND ENGINEERING
HEALTH SCIENCE BUILDING, 5.26
GPO BOX 2100 ADELAIDE SA 5001
TEL: +61 8 72218587
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CRICOS PROVIDER NO. 00114A

ข้อมูลเกี่ยวกับโครงการวิจัย

INFORMATION SHEET

หัวข้อวิจัย : **การพัฒนารูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็ว ในภาคตะวันออกเฉียงเหนือ ประเทศไทย**

Title: **"Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand"**

ผู้วิจัย:
นางสาวณัชชลิดา ยุคะลัง
นักศึกษาปริญญาดุษฎีบัณฑิต
สำนักวิชาสิ่งแวดล้อม
คณะวิทยาศาสตร์และวิศวกรรมศาสตร์
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+61 (0) 412923487

Investigator:
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School of the Environment
Faculty of Science and Engineering

Ph: +66 (0) 85 6430403
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อาจารย์ที่ปรึกษา :
ดร. เคิร์สทิน รอสส์
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คณะวิทยาศาสตร์และวิศวกรรมศาสตร์
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Supervisors :
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ดร.เบฟเวอร์เลย์ คลาร์ค
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Dr Beverley Clarke
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Faculty of Science and Engineering
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รายละเอียดการศึกษา:

การศึกษานี้เป็นส่วนหนึ่งของโครงการวิจัยเรื่อง "การพัฒนารูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็ว ในภาคตะวันออกเฉียงเหนือ ประเทศไทย"

วัตถุประสงค์การศึกษา :

วัตถุประสงค์ทั่วไป

เพื่อศึกษาองค์ประกอบที่จำเป็นสำหรับการที่จะประสบความสำเร็จในการดำเนินงานในการจัดการมูลฝอยแบบบูรณาการณ์

วัตถุประสงค์เฉพาะ

1) **เพื่อประเมินสถานการณ์ปัจจุบันของระบบการจัดการมูลฝอยในพื้นที่ตำบลท่าขอนยาง จังหวัดมหาสารคาม**
2) **เพื่อระบุอุปสรรคที่มีผลต่อระบบการจัดการมูลฝอยในพื้นที่ตำบลท่าขอนยาง จังหวัดมหาสารคาม**
3) **เพื่อลำดับความสำคัญในการวางแผนการจัดการมูลฝอยชุมชนสำหรับพื้นที่ที่มีการขยายความเป็นเมืองอย่างรวดเร็ว**
4) **เพื่อพัฒนาแผนการจัดการมูลฝอยชุมชนสำหรับพื้นที่ที่มีการขยายความเป็นเมืองอย่างรวดเร็ว**

การมีส่วนร่วมในการวิจัย

ท่านได้รับเชิญในการให้ข้อมูลโดยวิธีการประชุมกลุ่มย่อย โดยผู้วิจัยจะสอบถามความคิดเห็นของท่านเกี่ยวกับการจัดการมูลฝอยชุมชนในพื้นที่ที่ศึกษา โดนจะใช้เวลาในการร่วมประชุมกลุ่มย่อยประมาณ 2 ชั่วโมง ในระหว่างการประชุมผู้วิจัยจะบันทึกเสียงการสนทนาเพื่อช่วยในการบันทึกรายละเอียด ซึ่งบทสนทนานี้จะถูกแปลและบันทึกในรูปแบบไฟล์ในคอมพิวเตอร์ และข้อมูลนี้จะถูกทำลายเมื่อผลการศึกษาได้สรุปเสร็จสิ้นแล้ว การมีส่วนร่วมนี้เป็นการให้ความร่วมมือโดยความสมัครใจ

ประโยชน์ที่ท่านจะได้รับจากการมีส่วนร่วม

การแบ่งบันประสบการณ์ของท่านจะเอื้อประโยชน์ในการปรับปรุงแผนการจัดการมูลฝอยในอนาคต ซึ่งประชาชนในพื้นที่จะได้รับประโยชน์จากการปรับปรุงระบบการบริการการจัดการมูลฝอยที่มีประสิทธิภาพมากยิ่งขึ้น

การแสดงตัวตนของท่านในการมีส่วนร่วมในการวิจัยนี้

ชื่อและข้อมูลส่วนตัวของท่านจะได้รับการปิดเป็นความลับ ไฟล์เสียงจะถูกทำลายเมื่อบทสนทนาถูกแปลงเป็นไฟล์เอกสารในคอมพิวเตอร์ ข้อมูลใดๆ ที่ระบุตัวตนของท่านจะถูกลบ นอกจากนี้ข้อมูลจะถูกเก็บในคอมพิวเตอร์ที่มีการตั้งรหัสผ่านซึ่งจะมีเพียงผู้วิจัยเท่านั้นที่จะเข้าถึงข้อมูลได้ การให้ความเห็นของท่านจะไม่มีผลต่อกระทบใดๆ ต่อตัวท่าน

ความเสี่ยงที่อาจเกิดขึ้นต่อท่านจากการมีส่วนร่วม

ผู้วิจัยคาดว่าการวิจัยนี้มีความเสี่ยงน้อยต่อผู้เข้าร่วมประชุม หากท่านมีข้อกังวลเกี่ยวกับความเสี่ยงที่อาจเกิดขึ้นหรืออาจทำให้ท่านไม่สบายใจ กรุณาแจ้งผู้วิจัยให้ทราบ

การตอบรับการมีส่วนร่วม

หากท่านตกลงในการเข้าร่วมประชุม โปรดอ่านและลงลายมือชื่อในเอกสารการยินยอมการเป็นผู้มีส่วนร่วม และกรุณาส่งเอกสารกลับมายัง นางสาวณัชชลิดา ยุคะลัง

(โทรศัพท์: +66(0)43 754353 หรือ +66 (0) 85 6430403 หรือ อีเมลล์ yuka0004@flinders.edu.au)

- **การมีส่วนร่วมนี้เป็นความสมัครใจของท่าน และท่านจะไม่ได้รับผลกระทบใด ๆ ต่อหน้าที่หรือการเรียนของท่านหากท่านการปฏิเสธการมีส่วนร่วม**
- **การบันทึกเสียงสนทนาจะถูกเปลี่ยนเป็นข้อความเอกสาร**
- **ท่านสามารถถอนตัวจากการประชุมได้ทุกเมื่อ โดยจะไม่มีผลกระทบใดๆ ต่อตัวท่าน**
- **ท่านสามารถขอหยุดการมีส่วนร่วมได้ตลอดเวลา**

หมายเหตุ : ผู้ร่วมประชุมท่านอื่นอาจจะสังเกตเห็นท่านในการประชุมกลุ่มย่อย

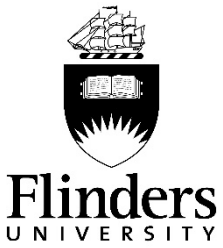
การคืนข้อมูลให้กับผู้เข้าร่วมประชุม

ท่านสามารถการคัดลอกสรุปบทสนทนาของท่านได้

ขอขอบพระคุณที่สละเวลาในการอ่านข้อมูล และหวังเป็นอย่างยิ่งว่าจะได้รับความร่วมมือจากท่านด้วยดี

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix E1: Consent forms for focus group (English)



CONSENT FORM FOR PARTICIPATION IN RESEARCH
(by focus group)

Project title : **Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand**

I ….....

being over the age of 18 years hereby consent to participate as requested in the …… for the research project on …….

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to audio/video recording of my information and participation.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.

5. I understand that:

- I may not directly benefit from taking part in this research.
- I am free to withdraw from the project at any time and am free to decline to answer particular questions.
- While the information gained in this study will be published as explained, I will not be identified, and individual information will remain confidential.
- Whether I participate or not, or withdraw after participating, will have no effect on my progress in my study or my work.
- I may ask that the recording be stopped at any time, and that I may withdraw at any time from the session or the research without disadvantage.
- Participation in the study is voluntary and refusal to participate will have no effect on your job/ study;
- A sound recording will be made of your participation, which will be transcribed;
- Any information that identifies people will not be transcribed;
- Participants can ask for any part of their participation to be omitted from the study.

6. I agree to the tape being made available to other researchers who are not members of this research team, but who are judged by the research team to be doing related research, on condition that my identity is not revealed.
7. I have had the opportunity to discuss taking part in this research with a family member or friend.
8. Anonymity cannot be guaranteed within the focus groups (the other focus group members might recognise you).

Participant's signature……Date……...

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name Miss Nachalida Yukalang

Researcher's signature……..Date…….

9. I, the participant whose signature appears below, have read a transcript of my participation and agree to its use by the researcher as explained.

Participant's signature……Date……...

Appendix E2: Consent forms for focus group (Thai)

เอกสารแสดงความยินยอมในการให้ความร่วมมือในการวิจัย

(การประชุมกลุ่มย่อย)

หัวข้อวิจัย : การพัฒนารูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็ว ในภาคตะวันออกเฉียงเหนือ ประเทศไทย

ข้าพเจ้า ..... ขอรับรองว่า ข้าพเจ้าอายุครบ 18 ปีบริบูรณ์ ยินยอมให้ความร่วมมือในการประชุมกลุ่มย่อย ในโครงการวิจัยนี้

1. ข้าพเจ้าได้อ่านข้อมูลที่เกี่ยวข้องกับโครงการจากผู้วิจัย
2. ผู้วิจัยได้อธิบายถึงกระบวนการวิจัยพร้อมทั้งความเสี่ยงที่อาจเกิดขึ้น ซึ่งข้าพเจ้าเข้าใจและยอมรับได้
3. ข้าพเจ้ายินยอมในการถูกบันทึกเสียงในขณะให้ข้อมูล
4. ข้าพเจ้าตระหนักถึงการเก็บสำเนาเอกสารการยินยอมเป็นผู้มีส่วนร่วมในการวิจัยนี้ไว้เพื่อเป็นหลักฐาน
5. ข้าพเจ้าเข้าใจว่า

- ข้าพเจ้าอาจไม่ได้รับผลประโยชน์จากการมีส่วนร่วมในการวิจัยนี้โดยตรง
- ข้าพเจ้ามีสิทธิที่จะถอนตัวจากโครงการได้ตลอดเวลาหรือมีสิทธิ์ปฏิเสธการตอบคำถามบางคำถาม
- การเผยแพร่ข้อมูลการวิจัยจะไม่ระบุตัวตนของข้าพเจ้า และข้อมูลส่วนบุคคลจะถูกเก็บเป็นความลับ
- ข้าพเจ้าจะไม่ได้รับผลกระทบใด ๆ หากปฏิเสธการมีส่วนร่วม หรือถอนตัว
- ข้าพเจ้าอาจขอให้หยุดการบันทึกเสียงได้ทุกขณะ และอาจถอนตัวได้ในทุกกระบวนการ โดยไม่จำเป็นต้องแจ้งให้ทราบล่วงหน้า
- การมีส่วนร่วมนี้เป็นความสมัครใจของข้าพเจ้า และข้าพเจ้าจะไม่ได้รับผลกระทบใด ๆ ต่อหน้าที่หรือการเรียนของข้าพเจ้า หากปฏิเสธการมีส่วนร่วม
- การบันทึกเสียงสนทนาจะถูกเปลี่ยนเป็นข้อความเอกสาร
- ข้อมูลที่สามารถระบุตัวบุคคล จะไม่ถูกบันทึกเป็นเอกสาร
- ข้าพเจ้าสามารถถอนตัวจากการประชุมได้ตลอดเวลา โดยจะไม่มีผลกระทบใดๆ ต่อตัวข้าพเจ้า

6. ข้าพเจ้าไม่ตกลงที่จะให้เทปบันทึกแก่นักวิจัยวิจัยท่านอื่นที่ไม่เกี่ยวข้องกับทีมวิจัยนี้ ยกเว้นในกรณีที่นักวิจัยผู้นั้นได้รับการตัดสินจากทีมวิจัยนี้ว่าเป็นผู้มีความเกี่ยวข้อง โดยไม่มีการเปิดเผยข้อมูลส่วนตัวของข้าพเจ้า

7. ข้าพเจ้ามีโอกาสในการหารือกับบุคคลในครอบครัวหรือเพื่อนของข้าพเจ้าในการที่จะเข้ามามีส่วนร่วมในโครงการวิจัย

8. ข้าพเจ้าเข้าใจว่า ไม่สามารถรับประกันได้ว่า การปกปิดชื่อและตัวตนของข้าพเจ้าจะเป็นไปได้ในการประชุมกลุ่มย่อย

ลายมือชื่อผู้มีส่วนร่วม.....วันที่.....

ข้าพเจ้าขอรับรองว่าข้าพเจ้าได้อธิบายข้อมูลเกี่ยวกับโครงการวิจัยให้กับอาสาสมัครผู้เข้ามามีส่วนร่วมและได้พิจารณาแล้วว่าอาสาสมัครเข้าใจถึงการมีส่วนร่วมและการมีอิสระในการตัดสินใจยินยอมเข้าร่วมโครงการ

ผู้วิจัย นางสาวณัชชลิดา ยุคะลัง

ลายมือชื่อผู้วิจัย ..... วันที่ .....

9. ข้าพเจ้า ผู้มีส่วนร่วมในโครงการวิจัย ผู้ลงนาม ได้อ่านเอกสารการยินยอมเป็นผู้มีส่วนร่วมในโครงการวิจัยนี้ และได้ตกลงยินยอมตามข้อตกลงดังรายละเอียดที่ให้ไว้

ลายมือชื่อผู้มีส่วนร่วม.....วันที่.....

Appendix F1: Consent forms for interview (English)

CONSENT FORM FOR PARTICIPATION IN RESEARCH
(by interview)

Project title : **Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand**

I ….....

being over the age of 18 years hereby consent to participate as requested in the …… for the research project on …….

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I agree to audio/video recording of my information and participation.
4. I am aware that I should retain a copy of the Information Sheet and Consent Form for future reference.
5. I understand that:

- I may not directly benefit from taking part in this research.
- I am free to withdraw from the project at any time and am free to decline to answer particular questions.
- While the information gained in this study will be published as explained, I will not be identified, and individual information will remain confidential.
- Whether I participate or not, or withdraw after participating, will have no effect on my progress in my work.
- I may ask that the recording be stopped at any time, and that I may withdraw at any time from the session or the research without disadvantage.
- Participation in the study is voluntary and refusal to participate will have no effect on your job.
- A sound recording will be made of your participation, which will be transcribed;
- Any information that identifies people will not be transcribe.
- Participants can ask for any part of their participation to be omitted from the study.

6. I agree to the tape being made available to other researchers who are not members of this research team, but who are judged by the research team to be doing related research, on condition that my identity is not revealed.
7. I have had the opportunity to discuss taking part in this research with a family member or friend.

Participant's signature……Date……...

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name Miss Nachalida Yukalang

Researcher's signature……..Date…….

8. I, the participant whose signature appears below, have read a transcript of my participation and agree to its use by the researcher as explained.

Participant's signature……Date……...

Appendix F2: Consent forms for interview (Thai)

เอกสารแสดงความยินยอมในการให้ความร่วมมือในการวิจัย

(การสัมภาษณ์)

หัวข้อวิจัย : การพัฒนารูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็ว ในภาคตะวันออกเฉียงเหนือ ประเทศไทย

ข้าพเจ้า ..... ขอรับรองว่า ข้าพเจ้าอายุครบ 18 ปีบริบูรณ์ ยินยอมให้ความร่วมมือในการประชุมกลุ่มย่อย ในโครงการวิจัยนี้

1. ข้าพเจ้าได้อ่านข้อมูลที่เกี่ยวข้องกับโครงการจากผู้วิจัย
2. ผู้วิจัยได้อธิบายถึงกระบวนการวิจัยพร้อมทั้งความเสี่ยงที่อาจเกิดขึ้น ซึ่งข้าพเจ้าเข้าใจและยอมรับได้
3. ข้าพเจ้ายินยอมในการถูกบันทึกเสียงในขณะให้ข้อมูล
4. ข้าพเจ้าตระหนักถึงการเก็บสำเนาเอกสารการยินยอมเป็นผู้มีส่วนร่วมในการวิจัยนี้ไว้เพื่อเป็นหลักฐาน
5. ข้าพเจ้าเข้าใจว่า

- ข้าพเจ้าอาจไม่ได้รับผลประโยชน์จากการมีส่วนร่วมในการวิจัยนี้โดยตรง
- ข้าพเจ้ามีสิทธิที่จะถอนตัวจากโครงการได้ตลอดเวลาหรือมีสิทธิ์ปฏิเสธการตอบคำถามบางคำถาม
- การเผยแพร่ข้อมูลการวิจัยจะไม่ระบุตัวตนของข้าพเจ้า และข้อมูลส่วนบุคคลจะถูกเก็บเป็นความลับ
- ข้าพเจ้าจะไม่ได้รับผลกระทบใด ๆ หากปฏิเสธการมีส่วนร่วม หรือถอนตัว
- ข้าพเจ้าอาจขอให้หยุดการบันทึกเสียงได้ทุกขณะ และอาจถอนตัวได้ในทุกกระบวนการ โดยไม่จำเป็นต้องแจ้งให้ทราบล่วงหน้า
- การมีส่วนร่วมนี้เป็นความสมัครใจของข้าพเจ้า และข้าพเจ้าจะไม่ได้รับผลกระทบใด ๆ ต่อหน้าที่การงานของข้าพเจ้า หากปฏิเสธการมีส่วนร่วม
- การบันทึกเสียงสนทนาจะถูกเปลี่ยนเป็นข้อความเอกสาร
- ข้อมูลที่สามารถระบุตัวบุคคล จะไม่ถูกบันทึกเป็นเอกสาร
- ข้าพเจ้าสามารถถอนตัวจากการประชุมได้ตลอดเวลา โดยจะไม่มีผลกระทบใดๆ ต่อตัวข้าพเจ้า

6. ข้าพเจ้าไม่ตกลงที่จะให้เทปบันทึกแก่นักวิจัยวิจัยท่านอื่นที่ไม่เกี่ยวข้องกับทีมวิจัยนี้ ยกเว้นในกรณีที่นักวิจัยผู้นั้นได้รับการตัดสินจากทีมวิจัยนี้ว่าเป็นผู้มีความเกี่ยวข้อง โดยไม่มีการเปิดเผยข้อมูลส่วนตัวของข้าพเจ้า
7. ข้าพเจ้ามีโอกาสในการหารือกับบุคคลในครอบครัวหรือเพื่อนของข้าพเจ้าในการที่จะเข้ามามีส่วนร่วมในโครงการวิจัย

ลายมือชื่อผู้มีส่วนร่วม.....วันที่.....

ข้าพเจ้าขอรับรองว่าข้าพเจ้าได้อธิบายข้อมูลเกี่ยวกับโครงการวิจัยให้กับอาสาสมัครผู้เข้ามามีส่วนร่วมและได้พิจารณาแล้วว่าอาสาสมัครเข้าใจถึงการมีส่วนร่วมและการมีอิสระในการตัดสินใจยินยอมเข้าร่วมโครงการ

ผู้วิจัย นางสาวณัชชลิดา ยุคะลัง

ลายมือชื่อผู้วิจัย ..... วันที่ .....

8. ข้าพเจ้า ผู้มีส่วนร่วมในโครงการวิจัย ผู้ลงนาม ได้อ่านเอกสารการยินยอมเป็นผู้มีส่วนร่วมในโครงการวิจัยนี้ และได้ตกลงยินยอมตามข้อตกลงดังรายละเอียดที่ให้ไว้

ลายมือชื่อผู้มีส่วนร่วม.....วันที่.....

Appendix G1: Letters of cooperation (English)

School of the Environment
GPO Box 2100
Adelaide SA 5001
Tel: +61(0)8 72218584
Kirstin.ross@flinders.edu.au
http://www.flinders.edu.au/people/kirstin.ross
CRICOS Provider No. 00114A

LETTER OF INFORMATION FOR CONSENT FOR COORPERATION IN RESEARCH

Dear Mayor of Tha Khon Yang Subdistrict Municipality,
Mayor of Mahasarakham Town Municipality,
Chief Executive of the Provincial Administrative Organization (PAO)

This letter is to introduce Miss Nachalida Yukalang who is a PhD student in the School of Environment at Flinders University. She is undertaking research leading to the production of a thesis on the subject of "Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand". The purpose of this research is to identify the components that are necessary for successful implementation of integrated sustainable waste management in this area. This research will be carried on in Tha Khon Yang Sub-district, Kantharawichai District, Mahasarakham Province.

I'm writing on behalf of Flinders University, Australia to ask for your cooperation. Miss Yukalang would like to invite you to assist in this project, by granting cooperation with specialist, staff and leaders of villages. Moreover, she would like you to provide information that is related to waste management in this area. This project will be conducted between April 2015 and October 2017. Site visits and meeting with the organization staff would be required occasionally. Interview is main method of this research. Participants will be asked to sign a consent form before participation.

This research will help to build an appropriate system for municipal solid waste management in Tha Khon Yang sub-district. By produce a sustainable waste management model which is based on community participation and can be integrated with the Integrated Sustainable Waste Management (ISWM) plan.

Be assured that any information provided will be treated in the strictest confidence and none of the participants will be individually identifiable in the resulting thesis, report or other publications.

Any enquiries you may have concerning this project should be directed to me at the address given above or by telephone on +61(0)87 72218584, or by email (kirstin.ross@flinders.edu.au).

Thank you for your attention and assistance.

Yours sincerely,

[redacted]

Dr Kirstin Ross
Lecturer
School of the Environment

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

Appendix G2: Letters of cooperation (Thai)

เทศบาลตำบลท่าขอนยาง
เลขรับที่ 644
วันที่ 6 / กพ / 58
เวลา 1430 น.

Flinders UNIVERSITY

School of the Environment
GPO Box 2100
Adelaide SA 5001
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CRICOS Provider No 00114A

เรื่องขอความร่วมมือในการทำวิจัยในพื้นที่

เรียนนายกเทศบาลตำบลท่าขอนยาง/ [illegible]

เนื่องด้วยนางสาวณัชชลิดายุคะลังนักศึกษาปริญญาดุษฎีบัณฑิตสำนักวิชาสิ่งแวดล้อมคณะวิทยาศาสตร์และวิศวกรรมศาสตร์มหาวิทยาลัยฟลินเดอส์ประเทศออสเตรเลียได้ทำการศึกษาในหัวข้อวิจัยเรื่อง"การพัฒนารูปแบบการจัดการมูลฝอยในพื้นที่ที่เจริญอย่างรวดเร็วในภาคตะวันออกเฉียงเหนือประเทศไทย"โดยมีวัตถุประสงค์ของงานวิจัยเพื่อค้นหาแนวทางการจัดการมูลฝอยอย่างยั่งยืนในพื้นที่ที่ศึกษาซึ่งการศึกษาครั้งนี้จะดำเนินการในพื้นที่ตำบลท่าขอนยางอำเภอกันทรวิชัยจังหวัดมหาสารคาม

ในนามของมหาวิทยาลัยฟลินเดอส์ประเทศออสเตรเลียข้าพเจ้าจึงได้ขอความร่วมมือจากท่านเพื่ออำนวยความสะดวกในการดำเนินโครงการวิจัยในพื้นที่และขอความร่วมมือในการสัมภาษณ์เจ้าหน้าที่ที่รับผิดชอบงานด้านการจัดการมูลฝอยรวมทั้งผู้ใหญ่บ้านหรือผู้นำชุมชนในพื้นที่ตำบลท่าขอนยางทั้งนี้ระยะเวลาการดำเนินโครงการเริ่มตั้งแต่เดือนเมษายน2558ถึงเดือนตุลาคม2560

ทั้งนี้หากมีข้อสงสัยในโครงการนี้ท่านสามารถติดต่อข้าพเจ้าได้โดยตรงตามที่อยู่ที่ให้มาพร้อมนี้
โทร+61(0)87 72218584หรืออีเมลล์kirstin.ross@flinders.edu.au
หรือติดต่อผู้วิจัยอาจารย์ณัชชลิดายุคะลังคณะสาธารณสุขศาสตร์มหาวิทยาลัยมหาสารคาม
โทรศัพท์04307540353, 085- 643 0403 หรืออีเมลล์yuka0004@flinders.edu.au

ขอแสดงความขอบคุณ

[redacted]

อาจารย์ดร. เครสทินรอส
(Dr Kirstin Ross)
School of the Environment

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 6784). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au

[redacted]

[illegible]

[redacted]

(นายมานพ นนทิลาด)
ปลัดเทศบาลตำบลท่าขอนยาง

Appendix H1: Ethics Approval Application (Flinders University SBREC)

From: Human Research Ethics
To: Nachalida Yukalang; Kirstin Ross; Beverley Clarke
Subject: 6784 Final ethics approval notice (21 April 2015)
Date: Tuesday, 21 April 2015 12:02:24 PM
Importance: High

Dear Nachalida,

The Chair of the Social and Behavioural Research Ethics Committee (SBREC) at Flinders University considered your response to conditional approval out of session and your project has now been granted final ethics approval. This means that you now have approval to commence your research. Your ethics final approval notice can be found below.

FINAL APPROVAL NOTICE

Project No.:	**6784**
Project Title:	Environmental health model for municipal solid waste management in a rapidly urbanizing area of northease Thailand
Principal Researcher:	Miss Nachalida Yukalang
Email:	yuka0004@flinders.edu.au
Approval Date:	21 April 2015
Ethics Approval Expiry Date:	**19 October 2019**

The above proposed project has been **approved** on the basis of the information contained in the application, its attachments and the information subsequently provided with the addition of the following comment(s):

Additional information required following commencement of research:

1. Permissions
   Please ensure that copies of the correspondence granting permission to conduct the research from owners of local businesses in Tha Khon Yang Sub-district are submitted to the Committee *on receipt.* Please ensure that the SBREC project number is included in the subject line of any permission emails forwarded to the Committee. Please note that data collection should not commence until the researcher has received the relevant permissions (item D8 and Conditional approval response – number 11).

RESPONSIBILITIES OF RESEARCHERS AND SUPERVISORS

1. **Participant Documentation**
   Please note that it is the responsibility of researchers and supervisors, in the case of student projects, to ensure that:
   - all participant documents are checked for spelling, grammatical, numbering and formatting errors. The Committee does not accept any responsibility for the above

mentioned errors.

- the Flinders University logo is included on all participant documentation (e.g., letters of Introduction, information Sheets, consent forms, debriefing information and questionnaires – with the exception of purchased research tools) and the current Flinders University letterhead is included in the header of all letters of introduction. The Flinders University international logo/letterhead should be used and documentation should contain international dialling codes for all telephone and fax numbers listed for all research to be conducted overseas.
- the SBREC contact details, listed below, are included in the footer of all letters of introduction and information sheets.

This research project has been approved by the Flinders University Social and Behavioural Research Ethics Committee (Project Number 'INSERT PROJECT No. here following approval'). For more information regarding ethical approval of the project the Executive Officer of the Committee can be contacted by telephone on 8201 3116, by fax on 8201 2035 or by email human.researchethics@flinders.edu.au.

2. Annual Progress / Final Reports

In order to comply with the monitoring requirements of the *National Statement on Ethical Conduct in Human Research (March 2007)* an annual progress report must be submitted each year on the **21 April** (approval anniversary date) for the duration of the ethics approval using the report template available from the Managing Your Ethics Approval SBREC web page. *Please retain this notice for reference when completing annual progress or final reports.*

If the project is completed *before* ethics approval has expired please ensure a final report is submitted immediately. If ethics approval for your project expires please submit either (1) a final report; or (2) an extension of time request and an annual report.

Student Projects

The SBREC recommends that current ethics approval is maintained until a student's thesis has been submitted, reviewed and approved. This is to protect the student in the event that reviewers recommend some changes that may include the collection of additional participant data.

Your first report is due on **21 April 2016** or on completion of the project, whichever is the earliest.

3. Modifications to Project

Modifications to the project must not proceed until approval has been obtained from the Ethics Committee. Such matters include:

- proposed changes to the research protocol;
- proposed changes to participant recruitment methods;
- amendments to participant documentation and/or research tools;
- change of project title;
- extension of ethics approval expiry date; and
- changes to the research team (addition, removals, supervisor changes).

To notify the Committee of any proposed modifications to the project please complete and submit the *Modification Request Form* which is available from the Managing Your Ethics Approval SBREC web page. Download the form from the website every time a new modification request is submitted to ensure that the most recent form is used. Please note that extension of time requests should be submitted prior to the Ethics Approval Expiry Date listed on this notice.

Change of Contact Details

Please ensure that you notify the Committee if either your mailing or email address

changes to ensure that correspondence relating to this project can be sent to you. A modification request is not required to change your contact details.

4. Adverse Events and/or Complaints

Researchers should advise the Executive Officer of the Ethics Committee on 08 8201-3116 or human.researchethics@flinders.edu.au immediately if:

- any complaints regarding the research are received;
- a serious or unexpected adverse event occurs that effects participants;
- an unforseen event occurs that may affect the ethical acceptability of the project.

Kind regards
Andrea

Mrs Andrea Fiegert and Ms Rae Tyler
Ethics Officers and Executive Officer, Social and Behavioural Research Ethics Committee
Andrea - Telephone: +61 8 8201-3116 | Monday, Tuesday and Wednesday
Rae – Telephone: +61 8 8201-7938 | ½ day Wednesday, Thursday and Friday

Email: human.researchethics@flinders.edu.au
Web: Social and Behavioural Research Ethics Committee (SBREC)

Manager, Research Ethics and Integrity – Dr Peter Wigley
Telephone: +61 8 8201-5466 | email: peter.wigley@flinders.edu.au
Research Services Office | Union Building Basement
Flinders University
Sturt Road, Bedford Park | South Australia | 5042
GPO Box 2100 | Adelaide SA 5001

Appendix H2: Confirmation email from Mahasarakham University (Ethics Approval)

From: อนัญพร พรหมเมตตา
To: Nachalida Yukalang
Subject: Re: Ethic approval
Date: Thursday, 19 March 2015 2:29:25 PM

Dear Nachalida,

If you applied for the ethic approval in your university or the country that you are studying already,
you do not need to apply again in Thailand. That is because your research topic is low risk.
Also your project has approved by the Australian University covers ethics approval in Thailand as well.

Regards,
Ananphorn Phrommetta,
staff of Mahasarakham University ethic committee,

2015-03-13 11:16 GMT+07:00 Nachalida Yukalang <yuka0004@flinders.edu.au>:

Dear Ananphornphromm Metta, staff of Mahasarakham University ethic committee,

I am Miss Nachalida Yukalang, a PhD student in the School of Environment at Flinders University.

I am undertaking research leading to the production of a thesis on the subject of

"Development of an environmental health model for municipal solid waste management in rapidly urbanizing area of northeast Thailand".

Purpose of this research is identifying the components that are necessary for successful implementation of

integrated sustainable waste management in this area. This research will be carried in Tha Khon Yang Sub-district,

Kantharawichai District, Mahasarakham Province between June 2015 and August 2015.

I'm writing this e-mail to ask for the research ethic process in the study area. There are two sessions in this study, as follow;

First, the interview session, lecturers from Mahasarakham University and Mahidol University, waste management staff

from local organizations and also specialists from related organizations will be interviewed.

Second, the focus group session, I would like to invite waste management staff, residents,

students and owner of local businesses to participant in focus group session in this project.

I would like to question you about research ethic processing. At this moment I already applied for

“ethical approval from “the Flinders University Social and Behavioural Research Ethics Committee (SBREC)”.

And it was considered that my research is low risk project. Therefore, do I need to apply for the ethic approval in Thailand again?

If you need more information or have any question for this project, please feel free to ask me directly

by email yuka0004@flinders.edu.au.

Yours sincerely,

Nachalida Yukalang

Appendix I1: Manuscript - Solid waste management in Thailand: an overview and case study (Tha Khon Yang sub-district) (first page only)

DE GRUYTER Rev Environ Health 2017; 32(3): 223–234

Review

Nachalida Yukalang*, Beverley Dawn Clarke and Kirstin Elizabeth Ross

Solid waste management in Thailand: an overview and case study (Tha Khon Yang sub-district)

DOI 10.1515/reveh-2016-0061
Received October 4, 2016; accepted November 15, 2016; previously published online January 11, 2017

Abstract: Due to rapid urbanization, solid waste management (SWM) has become a significant issue in several developing countries including Thailand. Policies implemented by the Central Thai Government to manage SWM issues have had only limited success. This article reviews current municipal waste management plans in Thailand and examines municipal waste management at the local level, with focus on the Tha Khon Yang sub-district surrounding Mahasarakham University in Mahasarakham Province. Within two decades this area has been converted from a rural to an urban landscape featuring accommodation for over 45,000 university students and a range of business facilities. This development and influx of people has outpaced the government's ability to manage municipal solid waste (MSW). There are significant opportunities to improve local infrastructure and operational capacity; but there are few mechanisms to provide and distribute information to improve community participation in waste management. Many community-based waste management projects, such as waste recycling banks, the 3Rs (reduce, reuse and recycle), and waste-to-biogas projects have been abandoned. Additionally, waste from Tha Kon Yang and its surrounding areas has been transferred to unsanitary landfills; there is also haphazard dumping and uncontrolled burning of waste, which exacerbate current pollution issues.

Keywords: government; Mahasarakham; municipal solid waste; urbanization; waste policy.

***Corresponding author: Nachalida Yukalang,** School of the Environment, Faculty of Science and Engineering, Flinders University, GPO Box 2100, Health Science Building, 526, Adelaide, SA 5001, Australia, Phone: +61 (0) 412 923 487, E-mail: nachalida.yukalang@flinders.edu.au; nachalida.y@gmail.com; and Faculty of Public Health, Mahasarakham University, Mahasarakham, Thailand
Beverley Dawn Clarke and Kirstin Elizabeth Ross: School of the Environment, Faculty of Science and Engineering, Flinders University, Adelaide, SA, Australia

Introduction

Municipal solid waste (MSW) refers to waste in a solid form, produced in the daily life of a society, such as packaging, food scraps, grass clippings, clothing, paper and electronics (1). Over 50% of the global population does not have access to regular waste collection, which makes managing solid waste easily, one of the key challenges of the 21st century (2). Furthermore, it has been shown that inadequate municipal solid waste management (MSWM) leads to hazards for human beings such as risks to health, living resources and ecological systems, adding to global warming, causing damage to infrastructure, and increasing waste management and disposal costs (3–5).

The number of rapidly urbanizing cities in developing countries is increasing. This has led to increased opportunities to consume pre-packaged consumer products which have resulted in the creation of enormous amounts of waste from daily life; from homes, offices, institutions and commercial establishments (6). The by-products of an urban lifestyle, including MSW, are higher than that of a rural lifestyle. Urban dwellers generate approximately double the waste of a rural resident.

According to Hoornweg and Bhada-Tata, high income countries tend to generate the highest amount of waste (46%), with lower middle income countries generating more (29%) than upper middle income (19%) and lower income countries (6%) (7). In 2003, 2.9 billion urban residents generated an average of 0.64 kg of MSW per person per day. This amount increased to 1.2 kg per person per day by 2012; by 2025 this will likely increase to 1.42 kg per person per day (7).

The number of urban residents has increased dramatically around the world (7). The amount of solid waste in developing countries is increasing as a result of continuous economic growth, urbanization and industrialization (8–10). It is becoming more difficult for national and local governments to ensure the effective and sustainable management of waste. This situation will continue unless every level of government takes active steps to address the serious issue of waste management.

Hoornweg and Bhada-Tata show that the wealth of a country has a direct influence on its MSWM system.

Appendix I2: Manuscript - Barriers to effective municipal solid waste management in rapidly urbanizing area in Thailand (first page only)

International Journal of
Environmental Research and Public Health

MDPI

Article

Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand

Nachalida Yukalang [1,*], Beverley Clarke [2] and Kirstin Ross [1]

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2 College of Humanities Arts and Social Sciences, Flinders University, Bedford Park, Adelaide, SA 5042, Australia; beverley.clarke@flinders.edu.au
* Correspondence: nachalida.yukalang@flinders.edu.au or nachalida.y@gmail.com; Tel.: +66-412-923-487

Received: 4 August 2017; Accepted: 1 September 2017; Published: 4 September 2017

Abstract: This study focused on determining the barriers to effective municipal solid waste management (MSWM) in a rapidly urbanizing area in Thailand. The Tha Khon Yang Subdistrict Municipality is a representative example of many local governments in Thailand that have been facing MSWM issues. In-depth interviews with individuals and focus groups were conducted with key informants including the municipality staff, residents, and external organizations. The major influences affecting waste management were categorized into six areas: social-cultural, technical, financial, organizational, and legal-political barriers and population growth. SWOT analysis shows both internal and external factors are playing a role in MSWM: There is good policy and a reasonably sufficient budget. However, there is insufficient infrastructure, weak strategic planning, registration, staff capacity, information systems, engagement with programs; and unorganized waste management and fee collection systems. The location of flood prone areas has impacted on location and operation of landfill sites. There is also poor communication between the municipality and residents and a lack of participation in waste separation programs. However, external support from government and the nearby university could provide opportunities to improve the situation. These findings will help inform municipal decision makers, leading to better municipal solid waste management in newly urbanized areas.

Keywords: municipal solid waste management; barriers; Thailand

1. Introduction

Municipal Solid Waste Management (MSWM) refers to waste in a solid form, produced in daily life from households and non-hazardous solid waste from commercial, industrial, and institutional establishments including hospitals, markets, yard and street sweeping [1,2]. Globally, the amount of solid waste is increasing due to population expansion, continuous economic growth [3,4], urbanization and industrialization [5]. In developing countries, high population growth and urbanization, together with rapid economic growth accelerates consumption rates [6]. These patterns have increased the generation rate of municipal solid waste and changed the composition of waste [7]. It is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste. In rapidly urbanizing cities, local governments need to consider the key activities of MSWM including; waste generation and separation, appropriate solutions for recycling, collection, transfer and transport, treatment and proper final disposal [2,3,8]. Inadequate MSWM processes can lead to impacts on human health, living resources and the environment, including water contamination, rodents and insect attraction and flooding due to blocked drainage [3,9–14].

Appendix I3: Manuscript - Solid Waste Management Solutions for a Rapidly Urbanizing Area in Thailand: Recommendations Based on Stakeholder Input (first page only)

International Journal of
Environmental Research and Public Health

MDPI

Article

Solid Waste Management Solutions for a Rapidly Urbanizing Area in Thailand: Recommendations Based on Stakeholder Input

Nachalida Yukalang [1,*], Beverley Clarke [2] and Kirstin Ross [1]

[1] College of Science and Engineering, Flinders University, Bedford Park, Adelaide, SA 5042, Australia; kirstin.ross@flinders.edu.au
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* Correspondence: nachalida.yukalang@flinders.edu.au; Tel.: +61-412-923-487

Received: 11 May 2018; Accepted: 19 June 2018; Published: 21 June 2018

Abstract: Municipal solid waste is a significant problem, particularly in developing countries that lack sufficient infrastructure and useable land mass to process it in an appropriate manner. Some developing nations are experiencing a combination of issues that prevent proper management of solid waste. This paper reviews the management of municipal solid waste in northeast Thailand, using the Tha Khon Yang Sub-district Municipality (TKYSM) in Maha Sarakham Province as a case study. The combination of rapid population and economic growth and its associated affluence has led to an increase in the use of consumer items and a concomitant increase in the production of municipal solid waste. In the TKYSM there is pressure on local government to establish a suitable waste management program to resolve the escalating waste crisis. The aim of this study is to provide viable solutions to waste management challenges in the TKYSM, and potentially to offer guidance to other similar localities also facing the same challenges. It is well established that successful changes to waste management require an understanding of local context and consideration of specific issues within a region. Therefore, extensive community consultation and engagement with local experts was undertaken to develop an understanding of the particular waste management challenges of the TKYSM. Research methods included observations, one-on-one interviews and focus groups with a range of different stakeholders. The outcomes of this research highlight a number of opportunities to improve local infrastructure and operational capacity around solid waste management. Waste management in rural and urban areas needs to be approached differently. Solutions include: development of appropriate policy and implementation plans (based around the recommendations of this paper); reduction of the volume of waste going to landfill by establishing a waste separation system; initiation of a collection service that supports waste separation at source; educating the citizens of the municipality; and the local government staff, and for the local government to seek external support from the local temples and expertise from the nearby university.

Keywords: integrated solid waste management; municipal solid waste management; opinions; solutions; urbanizing; developing countries

1. Introduction

Globally, population growth, together with economic growth and associated consumption behaviour, has resulted in a significant increase in solid waste production [1,2]. In developing countries, managing municipal solid waste (MSW) is a serious problem [2,3]. Urbanisation and increasing affluence have resulted in a significant increase in volumes of discarded materials [4–6].