Applied Environmental Research

Journal homepage : http://www.tci-thaijo.org/index.php/aer

SWOT Analysis for Preliminary Study of Municipal Waste Management Toward a Zero Waste Highland Community in Northern Thailand

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Article History
Submitted: 17 October 2017/ Accepted: 15 December 2017/ Published online: 27 August 2018

Abstract

This research aims to investigate the situation of municipal waste management in the highlands of Chiang Rai, Thailand in order to formulate a preliminary strategic action plan for efficient management of municipal solid waste. In-depth interviews, questionnaires and discussions between government officers and community residents were conducted, in addition to analysis of the composition of solid waste in the municipality. SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) of current municipal waste management was performed and considered together with the assessment indicators of zero waste management: geo-administrative, socio-cultural, management, environment, economic, organization and governance and policy, in order to identify key domains and locally relevant indicators. The results pointed to two main weaknesses of municipal waste management: lack of knowledge, combined with low levels of implementation of best practice in waste management. This was attributed mainly to language barriers impeding knowledge exchange. To improve the prospects for a zero-waste community in these highland areas, there is a need to improve administration and the social attitudes by promoting the 3Rs concept and initiating waste utilization projects to raise awareness and consciousness within local communities. Importantly, imparting the knowledge of waste management using effective parent language for communication is a key success factor for enhancing the effectiveness of municipal waste management.

Keywords: Municipal waste management; Highland; Zero waste; Northern Thailand; SWOT

Introduction

Thailand has long suffered from municipal waste management (MWM) as a result of rapid and unfettered urban development, and the lack of effective disposal systems. In 2015, Thailand produced a total of 27.1 million tons of solid waste- 73,560 tons/day or 1.13 kg/capita/day. However, only 11.8 million tons could be treated in sanitary landfills or other appropriate disposal methods. Approximately 5.6 million tons of waste was recycled, with 15.2 million tons still awaiting disposal [1]. When combined with 30 million tons of previously accumulated solid waste, full disposal will require massive additional effort, time and budget.

Overall, solid waste in Thailand comprises organic waste from food (64%), plastics (17%) and paper (8%) ranked second and third, respectively [2]. Lack of effective MWM programmes increase the risks of severe health hazards including communicable diseases, bad odours, nuisance, and environmental impacts such as pollution of soil, water and air if the waste is burnt in an uncontrolled manner, as frequently occurs [3].

With municipal waste generation in northern Thailand amounting to 10,266.76 tons/day, the three highest generators of waste are the municipalities of Chiang Mai (1,658.5 tons/day), Chiang Rai (1,100.47 tons/day), and Nakhon Sawan (1,027.62 tons/day). In these three municipalities 31.1% and 25% of total waste were properly treated and recycled, respectively, while 43.9% accumulated in the municipal and sub-district areas [4]. In Chiang Rai, 25% was properly treated, with 18% recycled and over half (57%) accumulating in the municipal and sub-district area [5]. MWM in northern Thailand is managed by the municipality or sub-district organization, which face a range of challenges such as improper disposal methods, limited sites for disposal and low efficiency of waste collection. Low collection rates lead increasing accumulation of waste in the municipality or sub-districts of Chiang Rai. The burden is especially acute in small communities lacking the capability to manage waste. Moreover, the efficiency of MWM in highland areas may be impeded by other factors such as topography, culture and traditions of hill tribes in the area, as well as access to education and the impacts of tourism. Around 52% of Chiang Rai area comprises mountainous areas (1,500 - 2,000 masl) which makes travelling inconvenient and slow, particularly during the rainy season. A further difficulty is posed by the traditional cultures of hill tribes in the area, which typically live in small, isolated communities with distinctive linguistic and cultural backgrounds, migrating frequently and with limited or no access to basic social services including education and health [5].

Considering the impacts of these factors, implementation of a zero waste programme is a very challenging prospect in this remote area. With the ambitious long-term goal to virtually eliminate the need for disposal, it also involves rethinking product design in order to prevent or reduce waste before it occurs. Waste that cannot be avoided should be designed for optimal recovery through recycling. Also, materials should always be used and managed in ways that preserve their value, minimize their environmental impacts, and conserve natural resources. Products that cannot be redesigned or recycled should be replaced with alternatives [6]. However, MWM deals with budget allocations of local municipality, public acceptance and adverse impacts on environment [7] and generally in developing countries, a waste management system consists of planning, engineering, organization administration, financial and legal aspects of activities associated with generation, storage, collection, transportation and disposal in an environmentally compatible manner adopting principles of economy and aesthetics [8]. If the population and resources are not supported by innovative

approaches to enhance community participation and boost government support, deterioration of environmental quality and social conflicts are all but inevitable [9]. This approach would promote effective strategies for conflict resolution in participatory environmental management [10]. It is becoming increasingly evident that a waste management programme that ignores the social aspect is doomed to failure. The problems of public participation in planning and implementation are no less important than the technical or economic aspects in waste management and decision-making [11].

The key tool used for the current study is SWOT analysis (Strengths, Weaknesses, Opportunities and Threats). Recently, a SWOT analysis on environmental management was carried out [5]. In this study, solid waste generation and its composition were investigated including in-depth interviews, questionnaires and discussion sessions between stakeholders namely government officers and community residents in order to formulate a preliminary SWM strategy and action under the zero-waste framework.

Materials and methods

1) Study area

The study area was located in three villages in Chiang Rai Province, northern Thailand: Mae Salong Nai, Mae Salong Nok, and Therdthai sub-district (part of Mae Fah Luang District). The area close to Mae Sai District (the major border crossing between Thailand and Myanmar) is shown in Figure 1. The elevation of the study area was between 1,500-2,000 masl, with natural tropical forests dominating this mountainous landscape. The study site was some 60km from the city of Chiang Rai itself. There are six main hill tribes living in this study area: Akha, Lahu, Karen, Hmong, Yao and Lisu- all with their own distinct cultural beliefs and languages.

The populations in Mae Salong Nai, Mae Salong Nok, and Therdthai sub-district were 25,565, 15,829 and 22,620, respectively with more than 30% comprising ethnic minorities [12-15]. Because of the large population and its popularity as a tourist destination, the area has many hotels, shops, schools, hospitals and market. Despite this, the main occupation is farming of crops such as corn, tea and rice using traditional methods suitable to these mountainous slopes.

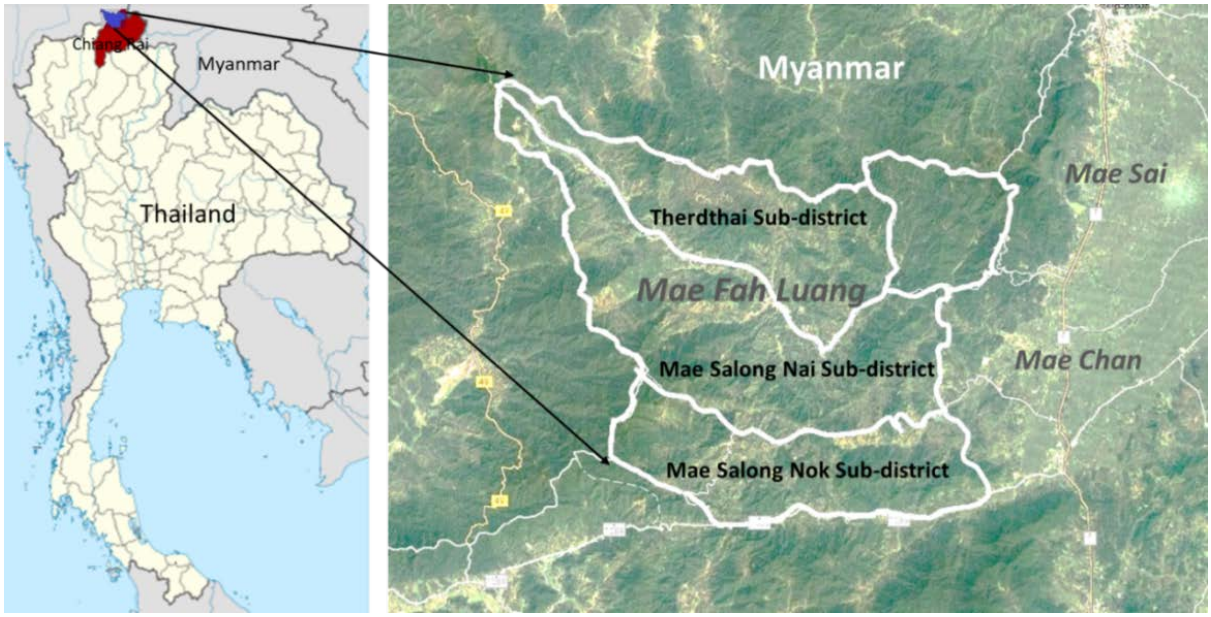


Figure 1 Location of study area (Therdthai, Mae Salong Nai, and Mae Salong Nok Sub-district).

Three villages from each sub-district were selected on the basis of population density, ethnic group, and access to basic services such as markets, hospital, shops and schools. In Mae Salong Nai, Ban Hin-taek was selected, having the largest hospital in Mae Fah Luang District, as well as a market, school and local shops. For Mae Salong Nok, the village of Ban Santikhiri was selected. Due to its popularity as a tourist attraction, the area has numerous hotels, shops, schools, temples and a public health centres. Ban Therdthai of Therd thai sub-district was selected due to the presence of the largest market and other services including a school, shop and church.

2) Data collection

Information on solid waste management including waste collection, storage, point schedule, transportation; routes and vehicle types, landfill locations and operation was collected using a by survey, interviews and review of secondary data.

In-depth interviews were conducted with government officers from each sub-district, focusing on waste management policy and operation. Additionally, group discussions were organized for each sub-district, attended by stakeholders including district government officers, community leaders and representatives from several groups of residents including hill tribes and different age groups. The discussions aimed to gain an understanding of the views of the sub-district populations on the current waste management situation, including practices, problems and success factors. SWOT analysis was subsequently performed in order to arrive at recommendations to help formulate a preliminary strategic action plan for MWM for these three communities, within the zero-waste framework.

Results and discussion

1) Current municipal waste management practices

Domestic activities account for a major proportion of solid waste in the three communities, contributing 12.51, 5.1 and 5.6 tons/day for Mae Salong Nai, Mae Salong Nok, and Therdthai sub-district, or 3.7, 0.9 and 1.1 kg/capita/day, respectively. Compostable or organic waste was the largest category of waste, accounting for 40-70% of the total weight. General waste accounted for 12-29%, while recyclable waste accounted for 8-26%. Alarmingly, hazardous waste was also present in significant quantities (from 1-11%), mostly in the form of medical waste from local hospitals. However, government officers reported that their investigation found this was as an anomaly resulting from incorrect collection; therefore this category is excluded from discussion in this paper.

Food waste and garden waste were found in similar amounts; however, it was difficult to identify the exact composition due to mixing and decomposition. The highest percentage of recyclable waste was represented by plastic (11.83-23.75%), milk cartons (15-22.50%) and glass (32.5-66.24%). Vehicle tyres were found only at Therdthai sub-district, comprising 40% of recyclable waste, while small amounts of metals (0.64-1.25%) were identified at Mae Salong Nai and Mae Salong Nok sub-districts. Plastic bags represented the largest stream of general waste, found in the range of 32.92-63.20%, followed by packaging and paper waste, accounting for 13.18-40.52% and 9.03-35.13%, respectively.

Management of solid waste covers all steps in the process, from waste generation, storage and handling, to collection, transportation and disposal. Municipal solid waste management in Mae Fah Luang district is operated by the Sub-district Administrative Organization (SAO) of each sub-district. Promoting waste reduction at source is not widely practiced. The SAO aims

to provide the basic equipment and education of waste separation as shown in Figure 2. Coverage of collection services of each SAO is incomplete with only around 50% of total villages in each sub-district served, due to the rugged terrain and lack of roads. As for waste storage, SAO provides a large plastic bin in front of every household to serve as a collection point. Waste is stored without separation but some waste is recycled. Nevertheless, since 2016, Mae Salong Nai has adjusted to use plastic bags instead of waste bins, and no longer collect organic waste. The waste collection schedules of the 3 sub-districts are similar, that is, one collection per week using a 3-ton truck (Figure 3). Household wastes are transported to the respective landfill for each sub-district, located more than 10 km from each community. Mae Fah Luang district lacks enough flat land for landfill disposal, and for the past three years has faced an overload of waste that cannot be disposed of. Furthermore, the landfill has never been operated as a sanitary landfill, and thus has become effectively an open dumping site (see Figure 3). In Mae Salong Nai sub-district, an incinerator operated for several years, but was incorrectly operated, with high-moisture mixed waste resulting in incomplete combustion, effectively also becoming an open burning site.

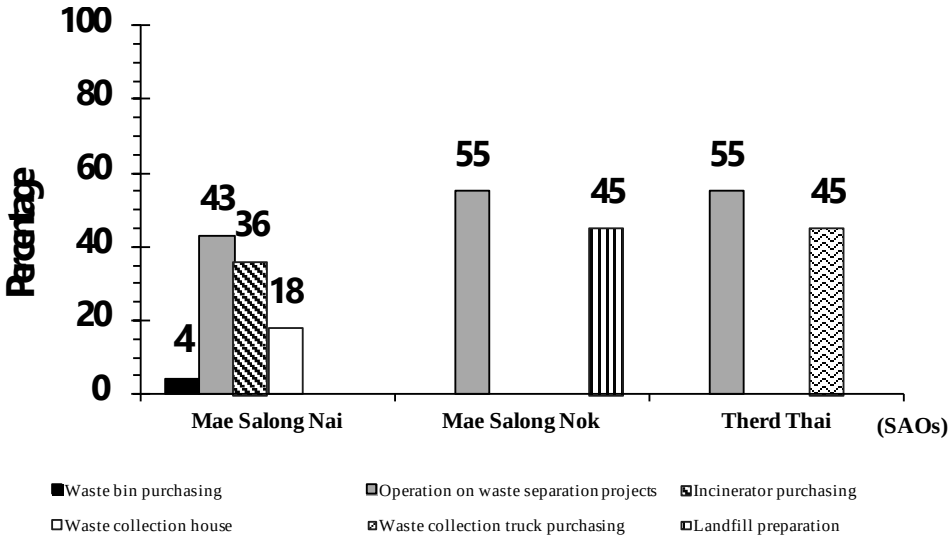


Figure 2 Budget spending within 3 years of each Sub-district Administrative Organization.

Figure 3 Overview of solid waste management in study areas.

2) SWOT analysis of community municipal waste management

A SWOT analysis was performed by government officers, community leaders, and representatives from several groups of residents such as hill tribes, including all major age groups, in order to identify opportunities to improve municipal waste management and future challenges for zero waste in their respective communities. The findings are summarized in Table 1, including recommendations for a proposed strategic action plan for the community. In terms of strengths (S) and threats (T), all government officers from the three sub-districts identified similar provisions, namely S1-S4 and T1-T4. In terms of opportunities, the national waste management agenda and zero waste promotion agenda in Chiang Rai (O1 and O2) was raised by a government officer from Mae Salong Nok sub-district.

Table 1 SWOT analysis and agenda of waste management

		External Factors	
	SWOT analysis	Opportunity (O) • (O1) Waste management is an important national agenda that the government is considering. • (O2) In Chiang Rai, there are communities' models that apply Zero Waste Management concept.	Threat (T) • (T1) There is no organization which buys waste that can be sold because of the inconvenience of transportation. • (T2) There are many tourists. Waste management may be ineffective. • (T3) In the future, there may be a change in the solid waste collection fees, to which local people may not agree. • (T4) Some waste may be generated by smuggling of people living outside the area.
Internal Factors	**Strength (S)** • (S1) People have cooperated and participated in the community's waste management. • (S2) There is model community on waste management. • (S3) Local authorities are involved in the community's waste management. • (S4) There are budgets to support the community's waste management.	• Develop community networks that supports in effective community's waste management (S1, S2, O2) • Support budgets that focus on waste management at the source to reduce community's waste management budgets (S3, S4, O1)	• Establish a waste bank in the community to encourage people to separate the waste that can be sold from other types of waste (S1, S2, S3, S4, T1) • Provide public media associated with community's waste management to tourists and the general public by focusing on participation of enterprises and people in the area (S1, S2, S3, S4, T2, T3, T4)
	Weakness (W) • (W1) Habits and behaviors of community members who do not cooperate on waste separation • (W2) Lack of knowledge on appropriate waste management. • (W3) Local entrepreneurs do not focus on waste management. • (W4) It's difficult to promote the community's waste management campaign because there are ethics in community which communicates with more than one language.	• Create other types of tools that publish knowledge about appropriate waste management, such as mobile applications (O1, O2, W1,W2,W3, W4)	• Develop a model community that has a solid waste management process based on Zero Waste Management concept by cooperating with all sectors and organizations (W1, W2, W3, W4, T1, T2, T3, T4)

Almost all stakeholders identified that the behaviour and habits of villagers represented a weakness, hampering the effectiveness of waste separation programmes. Furthermore, all government officers identified language as a barrier to effective communication. Moreover, lack of knowledge of appropriate waste management methods was identified by the villagers as another weakness. From the SWOT analysis, a preliminary strategy for municipal waste management was proposed, as presented in Table 1.

While considering the overall factors of strengths, weaknesses, opportunities and threats, the following strategic actions were identified as opportunities to boost the effectiveness of the municipality in MWM;

• Develop community networks to support effective community-based waste management (S1, S2, O2)

• Support budgets that focus on waste management at source to reduce the burden on community waste management budgets (S3, S4, O1)

• Establish a community waste bank to encourage people to separate wastes that can be sold from other types of waste (S1, S2, S3, S4, T1)

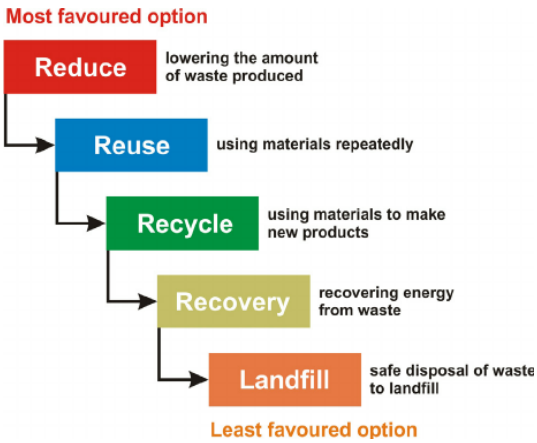
• Provide media associated with community waste management to tourists and the general public by focusing on participation of enterprises and local people (S1, S2, S3, S4, T2, T3, T4)

• Create innovative tools to disseminate knowledge about appropriate waste management, e.g. mobile applications (O1, O2, W1, W2, W3, W4)

• Develop a model highland community that has a solid waste management process based on the Zero Waste management concept by cooperating with all sectors and stakeholders (W1, W2, W3, W4, T1, T2, T3, T4).

3) Zero Waste (ZW)

In this research ZW is defined as maximizing recycling and focusing on the waste hierarchy in Figure 4 by aiming to reduce the amount of waste collected, and to reuse or recycle waste as a resource (Reduce, Reuse, Recycle; 3Rs) without the need for landfill or energy recovery [16]. Previous work has identified key assessment indicators for zero waste management systems (also shown in Figure 4).



Key domain in Zero waste management	
Key domain	Zero Waste indicators
Geo-administrative	Population, Household's income, Household's expenditures, Geographic boundary, Administrative boundary
Socio-culture	Education, Awareness, Consumption, Behavior
Management	Avoidance, Generation, Composition, Reuse, Recycle, Transport and recovery, Treatment, Disposal
Environment	Env.burdens, Env.benefits, Health&safety
Economic	Economic cost, Economic benefits, Incentives
Organization	No. of infrastructures, No. of facility, No. of instruments, Human resources, Waste information
Governance and policy	Awareness programme, Rules &regulation, Compliance &audition, Waste export &import

Figure 4 The waste hierarchy and key domains for zero waste management [17-18].

4) Social culture and zero waste management

The SWOT revealed that insufficient knowledge was an important weakness in this study area, confirming the findings of previous work in Romania, showing that local people and businesses prioritized "getting rid" of waste and were ignorant of the concept of sustainable development [19]. Education, awareness and behaviour are thus key to the success of sustainable waste management programmes [18]. The SWOT analysis also revealed challenges in communication as a weakness and key barrier to effective MWM (at least seven languages are used locally in the study area. Production of effective media /educational tools in these languages are needed in order to address this fundamental barrier.

The preliminary proposed Zero Waste municipal waste strategy and action plan is presented in Figure 5. Despite allocating the majority of its budget on initiatives such as waste separation training, the waste management problem remains unsolved. The new plan addresses the key constraint (lack of understanding of the Thai language) by developing parent language media such as video training, workshops and instruction in languages including Akha, Karen, Meo, and Yao. In addition, the strategy and action plan incorporates implementation of the 3Rs, establishment of local waste banks, and waste utilization schemes, in order to support the ZW framework. The 3Rs and waste utilization activities are recommended as household-level changes to behaviour; these include replacement of plastic bags with fabric bags, production of bio-extracts from food waste and composting, with the aim of creating "Zero waste homes". Waste reduction at source is particularly important in these highland areas due to the absence of sanitary disposal facilities, the poor roads and rugged terrain. With improved communication, community awareness and behavioural change are expected to improve and the fraction of plastic bags in the waste stream is expected to decrease continuously. In the longer term, zero-waste households can indeed be achieved. At community level, making economic use of local waste banks and waste utilization are strongly supported.

However, to succeed, this ZW management strategy needs the cooperation of SAOs, community leaders, villagers and the provincial government, to support the ZW waste management policy and road map originally launched in 2014.

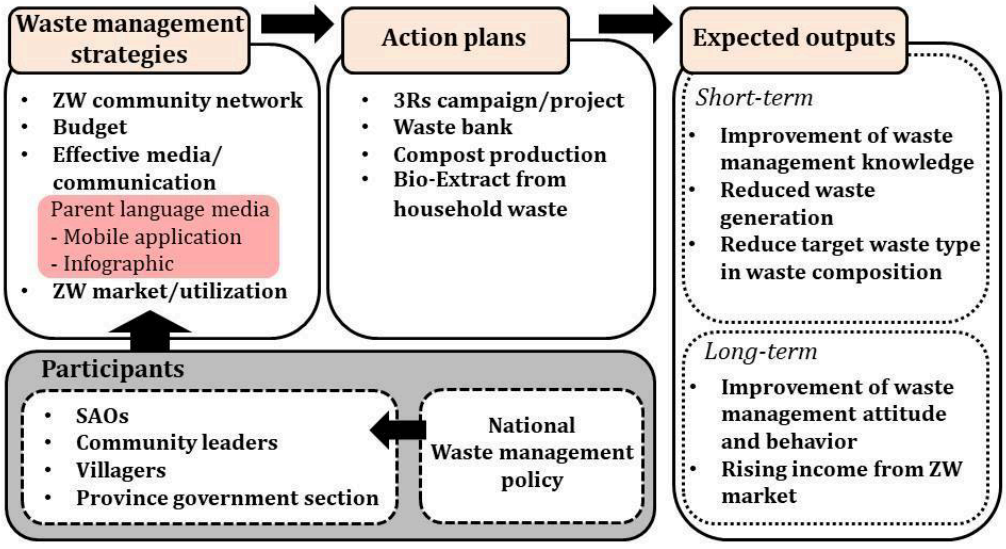


Figure 5 Proposed municipal waste management in framework of Zero Waste strategy and action plan.

Conclusions

In this study, in-depth interviews and discussion sessions with stakeholder groups were conducted in order to gain insight into the situation of solid waste management in Mae Fah Luang district; Mea Salong Nok, Mae Salong Nai and Therdthai sub-districts. SWOT analysis revealed communication and language as key barriers to adoption of practices leading to ZW households. The ZW concept was used as a guideline for improvement in waste management. The seven key domains of zero waste management were considered and how they related to the results. It was found that the 3Rs (reduce, reuse and recycle) concept was well suited to the local situation in the study area, since the waste stream typically comprised plastic bags in the range of 32.92-63.20%, while up to 70% of the daily waste stream comprised compostable waste.

Furthermore, lack of communication in various hill tribe languages was identified as a weakness, resulting in low levels of knowledge in relation to sustainable waste management. To increase local understanding and participation, it will be important to provide parent language media to educate the villagers in order to reduce these communication barriers and achieve zero-waste households as a long-term goal.

Acknowledgements

This research project was granted by National Research Council of Thailand.

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