

Driving the Circular Economy from Waste Materials in Khaopoopchang Town Municipality, Songkhla Province, Thailand

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Abstract - Unfortunately, within our previous the traditional linear pattern, it has been the standard appear to production and consumption following take, make, use, dispose. A lot of waste becomes in unfavorable spaces. In contrast, the circular economy aims to make minimum use of raw materials, maximum reuse of products and components, high quality reuse of raw materials as much as possible and reducing emissions, waste and eventually costs. Mixed method was used research consisting of qualitative and quantitative approaches. Documentary research, in-depth interviews and focus groups were used as data gathering tools, for qualitative approach. 400 of questionnaire survey were used for quantitative procedure. The results displayed that total cost of waste management in Khaopoopchang town municipality was 25,241,987 Baht per year; operational statement was 14,474,000 Baht, 57.34%, personal budget was 6,638,040 Baht, 26.30%, waste management was 4,129,947 Baht, 16.36%. Moreover, the total cost of garbage disposal was 1,830 Baht per ton; fixed cost was 480 Baht per ton, variable cost 1,350 Baht per ton. Using polluter pay principle, in term of 42,942 residences in area, garbage disposal fee was 588 Baht per year per person. Waste management must be an integration plan coping with waste generator, communities, all the way down to waste disposer, government agencies. As part of the plan, source reduction is considered vital to the success of an integrated solid waste management. Thus, making the community responsible for their waste is the key of the plan. A create incentives to change consumer behavior which involves inhabitants to handle and separate waste collection and improve recycling before in landfill them to reduce the number of the trash at the source and to facilitate recycling.

Keywords: Circular Economy, Municipal Solid Waste Management, Thailand, Waste Materials

I. Introduction

Since 1960's, Thailand's economy has grown expeditious, recording at an annual rate of around 7.5 percent before the Asian Financial Crisis [1]. Rapid economic growth in Thailand became a agriculture base to industry, and it economy emphasis on export promotion. Just only ten years, the impacts from booming economy led to significant use of natural resources, as 36 percent grew to consume for mineral resources and 40 percent increase for import [2]. According to the Pollution Control Department, there was 22 million tons of industrial waste produced in Thailand 2019, with only 33 percent were material being recycled. Thai economy growth also is based on middle-income households, rapid urbanization and extension domestic consumer spending. According to Thai Pollution Control Department, approximately 27 million tons of municipal solid waste (MSW) was generated in Thailand. A large city like Bangkok and key regional towns, for example Khaopoopchang municipality, have been serious problems. The central government have to spend about 177 billion baht on municipal solid waste management as limited success [3]. Municipal solid waste has gradually increased each year as principal reasons of the troubles for example the incapacity of the responsible groups to find suitable disposal location, and not enough facilities of waste container and dumping tools and equipment. Therefore, it shows a real warning to human health hazard.

The fundamental of the linear economy, in which raw materials are collected, transformed into products which are used, and then thrown away. It is called "Take-Make-Waste" which has proven itself to be unjustifiable. This is because there will be an infinite huge supply of raw materials, energy and labour for operation. Moreover, finally at the end of producing become waste. This linear economy, solid waste is the expiration point as unsustainable.

With increase global population, growth urbanization and consumption, annual world waste generation is expected to have increased about 70% from 2016 stages to 3.40 billion tons in 2050. Nevertheless, solid waste is recycled each year less than 20 percent which there are enormous quantities for sending to landfill locations [4]. The method to solved the severe problem is to change linear economic model to a circular economy scheme. As the circular economy is an alternative solution for opportunities to make value at whole stage of the production and consumption procedure. The economic is designed to the discarding of waste and pollution, keeping products and materials in use and reducing the consumption and production resources [5]. The Circular Economy has both significant friendly environmental benefits and also creates business chances for high revenues and profits.

A circular economy is challenge to grow sustainably, Thailand have to endorse a circular economy approach. Thus, the study aims to display the financial value of waste materials administration and possibility driving the circular economy from municipal waste management in Khaopoopchang town, Songkhla province. Adaptation solid waste management for achieving sustainable development goal is applied to use for the framework in Khaopoopchang municipal solid waste management, Songkhla province, Thailand.

II. Methodology

Area of study

This study was conducted in Khaopoopchang town, Songkhla province, Thailand which is located at part of South East Asia. The city has 42,942 inhabitants and an average population density of 1,562 people per km². The area of Khaopoopchang town is 27.49 km², and it is divided into 10 villages.

Research methodology

The diverse nature of the required data and the various sources they were collected from made the mixed methods approach suitable. Hence, qualitative and quantitative techniques such as interviews, fieldwork observations and document analysis were used to collect the necessary data.

The methodology of the research is classified two sections, the first sections of behavioral characteristics of solid waste and the second of driving the circular economy of Khaopoopchang municipal waste management. Therefore, the mixed methods are used approach suitable. Qualitative approach is exploratory and seeks to consider the present condition of municipal solid waste and feasibility of driving the circular economy in the location. There are 30 persons, which included municipal council members, groups of waste-collection, community leaders and community committees. An importance information was found municipal office document and face-to-face interviews.

Quantitative method is conducted primary data within characteristics of socio-demographic resident, behavioral characteristics of municipal solid waste collection and types proportion of waste management. 400 questionnaires are used to gather quantitative data which is sample size assuming 95 % of confidence interval and 5 % margin of error. Sampling technique of Stratified random was infirmed for this research that equal by 10 villages.

III. Result

Socio-demographic characteristics of the respondents

Four hundred residents in Khaopoopchang municipal were survey to participated in the study. The females and males are nearly approximately 215 (53.75%) the mean (\pm SD) age of respondents was 40.7 (\pm 10.24) years.

Most of the respondents were married 249 (62.25 %) and 225 (56.25 %) of them have completed lower than bachelor (N=225, 56.25%). Local living of over 5 years were indicated around 205 (51.25 %) of residence. Approximately 173 (43.25%) of them described a household consist of 4 to 6 occupants and the mean (\pm SD) monthly family salary of respondents was 31,500 (\pm 540.69) Baht (Table 1).

The household solid waste (HSW) generation rate was 2.87 (± 0.74) kilograms per day. Furthermore, the survey indicates that food litter comprises the largest component in the waste mixture (67.43%), followed by plastic waste (21.07%), bottles (8.58%), other (3.01%). 56.75% of household participant leaved waste at municipal collecting points. Around two thirds of respondents also normally desire to remove their waste bag to gathering site each day. However, nearly half of household survey, waste collection charge is delighted to pay by residents. The household also prefer to reused solid waste and waste sorting around 56.80%, 54.60% respectively (Table 2).

Behavioral Characteristics of Solid Waste

Table 1 socio-demographic characteristics of municipal solid waste collectors in Khaopoopchang region, Songkhla Province, Thailand, 2020 (n = 400)

| Variables | Frequency | Percentage (%) |
|-----------------------------|-----------|----------------|
| Gender | | |
| Female | 215 | 53.75 |
| Male | 185 | 46.25 |
| Marital status | | |
| Married | 249 | 62.25 |
| Single | 87 | 21.75 |
| Divorced | 25 | 6.25 |
| Widowed | 26 | 6.50 |
| Separated | 18 | 3.25 |
| Age group | | |
| < 25 years | 69 | 17.25 |
| 26-35 years | 119 | 29.75 |
| 36-45 years | 126 | 31.50 |
| 46-55 years | 28 | 7.00 |
| ≥ 56 years | 58 | 14.50 |
| Educational status | | |
| Lower than bachelor | 225 | 56.25 |
| Bachelor | 143 | 35.75 |
| Higher than bachelor | 32 | 8.00 |
| Residence Period | | |
| < 3 years | 87 | 21.25 |
| 3-5 years | 108 | 27.00 |
| ≥ 6 years | 205 | 51.25 |
| Family Number | | |
| < 4 person | 170 | 42.50 |
| 4-6 person | 173 | 43.25 |
| ≥ 7 person | 57 | 14.25 |
| Monthly Family Salary(Baht) | | |
| < 15,000 | 125 | 31.25 |
| 15,001-30,000 | 134 | 33.50 |
| 30,001-45,000 | 73 | 18.25 |
| $\geq 45,001$ | 68 | 17.00 |

Thailand generates, Khaopoopchang municipality, volume of municipal debris were 13,766,490 tons per year as of 2020. Total annual MSW generation in the town increase every year. The composition of MSW is mostly (1) food/organic waste 60.00%, (2) general waste 29.90%, (3) solid waste 10.00% and (4) hazardous waste and electronic waste 0.05% (Table 3).

Table 2 Behavioral features garbage gathering in Khaopoopchang municipality, Songkhla Province, Thailand, 2020 (n = 400)

| Variables | Frequency | Percentage (%) |
|--|-----------------------|----------------|
| Waste Place | | |
| Municipal waste collecting point | 227 | 56.75 |
| Other point | 173 | 43.25 |
| Waste Need Collect | | |
| everyday | 264 | 66.00 |
| > 1 day | 136 | 34.00 |
| Waste Fee Status | | |
| Need to pay | 178 | 44.50 |
| No need to pay | 222 | 55.50 |
| <i>Proportion of Household Solid</i> | Percentage (%) | S.D. |
| Waste Disposed | | |
| Food debris | 67.43 | 15.36 |
| Plastic waste | 21.07 | 5.68 |
| Bottles | 8.58 | 2.92 |
| Other | 3.01 | 1.47 |
| Household Characteristics of Solid Waste | | |
| Reduced | 55.00 | 17.40 |
| Reused | 56.80 | 18.82 |
| Waste sorting | 54.60 | 18.64 |
| | Mean | S.D. |
| Household waste per day (kilograms) | 2.87 | 0.74 |

Table 3 The types proportion of waste management in Khaopoopchang municipality, Songkhla Province, Thailand

| Types of waste | Percentage (%) |
|------------------|----------------|
| General waste | 29.90 |
| Organic | 60.00 |
| Solid waste | 10.00 |
| Hazardous waste | 0.05 |
| Electronic Waste | 0.05 |

Source: Document and interviews of Khaopoopchang municipality

Roles and responsibilities of local governments, in the presently have to deal miscellaneous public services. The scale of town is effect on increase quantity of duties operated. Operation and maintenance, development works, wages and salaries are composed of a substantial ration of this spending of municipal solid waste management [6-8]. In Khaopoopchang municipal organization of, 57.32% of the whole overheads on solid garbage administration was taken on operation cost, 26.29% on personnel salary, 16.35% on collection and only 0.03% on investment (Table 4).

Table 4 Expenditure of solid waste management of 2020 in Khaopoopchang municipality (Baht, Percentage)

| Total expenditure of solid waste management | | | 25,250,787 |
|---|------------|------------|------------|
| <i>Personnel budget</i> | | 6,638,040 | (26.29%) |
| Regular salary | 6,638,040 | | |
| <i>Operation budget</i> | | 14,474,000 | (57.32%) |
| Compensation | 850,000 | | |
| Utilization costs | 10,804,000 | | |
| Material cost | 2,820,000 | | |
| <i>Investment budget</i> | | 8,800 | (0.03%) |
| <i>Collection cost¹</i> | | 4,129,947 | (16.35%) |

¹ Solid waste management cost is 300 Baht per ton

Source: Document and interviews of Khaopoopchang municipality

Table 5 Total cost of solid waste disposal by family size in Monthly

| Solid waste management (monthly) | Family size | | | | |
|------------------------------------|-------------|-----|------------|-----|-----------|
| | 1-3 person | | 4-6 person | | > 7person |
| Total cost of solid waste disposal | 49 | 147 | 196 | 294 | 343 |
| Personnel cost | 13 | 39 | 52 | 77 | 90 |
| Operation cost | 28 | 84 | 112 | 169 | 197 |
| Collection cost | 8 | 24 | 32 | 48 | 56 |

Source: Calculated form document and interviews

The authorized data and interviews with local government agencies, the total generation of municipal waste each day in Khaopoopchang was about 13,766,490 tons in 2020 and 0.82 kg of making of disuse per by person per day (interview and calculated). The empirical data show that the average of waste generation in communities has more than the average of whole nationwide in 2020 which 0.64 kg per day [9]. Simultaneously, solid waste generation and composition determined by key socioeconomic factors for example household scale, number of rooms, monthly salary, social status, education level, residential site, and employment status [10-13]. Therefore, the study is selected household scale for represent for verified waste composed by family. A small family size, less than 3 persons, in terms of polluter pay principle will be pay 49 to 147 Bath per month. Moreover, a medium family size, member of 4 to 6 persons, have to pay 196 to 294 Bath per month. Finally, about 343 Bath per month is for a large family size (Table 5).

As amount of Khaopoopchang municipal waste was 13,766,490 tons per year, 25,250,787 Bath of total expenditure of solid waste management in 2020. The MSW produced is primarily (1) 60.00% of organic waste (2) general waste 29.90%, (3) solid waste 10.00% and (4) hazardous waste and electronic waste 0.05%. Assume that choosing i option, reduces an organic waste 0.05 and solid waste 0.10, which is decreased waste disposal of 550,659.60 tons and 1,009,679.48 Baht that 4% save of budget for municipal waste management. Moreover, choosing v option, budget for municipal waste management is save 40%, 5,506,596.00 tons of decreasing for waste disposal and 10,096,794.80 Baht of municipal waste management (Table 6). Nowadays, municipal solid waste management expenditures have roughly increased as serious problems in many communities [14] because of growing pricing town waste gathering, carrying and processing [14-16]. The local government and leader of communities pointed that capability cost savings have to enhancing inhabitant behaviours and facilitating solid waste separation at location.

Table 6 Amount of waste and Reduced waste feasibility study

| Types of waste | % | Reduced waste feasibility study model | | | | |
|------------------|--------------------|---------------------------------------|------|-------|-------|-------|
| | | i | ii | iii | iv | v |
| General waste | 29.90 | 0 | 0 | 0 | 0 | 0 |
| Organic waste | 60.00 | 0.05 | 0.10 | 0.25 | 0.35 | 0.5 |
| Solid waste | 10.00 | 0.10 | 0.25 | 0.50 | 0.75 | 1.00 |
| Hazardous waste | 0.05 | 0 | 0 | 0 | 0 | 0 |
| Electronic waste | 0.05 | 0 | 0 | 0 | 0 | 0 |
| 13,766,490 | Quantity (million) | 0.55 | 1.17 | 2.75 | 3.92 | 5.51 |
| 25,241,987 | Baht (million) | 1.00 | 2.15 | 5.05 | 7.19 | 10.10 |
| | Save (%) | 4.00 | 8.50 | 20.00 | 28.50 | 40.00 |

Source: Calculated form document and interviews

Possibility driving the circular economy of municipal waste management in Khaopoopchang

This research explores the espousal from the linear “take, make, dispose” approach, to the circular economy concept of “make, use, return” (Figure 1-2). The issue of circular economy is not only political developed economies but also the challenged Thailand’s government.

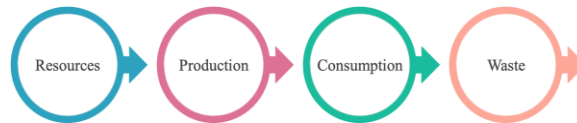


Figure 1 The linear economy approach

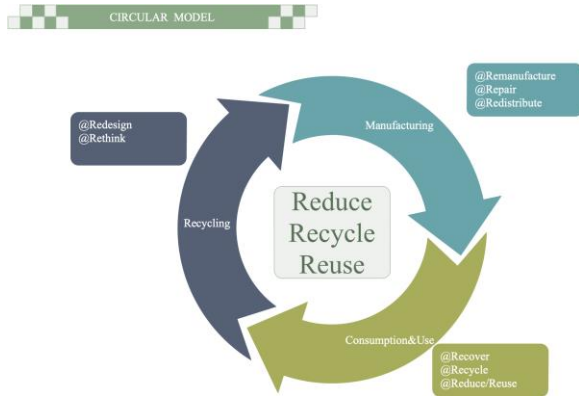


Figure 2 The Circular economy approach

For characteristics of solid waste survey, only 3.00 % of residents take always solid waste separation in the household. Most of them about 41.75% take sometimes solid waste separation but 16.00% of participants of survey never do the waste separation from their own house. Most of residents 33.50% will take waste separation on medium level when easily access in the local communities, 21.75% of them for high level with easily access. It is surprisingly even ability to easily access of waste separation, approximately 2.50% of the survey will do not anything for litter separation. Inhabitants of survey about 83.49% have indicated that waste segregation is a personal responsibility for social responsibility awareness as activity may be make money for garbage 56.91%. However, in case of circular economy occasion, it occurs trading of secondary raw materials and trading of waste for recycling, 70.52% and 62.74%, respectively. The residents believe that saving cost of production, 92.86% has more than saving money of consumption, 69.58 in case of circular economy pattern. In addition to, the circular economy will be benefit of friendly environment (81.93%), product attractiveness (78.84%), innovation market (76.44%), and product quality (61.51%) (Table 6).

Table 6 Characteristics of solid waste and attitude of feasibility driving the circular economy

| Subject matter | Frequency | Percentage (%) |
|-----------------------------------|-----------------------|----------------|
| Waste separation | | |
| Always | 12 | 3.00 |
| Usually | 43 | 10.75 |
| Sometime | 167 | 41.75 |
| Rarely | 114 | 28.50 |
| Never | 64 | 16.00 |
| Easily access of waste separation | | |
| High | 87 | 21.75 |
| Medium | 134 | 33.50 |
| Low | 94 | 2.35 |
| Very low | 75 | 18.75 |
| No impact | 10 | 2.50 |
| Level of agree in CE | Percentage (%) | S.D. |
| Individual responsibility | 83.49 | 5.79 |
| Make money for waste | 56.91 | 12.73 |

| | | |
|-----------------------------------|-------|-------|
| Market of secondary raw materials | 70.52 | 6.85 |
| Market of waste for recycling | 62.74 | 7.05 |
| Saving cost of production | 92.86 | 8.42 |
| Saving money of consumption | 69.58 | 10.54 |
| Friendly environment | 81.93 | 4.81 |
| Innovation market | 76.44 | 5.97 |
| Product quality | 61.51 | 7.89 |
| Product attractiveness | 78.84 | 8.91 |

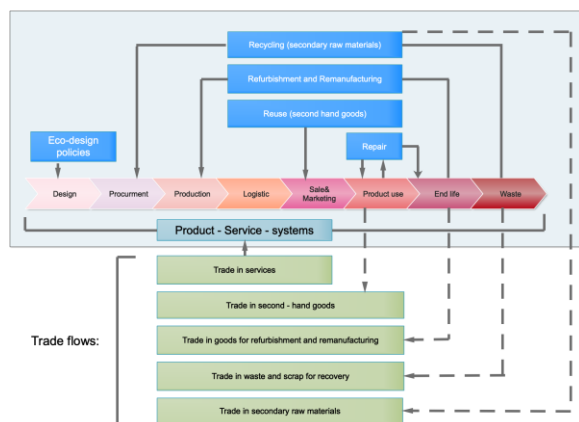


Figure 3 Value chain of Circular Economy approach

IV. Discussion and Conclusion

Local government have a lot of duty for community services. Local budget is not enough for rising expenditures in the municipality, so central budgets of Thai government is quite necessary for local services. A proper data is presently the great tool for sustainable development. The internal cost of local administration is source for real-time analytics, and are used widely for socio-demographic characteristics, marketing and policy metrics. Growth city and rapid progress of economy have effect on increasing municipal solid waste management very year [17-18]. Unbalance of administration in the past, demand-side aspects and supply-side aspects have still severe of the insufficient litter gather services in the community. Thus, the study aims to present the financial value of waste materials administration and possibility driving the circular economy from Khaopoopchang municipal waste management, Songkhla province, Thailand [19]. The main result indicates the local policy have to play an important role that put forward by CE approaches for promote efficient growing economic while minimizing environmental impact. All partnerships of society have to pay intention from upstream midstream and downstream components of production and consumption (Figure 3). For example, the circular economy has to understanding about the process of waste management, including waste collection, separation, recycling and utilizing resources to maximize its benefits [20].

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