

VALUE CHAIN OPTIMIZATION FRAMEWORK FOR SOLID WASTE MANAGEMENT IN THAILAND: A CASE STUDY OF SAMUI ISLAND

by

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ABSTRACT

Nowadays, solid waste management is one of the key issues in Thailand's environmental problems. Traditionally, each city use open pit method to dispose of its solid waste. This paper illustrates the different value chains of waste management of Thailand, which are based on different technologies, such as composting, biodegradation, incineration, etc. The value chains are modeled and can be optimized to match with different locations and their constraints. The results show that modeling concepts can be used as decision support system (DSS) for decision makers to select appropriate technology for their solid waste management system. Samui Island's solid waste management is use as a case study for the development of the DSS model.

KEYWORDS

Solid Waste, Value Chain Management, Samui Island

INTRODUCTION

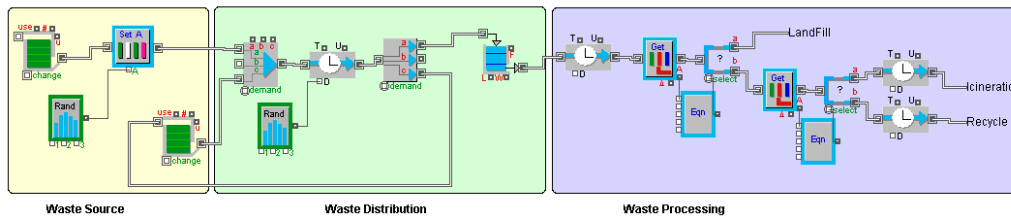
Solid waste in Thailand land is defined as solid waste generated from community activities, e.g. residential (household), commercial and business establishments, fresh market, institutional facilities, construction and demolition waste, excluding hazardous and infectious wastes. (PCD, 2010) Local governments are responsible for solid waste collection and disposal. Each local government may adopt solid waste disposal method appropriate for the waste collected in their area. The different method of solid waste disposal such as incineration, composting, sanitary landfill, open burning and dump on open ground, impose different value on the solid waste. Samui Island is chosen as a case study, as the problem of solid waste disposal on the island has become serious in the past few years, when the incinerator has stop it operation. The Samui municipality has to look for alternative ways for solid waste disposal. The paper examined the value for each method of solid waste treatment for Samui Island to develop a decision support system (DSS) to assist Samui municipality to plan for solid waste management policy on the island.

METHODOLOGY AND ASSUMPTIONS

The method of this study is based on value chain optimization framework, which refers to an adaptive system. Value Chain Optimization (VCO) enables dynamic, real-time execution across all participants to continually "adjust" all operations (Culotta 2000). This framework is based on an assumption that the operators in the value can adjust themselves to an optimal condition. Therefore, the methodology consists of three main steps, i.e. 1) indentifying key value chain topologies, 2) modeling and optimizing the chains by dynamic model methods, and 3) analyzing different choice of implementation.

In depth interviews and secondary data collection of each areas are the key techniques used to construct different value chain topologies. This stage gives both existing and prospective conditions. Expert system techniques are used for verification and filter the different topologies of value chain. Figure 1 shows an example of value chain modeling, each value chain is analyzed via dynamic modeling method for giving insight information for each value chain. Therefore, the results provide different indications for decision maker to design what value chain that suitable for their condition.

**FIGURE 1
AN EXAMPLE OF DYNAMIC MODELING FOR VALUE CHAIN OPTIMIZATION**



For the Samui case, the solid waste management technique has resulted in different value of solid waste after disposal. The paper examined three methods that may be appropriate for Samui. The three methods are 1) incineration, 2) sanitary landfill, and 3) waste separation and recycling. The paper undertakes simple cost analysis for these methods as a part of the decision support system. The value chain for each method is then analyzed.

SOLID WASTE MANAGEMENT IN THAILAND – AN OVERVIEW

The total solid waste generation in Thailand was approximately 42,000 metric tons per day or approximately 15 million metric tons per year in 2007. Although Bangkok accounted for only 9% of Thailand’s population, in generates 22% of the total solid waste. Other cities and Pattaya account for 71% of the population and 35% of the total solid waste. Rural areas account for 71% of the population but contributed only 43% of the total solid waste generated in Thailand. (Towprayoon, 2007)

The recycle rate of solid waste in Thailand is 7-8% in 1994 and increased to 13% in 1999, the most common recycle materials are metal, paper and glass. The recyclable materials are separated and collected by a buyer before the local governments collected the waste. The local governments are responsible for solid waste collection in each governing area. However, the problem lies with solid waste disposal. The local governments are lack of experience and budget to dispose collected waste appropriately. The majority of wastes (64%) are left in the open or open burn, 35 % are disposed of in landfill sites, and only 1% of collected waste is incinerated.

The current problems of solid waste management in Thailand include the lack of decision support tools for appropriate waste treatment technology, lack of skilled designers and operators for solid waste disposal site, and limited budget.

SAMUI ISLAND’S SOLID WASTE MANAGEMENT – AN OVERVIEW

Samui Island is an island belonging to Surat Thani Province, off the east coast of the Kra Insthmus in Thailand, close to the town of Surat Thani on the mainland. It is Thailand's third largest island, with an area of 228.7 km² and a permanent population of approximately 55,000 (2008). (Samui Municipality, 2010) However, Samui Island has become an international tourist destination with approximately 1 million tourist travels to Samui annually. This has put a tremendous stress on the Island environmental management, especially water resources and solid waste management.

The majority of waste generated and collected in Samui comes from the 467 hotels and resorts around the island itself. Samui has adopted incineration method to dispose of the waste generated and collected since, 1998. The facility is able to burn 140 tons of waste per day (Samui Municipality). Between 2003 and 2006 the rate of waste has been increasing by approximately 20%. However, between 2006 and 2007, the amount of waste generated has decreased due to the slow down of global economy, which has reduced the number of tourists traveled to Samui. In 2008 the amount of waste has increase by 7.23%. In 2008 the incinerator has stopped it operation due technical problem, the incinerator has started its operation in 2010, after the technical problem has been resolved.

During the breakdown of the incinerator, Samui municipality has been disposing solid waste collected in sanitary landfill site. But this method is not sustainable on Samui Island due to limited land availability.

TABLE 1
SOLID WASTE GENERATION IN SAMUI ISLAND BETWEEN 2003 and 2008

Year	Tons of waste/day	Tons of waste/year	Increase rate (%)
2003	65.71	23984	n.a.
2004	80.11	29240	21.91
2005	95.9	35004	19.71
2006	117.79	42993	22.83
2007	115.66	42216	-1.81
2008	124.02	45267	7.23

The composition of solid waste in Samui is the key indicator to determine appropriate disposal method for the waste.

TABLE 2
WASTE COMPOSITION ON SAMUI ISLAND

Waste Composition	Percentage (%)
Paper	10.65
Textile	4.70
Food	27.35
Garden waste	5.32
Plastic	29.36
Rubber	1.90
Others	20.72

Source: Samui Municipality (2010a)

SOLID WASTE VALUE CHAIN MANAGEMENT

The different method of solid waste management has imposed different cost for waste disposal. The cost of each method and value is analyzed and compared, as a part of the model for the DSS.

Incineration

The incineration method has been adopted in Samui since 1998, with an excuse of 2009-2010 during the technical problem. The advantage of this method is minimum land requirement (36,500 m²) compared to sanitary landfill sites. The volume of waste would reduce greatly. The cost of solid waste collection and incinerated is shown in Table 3.

TABLE 3
COST OF WASTE COLLECTION AND INCINERATION IN SAMUI

Year	Tons of waste/year	Collection Cost (THB)	Disposal Cost (THB)	Total Cost (THB)
2007	42216	43,800,000	45,000,000	88,800,000
2008	45267	46,666,666	45,000,000	91,666,666

Sanitary Landfill

Land requirement for 20 years operation for Samui is 14,000 m² or almost four times the land required for incineration. The estimated land cost for inner Samui Island is 750 THB/m² (Watta, 2008). Therefore the land cost for Samui is approximately 10.5 million THB. However, there is a potential revenue generation from investing in landfill gas

recovery system, and develop a Clean Development Mechanism project that will generate additional income in form of Certified Emission Reductions (CERs) or carbon credit.

**TABLE 4
COST OF WASTE COLLECTION AND INCINERATION IN SAMUI**

Year	Tons of waste/year	Collection Cost (THB)	Disposal Cost (THB)	Potential revenue (THB)	Total Cost (THB)
2007	42216	43,800,000	12,664,800	2,624,640	53,840,160
2008	45267	46,666,666	13,580,100	2,668,480	57,578,286

Waste Separation and Recycling

As another option that has been recently initiate through “The Green Island Project, Koh Samui Thailand” is waste separation and recycling at source. The project was jointly promoted between Samui Municipality and the Green Island Foundation (The Green Island Project, 2010). The organic waste or waste that can be decomposed under appropriate environment to produce organic compost, are separated and composted. Other recyclable materials are separated at source, which will also reduce the collection and disposal cost.

Wastes that are separable at source are food, paper and plastic, the total waste separated accounted for 67.36% of total waste generated. Hence, only 32.64% of waste will be disposed off at sanitary landfill sites or incinerated. It is assumed that the final disposal of the waste would be taken to sanitary landfill sites. Table 5 illustrates the cost for final disposal of waste.

**TABLE 5
WASTE SEPARATION**

Year	Tons of waste/year	Revenue from recyclable (THB)	Collection Cost (THB)	Disposal Cost (THB)	Total Cost (THB)
2007	13,779	25,244,368	14,296,320	4,133,790	18,430,110
2008	14,775	31,308,065	15,232,000	4,432,545	19,664,545

Source: Price of recyclable from <http://www.wongpanit.com/wpn>.

COMPARATIVE ANALYSIS IN SAMUI

The cost of waste management can be divided into two major cost, collection and disposal. Recycle option is the only option that generates revenue in the waste management system. The costs of different option in Thai Baht (THB)/tons are compared in Table 6.

**TABLE 6
COST OF DIFFERENT WASTE MANAGEMENT OPTIONS PER TON/YEAR**

	Incineration	Landfill	Separation, recycle and landfill	Separation recycle and incineration
Cost (THB/ton)	2,103.47	1,275.35	677.37	439.88

The cost of incineration method is the highest cost at 2,103.47 THB/ton of wastefrom the 4 options analyzed, while waste seperation, recycle and landfill is at 439.88 THB/ton. Hence, the option of waste separation, recycle and incineration is the lowest cost option.

CONCLUSION

Solid waste management is a critical issue in Thailand's environmental problems. The value chain optimization concepts allow the modelers to think holistically and dynamically. For the Samui island case study, cost per ton is recommended as a key performance indicator of the value chain. The results show that the lowest cost options are recycle and incineration, recycle and landfill, landfill, and incineration, respectively. However, the further details study is recommend, particularly in other dimension, such as social and environmental impact cost and revenues.

REFERENCES

Neto, A.C.L., Legey, L.F.L., Araya, M.C.G., Jablonski, S. (2005). "A System Dynamics Model for the Environmental Management of the Sepetiba Bay Watershed, Brazil," *Environ Manage*, vol.38, 879–888.

PCD (2010). Pollution Control Department, Ministry of Natural Resources and Environment, [Online Available]: http://www.pcd.go.th/info_serv/waste_garbage.html.

Samui Municipality (2010a). An Interview with Mayor if Samui Municipality 20 October 2010.

Samui Municipality (2010b). "Samui Solid Waste Incineration Plant, Let's Recycle, Reduce to Resole Refuse Problem," Samui Municipality.

The Green Island Project (2010). "The Green Island Project Koh Samui Thailand", [Online Available]: <http://www.thegreenislandproject.org/New>.

Watta (2008). "Land price in Thailand", Watta Classified Company Ltd., ISBN: 978-974-05-3930-8.