A systemic approach to integrated sustainable solid waste management through community engagement: A case study of Tan Deaw sub-district, Saraburi province

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Abstract. The recent residue solid waste management has become a significant global concern. Due to the increase of population, the economic growth and the urban expansion, the number of solid waste has heavily risen. However, there are still lack of an appropriated solid waste management. According to Tan Deaw solid waste survey report in 2019 (Regional Environmental Office 7 Saraburi, 2018), it revealed that Tan Deaw sub-district has been facing critical solid waste management issues. This area produced 9.41 metric tons per day, while the appropriated solid waste disposal management was less than 40 percent and residue waste remains around 2,000 MTs. Therefore, the objectives of this research are to develop learning community and public awareness towards the appropriated solid waste disposal management, including 3Rs principle, to develop the systemic solid waste management strategies with the engagement from all stakeholders, and to promote and support collaborative activities among local people in the community and the concerned stakeholders in the solid waste management. A systemic approach, through participatory action research between Soft Systems Methodology (SSM) (Checkland & Scholes, 1990; Checkland & Poulter, 2006) and Critical Systems Heuristic (CSH) (Ulrich, 1983), is a significant application for structuring the process of collecting perspective from all stakeholders, exploring the key problems of solid waste management, and finding out strategies to address the key problems in Tan-Deaw solid waste management afterwards. Root definitions and models were generated by stakeholders for two activity systems identified by them for attention: Activities promoting knowledge about solid waste sorting and a community waste bank. The findings explored the seven strategies to address Tan-Deaw solid waste management problems in two aspects. This research contributes to both theoretical and practical contributions. In terms of the theoretical contribution, the application of systemic approach conducts a significant knowledge surrounding solid waste management problem solving. Regarding the practical implication, the strategies will address the solid waste problems and barriers in the area with the cooperation of all concerned stakeholders.

Keywords: solid waste management, a systemic approach, Soft Systems Methodology (SSM), Critical Systems Heuristic (CSH)
1. Introduction
Due to the increase in population and economic expansion in Thailand, the amount of solid waste has been sharply risen (Pollution Control Department, 2019). The unsystematic and improper solid waste management is one of the causes of global warming and climate change as it emits pollution to the atmosphere leading to destroy the environment. This has become a global environmental crisis (www.prachachat.net/, 2019).

According to the waste survey report 2018, Regional Environment Office 7, Saraburi (2018) revealed that Tan Deaw sub-district encounters more serious problem with the solid waste management comparing to the other areas in Saraburi Province (Pollution Control Department, 2019). The waste generation rate is 9.41 ton/day, but less than 40 percent were properly disposed of. Moreover, there are more than 2,000 tons of residual accumulated waste in the area. These lead to a great direct impact on the environment, health, and well-being of the community. Therefore, the aims of this research are to develop systemic solid-waste management strategies with the engagement of all stakeholders, to minimise the quantities of solid waste to landfills with the willingness to increase in recycling rate in Tan Deaw sub-district. In order for waste minimization as an essential goal of solid waste management, recycling and the utilization of waste material are key elements through households and commercial sectors separated material recyclables. This aims to minimize the amount of waste, to maintain public health and sanitation, and economic benefits waste into value-added products recyclables.

2. Research Methodology
Participatory Action Research (PAR), with the interview and focus group discussion, was conducted with the two selected villages; village 7 and village 8 in Tan Deaw Sub-district through a purposive sampling technique. This technique is based on a systemic approach applying soft systems methodology (SSM) (Checkland & Scholes, 1990; Checkland & Poulter, 2006) and critical systems heuristics (CSH) (Ulrich, 1983) to set the learning and problem-solving process for solid-waste problems in the community with local people in the community working with all concerned stakeholders.

3. Research Findings
A research framework applied soft systems methodology (SSM) to study the following seven steps and critical systems heuristics (CSH) to utilize the 12 questions of the ‘is’ and ‘ought’ modes of CSH. The results would be presented followed the SSM seven steps as follows.

Step 1 A discussion among the local people in the community and all concerned stakeholders on general situation and problems of solid waste management in the area as table 1.

Table 1. General situation and problems of the solid waste management in the two villages.

| Issue                  | Village 7                                                                 | Village 8                                                                 |
|------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Characteristic         | - various migrants in the community, leading to the lack of sense of ownership | - most of the members are local people, with the sense of kinship relation |
|                        | - most of living areas are built-up land, high building                    | - the area is regarded as agricultural community                           |
|                        | - the community tends to be more urbanised, where people were isolated     |                                                                           |
| Types of waste         | - mostly are recyclables, from plastic bags and bottles, and hazardous waste |                                                                           |
| Waste sorting habit    | - no waste sorting                                                        | - food waste was decomposed into the compost, and plastic bags and bottles were put into separated cart/trash with incorrect waste sorting |
|                        | - all types of waste were put together into the bin with overflow and bad smells | - other types of waste were sent to landfill through SAO’s vehicle        |
|                        | - all types of waste were sent to landfill through SAO’s vehicle           |                                                                           |
Supply chain of waste management  
- waste drop points were set by the community and SAO which is insufficient  
- SAO plays a key role to collect and depose into the landfill  

SAO’s duty  
- the solid-waste sorting of the SAO was a cooperation between the government agencies that promoted the utilization of solid waste, which had led to the concept of “valuable waste”. It generated the income to develop and reconstruct the area in the sub-district.  
- however, the value added from the solid waste concept had not been published to the local people for the collective benefits

| Issue                  | Village 7                                                                 | Village 8                                                                 |
|------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
|                        | - waste drop points were set by the community and SAO which is insufficient | - food/wet waste was composted by households                               |
|                        | - SAO plays a key role to collect and depose into the landfill             | - waste drop points of plastic bags and bottles were set by the community |
|                        |                                                                           | - SAO plays a key role to collect and depose other types of waste into the landfill |

Step 2: Rich picture showed the concerned discussion issues, and explore the situation of waste supply chain management in figure 1 and table 2. The research results showed the following:

Figure 1. Rich Picture of Waste Management in the village 7 and 8, Tan Deaw Sub-district.

The results of the focus group discussion identified the key problems and directed the group to the guidelines for the management of the two issues: the promotion of sorting household solid waste through building community participation; and the location for collecting solid waste to be utilized as the waste bank.

Step 3: Creating a learning process for solid waste management together with all concerned stakeholders from various sectors to analyse and determine the solution for the solid-waste problem. The information obtained from Steps 1 and 2 was used to set the scope by applying a CATWOE analysis in the study. The activities and learning process for solid waste management were divided based on the two main issues as follows.

Root definition 1: Activities promoting knowledge about solid waste sorting and campaigning for participation in community solid-waste management based on the threeRs (Reduce, Reuse and Recycle). The knowledge involved would include compostable waste management, recycle waste management, hazardous waste management, and general waste management, and Root definition 2:
Activities promoting knowledge about setting up a community enterprise structure and an operation for solid waste management or the guidelines for a community waste bank.

Table 2. CATWOE analysis of root definition (RD1 and RD2).

| CATWOE | RD1 (Waste Sorting)                                                                 | RD2 (Waste Bank)                                                                 |
|--------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| C      | Customer Populations in the village 7 and 8                                       | Populations in the village 7 and 8                                              |
| A      | Actors Tan Deaw Sub-district Administration Organization and the community leader | Tan Deaw Sub-district Administration Organization and the community leader       |
| T      | Transformation - Give people knowledge about sorting household solid waste        | - Promote knowledge of setting the community enterprise structure and an operation for solid waste management or the guideline for community waste bank as the guideline for the systematic waste sorting |
|        | - Give people knowledge about compostable waste, recycle waste, hazardous waste, and general waste managements | - Promote the deposit of household sorted solid waste at the community waste bank |
|        | - Give knowledge about solid waste utilization, such as making compost from compostable waste, reusing the recycle waste and create added value from solid waste, etc. | - Arrange the market to buy the waste from the community by inviting network associates to participate in the activities |
|        | - Develop the community leader to be a role model and provide people with knowledge about sorting household solid waste | |
| W      | Weltanschauung - world views - Campaign and promote the participation of people in sorting household solid waste | - Campaign and promote the participation of people in household solid waste sorting |
|        | - Government sector has the appropriate policies and measures to promote solid waste sorting from the household level and substantial guidelines for solid waste utilization | - The government sector has the appropriate policies and measures to promote solid waste sorting from the household level and substantial guidelines for solid waste utilization. |
|        | - Integration of all sectors’ participation in supporting the solid waste sorting activities. | - Integration of all sectors’ participation in supporting solid waste-sorting activities |
| O      | Owners Tan Deaw Sub-district Administration Organization and the local people      | Community Waste Bank Committee                                                   |
| E      | Environment - Attitude of people towards the participation in solid-waste sorting in the household | - Attitude of people towards the participation in solid waste sorting in the household and solid waste deposit at the waste bank |
|        | - Plan and measurement of waste management from the upstream to the downstream     | - Conflict of interest from the value added solid waste                          |

Step 4. Creating a model that clarifies the changes in Step 3 by emphasizing the opinions of all people concerned at the focus group, particularly the method to change solid waste management in the
community. The obtained model consisted of two models, which were a model for solid waste sorting by community participation and a model for the community waste bank, as shown in figure 2 and 3.

![Figure 2. Model of Solid Waste Sorting from Household.](image)

![Figure 3. Model of Community Waste Bank.](image)

**Step 5** Comparing the current situation and the solution by applying the 12 questions from CSH to all stakeholders, as in table 3.

**Table 3.** The comparison between Conceptual Model and Real World.

| Conceptual model activities                                      | Real world                                                                 | What could we do                                                                 |
|-----------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 1. Solid waste sorting from the household level                 | 1. People lack knowledge about solid waste sorting                          | 1. Provide knowledge about sorting household solid waste.                       |
| 2. People have no understanding of waste sorting and the perception of benefits from waste sorting. | 2. Provide knowledge about the method of compostable waste, recycle waste, hazardous waste, and general waste managements |                                                                                 |
| 3. People do not recognize the importance of household solid waste sorting. They think that the municipality's refuse collection vehicle will eventually put them all together, even if they sort them. | 3. Share knowledge about utilizing solid waste, such as making compost, reusing recycled waste and adding value to solid waste, etc. |                                                                                 |
| 4. There is an insufficient number of sorting bin or sorting location. | 4. Develop learning in the community for the systematic solid waste management through promoting knowledge to the |                                                                                 |
### Conceptual model activities

| 2. Establish a community waste bank | 1. There is no mechanism for the systematic solid waste management in the community, such as processing waste after sorting.  
2. The community does not recognize the value of household solid waste that can be value added or exchanged with products.  
3. The community lacks communication with the government sector about the participation in the systematic solid waste management.  
4. The benefits of solid waste are limited to a specific group despite the solid waste being community or household property. | 1. Promote knowledge on setting up a community enterprise structure and operation for solid waste management or the guidelines for establishing a community waste bank to accelerate the sorting of systematic solid waste  
2. Encourage the sorted solid waste deposit at the community waste bank to increase the household revenue/exchange products that finally lead to community welfare  
3. Provide the market to buy the solid waste from the community by inviting the network associates and private sector to operate. |

The research results of Steps 6 and 7 were the policy recommendations for community solid waste management, which will be shown in conclusion and recommendations.

### 4. Conclusion and Recommendations

This research involved applying the systemic approach to participatory action research with the aim of making a change in Tan Deaw Sub-district, where there was a residual solid waste problem, by developing systematic solid waste management and promoting the participation of the people in household solid waste sorting in order to develop the learning in the community about systematic solid waste management. Moreover, the community waste bank was established as the waste management centre, while the participation of all network associates in solid waste management was encouraged. For example, the government sector should set a policy to promote the community potential for own-waste management in order to reduce waste quantity from upstream, which would minimize the cost of solid waste management in the long term, construct the necessary networks within the private sector to sell solid waste from the community and develop the guidelines for solid waste utilization and value added. The research results identified seven guidelines to help resolve the two key issues: providing knowledge to the people on household solid waste sorting, methods of waste management; and developing the community leader to establish learning in the community and the promotion of the enterprise group to form the community waste bank. Furthermore, the research results respond to sustainable development goals numbers 3, 11 and 13 of the United Nations.

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