IMPLEMENTATION OF SYSTEM DYNAMICS AND MULTI CRITERIA DECISION ANALYSIS OF FOOD AND BIODEGRADABLE WASTE THE CASE OF OITA CITY IN JAPAN

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A DISSERTATION SUBMITTED TO

GRADUATE SCHOOL OF ASIA PACIFIC STUDIES

RITSUMEIKAN ASIA PACIFIC UNIVERSITY (APU)

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY IN ASIA PACIFIC STUDIES

Beppu, Japan, 2015

Abstract

The increased focus on material recovery in Japanese cities has led to the increase of resources from waste material being used in various ways. Recently, energy recovery from waste has gained recognition as a prioritized treatment option all over Japan. Utilization of all types of municipal waste is essential in order to maximize the full potential of energy production from municipal waste. As such, municipalities are responsible for handling their waste management including food and biodegradable waste (FBW) and this as a result in some complex schemes. In Oita city, incineration remains the main methods of treating large amount of FBW. In spite of increasing importance of research on integrated municipal solid waste management system and the adaptation of material recovery from related waste treatment facilities, there has been little research on the comprehensive assessment of the contribution of food and biodegradable waste management (FBWM). It is important to carry out a study that aims at improvement and development on the current waste systems. Therefore, the objective of this study is to examine the potential contribution that the treatment of FBW could make towards achieving sustainable waste management targets. In order to achieve this result the following approaches were used: (a) develop and identify ways to improve the food and biodegradable waste management system; (b) investigate the technical feasibility of the continuous treatment of FBW using different waste treatment options; (c) analyze and simulate various factors influencing the current FBWM practices; and (d) explore various policy scenarios (to be proposed) for decision-making strategies.

For the objectives listed above to be attained, the study combines the key strength of System Dynamic and Multi Criteria Decision Analysis approaches in analyzing the existing data and knowledge on FBW to underline the existing limitations and challenges in order to develop sustainable solutions and practical suggestions. The analysis of the current waste management system using these approaches helps in capturing the main elements of the municipal solid waste management system in Oita city.

The analytical approach uses four cases which were based on information collection, trade-off, decision-making, planning and management in integrated and sustainable management of FBW. The result demonstrated in the first two cases show that anaerobic digestion well suited for the treatment of FBW with regard to resource generation follows by incineration, composting and landfill been the least favored. The sensitivity analysis indicates no different result across four different scenarios. On

the whole, three of all four alternatives are better than landfill. These cases were based on investigating the technical feasibility of the continuous treatment of FBW using different waste treatment options. The development of FBW management using anaerobic digestion as a treatment option requires a geographical evaluation of Oita city. As such, Geographic Information System-Based Multi Criteria Decision Analysis (GIS-MCDA) is used to assess land suitability of siting the anaerobic digestion plant. The result shows that three suitable sites were produced and the third option is chosen as the most suitable and ideal local/site for anaerobic digestion. About 13.36 km2 in the entire area of Oita city is suitable and the remaining two options are still suitable to be used for the intended purpose, but the whole decision will have to be trusted to the decision makers' judgment.

Consequently, an additional case was added in order to illustrate and investigate the benefit of separate treatment of FBW in the MSW management system as well as to understand the dynamic interactions between all aspects and elements of the current MSW management system. The result demonstrates that strengthening of regulation for sorted waste and the reduction in the amount of FBW treated in incineration will improve the current MSW management system in Oita city. It also indicate that the use of AD plant as a treatment for FBW would increase the efficiency of incineration and after the first five years the project will generate profits. It further conclude that any policy regulation less than the proposed result will yield less benefit to the MSW management system; thus making regulation strengthening a crucial part in the suitability of FBW management in the long run. It is therefore appropriate to adopt a proposal such as the one presented in this study that gives support through a set of evaluation procedures and decision-making instruments for better decision making process, planning, implementation, guiding and informing, getting feedback and continuous management of FBW. Hence, contribution of this study can be classified into two aspects, firstly it provide a platform for assessing, developing and planning any FBW management project and secondly it can be used for testing the impacts of various policy measures and management strategies of FBW management.

Keywords: Anaerobic Digestion, Incineration, Analytic Hierarchy Process, Benefit and Cost Analysis, Criteria, System Dynamics, GIS, Food and Biodegradable Waste, Multi-Criteria Decision Analysis, Waste Treatment Technology, Sustainability