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E47304

**DEVELOPMENT OF SUSTAINABILITY INDICATORS FOR EVALUATION OF  
MUNICIPAL SOLID WASTE MANAGEMENT SYSTEMS- LCA PERSPECTIVE**

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**ID: 51920106**

**A THESIS SUBMITTED AS A PART OF THE REQUIREMENTS  
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY  
IN ENVIRONMENTAL TECHNOLOGY**

**THE JOINT GRADUATE SCHOOL OF ENERGY AND ENVIRONMENT  
AT KING MONKUT'S UNIVERSITY OF TECHNOLOGY THONBURI**

**2<sup>ND</sup> SEMESTER 2010**

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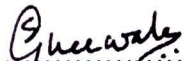
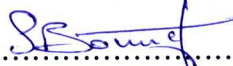

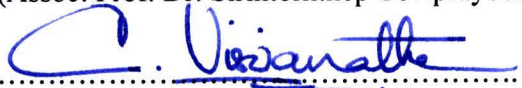


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for the Degree of Doctor of Philosophy  
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### Abstract

**E 47304**

Development of sustainable solid waste management methods is a critical issue for most of the developing Asian countries. The biggest drawback today is the lack of right signals or indicators to quantify the foremost sustainability aspects in a tangible way and to make policies and decisions at the right time.

This dissertation is basically focused on development of sustainability indicators for evaluating Municipal Solid Waste (MSW) management systems in LCA perspective. Methodological framework was designed for three-dimensional sustainability indicator development via life cycle thinking. The most relevant midpoint indicators were identified and the mathematical formulas were developed to quantify the damage at midpoint level considering all the phases of the life cycle since they are useful for the scientific decision-making process. To assess the sustainability in a more tangible way, endpoint composite indicators were also developed to measure the most critical ultimate damages. The developed set of robust composite indicators would be very useful as an attractive tool for policy makers to support policy implementation

In addition, the indicators were applied to assess the three-dimensional sustainability of existing and intended appropriate MSW management approaches in three Asian countries namely: Thailand, Sri Lanka and India. Quantified environmental, economic and social impacts of existing MSW management systems in these countries would be useful for convincing stakeholders at all levels about the strengths and weaknesses of the present systems. Evaluation results of the intended integrated systems in these countries have clearly indicated the three-dimensional sustainability improvement potential by incorporating appropriate MSW technologies within a system. Thus, the results of this study would be beneficial to policy making and strategic planning for developing and implementing appropriate sustainable waste management systems in the future.

Key words: MSW, Sustainability Indicators, LCA, Thailand, Sri Lanka, India

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## List of Abbreviations

AD- Anaerobic Digestion

ADP - Abiotic resource Depletion Potential

AP- Acidification Potential

BMA - Bangkok Metropolitan Area

CALCAS- Co-ordination Action for innovation in Life-Cycle Analysis for Sustainability

CDM - Clean Development Mechanism

CE – Capital Expenditure

CER- Certified Emissions Reductions

CER- Certified Emissions Reductions

CF – Characterization Factor

CIA - Central Intelligence Agency

COGEN – Cogeneration

CSWS - Council for Solid Waste Solutions

DALYs - Disability Adjusted Life Years

DE – Damage to Ecosystem

EF – Ecological Footprint

EF(j) - substance j Equivalency Factor

EP - Eutrophication Potential

EP- Environmental Impact

EPA- Environmental Protection Agency

EPS - Environmental Priority Strategies

GDP- Gross Domestic Product

GDP-PPP-GDP-Purchasing Power Parity

GHGs- Greenhouse Gases

GPS - Global Positioning System

GWP- Global Warming Potential

HDPE- High Density Polyethylene

HTP - Human Toxicity Potential

IC- Internal Combustion

IPCC- Intergovernmental Panel on Climate Change

ISO - International Organization for Standardization

ISWM- Integrated Solid Waste Management  
KMC - Kolkata Municipal Cooperation  
LAs - Local Authorities  
LCA-Life Cycle Assessment  
LCC- Life Cycle Cost  
LCI – Life Cycle Inventory  
LCIA - Life Cycle Impact Assessment  
LCR- Life Cycle Revenue  
LFG- Landfill Gas  
LO – Land Occupation  
MCI - Marginal Cost Increase  
MSW- Municipal Solid Waste  
MSW- Municipal Solid Waste  
MT – Million Tonnes  
OMC – Operational and Maintenance Cost  
PCD – Pollution Control Department  
PDF - Potentially Disappeared Fraction  
POFP - Photo-oxidant formation potential  
REPA- Resource and Environmental Profile Analysis  
SLCA - Social Life Cycle Assessment  
SLCA- Social Life Cycle Assessment  
VMS- Vehicles Monitoring System  
WHO – World Health Organization  
WTP - Willingness to Pay  
YLD - Years Lived Disable  
YOLL - Years of Life Lost