A Decision Support Model for Waste Management in Support of Developing Low Carbon, Eco Regions:

Case Studies of Densely Populated *Kampung* Settlements in Urban Areas in Jakarta

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Abstract

Due to the various types of waste disposal, treatment, utilization and technologies, decision support model for waste management is needed to assist planners and decision makers in finding most suitable way to manage municipal solid waste efficiently. Many planners and decision makers in the area of municipal solid waste have a lack of thorough understanding of the complex chains of waste management system. Therefore the impact for the environment quality and the public health can only be judged at the rudimentary level.

However, most existing models are primarily focusing on cost or environmental analysis. Only few consider other crucial factors such as the demographic condition, the characteristics of urban form and urban infrastructure, land transformation aspects due to urban development. Consequently, such models often meet difficulties to cope with cultural requirement.

Based on those reasons, a decision support model to set up alternatives of most appropriate technology for sustainable waste management towards a low carbon eco-city on a regional basis is developed in this PhD study. The Low Carbon- and Eco-Region, in particular the contribution of waste management sector, is a vision of living in low rate of carbon generation, using fewer natural resources, and encouraging energy recovery and/or waste reduction at source by improving the used material quality (up-cycling).

This decision support model is constructed mainly based on the cultural requirement and local context of a region and synergize the geographic, environmental, social capital and economics aspects in order to fulfill the needs of the respective region and its society. The method employed in this model is not solely a new developed model, but also an advanced model in material flow analysis (STAN), and life cycle assessment on solid waste system (EASEWASTE) and Geographic Information System (GIS). At the same time the model also assists the stakeholders in improving the environmental quality and the public health by promoting waste separation at source and reducing the greenhouse gas emission potential from waste sector.

Abstrakt

Aufgrund der vielfaltigen Techniken und Methoden der Abfall- Entsorgung, -Behandlung und -Wiederverwendung ist ein Entscheidungshilfe-Modell benötigt, um die Entwerfer und Entscheidungsträger bei der Suche nach der effektivsten Managementmethode der Kommunalabfälle zu unterstützen. Viele Planer und ET im Bereich der Kommunalabfall haben mangels vollständiger Kenntnisse über die komplizierten Abläufe des Kommunalabfallmanagementsystems, deswegen kann der Einfluss auf die Qualität der Umwelt und die allgemeine Gesundheit nur auf rudimentären Ebene gemessen werden.

Allerdings konzentrieren sich die meisten existierten Modelle vor allem auf die Kosten oder die Umweltanalyse, nur wenige berücksichtigen andere entscheidende Faktoren, wie die demografischen Bedingungen, die Eigenschaften der Stadtform und städtischen Infrastruktur, Land-Transformationsaspekte durch Stadtentwicklung. Deshalb haben solche Modelle oft Schwierigkeiten mit den kulturellen Bedürfnissen zurechtzukommen.

Auf dieser Grundlage ist, ein Modell zur Entscheidungshilfe für das Einrichten von Alternativen für die meist geeigneten Technologien für nachhaltiges Kommunalabfallmanagement nach einem niedrige-Kohlstoff- und Öko-stadt auf regionale Ebene ist bei dieser Promotion entwickelt worden. Die niedrig Kohlenstoff und Ökoregion, insbesondere die Beteiligung des Kommunalabfallmanagementsektors ist eine Vision um in einer niedrigen Kohlenstoff-Erzeugungsrate zu leben, weniger natürliche Ressourcen zu benutzen, und Zurückgewinnung von Energie zu fördern mit/ohne an der Quelle Abfallminimierung durch die Verbesserung der Qualität von angewendeten Materialien (up-cycling).

Dieses Entscheidungshilfe-Modell ist hauptsächlich aufgebaut auf der Grundlage der kulturellen Bedürfnisse und dem lokalen Zusammenhang einer Region, es synergiert alle geografische, ökologische, soziale und wirtschaftliche Aspekte, um die Bedürfnisse der entsprechenden Region und derer Gesellschaft. Die in diesem Modell verwendete Methode ist nicht nur ein neu entwickeltes Modell, sondern auch ein fortschrittliches Modell, das mit der Materialflussanalyse (STAN), der Ökobilanz von Kommunalabfallsystemen (EASEWASTE) und dem Geografischen Informationssystem (GIS) entwickelt worden ist. Gleichzeitig unterstützt das Modell die Interessenvertreterin bei der Verbesserung der Qualität der Umwelt, und die allgemeine Gesundheit, durch die Förderung der an der Quelle gesteuerte Abfalltrennung, und Reduzierung des Potenzials an Treibhausgasemissionen aus dem Abfallsektor.

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فَبِأَيِّ ءَالَآءِ رَبِّكُمَا تُكَذِّبَانِ

“So which of the favors of your Lord would you deny?”

(mentioned 31 time in Quran Surah: Ar - Rahman (QS:55)

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List of Abbreviations

3R	Reduce, Reuse and Recycle
APC Residue	Air Pollution Control Residue
ASTM	American Standard Test Method
BU	Benefit Unit
Br	Bromine
CACBO	Collective Action and Community-based Organization
CAD	Combined Composting and Anaerobic Digestion
CBD	Central Business District
CC	Carrying Capacity
CFC	Chlorofluorocarbon
CHP	Combined Heat and Power
C_2H_6	Ethane
CH_4	Methane
Chigh	Composting High Quality
CIA	Central Intelligence Agency
CL	Controlled Landfill
Clow	Composting Low Quality
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CU	Cost Unit
DSM	Decision Support Model
DKI Jakarta	*Daerah Khusus Ibu Kota* Jakarta (the Special Territory of Jakarta)
Ec.	Economic Impact
EF	Ecological Footprint
EIU	Environmental Impact Unit
En.	Environmental Impac
Eq.	Equation
eq.	Equivalent
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GEO	Geography
GIS	Geographic Information System
GHG	Green House Gas
GPS	Global Positioning System
HC	Home Composting
HCF	Hydrochlorofluorocarbon
I10%ER	Incineration with 10% Energy Recovery
InoER	Incineration with no Energy Recovery
ISO	International Organization for Standardization
ISTA	Incineration State of the Art
ITF	Intermediate Treatment Facility
LCA	Life Cycle Analysis
LCCI	Low Carbon City Initiative
LFG	Landfill Gas
MBT	Mechanical-Biological Treatment
MCDA	Multi-criteria Decision Analysis
MFA	Material Flow Analysis

MSWMS	Municipal Solid Waste Management
N	Nitrogen
n	Number of Bin based on Bin Type
N_2O	Nitrous Oxide
NH_3	Ammonia
NO_x	Nitrogen Oxide
n.a.	not available
O	Owned
OD	Open Dump
P	Phosphorous
PKK	*Pembinaan Kesejahteraan Keluarga* (Empowerment Family Welfare)
Posyandu	*Pos Pelayanan Terpadu* (Community Integrated Service)
PE	Person Equivalent
PIC	Potential Impact Category
Qls	Qualitative Score
Qns	Quantitative Score
R	Rented
RT	*Rukun Tetangga* (Household Association)
RW	*Rukun Warga* (Neighborhood Association)
RB	Recycle Bank
RT	Recycling Technology
S	Scenario
SAPROF	Special Assistance for Project Formulation
SL	Sanitary Landfill
SME	Small-Medium Enterprise
So	Social Impact
SOCECO	Socio-Economic
STAN	Software *für Stoffflussanalysen*
T	Technology
TCP	Number of Collection Point
TOR	Term of Reference
TWA	Total Waste Amount
TWATCP	Total Waste Amount per Collection Point
UNEP	United Nations Environment Programme
UNFPA	United Nation Population Funds
WCED	The World Commission on Environment and Development
WF	Waste Fraction
WtE	Waste to Energy
WWF	World Wild Fund
VOC	Volatile Organic Compound

Glossary

Active Person	a person who is regarded as being the most involved in many collective actions and community based-organization
Buffer zone	the surrounding area/area of influence of the active person/Meeting points
CACBO	Collective Actions and Community Based Organization
DSM	Information system which developed to support the decision making activities
Dasa Wisma	a strategy from PKK to form a small group in the community (12-20 houses) to increase the community involvement
GEO	Group Inventory 1 for Physical Map
household	a person or group of people who usually live together in a building or a house that the management of eating from the same kitchen, the management of daily needs are administered into one. (BPS Provinsi Jakarta 2012, p.68)
IMPACT	Group Inventory 2
Kampung settlement	Urban settlement which densely populated and in which the majority of its population is rural migrants and poor
Local Leader	a person (community members) who are trained and has the responsibility to transfer the knowledge to the other community members
Person Equivalent (PE)	the impact factor of one person in a reference year
Physical Map	a-map based inventory of the physical condition of one area
RT/ Household Association	a group in the community which contains several households
RW/ Neighborhood Association	a group in the community which contains several household associations
Scavenger (*Pemulung*)	a person who searches for the recyclables from anywhere such as streets, vacant lands, waste bins and landfill and then sell the recyclables to waste collectors (pengepul).
SME	Small-Medium Enterprises
SOCECO	Group Inventory for Social-Economic Aspects
Waste Collector (*Pengepu*l)	a person who comes to houses to buy recyclables such as old newspapers, any metal contains like broken air conditioner/bicycle/refrigerator/fan, glass and plastic bottle and also sell them to the waste collectors
"Waste" term in this study	solid waste collected from houses and small enterprises and community facilities
Waste Picker *(tukang loak*)	most common to be called big boss, is a retailer who will then sell the recyclable to companies.

Chapter 1 Introduction

Background

Solid waste management is a very important issue, which is closely coupled with urban population growth and increased waste generation. The global population is growing but the amount of land on the earth is not. As a result, more than 50% of the world's population lives in urban areas today. An increase in waste generation in urban areas is thus inevitable. Figure 1-1 shows the world urban population based on The United Nations Population Fund (UNFPA) data in 2007. The bubbles in red and orange show the countries that are predominantly urban. Inside the bubbles, the number gives the urban population and the percentage of the urban population living in the urban area per country.

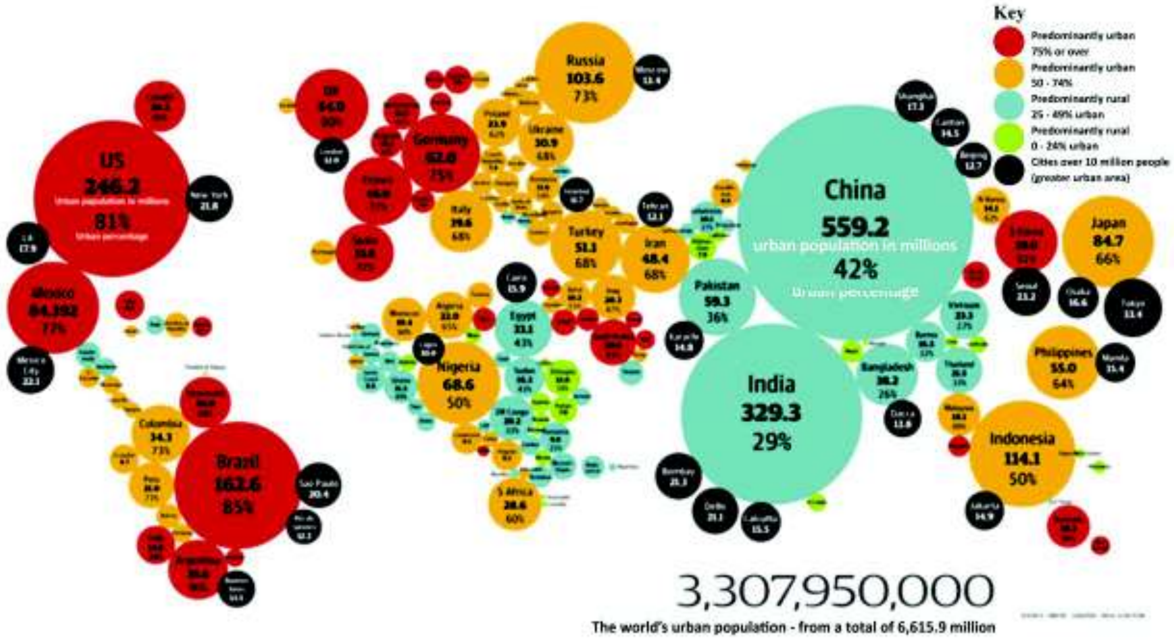


Figure 1-1 The urban world population

Source: UNFPA, graphic Paul Scruton (2007)

A not small portion of the world's urban population lives in urban *kampungs*. A *kampung* is an urban settlement which is densely populated and in which the majority of the population is rural migrants and poor (Harjoko 2009, p.7). The main problem of waste management in *kampung* settlements is low access to waste management services causing environmental problems. An approach to dealing with such problems is dealing much more with empowering people.

A Decision Support Model (DSM) is one way of doing this. A DSM is an information system that supports decision making activities. It compiles useful information from a combination of raw data, documents and personal knowledge. It helps to solve problems and make decisions. DSM facilitates communication among and between decision makers and other stakeholders (Sprague and Watson 1993, p.6). It can be fully computerized, done by hand or a combination of both. In this context the DSM, which is purely instrumental or technical, should be enhanced by paying attention to the social aspects of management.

Various advanced waste treatment technologies and utilization options exist. There are not so many DSMs that are addressed to the waste management situation of developing countries (Jain et al. 2005, p. 3732). Planners and decision makers in the area of municipal solid waste, particularly in developing countries, often lack a thorough understanding of waste management systems. Often, the impact can only be judged at a rudimentary level.

Many DSMs for waste management are not widely marketed and lack practical ideas on implementation actions. They incorporate a wide range of variables in a mathematical model and include assumptions and constraints affecting the decision making process (Bani et al. 2009, p.161). Such models are sophisticated, but of little use for developing countries.

Many of these sophisticated DSMs do not take into account the high organic waste content, low investment capacity, vast quantity of manpower, poor performance of the formal sector, and the size of the established informal sector that are characteristics of the waste management situation in developing countries (Jain et al. 2005, p.3732). They are not easy to apply in developing countries.

Moreover, most existing DSMs primarily focus on cost and environmental analysis, and only a few consider other crucial factors happening on the 'ground', such as demographic conditions, the character of urban infrastructure, land transformation aspects due to urban development, and community involvement. Consequently, such models have difficulties coping with the socio-cultural context, and sometimes end up eliciting community protests. These factors further show the limitations of the DSM's applicability for developing countries.

Low Carbon- and Eco-Regions

There is an emerging awareness of a need for change in relation to the contribution of the waste sector to greenhouse gas emissions and environmental degradation. This has given birth to the vision of living in a manner that generates only low rate of carbon and other greenhouse gases emissions, uses fewer natural resources and encourages energy recovery and waste reduction at the source by improving the used material quality (up-cycling). To address ways of achieving this in developing countries, here a DSM is developed, which contains appropriate technology alternatives for waste management. The goal is to move towards the development of low carbon- and eco-communities at a regional level.

A special focus is placed on the urban *kampung* settlements in this study. These settlements, which are commonly found within cities in Indonesia, and are also similar to urban settlements found in other developing countries, are characterized by low- to middle-income people. They are typically densely populated urban areas and are more likely to be disconnected from the Municipal Solid Waste Management system (MSWMS). If any exists, the service is often insufficient. In many cases, waste management from *kampung* settlements is unorganized. The *kampungs* lack access to public services and this encourages irresponsible acts, such as illegal dumping inside and outside the area.

Two case studies of kampung settlements in Jakarta, Indonesia: Srengseng Sawah – Cipedak and Cikini- Pasar Ampiun, were taken as the research sites for this study.

Problem Statement

Waste problems in the urban *kampung* areas in Jakarta and other megacities in Indonesia need to be addressed. Densely populated *kampungs* need particular attention and the introduction of effective measures that are socially acceptable and environmentally sound. Unfortunately, available DSMs are not structured to cope with the typical waste management situations found in such settlements. DSMs cannot simply be rationally planned and implemented in such settlements. Low-income people need an inclusive waste management scheme, which involves community participation, increase environmental and health awareness tied to waste issues, and expands participation in waste management.

Research Questions

The questions addressed in this study related to waste management associated DSMs are: what kind of adjustment can be made to existing DSMs to make them socially acceptable as well as applicable in solving waste management in *kampung* areas? What is the role of the local government vis-à-vis community involvement? These questions are broken down into three further specific questions:

(1) Why can the many existing DSM models not be used in developing countries especially those with high shares of urban poor settlements?
(2) What DSM is compatible with the socio-economic aspects of the urban poor living in *kampungs* and what aspects should be emphasized to increase the flexibility of the model in terms of enriching the treatment of socio-cultural values and the specific conditions of localities?
(3) Which systems addressing these problems should be incorporated into a city's waste management system as a whole and can the *kampung* settlements and other urban poor areas be integrated into Municipal Solid Waste Management?

Hypothesis

Urban solid waste management in the *kampung* settlement in Indonesia can become sustainable if, and only if, it incorporates societal aspects into the system as a whole.

Aim of the research study and the research focus

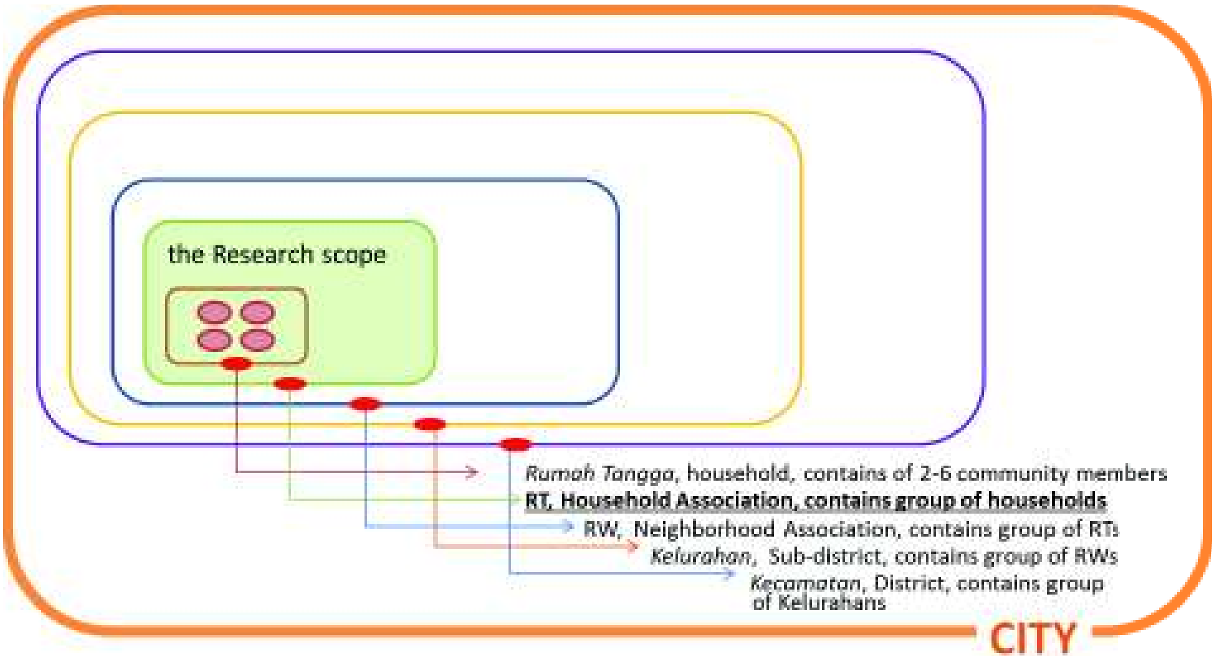


Figure 1-2 The research object in this study

The aim of the study is to improve current waste management approaches in densely urban populated areas and to address the needs of urban poor in *kampung* settlements. Doing this requires improvements in the municipal waste management systems and a shift towards low carbon- and eco-region thinking. As research objects, household associations in *kampung* settlements are taken (Figure 1-2).

Objectives

(1) To stimulate active involvement at the community level, developing a sense of belonging and community acceptance
(2) To increase community awareness and understanding of environmental problems and open the avenues for making improvements
(3) To increase community contributions to improve the existing *kampung* waste management systems and their possible integratetion into the municipal waste management system

Approach

Social sustainability is very important in developing countries with intermediate amounts of capital, vast quantities of manpower, and where the human resources are cheap compared to developed countries. This study uses a community participatory-based form of action research.

The study follows an action research methodology. The community is seen as playing a central role in the model's implementation. A DSM shall be developed with reference to the cultural requirements and the local context of the studied region and synergized with geographic, environmental, and economic aspects. For the inhabitants of the community, the relevant questions are: "What do you want to do with your waste? What actions are you willing to take to improve waste management? What is your actual capacity for change?" These questions must be asked in the community in a tiered decision making process.

The tools employed in this model are not only composed of newly developed models but also make use of well-established models: STAN, a material flow analysis model from Vienna University of Technology (TU Vienna) and EASEWASTE, a life cycle assessment model on solid waste system from Denmark University of Technology (DTU). Geographic Information System (GIS) is also employed in this model, mainly to analyze the location-based characteristics and social relationships. These existing models were used to widen the life cycle assessment benefit, particularly for urban *kampung* settlements, so that the information can be processed at a smaller scale as well as and through conventional ways.

An economic assessment is minimally considered in this study due to time and resource limitations. Such an economic assessment could be a subject for consideration in the future development of the model.

Chapter 2 Review on Decision Support Models for Sustainable Waste Management

2.1 The Review Method

A review of existing DSMs for the evaluation of Municipal Solid Waste Management Systems (MSWMS) was carried out to answer the following questions: (1) why can many existing models not be used in developing countries, especially those with high shares of urban poor settlements, (2) what DSM is compatible with the socio-economic aspects of the urban poor living in *Kampungs* and (3) what aspects should be emphasized to increase the flexibility of models in terms of enriching their attention to socio-cultural values and the characteristics of specific localities

In this study 43 models were reviewed out of which 12 models were selected for deeper discussion. They represent models from developed and developing countries from 1996-2007. The selection of the models is specific to MSWMS. The discussion about the models focuses on how to extend them to developing countries where the models are needed that speak to the wide range of unsolved waste management problems they face, including unsatisfactory hygienic situations.

The following criteria were used in determining which models to review (paper-based):

- The paper or article should have been written by the author of the model and either have appeared in a waste management related-international journal or been presented as an international conference paper (with the authors explaining about the model themselves).

- The paper should focus on the work of a single models development and/or application (and not be about a comparison between two or more models).

- The paper should discuss modeling related to municipal solid waste. It can include all or one of various sub-systems, such as collection systems, treatment technologies, energy recovery, costs, environmental impact/life cycle assessment (LCA), or the facility siting.

- The paper should contain clear information about:
    - how the work is modeled,
    - how the decision is taken,
    - what are the main considerations in decision making,
    - what are the inputs and outputs, and who are the targeted users, and
    - when and where was the model developed and for what purpose.

The main objective of this review is to: 1) compare the models of developed and developing countries; 2) describe the limitations and the bottlenecks of the model to implementation in developing countries, and 3) suggest some approaches to develop an improved model for suitable application in developing countries. In doing this, an emphasis is placed on the economic, environmental and social sustainability considerations that need to be taken in the creation of a DSM model that is applicable to developing countries.

2.2 Decision Support Models

The DSM shall consider the full range of the waste streams to be managed and view the existing waste management options based on specific site considerations. Gottinger (1991) and MacDonald

(1996), for example, emphasized that the goal of DSMs is to assist planners in developing more efficient solid waste management strategies and systems.

Figure 2-1 indicates the general flow within a tool for DSM such as the criteria/parameter, assessments (process tools, simulation tools and scenarios). The **criteria/parameter** is set up at the beginning together with the conditions setting in order to give clear restrictions to the system boundaries and instructions on what to do with the inputs. During the process, the **assessment tools** assist the users to simulate scenario under the given criteria/parameters. The dialogue between the criteria and the simulation tool provides comparative results. Additionally, external conditions are incorporated into the model. Users add their key assumption factors to the final decisions. The intended users are researchers, governments and/or community members. However, models alone can say little. They are simply there to assist the users to find suitable decisions based on given settings and model parameters.

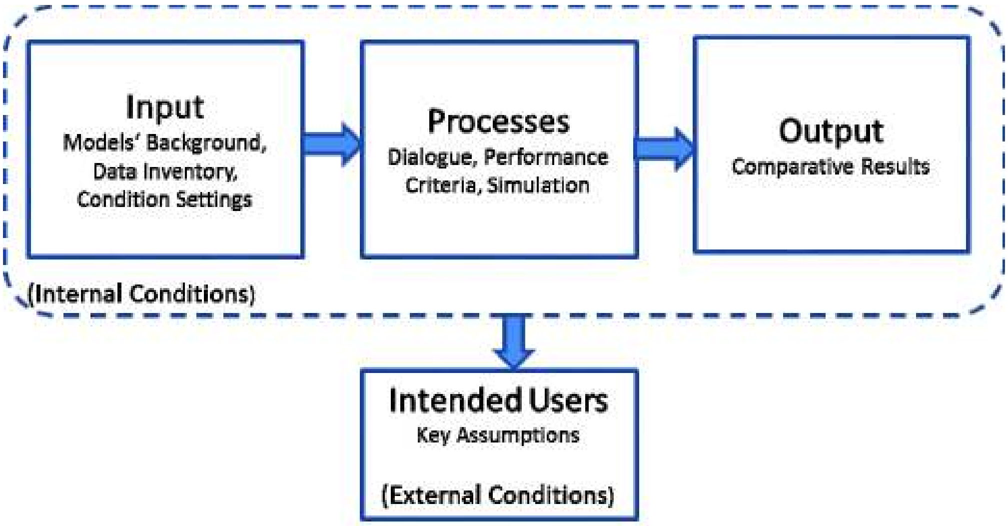


Figure 2-1 Generalization of Decision Support Models (DSM)

Source: adapted from Sprague and Watson (1996)

Only a few of the existing models are used for practical reasons. Most are intended as scientific works rather than as how to guides. Many have large numbers of variables and are based on complex mathematical models. Meanwhile the more complex and confusing the model, the bigger the possibilities are for the users to exclude the implications of environmental quality and public health considerations and concentrate only on financial aspects (Powell 2000 p.9).

2.2.1 History of the Model Development for Waste Management Sector

Figure 2-2 shows the summary of the history of model development from the 1970s to 2000s and beyond. In the 1970s, the models mainly focused on the optimization of collection systems, routing and facility siting and searched for more realistic waste management practices. As the problem of waste management became more complex in the 1980s, the models were adjusted to reflect the interrelationships among collection, haulage and disposal systems. The models started to focus primarily on cost minimization.

The focus later widened to include options for waste prevention, material recovery and using waste as a resource material with a goal of closing landfills during the 1990s. In this period, the term of Integrated and Sustainable Waste Management was promoted (please refer to chapter 3 for a definition of sustainable waste management). Today, population and education factors are viewed as keys to improve system effectiveness (Morrissey and Browne 2004, Bani et al. 2009, and Najm et al. 2002).

Sudhir et al. (1996) discovered some early models faced shortcomings. In many cases only one time period was used for evaluation, recyclables were rarely taken into consideration, there was only one processing option for each waste fraction, or only a single generation source was considered. Neglecting these aspects introduces difficulties when designing a long-term waste management plan.

McDougall et al. (2001) pointed out that one of the key indicators of the effectiveness of a waste management system is social acceptability. Pariatamby et al. (2009) stated that to devise a sustainable management plan, it is absolutely necessary to consider local conditions. Their focus on the local values is similar to the argument made in the report of Gottinger (1991) that the restriction of some models is that they are uneconomical mainly because they cannot easily be re-applied from place to place. Many different conditions exist at the local level. Societal/public acceptance and local contents are now understood as being among the main factors influencing model effectiveness.

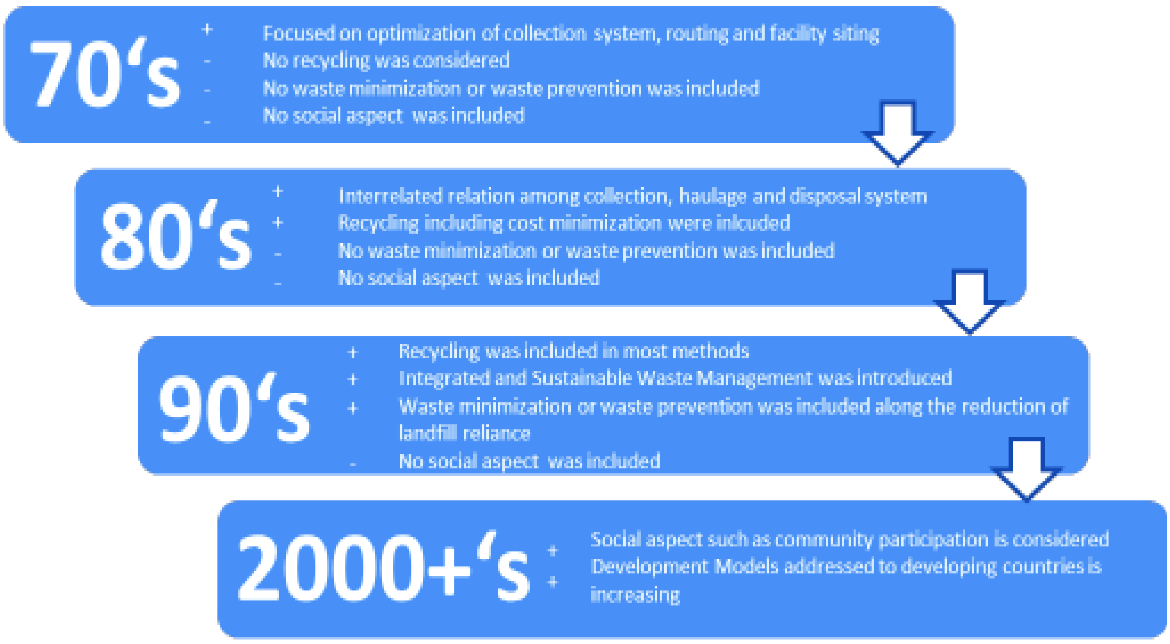


Figure 2-2 History development of Decision Support Model (DSM)

The early models focused on the optimization of the collection system. Later models started to consider recycling, to include cost minimization and then moved toward considering waste minimization and/or prevention which also emphasized the concept of integrated and sustainable waste management. Recent DSMs are starting to take into consideration social aspects.

2.2.2 Overview of Decision Support Models (DSMs)

In general, a DSM includes the stages of collection from the generation source, the transportation of waste to the facilities, and the waste processing and hauling. A large number of methods, approaches and modeling tools provide support for waste management decisions. Finnveden et al. (2007), Morrissey and Browne (2004) and Bani et al. (2009) reviewed three assessment methods of 3 types of models based on the analysis methods: 1) cost-based models, 2) environmental impact-based models and 3) multi-criteria-based models.

Table 2-1 describes the general characteristics of three types of waste management models based on the analysis method. The most common model is cost-based reflecting peoples concerns about and understanding of the monetary values. The most common model used among environmental researchers is the environmental impact-based model. The Life Cycle Analysis (LCA) is an environmental impact-based model and it is believed to be a tool for the of future waste management decision support (Kikerby et al. 2007 p.961). The multi-criteria decision (MCDA) model is the most time consuming model since it requires data/value weighting (Morrissey and Browne, 2004 p.302).

Table 2-1 Model characteristics (based on analysis method)

Model	Cost-Based	Environmental Impact-Based	Multi-criteria Decision
Characterisctic	The first and most common model	The most common model among researchers	The most comprehensive/widest scope model
Standard measurement	Monetary value, especially cost and benefit	The use of natural resources and their potential impacts on the environment	multi-dimensional sustainability (economical, environmental and social consequences)
Approach to obtaining outcomes (examples)	Estimation of individual willingness to contribute fees for environmental improvement in comparison with the total cost	Environmental performance in the waste management system	Parameter or criteria weighing/valuing/scoring of waste treatment plants from the source persons by the stakeholders/users.
Guide in to decisions (example)	Greatest benefit with lowest cost	Lowest environmental impact/consequence	Scenarios which are fit to certain given score

2.2.3 Decision Support Models Used in Developed Countries

Many DSM pioneers in the area of municipal solid waste come from developed countries. They invented models, starting with mathematical formulations. From the 1980s onward, the use of computers including computer-based geographic maps grew. Many models use computer-based and computer-based geographic mapping, such as Geographic Information Systems (GIS) in assisting planners and decision makers. For some models, GIS based approaches are useful for determining, for example, the number and location of material recycling depots in the waste management system (Valeo et al. 1997).The GIS can help planners understand the spatial nature of particular programs and how they may impact the public and the environment (Bani et al. 2009, p.162). Table 2-5 shows an overview of some of the models from developed countries as follows:

- Chang and Wang (1996), in Taiwan, worked on DSM as a graphical, interactive, problem-structuring tool for the management and planning of solid waste management systems. They use specific software, including SAS, SAS/BASE, SAS/OR, and SAS/GRAPHS. They employ an interactive model and that provide information on the geographical boundaries of the areas selected for analysis, waste generation, waste composition, and population trends. The aim of this model is to select suitable allocation for recycling and incineration facilities.

- Barlishen and Baetz (1996), from Canada, made use of a problem-solving approach model for a long-term planning (20-30 years). They linked mathematics and waste management expert models in order to assist users with waste forecasting, technology evaluation, recycling and composting program design; facility sizing; location and investment timing, waste allocation and MSW management systems. A simulation compares the relative costs from various alternative MSWs. The environmental, social and political factors were compared based on location, size and the mixture of facilities suggested by the chosen model.

- Valeo et al. (1998), in Canada, worked on a location-allocation model to determine the maximal coverage of a recycling depot site based on typical walking and driving distances. Distance can acts as a constraint to the potential for a voluntary-based recycling program, as distance impacts recycler behavior . Paying attention to the distance to a recycling center is a method of optimizing the location of recycling centers and allocating costumers or demand to centers in a certain area. The model evaluates shopping centers, municipal parking lots and roadside streets as candidate spots for collection locations. The two main physical factors influencing public participation in recycling are the availability of land for collection sites and the number of depots. GIS is used to provide maximum coverage of the model. It selects a coverage area within the constraints of a selected point. It contains layers of data or coverage linked by the same geographic condition. The data set they used is a digitized coverage containing information on transportation networks, houses, buildings, rivers, etc. The advantage of this kind of system is that numbers and figures, such as people living in each housing unit can be updated on relevant layers. The additional value of this model is that it considers user awareness and program acceptance.

- Kikerby et al. (2007), in Denmark, developed the Environmental Assessment of Solid Waste Systems and Technologies (EASEWASTE) model. It is a model of environmental impact analysis and technology assessment. It uses a Life Cycle Analysis (LCA) methodology. This complex model covers such factors as the use of landfilling, mechanical treatments, thermal treatment, electricity generation, and material recovery. In this paper, Kikerby et al. described the specific issue of landfilling. The landfilling sub-model is a part of a solid waste management system on EASEWASTE where the collection system, material recovery facilities and other waste treatment methods are included. The model uses a wide range of database derived from Denmark and the European Union (EU).

- Thorneloe et al. (2007), in the USA, developed the Municipal Solid Waste Decision Support System (MSW-DST) to determine the best option to manage solid waste and assist communities in finding more sustainable ways to minimize environmental burdens and maximize resource conservation. The model uses Life Cycle Analysis (LCA) and Full-Cost Accounting methodologies. It is a mathematical evaluation that accounts for cost, energy and environmental emissions. The model was first developed at the end of the 1990s.

- Den Boer et al. (2007), in Germany, developed a model under the project The Use of Life Cycle Assessment Tool for the Development of Integrated Waste Management Strategies for Cities and Regions with Rapid Growing Economies (LCA-IWM). The work on th e tool was carried out from 2002-2005. The model contains modules that represent individual waste management processes, such as temporary storage, collection, transport and treatment.

Using this model the users design scenarios for his or her municipality. The database is derived from the European Union (EU).

2.2.4 Decision Support Models Used in Developing Countries

There are not that many decision support models designed for use in developing countries. Pioneers of decision support models from developing countries are mainly from the Southeast Asia region, especially India and Thailand. Some models from developing countries employ mathematical formulations and GIS. As population density in developing countries is higher, the use of GIS is therefore more complicated and needs more attention. Table 2-6 shows an overview of some of the models originating in developing countries:

- Jain et al. (2005), in India, developed a computer-based model to determine the least expensive treatment and disposal system and to calculate the energy recovery potential from using different methods (biomethanation digester processing, composting, incineration and landfilling). This was done by calculating the cost incurred and the energy recovered in the residential-, industrial-, mixed-used- and agricultural-zones. The same evaluation runs for each zone and thus gives different results.

- Ghose et al. (2005), in India, worked on a model to design and develop an appropriate storage, collection and disposal path plan using GIS. This model works to optimize the routing system for bin collection and the transportation of solid waste in order to achieve an effective system. The model works to find an efficient management approach for daily operations for transporting solid waste, balancing load within vehicles, managing fuel consumption and generating work schedules for the workers and vehicles. GIS in this model is used to trace the minimum cost/distance efficient collection path for transporting the solid wastes from the three types of proposed bins to the landfill under the considerations of cost and distance.

- Kurian et al. (2005), in India, worked on dumpsite rehabilitation using an Integrated Risk Based Approach (IRBA). Dumpsite rehabilitation can be appropriate for sites with health risks, environmental impacts and high level of public concern. Kurian (2005) developed criteria as decision support for hazard evaluation and made recommendations for the assessed dumpsite. The criteria were developed based on two existing dumpsites in India. These criteria then became the attributes to be weighed and ranked. The information was collected from academics, municipal officers, regulator, and consultants.

- Gomes et al. (2006), in Brazil, proposed the multi-criteria decision aid model or the Decision Aiding Hybrid Algorithm (THOR). They worked on finding the best alternatives for plastic and demolition waste recycling. Four types of stakeholders (government, managers, consumers and integrated view points) were considered as decision makers in this work. Stakeholders were asked to weight criteria related to plastic waste destinations. Scores where then developed for each alternative treatment type intended for demolition waste recycling facilities. Table 2-6 describes their findings in relation to waste recycling of municipal solid wastes.

- Ghewala (2006, 2007, and 2009) has done active research on waste models for cases in Thailand. Gheewala and Wanichpongpan (2006) used a life cycle analysis (LCA) methodology to holistically evaluate the environmental consequences of landfilling. The LCA provides a comparative evaluation of one large landfill with electricity generation (scenario I) and two small landfills with the flaring of collected methane (scenario II). With the use of the impact assessment methodologies, they evaluated each scenario in terms of the potential greenhouse gas (GHG) emission reduction and Landfill Gas (LFG) utilization for electricity (credit). They examined the effects of improving gas collection efficiency, methane oxidation rates, electrical efficiency and economic aspects based on the two scenarios. The model supports stakeholders in finding suitable ways to manage the waste in their municipality.

- Gheewala and Liamsanguan (2007) in Thailand, also used the LCA methodology to conduct an environmental assessment of the municipal solid waste system in use in Phuket Province. They considered the environmental performance evaluation of landfilling (without energy recovery) and incineration (with energy recovery) based on the direct waste management activities and life cycle perspectives. The work produced a comparative evaluation of energy generation and greenhouse gas emissions for each technology.

2.3 Comparison of the Models from Developed and Developing Countries

Table 2-2 underlines the differences between the models originating in developed and developing countries based on their scope, focus and background. Concerning the scope of the models, it is obvious that the complexity of models from developed countries is wider than the models from developing countries, which came decades later. In most of the described models, whether from a developed or developing country origin, attention is given to economic and environmental sustainability; social sustainability is typically neglected. Often the models do not consider socio-cultural aspects or local values.

Table 2-2 Comparison of models from developed and developing countries by scope of the model

Models From Developed Country	Comparison Aspect	Models From Developing Country
Bigger scope: Cover the whole waste management system: the collection points, haulage systems and treatment plants.	Scope	Smaller scope: Only cover treatment plants or the collection points and the collection system.
Focus on the cost/economic variables from the late 90s. Later, the focus is broader.	Focus	The focus of the models, even after 2000, is mainly on cost/economic analysis
A focus on the environmental impacts of the whole waste management system is the most important consideration of early models.		Cost/economic factors are dominant in each model; environmental impact considerations are only made for waste management sub-systems.
Early model construction is mainly done by an environmental agency or big scale projects and for a long-term development period (usually more than 1 year).	Development Background	Models are constructed mainly based on the researchers initiatives, applied to a small scale projects and for short term development periods (no longer than 1 year).

Since property rights are often poorly developed and applied in developing countries, collective decisions on how to manage common resources are critical to maximize their use and yield

(Grootaert and Van Bastelaer 2002, p.7). One of the weaknesses of the service or management from developing countries is that the informal sector usually lacks formal institu tions. The worldviews recommend such things to be determined by society, which are in fact lacking formal institutions (Harjoko 2009, p.21).

2.4 Limitations of Model Implementation from Developed Countries in Developing Countries

Many models from developed countries are sophisticated. They use a wide range of data, are based on highly-technologically and advanced treatments, build on established collection systems, and are computerized. These very same factors limit their applicability to developing countries. These sophisticated models are not suitable for developing countries because of theie very different conditions as described in Table 2-3.

Developing countries commonly have poor waste treatment (especially open dumping practices), scavenging activities, established but informal collection and recycling systems, low rates of service coverage and insufficient support data. These issues typically do not exist in developed countries. In developing countries there is an urgent need for appropriate, functional and integrated models to improve hygiene conditions.

Table 2-3 Sophisticated models and the required condition

Sophisticated Models	Developed Countries	Developing Countries
Designed to limit human resources inputs with high wages	fit	Unfit: Vast human resources with low wages
Supported by well-established database systems	fit	Unfit: Still improving the database system, currently: weak (unsupported database)
Often requires a wide range of data variables and a certain level of knowledge/understanding, especially of waste management technology	fit	Unfit: Limited capacity in terms of knowledge/understanding
The technology discussed have high maintenance and high cost investment requirements	fit	Unfit: Still need to concentrate on the basic level: the search for appropriate waste technology
Concentrated on the advanced levels of efficiency of waste technology	fit	Unfit: Limited capacity in economics
Discussed in relation to well-established and formal waste management system	fit	Unfit: Well-established but informal collection system
The models often have a wide scope/macro level and top down approach	fit	Unfit: Diverse community type and bottom up approach

Figure 2-3 summarizes the different conditions found in developed and developing countries. These factors help to explain why the more sophisticated models found in the developed countries often cannot be applied in developing countries.

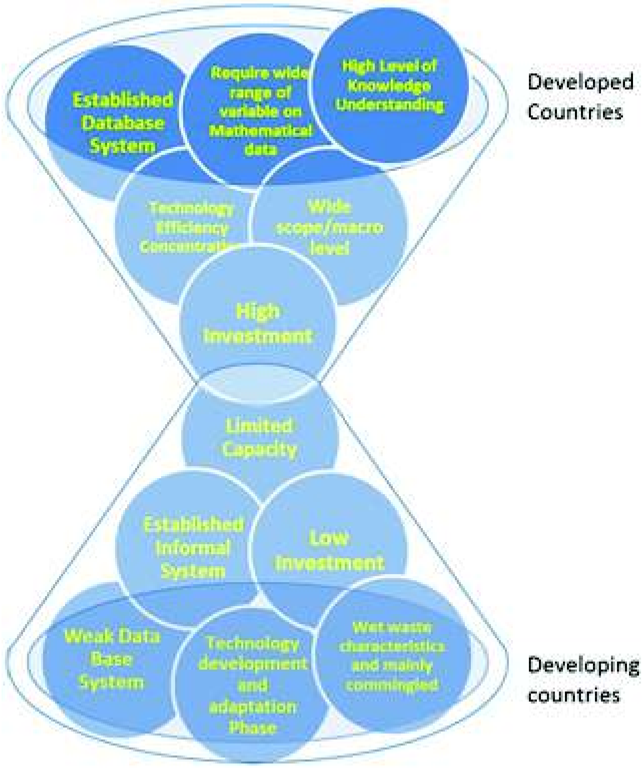


Figure 2-3 The different conditions in developed and developing countries

2.5 The Development of a Model Compatible with Developing Country Conditions

The models reviewed in this chapter apply different approaches to deliver comparable results. One of the goals of this study is to develop a model that can be applied in developing countries. Kikerbys (2007) and Jains (2005) model s demonstrate a good example due to their flexibility and the quality of their results.

The EASEWASTE model, developed by the Denmark Technology University (DTU), is a good example of how flexibility can be built into a model. It considers the holistic waste system starting from the generation point until the treatment stage under various technological options. Although it is a complex model, it allows the assessment of waste flow under a specific treatment technology. The users also have the flexibility to design scenario(s) based on local conditions and to determine partial assessments of full complete systems.

Another good insight for the model development in this study is the work of Jain (2005). Jains model assesses the cost and energy recovery potential separately based on the use of the land (zone), whether a pure residential zone, industrial zone, mixed use or agricultural zone. The assessment showed different results for different zones as each zone has different characteristics of waste.

What is needed for developing countries is a highly useful, user-friendly, contextual and flexible model, particularly when the focus is on the marginalized urban poor. There are many countries that could be chosen for such a study given the large number of urban poor in developing countries. Here the case of the urban poor living in *kampung* settlements in Jakarta, Indonesia is taken due to the authors cultural, linguistic, and social familiarity with such settlements and access to research sites.

The review conducted in this chapter has underlined some of the limitations of current waste management models in terms of their applicability to developing countries. Four important shortcomings are that most existing models do not adequately address the social sustainability of their proposal, are not suited to areas where there is limited availability of statistical data, do not consider what to do in cases where investment capital is lacking and are not user-oriented. These factors restrict the applicability of these models for developing countries. In the case of developing countries, it is strongly recommended that models should include:

Table 2-4 Limitations of existing models and suggestions for the development of a new model

No.	Underlined Limitations	Discussion and Suggestions
1.	**Social Sustainability** The review emphasized whether or not the models consider economic, environmental and social sustainability. The review showed that 9 models considered economic sustainability, 8 models considered environmental sustainability and only 3 models considered social sustainability. Six of the models considered multi-sustainability aspects. 2 of the 3 models considering social aspects are from developing countries.	The review shows that there is minimum consideration given to the social sustainability anad the local conditions prevalent in developing countries with large populations. More attention should be paid to social sustainability by strengthening the focus on socio-cultural considerations of specific localities, characterizing communities, and understanding community interests.
2.	**Database System** A fundamental weakness of developing countries is the inadequacy of their databases. When a database exists, it is often old and not kept up-to-date. Many models often require a good dataset in order to perform high-level analytical mathematical analysis of data.	Some databases have high levels of detail for local values while many are more general. To have data with higher certainty would be an advantage as it can result in more accurate results. Simple database systems should be developed that can be easily updated. Alternatively, existing databases should be updated.
3.	**Investment Capital** Sophisticated models found in developed countries often assume a potential to introduce technology requiring high levels of investment capital. Such technology needs skilled labor due to maintenance requirements.	Focus on available capacity (in developing country contexts, this often means limited skilled labor and investment capital) and prioritize accordingly.
4.	**User Oriented** Many models are developed based on the interests of researchers. Often, they do not go deeply into what the user actually needs. Governments must make appropriate decisions on waste management, yet at the community level, local communities often are excluded from decision making processes. As a result, a feeling of a sense of belonging and responsibility is not being fostered among communities.	Use the community participatory approach, with a mixture of bottom up and top down approaches and education. To define a specific user is also challenging as they should be the most influential people among the community and could make both a positive and negative impact during the decision making process. For this purpose women (housewives) are the potential actors as they spend most of their time at home. Also, children are a critical target group for the long-term approach (regeneration). Therefore women and children should be actively involved. Note: by fostering good relationships and trust with the community, gaps can be reduced.

The new decision making model in this styudy are developed based on these findings. Further development are described in Chapter 3 Methodology.

Table 2-5 Overview of some models from developed countries

No.	Author	Sample Inputs	Sample Outputs	Targeted User	Model Type
1.	**Chang and Wang (1996)**	Waste collection capacity, price of recyclables, waste generation and composition, transportation costs, construction and operating costs for processing facilities	Graphic display such as population trends, flexible waste management strategies for optimal recycling and incineration	Not specifically mentioned	Cost-based model
2.	**Barlishen and Baetz (1996)**	The current capacity, the operating costs and tipping fees, the fractions of the waste streams (input), the revenues generated from the sale of recovered materials/energy, number of operating days	Impact of different waste generation growth patterns, impact of waste reduction for the community, impacts of reuse and recycling, impacts of fluctuating material and energy	Consultants and waste managers, engineers, recycling coordinators, municipal managers and decision makers	Cost-based model
3.	**Valeo et al. (1998)**	Availability of land, number of depots, number of trucks available for pickups and frequency of pickups, size and number of bins, number of houses and apartment buildings including the people in each unit, zoning/land use maps	Spatial relationship between the location of the user and the location of the depots, recommended location for recycling depots and their assigned demand	Not specifically mentioned	Multicriteria-based model minus social sustainability
4.	**Kikerby et al. (2007) Landfilling Sub-Model**	Material and energy use for construction, material and energy use for landfill operation, soil and clay movement, gas and leachate production	Environmental impact characterization, normalized environmental impact in Person Equivalent (PE). PE expresses all environmental impacts and resource construction in the same unit), weighted environmental impacts	Researchers and experts in waste management	Environmental impact based model
5.	**Thorneloe et al. (2007)**	Cost for permitting, design, operation and long term monitoring, recycling costs, landfill gas generation and net saving of acidification (using TRACI)	Track environmental benefits and cost savings, change Life Cycle Inventory (LCI), environmental trade-offs	Local government, solid waste planners, environmental consultants, etc.	Multicriteria-based model minus social sustainability
6.	**Den Boer et al. (2007)**	E.g. for environmental sustainability assessment: Degradability and contamination, characteristics of water and organic content, e.g. for economic sustainability assessment: costs per ton or per household for waste management system, revenue from recovered materials, e.g. for social sustainability assessment: average convenience of walking distance from generation source to temporary storage	E.g. for environmental sustainability assessment: environmental credit for products from secondary materials from recyclables, compost and energy, e.g. for economic sustainability assessment: economic feasibility, proposal for new facilities, e.g. for social sustainability assessment: aggregate of variable values between 0-1	Municipal officers responsible for waste management planning (esp. those who seek to have more insight on the decision)	Multicriteria-based model

Table 2-6 Overview of models from developing countries

No.	Author	Sample Inputs	Sample Outputs	Targeted User	Model Type
1.	**Jain et al. (2005)**	Dry waste quality, energy recovery potential, power generation potential, output cost	Economic viability of treatment technology options	Not specifically mentioned	Cost-based model
2.	**Ghose et al. (2005)**	Population density, waste generation capacity, road network, types and width of roads, type of storage bins, types of collection vehicles	Optimal routing for collection and disposal of solid waste, optimal routing of transport system per type of vehicles and specific type of bins	Not specifically mentioned	Cost-based model
3.	**Kurian et al. (2005)**	Distance from the nearest waste supply source, depth of filling waste, public acceptance	Hazard Potential Index (1000-0), where a low index indicates a potential site for a future landfill with insignificant environmental impacts	Not specifically mentioned	Multicriteria-based model minus economic sustainability
4.	**Gomes et al. (2006)**	Criteria weight (1-6) on investment, operational cost, disposal treatment cost, CO_2 emissions, corporate image and benefits.	Performance result from scoring of alternatives: reuse, mechanical recycling, thermal recycling, incineration and landfill	Integration of stakeholders (governments, managers, consumers)	Multicriteria-based model
5.	**Wanichpongpan and Gheewala (2006)**	Diesel fuel consumption and emission factors from Light-Duty-Vehicles, waste in place, air emission from MWS in the landfill (using LandGEM software), gas collection and annualized cost calculations	The performance of the two scenarios such as the credit obtained from selling electricity products	Local government, landfill operator, and sanitary engineers	Multicriteria-based model minus social sustainability
6.	**Liamsanguan and Gheewala (2007)**	Energy consumption and emission to air, fossil CO_2 emitted from plastic for incineration scenario, CH_4 emitted for landfill scenarios, emission generation in diesel and lime production	The performance of incineration and landfilling in terms of credits obtained from selling electricity products, and energy consumption	Not specifically mentioned	Environmental-based model

Chapter 3 Theoretical Background

3.1 The City of the Future

In 2011, the percentage of the worlds' total population living in urban areas reached 52%. In more developed regions this value is 78% and in less developed regions 46% (UNDESA, 2012). This means 3.6 billion people are living in the world's urban areas. The agglomeration of the new urban areas is contributing to the growth of the cities. The ways in which cities develop will greatly influence the planet's future and the quality of life of the people.

Lewis Mumford, a philosopher and sociologist who studied city and urban architecture, offers a definition of a city that is inviting and pleasing. He calls a city "a geographic network with economic organizations, institutional processes, and a theater of social actions" and further states that "it is an aesthetic symbol of collective unity" (Mumford 1937, p.183). William E. Rees, an ecologist, presents a dimmer vision, calling a city: "a node of pure consumption existing parasitically on an extensive external resource base" (Rees 1992, p. 128). Both definitions speak to the complexities, dynamics and mobility of a city and the interdependencies between those living there and the place they reside in.

People rely both on natural resources and spaces for their urban infrastructures. Concerning the ability to sustain life on earth, the concepts of carrying capacity (CC) and ecological footprint (EF) are normally used as parameters to measure levels of consumption. They also emphasize the necessity of developing low carbon- and eco-cities as the cities of the future.

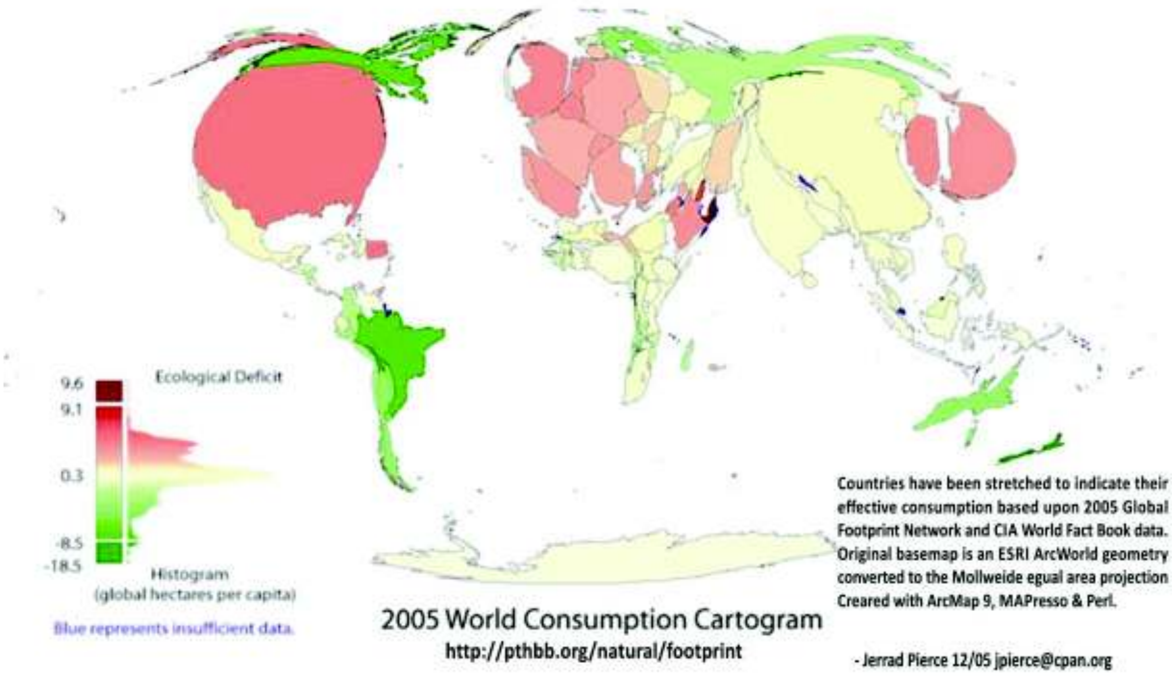


Figure 3-1 Map of the Ecological Footprint per capita, by nation

Carrying Capacity (CC) means the size of a population of a given species that can be supported indefinitely in a given habitat without causing any permanent damage to the ecosystem on which it depends (Rees 1992, p.125). The EF measures how much of the globe's resources a community uses to maintain its lifestyle (Rees 1992, p.121). Figure 3-1 shows the ecological footprint per capita in 2005, by nation, based on the Global Footprint Network and CIA World Fact data in 2005. The reddish color indicates perilous ecological deficits in the respective countries.

3.1.1 The Low Carbon – and Eco- City

The Low Carbon-City and Eco-City concepts are goals for future city development, which consider the relationship between the EF and CC. Whereas the Eco-City focuses more on cities in general, the Low Carbon-City specifically focuses on industrial activities within a city. As one integrated concept, the Low Carbon- and Eco-City addresses the holistic, composite built environment, including the environmental infrastructure - water supply, sewerage, solid waste disposal, and transportation network. The low carbon- and eco-city concept is in line with the "green concept". Some of the key features in this concept are emission reductions, energy and resource efficiency, the planting or preservation of forests (giant redwoods) and fruit trees, the maintenance of creeks, and less ownership of private automobiles (Roseland 1997, p.4).

The concept of "ecocity/ Eco-City/Eco City" was first coined by Richard Register in 1975 (Roseland 1997, p.2). The concept describes an ecologically healthy city, a city which does not yet exist in reality. The concept is a direction rather than a destination (Register 1987, p. 135). Register calls an eco-city an integrated, diverse "mixed-use" neighborhood, with integrated functions, of which are closely linked to each other, from home, jobs, and schools, to recreation and natural and agricultural features. Combined they have the resemblance of a village within the city (Register 1987, p.23).

The phrase "Low Carbon City/low carbon-city" as a concept was first launched in 2008 as a Low Carbon City Initiative (LCCI) program of the World Wild Fund for Nature (WWF) for cities in China. The program allows Small- and Medium-Enterprises (SMEs) or any kind of industry to explore a low carbon development model in order to develop promising technologies in the fields of living, transportation and energy production (WWF China, 2012).

In Asian countries, China, Singapore, Japan, and India are among the most active countries where the concepts of the Low Carbon-City and Eco-City have recently flourished. These countries are also developing models low carbon and eco-cities. In Europe, such cities have already begun to be developed in the years after the Kyoto Protocol (1997).

3.1.2 The Growth of Cities and their Sectoral Division in Residential Areas

Before looking to the future, it is helpful to consider what scholars of cities of the past can tell us. Burges' (1925) sociological study of the growth of the city is concerned with the definition of the processes of expansion, metabolism and mobility (Burges 1925 p.71). The study showed the tendency of urban growth to expand radially from a Central Business District (CBD) to a zone of deterioration, a zone of working peoples' homes, a residential area, a commuter zone, and finally the greater agglomerate, with each area based on land value (Figure 3-3). The study found that the city shows the normal manifestations of urban metabolism, in regards to the distribution of population, the division of labor, and the differentiation into social and cultural groups.

Extending Burges' study, Hoyt (1939) did a specific analysis of the residential area and focused on the housing and rent situation. As the city is inhabited by people with different levels of economic status, there are varying degrees of ability to afford land in residential area. Those who have much capital can afford to live in the area with the most desirable land (high residential grade). This is the most powerful force behind urban growth patterns. Those who do not have sufficient money live immediately surrounding the high-grade areas. Those with the lowest capital typically reside on the least desirable land (Hoyt 1939 p.34).

Figure 3-2 illustrates the growth of the city and the sectoral divisions into residential areas based on the study from Burges (1925) and Hoyt (1939). Their work mapped where most poor and rich people live and show that the poorest inhabit the least desirable land (the lowest rent) in the city. Burges (1971) added that the occurrence of diseases, crime, disorder and insanity are the negative or 'abnormal' expression of a city.

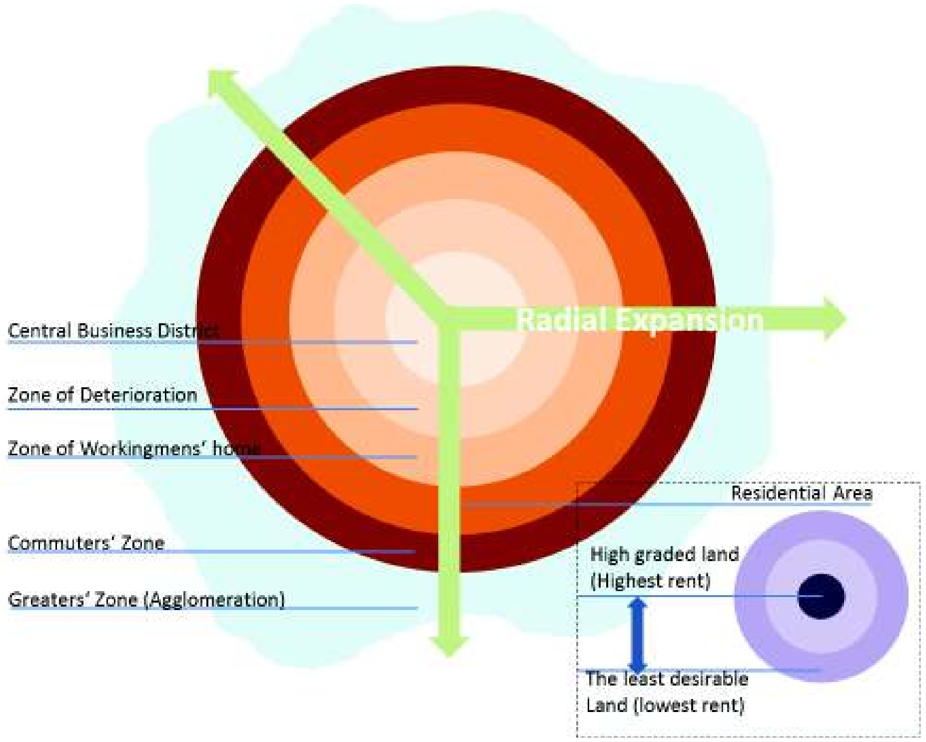


Figure 3-2 Growth of the city and the sectoral division in residential areas

Source: adapted from Burges (1925) and Hoyt (1939)

3.1.3 The Image of Urban Kampung Settlement s

This section looks at the term "urban *kampung* settlement", a term used in this study, based on Harjoko (2009) and Sihombing (2010) in their studies on urban *kampung* settlements in Jakarta, Indonesia.

An urban *kampung* settlement is part of an urban settlement or city of "Kota" but is more specific, referring to a densely urban populated settlement, which is inhabited by the urban poor and rural migrants. Its physical appearance is characterized by a lack of uniformity of the housing units and minimum access to urban infrastructure, such as sanitation and drinking water networks (Harjoko

2009, p.7 and Budiarto 2005 p.5). Both urban settlements and *kampung* settlements are included in the administrative responsibilities of a city.

An urban *kampung* is an unstructured, unorganized and informal settlement in relation to the broader socio-economic system (Sihombing 2004, p.1). While the common physical appearance of urban settlements is of rigid blocks, the division of lands and empty street-edges, the *kampung* follows a 'chaotic' housing pattern, with narrow and small alleys which are always busy with dwellers (Budiarto 2005, p.5). This study defines a *kampung* settlement as an area inhabited by middle- to low-income people who possess the legal right to stay. The *kampung* studied here is different from a squatter settlement or *perkampungan liar*, which are inhabited by the urban poor. A main difference is that in the former, residents having a legal right to be there; it is not the case in a squatter settlement. Therefore squatter settlements are not considered in this study.

Table 3-1 describes the differences between Kota (a city), a *kampung* settlement and a squatter settlement based on Sihombing (2010). Concerning land ownership, normally each house in the *kampung* has no- or only a low-fence, meaning there is no clear barrier between one and another's land. This thus strengthens socio-cultural relationships, such as is found in a system of kinship.

Table 3-1 The Image of city (*kota*), *kampung* settlement and squatter settlement

Urban Settlement:	Image of "City" (*Kota*)	Image of „*Kampung* Settlement„	Image of „ Squatter settlement „ (*Pemukiman Liar*)
Space and place	High-rise settlement (up to the sky) Uniformity/monotony Dense (vertically) Hard space Private	Low-rise settlement (on the ground) Heterogenic/diversity Dense (horizontally) **Soft space** Public	Low-rise settlement (on the ground) Heterogenic/diversity Dense (horizontally) **'Chaotic' space** Public
Legal Aspects	Majority legal (certified) Protected Secure Planned and Regulated Formal and controlled	**Majority legal (certified**) Un-protected Insecure Unplanned and unregulated Informal and uncontrolled	**Majority illegal (uncertified)** Un-protected Insecure Unplanned and unregulated Informal and uncontrolled
Structure	Top-Down Bureaucracy Government	Democratic **Bureaucracy** Community Leader	Democratic **No Bureaucracy** Community Leader
Social-Cultural Aspects	Individualism Top-down management of crisis Inadaptable Multi-cultural	Community Group Self-management of crisis(es) (mutual self-help) Adaptable tribal	Community Group Self-management of crisis(es) (mutual self-help) Adaptable tribal
Multiplicity	Single use of buildings Single job	Multiple use of buildings Multiple jobs	Multiple use of buildings Multiple jobs
Modernization	Modern	Traditional	Traditional

Source: adapted from Sihombing 2010, p.309

Note: the differences between *kampung* settlement and squatter settlements are highlighted.

In metropolitan cities, like in Jakarta, Indonesia, the typical urban poor community inhabits urban *kampung* settlements. According to Burges (1925) and Hoyt (1993), one could argue they are inhabitants of some of the least desirable residential areas where growth is unplanned and uncontrolled (Sihombing, 2004, p.7).

The *kampung* effectively supports dwellers' everyday life and shapes their socio-economic behaviors (Budiarto 2005, p.6). It is common for people who live in a *kampung* to know who their neighbors are and to be aware if their neighbors do not appear for a while, which could mean the person is sick and a visit is thus necessary. Sihombing (2010) added in that in *kampung* settlements, the community leaders play an important role in maintaining social harmony and the relationships among community members. The orientation of the house is also an important factor which is influenced by the surroundings such as the access to the common access to mosques and common-wells.

3.2 Sustainable Waste Management

In the following sections, waste management options will be discussed with regard to the implementation in *kampung* settlements. Some definitions are also added to build common understandings among the inhabitants about recent developments in waste treatment and treatment technologies.

Waste management is a complex system; it consists of several sub-systems, ranging from generation to collection and transport, waste disposal and treatment, and finally utilization. Landfilling and incineration are among the most important waste technologies regarding waste quantities. Both have significant environmental impacts and are alone not enough for dealing adequately with all the waste generated by the city (Bagghi 2004 p.3).

In 1987, the World Commission on Environment and Development (WECD), sponsored by the United Nations, introduced the term "Sustainable Development". WECD (1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs, where the concept refers to the essential needs of the world's poor and established them as a priority. Constraints are imposed by the limitations of environmental ability to meet present and future needs".

The "Sustainable Development" idea has also fostered the area of waste management (Bagghi 2004, p.3). McDougall et al. (2001) define "Sustainable Waste Management" as treating waste in an economically affordable, socially acceptable, and environmentally effective manner. Moreover, it is generally integrated, market oriented, flexible and well-operated on a regional scale (McDougall et al. 2001, p.15). The practice of 3R (Reduce Reuse and Recycle), a well-known concept in the waste management world, fits very well into the concetp of "Sustainable Waste Management".

3.2.1 Waste Hierarchy

Politicians, followed by engineers and waste managers have begun to embrace waste minimization, pollution prevention, and other systematic approaches into sustainability. The zero-waste approach is one of the advanced options to create an ecologically sustainable system (Vallero 2011 p.11). The European Commission Directive 2008/98/EC emphasizes that the basic waste management principle is to manage waste without any resulting threat to human health or causing any harm to the environment, particularly in relation to water, air, soil, plants or animals. It should not be a nuisance that affects the countryside or places of special interest. The directive introduced the "polluters pays principle" and the concept of "extended producer responsibility". These basic principles should apply universally, also in developing countries.

Figure 3-3 Waste hierarchy – regarding EU Directive

Source: European Commission Directive 2008/98/EC, Environment

Figure 3-3 shows the waste hierarchy based on Directive 2008/98/EC. This hierarchy shall apply in all waste prevention and management legislation and policy as called for in article 4 (European Commission 2012).

3.2.2 The 3R, Waste Prevention and Waste Minimization

Waste prevention[1] work is often done together with recycling, and the two approaches influence one another. Salhofer et al. (2011) described the differences between recycling alone compared to recycling integrated with waste prevention: recycling alone consumed more resources and generated more waste for disposal. Creativity, invention and innovation are necessary to design sustainable waste minimization programs (Franchetti 2009, p.209).

The concept of sustainable production and consumption is also linked to waste management as means of waste prevention and waste minimization. The term "Sustainable Production and Consumption (SCP)" was introduced in 1995 by the United Nations Environment Programme (UNEP). The UNEP (2012) defines SCP as "the use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials, as well as the emissions of waste and pollutants over the life-cycle so as not to jeopardize the needs of future generation".

3.2.3 Waste as Resources

In nature, there is no such thing as waste, since it can naturally 'recycle' the elements in the ecosystem (Pariatamby 2011, p.109). Research on waste has also lead to the development of modernization of waste management technologies. Research has created new and innovative ideas that have changed human perceptions of waste. One is the idea of treating waste-as-resource (Pariatamby et al. 2009, p.628). Organic waste is no longer considered a material destined for landfills, but is rather composted. Waste paper is used as a raw material for recycled paper and other

[1] The term "waste prevention" is preferred in European countries like Germany, United Kingdom, Denmark, and Austria while the US prefers "source reduction" to include both waste prevention and minimization (US EPA 2011).

types of waste can serve as substitutes for virgin materials. As a result of this research, the mass of waste for disposals has decreased. Greener designs replace traditional methods of manufacturing, and resource use (Vallero 2011, p.12).

In line with the waste hierarchy of the EU Directive 2008/98/EC, the activities to Reduce, Reuse and Recycle increase. The main objective of the 3R is to minimize the waste which ends up in landfills and to allow the use of the waste materials for special secondary material production (Zhu 2008, p. 125). Waste prevention and minimization needs specialties in human involvement. They are the key elements of forming a sustainable society (Allaway 2012, p.3). Waste prevention is the most efficient way of saving resources and to gain environmental benefits (Salhofer et al. 2011, p.185).

In the case of developed countries, recycling activities are mainly carried out by the private recycling companies while in developing countries they are mainly done by the informal sector. However in both developed and developing countries, advantages are seen for the management of the waste, the economy and the environment. Such examples are for instance the cost savings in collection and transport, job opportunities, and less fuel consumption which leads to less pollution (Zhu et al. 2008, p. 128).

3.2.5 Waste to Energy (WtE)

Due to the increasing demand and dependency of energy on fossil fuels, the use of alternative forms of energy is encouraged. Waste-to-Energy (WtE) or energy from waste is the process of creating energy in the form of electricity or heat. Many countries are currently developing their waste treatment into WtE direction. The most common technology for energy production is coming from waste combustion or waste incineration (Pinto et al. 2009, p.42). Due largely to the air pollution resulting from the plant, the construction of the WtE evoked public criticism and objections (Cheremisinoff 2003, p. 40). Further discussion on waste treatment technologies, including WtE technology will be discussed in section 3.3.

3.2.4 Environmental Impact Assessment

The various waste management options influence the environment in different ways. Life Cycle Assessment (LCA) is a decision support tool that assesses environmental impacts from products or services through their entire life cycle from cradle to grave. The term of products in LCA also refers to waste management (Finnvenden et al. 2007, p.264). It is restricted to environmental impact (Morrisey and Browne 2004, p.300). Some of the advantages in using LCA are that it assists decision makers in developing strategic planning and priority setting.

Error! Reference source not found. shows the description of the impact categories evaluated within LCA. The International Organization for Standardization (ISO) has developed an ISO for LCA, providing a framework, terminology and some methodological choices. In waste management, LCA starts with the definition of the service to be provided, from the raw material, extraction and acquisition, through energy and material production and manufacturing, to product use and end of treatment and final disposal (ISO 14040 2006). LCA is an iterative process and thus brings credible, useful and realistic results. The holistic approach is the strength of LCA to support the decision making process for deciding upon a waste management system (Hauschild and Barlaz 2011).

Table 3-2 Environmental impact categories based on Life Cycle Analysis (LCA)

Impact Category	Unit	Definition	Main substances of interest	Examples from Man-made contribution	Impact	Physical Basis
Global Warming	Mass unit CO_2eq (e.g. ton carbon dioxide equivalent)	Global Warming is a warming of the atmosphere due to the accumulation of greenhouse gases.	Carbon Dioxide (CO_2), Methane (CH_4) , Nitrous Oxide (N_2O)	Combustion of fossil fuels like oil and coal	An increase of the earth�saverage of temperature, sea level rise, changes in regional and global climates	Global
Stratospheric Ozone or Ozone depletion	Mass unit CFC-11eq (e.g. ton hydrochlorofluoro carbons equivalent)	Ozone depletion refers to the destruction process of the stratosphere due to man-made emissions of halocarbons. In the stratosphere, the sunlight breaks down those halocarbons and these in turn destroy ozone, resulting in a thinning of the ozone layer.	Chlorofluorocarbon (CFC), Hydrochlorofluoro carbons (HFC) , Chlorine (Cl) and Bromine (Br)	The use of (old) refrigerators	Skin cancer for humans, damage for vegetation	Global
Photochemical Ozone Formation	Mass unit C_2H_6eq (e.g. ton ethane equivalent)	Photochemical Ozone Formation is a process of photochemical ozone formation due to released Volatile Organic Compounds (VOC�s). Carbon Monoxide (CO) is oxidized in the presence of Nitrogen Oxide (NO_x) in the atmosphere. It leads to extreme concentrations of photochemical ozone at the ground-level troposphere.	Volatile Organic Compounds (VOC�s), Carbon Monoxide (CO), Nitrogen Oxide (NO_x)	VOC: Landfilling, waste collections and transportation system, and NO_x: incineration	Damage to respiratory tracts for human and damage for vegetation	Regional
Nutrient Enrichment or Eutrophication	Mass unit NO_3eq (e.g. ton nitrate equivalent)	Nutrient enrichment is also called eutrophication. Nitrogen (N) and Phosphorous (P) are macronutrients for higher plants and algae. The release of compounds with these two elements has the ability to fertilize natural ecosystems, increasing their primary production but also changing their species composition.	Nitrogen (N), Phosphorous (P), NO_x	P: Municipal wastewater treatment and agriculture and NO_x: Incineration and transportation	Over fertilizes natural ecosystems, such as coastal waters, algae blooms followed by oxygen depletion and fish death	Regional

Impact Category	Unit	Definition	Main substances of interest	Examples from Man-made contribution	Impact	Physical Basis
Acidification	Mass unit SO_2eq (e.g. ton sulfur dioxide equivalent)	Acidification is caused by acids and compounds, which can be converted into acids. It happens when the emissions of NO_x, ammonia and SO_x release Hydrogen Ions when the gases are mineralized.	Nitrogen Oxide (NO_x)	Combustion, transport	Dead lakes and forest decline	Regional
Eco Toxicity	Volume unit media (water/air/soil)	Toxic substances damage individual species and change the structure of the function of the ecosystem ranging from death to reproductive damages to behavioral changes.	Toxic metal and persistent organic pollutants	Waste management (toxic metal and persistent organic pollutant)	Damage to individual species, changes in ecosystem structures or functions ranging from death to reproductive damages to behavioral changes	Regional
Human Toxicity	Volume unit media (water/air/soil)	It is the most important exposure to particles from waste incineration and toxic metal and persistent organic pollutants like dioxin and furans.	Dioxins, Furans	Incineration and transportation of exposure particles	Skin penetration	Regional
Land Use	Area unit	Land use is used to show the area, which is used in the production of a product and quantified as the product of the size from the affected area, the duration of the impact and the quality change caused by it.	Land	Land ownership with specific use for production	The changes in ecosystem that are harming the environment	Regional
Spoiled Ground Water	Volume unit media (m^3 water/person/yr)	Spoil ground water shows the amount of each salt ion leached, which is divided by the accepted concentration limit in groundwater that eventually becomes drinking water. It estimated as the volume of groundwater.	Salt	Ground water contamination by uncollected leachate	Spoiling the ground water as drinking water	Local

Source: adapted from: LCA Food Data Base DK, 2007; Hauschild and Barlaz, 2011; Christensen et al, 2007

3.3 Waste Treatment and Disposal

Table 3-1 shows an overview of waste treatment and disposal options. The worldwide most frequently used method is landfilling. Other technologies include thermal treatment, biological treatment and utilization on site. There has also been a strong increase in the development of waste treatment technologies, which are able to treat a variety of waste streams. One example is Mechanical-Biological Treatment (MBT).

Table 3-1 General processes and potential output of waste disposal and treatment technologies

Disposal and Treatment	Acronym	General Process Description	Output	
			Potential Product	Emission
Open Dump	**OD**	In principle, the landfilling process forms two outputs: leachate and gas. Leachate is formed by the percolation of precipitation, uncontrolled runoff, and irrigation water into the landfill. Landfill gas is formed after an anaerobic decomposition of the biodegradable organic fraction of the solid waste occurs in the landfill. In open dumps, both generated leachate and gas are uncontrolled as no treatment exists but dumping. The landfill process includes the monitoring of the incoming waste streams, the placement and compaction of the waste and an installation of landfill environmental monitoring and control facilities for the deposited solid waste. The landfill is suited with a final cover in sanitary landfills, which is used to cover the entire landfill surface once all operations are complete. Liners are used in controlled landfills and on the bottom surface of the landfill to prevent the migration of landfill leachate and gas (1).	-	Leachate and gases, primarily CH_4 and CO_2
Sanitary Landfill	**SL**		-	Leachate and Gases, primarily CH_4 and CO_2
Controlled Landfill	**CL**		Energy from methane conversion from gas to electricity and heat	Leachate and gases, primarily CH_4 and CO_2
Incineration without Energy Recovery	**InoER**	The process of incineration starts with a moving grate furnace and horizontal steam boiler generating energy in the form of power and heat. In the furnace, the overall result of the incineration process is that the combustible components react with the oxygen of the combustion air, releasing a significant amount of hot combustion gas. Thereafter, the moisture content is evaporated while the incombustible parts form a residue. The lower heating values of the waste shows the energy content from complete combustion when assuming no energy losses. It is therefore important to determine whether the waste can sustain the combustion process without additional fuel (2).	Air Pollution Control (APC) residue , bottom ash or slag, Lower Heating Value	Flue gas (contains ash, heavy metals and organic compounds)
Incineration with Energy Recovery	**IwER**			
Composting	**C**	Composting goes from a mesophilic to a thermophilic and on to a maturation phase. In the first phase, the rapid decay of organic waste occurs and releases energy in the form of heat, which increases the material temperature. In the thermophilic the temperature achieves the highest self-limiting temperature. This is the phase where pathogen agents are reduced as well and hygienization is occurs. The next is the maturization phase, which includes the mineralization of the slowly degradable molecules and humifications. The composting requires an O_2 biological process, which leads to the generation of CO_2, water, minerals and biologically stabilized organic matter (3,4).	Compost	Leachate, exhaust gas (It is primarily related to CH_4, NH_3, N_2O and odors)
Home Composting	**HC**			

Disposal and Treatment	Acronym	General Process Description	Output	
			Potential Product	Emission
Anaerobic Digestion	**AD**	Anaerobic Digestion goest from hydrolysis to acifogenesis, to acetogenesis phase and a methanogenesis phase. In the first phase the carbohydrates, proteins and lipids are hydrolyzed, which means the molecule is decomposed in reaction with water. The products formed in this step are sugars, amino acids and fatty acids and thereafter the amino acids and sugar are converted into volatile fatty acids, alcohols, hydrogen and CO_2 in the fermentation phase. During this phase, highly oxidized products such as acetate are generated and this time provides the most considerable energy yield. In the next phase, the products from the fermentation process are oxidized to acetate in order to produce H_2. Acetate and H_2 are the end products and the concentration of H_2 is very critical. The last phase is methanogenesis, where methane is generated (5).	Digestate, energy rich biogas (it mainly CH_4 and CO_2)	Exhaust gas (odor, various organic compounds: N_2O and CO)
Paper Recycling	**RT**	The recycling of the paper fraction is divided into 8 steps: sorting →baling →pulping → screening → de-inking → pouring → rolling → packing. The first two steps are made before the waste arrives at the paper recycling facility. Once it is there, the waste paper is mixed with water. It breaks the paper into small strands of cellulose fibers or so-called pulp. After filtration and screening to remove contaminants such as glue and plastics, pulp should be de-inked to remove printing colors and thereafter poured onto a huge wire mesh. This is the phase where the pulp and the recycled fiber are bound together to form sheets after dewatering and a drying process, and then it is ready for rolling and packing (6).	New paper product	Wastewater
Glass Recycling		The recycling of glass fractions is divided into 6 steps: sorting → crushing → contaminant removal →melting →molding. Before arriving in the recycling facility the glass is separated during the collection: container glass (green, brown and white), float glass, cookware and automotive glass. Each type has different melting temperatures. Once the types of glass are sorted, they are crushed and this product is called a cullet. Then the cullet undergoes several contaminant removal processes, to remove metals, paper and dust. Thereafter it is melted to form a liquid glass called molten glass and is then ready to be shaped. The use of recycled glass consumes 30% less energy than making glass from virgin materials (6).	New glass product	Removed residues
Metal Recycling (Aluminum)		The recycling of the metal fractions and particularly aluminum is divided into 3 steps: sorting → baling → compressing. The sorting step is carried out to remove any magnetic metal. This step is done before the metal fraction goes to the recycling facility. Metals are shredded into small pieces, de-coated from any coating or decorations and later melted to form liquid aluminum. This liquid is then poured into cooled rectangular, shaped molds which allow liquid to solidify (6).	New aluminum product	Removed residues
Disposal and Treatment	**Acronym**	**General Process Description**	**Output**	
			Potential Product	**Emission**

Plastic Recycling		The recycling of plastic is divided into 6 steps: sorting → shredding →cleaning → melting → extrusion → pelletizing. Plastics are the world's most used raw material. Before plastics reach the recycling facility, they are sorted based on their polymer type, which indicates certain properties and characteristics, such as the melting temperature and suitability for recycling. Once plastics arrived, they are shredded and cleaned to remove any metal and dust. To produce new shapes, some types of plastics like mineral water and food containers are then melted, filtered and formed as strands. These strands are then cut into pellets, cooled in water and ready to be molded as new plastic products (6).	New Plastic product	Removed residues
Recycle Bank	**RB**	The recycle bank is a voluntary and community based activity. The form varies from place to place, based on the interest of the stakeholders. But in general, once the RB has been established, the management process is divided into 5 steps: costumers (the community members) sorting the waste at source → storing to the bank (in this case the bank can be anyone or any organizations) → weighing →the process of utilization by the community, such as crafts → selling →giving money back to the costumer (A).	Design Products from recycle products	-

Source: (1) Tchobanoglous 1993, p.364; (2) Hulgaard and Vehlow 2011, p.374;
(3) Stentiford and de Bertoldi 2011 p.516; (4) Angelidaki and Batstone 2011, p.586;
(5) Boldrin et al. 2011, p.573, (6) Franchetti 2009, p.56-58; (A) Author

Methods described in Table 3-1 represent the general process of waste disposal and treatment options. In the following sections, options which are considered as potential options in this study will be evaluated based on their social, environmental, and economic advantages and disadvantages.

3.3.1 Dumping and Landfilling Options

Landfilling is the process of disposing the residual solid, industrial, and hazardous waste, as well as sludge at various designated waste disposal sites. Even with the implementation of waste reduction, recycling and transformation technologies, the landfill still remains important for integrated waste management for long time. In this study, only the most common types of landfills are included. These are the sanitary and the controlled landfill. The definition of landfills is mainly derived from on the work of Christensen et al. (2011a).

O*pen dumping* (OD) is not considered as a method, but this practice is the most commonly used waste management system in developing countries. Open dumping is simply used as a control in the assessment and a point of comparison of its impact with the impacts of other treatments. An open dump (OD) is a waste disposal site of unsorted waste, which also includes industrial and hazardous waste (Christensen et al. 2011a, p.686). Many researchers are reluctant to call open dumps a landfill. It is easy to recognize an open dump by its mixed waste and end-of-pipe characteristica. Open dumps can have a negative impact on the environment, such as rodents, smells and open fires. These are typically more local scale problems. Normally an open dump starts from when people thrown their own waste on vacant land, which may also be owned by community members. In open dumps, neither the leachate nor landfill gas is collected which also strongly contributes to environmental pollution (Pariatamby et al. 2009, p.631).

Table 3-2 summarizes the evaluation of the social, environmental and economic impacts from open dumps and landfill approaches.

Table 3-2 Evaluation of social, environmental and economic impacts: open dumps and landfill options

Waste Disposal Site	Advantages	Disadvantages	Note
Open Dump (OD)	The cheapest options of waste treatment (Ec.) Creates jobs to collect recyclables (Ec.)	Space consuming and landslide risk (So., En.) The leachate contaminants can reach the ground water (En.) Intolerable local problems such as odors and smells, flies and rats (rodent), blowing litter, local fires (So.) Often include industrial and hazardous waste (En.) Potential for gaseous emissions (En.)	It is the most widespread method of disposing MSW in developing countries. In some developed countries it is already banned, not only because it is land consuming, but also for its negative environmental impacts (European Commission, 1999) Among the 3 types, it is to be the most dangerous type for the community as it normally appears in many places in the settlement.
Sanitary Landfill (SL)	Boundaries are clear (fences) and limits the access to the site (S) Protects human health by reducing direct and indirect contact with waste (En.) Fewer rodents and smells (So, En.) Creates jobs (collecting of recyclables) (Ec.)	Can consume a large amount of native soil (any material which is used as the intermediate or layer or final cover) but is limited in size (En., Ec.) Needs heavy machinery for digging, such as tractors and is often difficult to use during the rainy season (Ec.) Potential for gaseous emission and leachate contamination (En.)	There is not much attention paid to the issue of gas and leachate. Therefore it may cause damage to vegetation in the vicinity, in addition to posing a risk for uncontrollable fires.
Controlled landfill (CL)	Offers controlled landfill gas production, thus generating an economic product (Ec., En.) Not damaging the ground water and surface water (En.)	The liners may not stay impermeable and are expensive (Ec., En.) Leachate collection may clog (En.) Landfill covers are needed to ensure efficient gas utilization (Ec.)	Introduces the liner system and collection and treatment system for leachate and gas. Also called a containment landfill.

Note: So.: Social impact; En.: Environmental Impact; Ec.: Economic Impact

Adapted from Tchobanoglous et al. 1993, Christensen et al. 2011a, Sang-Arun et al. 2011

A *sanitary landfill* (SL) is a waste disposal site with sanitary improvements designed to provide less contact with waste for the local people, and a more organized approach to dealing with rodents (Christensen et al. 2011a, p.686). It has clear boundaries like fences and is often covered by soil. Such landfills are easily recognized intermediate soil layer system, which acts as a waste cover. In the long term, the sanitary landfill may cause environmental problems, like damage to vegetation, and pollute the groundwater and atmosphere.

A *controlled landfill* (CL) collects both gas and leachate and thus is an improvement over the other systems described above. It has treatment facilities for gas and leachate. The CL is a waste disposal system, which gives priority to protect against groundwater contamination, the most common form of pollution from landfills (Christensen et al. 2011a, p.686). Controlled landfills are easily recognized by their liner systems. However, even when the liner system keeps modern standards, it can have leakage problems and the leachate may clog the liner.

Incineration Options

Incineration encompasses the burning of waste (open fires) and thermal treatment and utilization. In thermal waste treatment or utilization technologies, waste is destroyed under controlled condition by burning at high temperatures with an excess of air (Sang-Arun et al. 2011, p.20 and Hulgaard and Vehlow 2011, p.365). Whereas treatment addresses waste removal as the first task, thermal utilization considers energy recovery from the burning process.

Table 3-3 summarizes the evaluation of the social, environmental and economic impacts of incinerations.

Table 3-3 Evaluation of social, environmental and economic impacts: incineration options

Incineration	Advantages	Disadvantages	Note
Incineration – Open Fire (InoER)	Reduction of waste volume and weight, especially bulky waste with high combustible content (Ec.) Destruction and detoxification of certain material for final disposal, e.g. combustible carcinogens, pathologically contaminated materials, toxic organic compounds, or biologically active materials (En.) The ashes can be used for street construction – when they are not contaminated (Ec.)	The emission of heavy metals and dioxin during combustion, poses a risk for public health (En., So.) Burns everything, including valuable materials from recyclables (Ec.) Still need final disposal for the end residue (So., Ec., and En.)	Although dioxin and heavy metal (mercury) which may lead to cancer can be avoided, many environmental activists hold the issue of dioxin emission against incineration.
Incineration – Thermal Treatment (IwithER)	Destruction of the organic compounds, which potentially generate greenhouse gas emissions when landfilled (En.) Recovery of energy from waste with sufficient organic content, especially dry matter content (Ec.) Replacement of fossil fuels for energy generation with the beneficial consequence of greenhouse gas reduction (Ec., En.) The ashes can be used for street and construction – when it is not contaminated (Ec.)	Needs high capital investment, especially for controlling emissions. Has a longer payback investment period (En.) In countries where the organic compounds are mostly wet, the destruction of this material through incineration is inefficient and costly (Ec.). Needs high capital investment, especially for controlling emissions. It has a longer payback investment period (En.) Still needs a final disposal option for end residue (So., Ec., and En.)	It is considered as expensive destruction of valuable materials.

Note: So.: Social impact; En.: Environmental Impact; Ec.: Economic Impact
InoER=Incineration with no Energy Recovery; IwER=Incineration with Energy Recovery

Adapted from Hulgaard and Vehlows 2011 and US-EPA 2012b

Since the beginning of its implementation, incineration has always faced conflicts, especially due to the eventual generation of pollutants (Tangri 2003, p.1). Incineration can generate dangerous secondary waste streams, in addition to emitting dioxin and mercury to the air when not used in conjuction with a circulation facility that controls the emissions. Such facilities, however can have a high investment price.

Modern incineration includes combined facilities for heat and power plants (CHP). Nowadays there are many specifications within various types of incineration. This study, unless it is specifically described, the focus is on incineration with open fires and thermal utilization (with energy recovery). Incineration with energy recovery is still criticized as an expensive method for destruction valuable materials which are contained in the waste.

In various European countries, such as Germany, Austria and Denmark, incineration is mainly under the authority of municipalities which have contributed to a widespread use and the public acceptance. Not every culture accepts incineration, but in general when the odors are gone, the community tends to accept it.

3.3.2 Biological Treatment Options

Organic waste treatment by landfilling and incineration is a critical issue for climate change. Its biodegradable compounds can generate anthropogenic greenhouse gas emissions, such as methane (CH_4), nitrous oxide (N_2O), and ammonia (NH_3) (Amlinger et al. 2008, p.47). Methane emissions are among the most potent greenhouse emissions from the waste sector; since methane has a 21-25 times higher global warming potential than carbon dioxide (CO_2) (UNFCCC 2007a).

Technology options using biodegradation are composting (C) and anaerobic digestion (AD), since the products are desirable. Combined anaerobic digestion and composting (CAD) will not be specifically discussed in this chapter, as it is acombination of technologies.

Composting (C)

In principle, waste with a high content of natural organic matter is compostable (Krogmann et al. 2011, p.534). Composting is a technique to enhance the degradation of solid organic matter under controlled aerobic conditions (Stenford and de Bertoldi 2011, p. 516). Composting reduces the amount of waste going for disposal and also increases the output of agricultural products (Körner et al. 2008, p.64). In this way, composting could increase crops yields thus increase the lands's carrying capacity (CC).

The composting process is influenced by biodegradability, moisture, oxygen (O_2), temperature, nutrients, pH and their supervision (Krogmann and Körner 2000, p.132). During the composting process, the organic matter degradation generates carbon dioxide (CO_2), water and humus products or compost (Sang-Arun et al. 2012, p.17).

In composting, the maturity and hygienic purity of the compost product are important. Mature compost will not cause odor problems when spread and stored (Boldrin et al. 2011, p.577). The maturity of the compost product is indicated by a low C/N ratio (McDougall et al. 2001, p.243). Hygiene is important to make sure the compost can be safely used and included in the consumption chain. Temperatures around around 65 ^{o}C will inactivate microorganisms, thereby reducing biological activity significantly (Tchobanoglous 1993, p.687). The moisture content is also important; very wet waste use is not suggested for composting, unless dry materials are added.

Table 3-4 summarizes the evaluation of the social, environmental and economic impacts of biological treatment options.

Table 3-4 Evaluation of social, environmental and economic Impacts: biological treatment options

Biological Treatment	Advantages	Disadvantages	Note
Composting (C)	Reduces the volume and weight of waste by 30-50% (Ec.) The product (compost) is pathogen free and good for improving the soil structure, for adding nutrients to soil and for improving the water-holding capacity of the soil (En.) Saving money by replacing the use of chemical fertilizers (Ec., En.) Cheaper than incineration (Ec.)	Suitable for organic solid waste. For liquid waste, dry materials should be added (Ec.) Bad smells can occur, vector-borne diseases can spread, methane, nitrous oxide (N_2O) and ammonia (NH_3) can be generated when not managed properly (En.) Requires maintenance and monitoring of compost quality (Ec., So.) Skilled personnel needed (So.)	In the case of composting and digestion with digestate for use, it is important to separate out impurities at the beginning through source separation in order to prevent contamination, mainly from heavy metals.
Anaerobic Digestion (AD)	Suitable for solid and liquid waste such as food waste, vegetable waste, fruit residue and kitchen wastewater -but not suitable for lignocelluloses waste such as twigs and branches (Ec.) Requires less space than composting (Ec.) Generates methane which can be used as heat and energy (Ec.) Generates digestate which can be used for soil amendment (En.)	In certain cases, the investment capital needed is higher than composting (Ec.) Skilled personnel are needed (So) Transportation cost for the product (Ec.) Generate digestate, which causes the problems of excess quantities with the difficulties of transfer: there is currently no market for the product (En., Ec.)	In order to prevent management problems, the use and the transportation of digestate should be cleared from the beginning.

Note: So.: Social impact; En.: Environmental Impact; Ec.: Economic Impact

Adapted from Sang-Arun et al. 2012, Krogmann and Körner 2000, and US-EPA, 2012-b

Anaerobic Digestion (AD)

Anaerobic digestion is a technique to enhance organic matter degradation under anaerobic conditions. It is often also called biogasification (Angelidaki and Batstone 2011, p.583). The main purpose of anaerobic digestion is biogas production and waste stabilization (Jansen, 2011, p. 601). Anaerobic digestion is mainly used for agricultural waste, but recently it is also being used for municipal solid waste.

Anaerobic digestion allows for energy recovery if the digestate are post-treated by composting (Tchobanoglous 1993, p.705). During the AD process, methane (CH_4), an energy-rich gas and Carbon Dioxide (CO_2) are both generated from the biogas. Residue from the anaerobic digestion process remains as digestate. The digestate can be used for composting or applied directly as soil amendment, while the methane can be converted into heat, electricity or natural gas substitution.

In anaerobic digestion, digestates are produced in a huge amount. The high moisture is one of the main problems. When the digestate is not used as a soil amendment, then it must be transferred to somewhere else. Since digestates are odorous, it can cause environmental and social problems when they are not handled appropriately.

3.3.3 On-site Utilization Options

On-site utilization refers to waste treatment, which occurs in communities at a small scale. It is mainly to support government programs for waste management by increasing interest in composting and recycling done directly on site, at the community level. The aim of utilization on site is to achieve significant reduction in the amount of residual waste that goes to the central facilities. The on-site utilization discussed in this chapter includes home composting and recycle banks.

Other options, like small-scale biogas plants and animal feeding are also occurring at the community level and are very appropriate in rural areas. As this study considers *kampung* settlements in urban areas, small scale digestion and animal feeding will not be discussed as options for waste management.

Home composting or backyard composting (HC) means direct use of kitchen and garden waste for composting within the community/neighborhood or individually. In developed countries home composting should not be seen as an alternative waste treatment option for all organic waste, but rather a supplementary solution (Andersen et al. 2011, p.1934). In developing countries home composting is a common practice and some programs have already shown positive results in reducing the load of municipal solid waste getting into landfills.

In home composting, often the waste producer is also the processor and the end user of compost. In many cases no water, electricity or fuel is used during composting, and the major environmental burden is gaseous emissions to air and leachate (Andersen et al. 2011, P.1934). However, as anyone can compost and composting is not controlled the purity of the compost product is critical concern.

Recycle banks (RB) or *Bank Sampah* is now popular in Indonesia. They are looked forward able to solve the waste problem in big cities like Jakarta. The recycle bank scheme encourages the community in the neighborhood to store their recyclables at the 'bank'. This bank can be a Small-Medium Enterprise (SME) or an individual who plays the role the as a bank. The bank collects the recyclables (instead of money) from the community, and after sometime returns the revenue to the community in the form of money.

The bank can either sell these recyclables to companies or give the recyclables back to the society and let the society up-cycle themselves (producing marketable products such as bags, flowers, and merchandise out of those recyclables). Up-cycling must be linked to a marketing scheme so that the recyclable products can be sold. In this way the bank gets money from the companies or from the activity of selling the products. The revenue from recyclables or up-cycling product sales, after some administrative fees are applied, is then given back to the bank costumers, who are community members.

The RB and HC are strategies to gather community awareness to cope with waste management problems and to generate direct economic benefits. Without 3R (Reduce, Reuse and Recycling) integration, it cannot be used alone in order to achieve sustainable development with a healthy environment (Masnellyarti, 2012).

Both RB and HC are community-based initiatives that are viable as waste separation practices, including at the generation source. As home composting and recycle banks concentrate on compostable waste and recyclable waste respectively, and both are community-based waste management actions, in this study they can be considered together as one option.

Table 3-5 summarizes the evaluation of the social, environmental and economic impact from the two on-site utilization options.

Table 3-5 Evaluation of social, environmental and economic Impacts: on-site utilization options

Utilization on Site	Advantages	Disadvantages	Note
Home Composting (HC) and Recycle Bank (RB)	Can be done by anyone (Ec., So.) It reduces the collection and transportation fees (Ec., En.) Directly at the society/community level (source generation) (So.) Creates awareness in society, which increases the control over appropriate waste separation practices (So.) Can potentially create additional income for community members and increase entrepreneurship (Ec.) Has the potential to increase the environmental quality and public health directly (En.) Reduces the potential waste to be landfilled and reduces the emissions from landfilling (En.) Reduces the transport consumption (Ec.) Removes the scattered waste from the neighborhood (En.)	Especially with home composting, can generate greenhouse gas emissions and leachate (En.) Creates suspicious attitudes within society, which can create hostility (So.) Time consuming since it involves several procedures in order to achieve a level of capacity and social capital; requires investigating the local people's capacity (So.) Has to be started with facilitation, such as universities or NGO initiatives (So.) Hygienic issues, lack of scientific knowledge (En.) Needs high engagement and committed community members / depends very much on the motivation of participants (So.) Needs to develop a market for recyclable products (Ec.) Needs designated location for the composting process (So.)	Home composting and recycle banks are the priority for low to middle income communities. As it mainly focuses on waste separation at source, it has the tendency to stimulate interest in composting and recycling sensitivity (direct interaction with waste).

Note: S.: Social impact; En.: Environmental Impact; Ec.: Economic Impact

Source: Andersen et al. 2011 and Masnellyarti, 2012

3.4 Social Capital and Community-Based Management in Urban Areas

Social capital is one of the most important factors in community-based management as it promotes cooperation between individuals. Social capital is the ability of people to work together in groups and organizations and it is related to traditional virtues like honesty, the keeping of commitments, engagement, reliable performance of duties, reciprocity and the commons among community members (Fukuyama 2000, p. 3 and Bhuiyan 2005, p.191). Although the necessity of social capital is recognized in many community-based activities, Fukuyama (2000) emphasized that it is hard to generate social capital through public policy. Social capital is informal and it is rather formed spontaneously (Fukuyama 2000, p. 13).

Bhuiyan (2005) pointed out that often in developing countries, government initiatives alone tend not to be able to solve the problem of solid waste, and therefore increasingly community-based initiatives are expected to fill this gap. In developing countries, the lack of or inadequacy in the services performed by government are normally due to a lack of funds, inappropriate equipment, inefficient management and the lack of skilled personnel (Antschütz 1996, p.71).

Antschütz (1996) did a study on community-based urban solid waste management in 8 cities in 6 developing countries: Brazil, Peru, Kenya, Indonesia, India and Pakistan. The study of Antschütz underlined 5 basic problems faced by community-based waste management programs (Table 3-6). These include: the low participation of households, management problems, and the social problems related to program operation, financial problems and cooperation difficulties with the municipality (Antschüt, 1996, p.13).

Table 3-6 Basic problems on community-based management and the examples of successful solutions

Problems	Some Solutions Proofed to be Successful
Participation Problems	
Low community priority for solid waste management	Education, provision of appropriate incentives
Low willingness to participate in collection and recycling	Pay households for their participation, exchange waste for free bus tickets or food packages, gives proceeds of recyclables to servants, education
Low willingness to keep public spaces clean	Education and make competition
Low willingness to pay	Change way of payment, for example with water bills or as a lump sum payment
Management Problems	
Low willingness to manage	Education
Lack of accountability	Define rights, obligations and responsibilities
Unrepresentative management	Agency intervention during implementation to adjust the composition of committees or work directly with beneficiaries (by by-passing an existing committee)
Social Operation Problems	
Low Salaries of Operators	Provides group benefits and exemption from municipal taxes
Space Problems	Consultation with the local NGO and the leader, start a media campaign with the help of youth.
Financial Problems	
Inadequate fee collection	Give fee collectors more personal benefits; establish sanctions for non-paying community members; fee collection by respected community members
Cooperation Problems with Municipalities	
Lack of assistance from the municipality	Local authority involvement from the beginning, structured facilitation of formal-informal cooperation

Source: Antschütz 1996

Antschütz (1996) presented successful stories of how community participation, such as from Katmandu and Curitiba, were formed based on the integration of education campaigns and incentive awards through competitions. In Katmandu, the program achieved high levels of community participation by starting a competition among households to win a bucket of provisions for having the cleanest environment (Antschütz, 1996 p.27). In Curitiba, through the education campaign "the waste is not waste" program, households could exchange their waste for free bus tickets and food packages (Antschütz, 1996 p.29).

The study of Antschütz (1996) also underlined the problems of inadequate waste services for low-income communities, and inequalities in the provision of waste services and employment. The study also observed that only one-third of the studied projects were aware of women's and youth's roles in the program. While women tend to work voluntarily, youth tend to expect a material reward for their participation in the management effort (Antschütz 1996, p.21). Regarding payment, in India, it was seen that while men prefered to leave and find other jobs, the women saw this as their only source of income and thus they were more responsible and eager to perform well (Zhu et al. 2008, p.92).

In some projects, women held the most important role as initiators, managers, operators, political activists and watchdogs of the community, whereas in some others women were only involved as operators but seldom as managers (Antschütz 1996, p.70). The study showed that in projects where the women are initiators, they usually remain in charge of the operation and management of the service and thus promote sustainability. The study also emphasized that motivational issues and winning the cooperation of municipalities as the main obstacles to successful-community based solid waste management programs (Antschütz 1996, p.71).

The challenge of waste management has become a growing concern for many national governments, local authorities, environmentalists, researchers and communities. Bhuiyan (2005) did a study on the benefits of social capital in Bangladesh and emphasized that social capital alone is not enough to sustain the community. It needs other support mechanisms such as the influence of kinship and stakeholders' relationships (Bhuiyan 2005, p.219). Budiarto (2005) emphasized that the system of kinship grows territoriality and thus affects social capital.

Community-based solid waste management encompasses activities carried out by members of communities to clean up their neighborhood and/or to earn revenues from solid waste. It is already a common practice in developing countries (Antschütz 1996, p.13). Such activities, the so-called collective actions, possess the advantage of local participation, a particular segment of society which can be defined in spatial terms on a relatively small scale and embraces local forms of activities (Bhuiyan, 2005, p.10). Some examples are community initiatives to collect solid waste, trade recyclables, and do home composting.

In the case of Indonesia, Antschütz (1996) found the waste problem obtains a higher level of importance when the initiative came from the community itself. Community initiatives have proven the importance of community involvement for waste management programs, not only for decision making, but also for everyday activities. The main importance of community and stakeholder involvement in waste management programs is the opportunity to voice concerns that can be addressed through the program, thus supporting the sustainability of the initiative (Zhu et al. 2008, p.160).

Chapter 4 Jakarta and Jakarta’s Waste Management

4.1 A Glimpse of Jakarta and Greater Jakarta

Geographic and Demographic Condition

Jakarta, officially known as the Special Territory of Jakarta or *Daerah Khusus Ibu Kota* (DKI) Jakarta, is a province as well as the capital of and the largest city in Indonesia. It lies in a lowland area with an average elevation around 7 meters above the sea level, and is located at 6^{o}12’ South latitude and 106^{o}48’ East longitude (Figure 4-1). Jakarta has 9 rivers and 2 channels. Jakarta is home to a population of 9.6 Million people inhabiting 662 km^2 of land, with a density of 14,596 people/km^2 (BPS Provinsi Jakarta 2012, pp.1-5).The city is one of the world’s most populous cities (City Population, 2012).

Figure 4-1 Map of Indonesia and the location of Jakarta

Source: Wikipedia (2008), Google Earth (2008) and Indonesian Embassy (2008)

Climate

Jakarta has two seasons. From October to May is the rainy season; the rest of the year from June to September is considered the dry season. When the rainy season comes, 9-26 days in the month could be rainy while in the dry season there will be few or no rainy days at all in a given month. In general, climate conditions in Jakarta are tropical, with the humidity between 71-90%, an average maximum temperature of 32 ^{O}C, an average minimum temperature of 25 ^{O}C and a rainfall of total 1706 mm per year (BPS Provinsi Jakarta 2012, pp.18-20 and WMO, 2012).

Economic Development

The large population and the availability of work contribute to the need to increase housing in Jakarta. Land prices are getting more expensive and becoming unaffordable for those who work in the capital city (Widoyoko 2007, p.28). This situation encourages the emergence of housing areas in the outskirts of Jakarta, the so-called Greater Jakarta.

Currently, Greater Jakarta, the urban agglomeration surrounding Jakarta which includes Bekasi, Tangerang, Tangerang Selatan, Bogor, Depok is the largest megacity in South East Asia (City Population 2012). Jakarta and its greater surroundings depend on each other as many commuters' travel within this region during working days. However the main destination within this region is still Jakarta as it is the center of the economy of the country and the engine of the economic growth (Widoyoko 2007, p.28).

During 2007-2011, the country achieved a $ 3,495 GDP per capita level; the level has consistently increased over the last two decades (The World Bank 2012). For Indonesians, Jakarta is considered the most attractive place to earn a living. The expectation of having a better income or wage improvement is one of the main factors of immigration to Jakarta (Budiarto 2005, p.2). The economic growth of Jakarta in 2011 was 6.71%, 0.20% up from the previous year (BPS Provinsi Jakarta 2012, p.2). At the national level, Jakarta and the neighborhood provinces, East Java and Banten, provide the highest wages for employment in the country, followed by areas outside Java and Bali, East Java and Bali, and Central Java (BPS 2012).

4.2 The Administrative Framework of Jakarta

Figure 4-2 shows the Administrative framework of Jakarta:

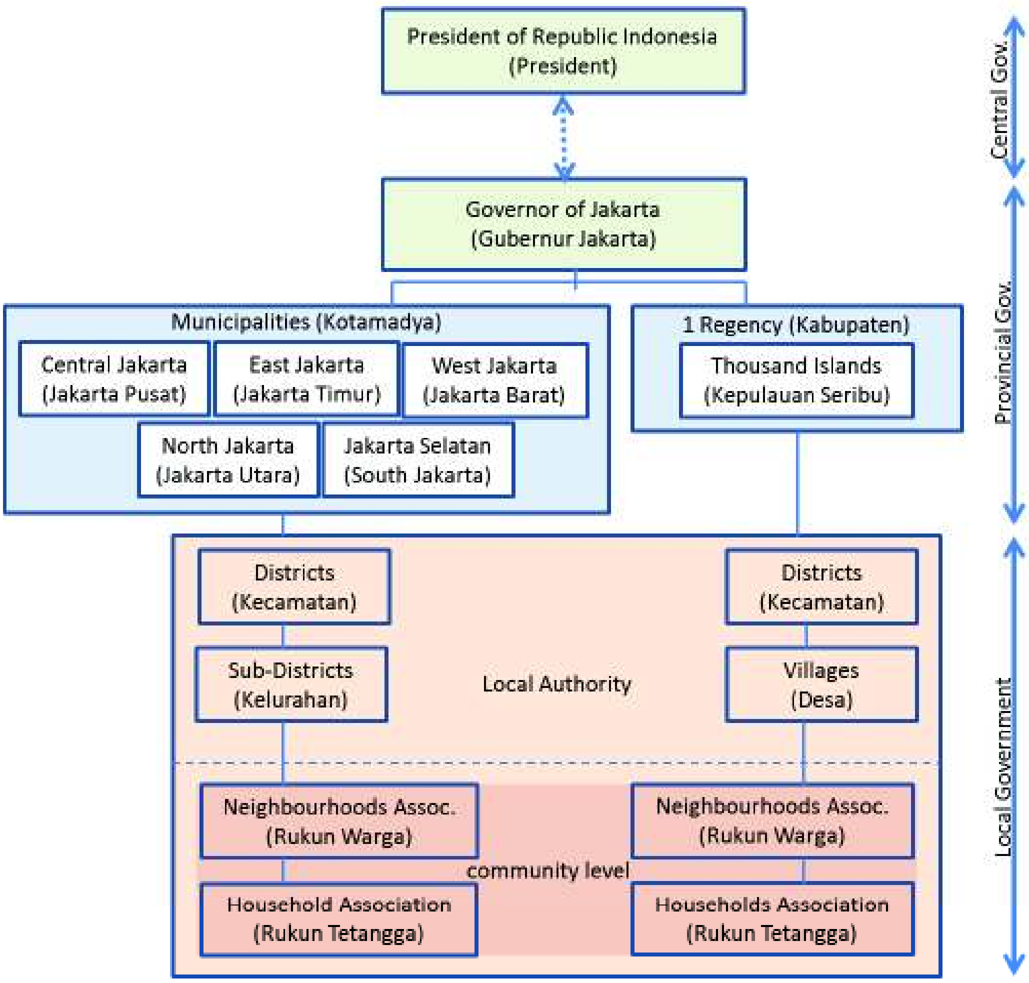


Figure 4-2 Administrative framework of Jakarta

Source: Adapted from Harjoko, 2010, p. 109

As a province, Jakarta is headed by a governor who is responsible directly to the president (UU 32 tahun 2004 tentang Pemerintahan Daerah). Jakarta is divided into five cities or municipalities (*kotamadya*): Central Jakarta (Jakarta *Pusat*), East Jakarta (Jakarta Timur), West Jakarta (Jakarta *Barat*), North Jakarta (Jakarta *Utara*), South Jakarta (Jakarta *Selatan*) and one regency (*kabupaten*), thousand Islands (*Kepulauan Seribu*). The municipalities are headed by a city mayor (*walikota*) while the regency by a regent (*bupati*). Each municipality/regency is also divided into smaller divisions: districts (*kecamatan*) and sub-districts (*kelurahan*)/village (*desa*) (Figure 4-2).

As an administrative framework, at the local level, the smallest organization after the household is the households association or *Rukun Tetangga* (RT) which consists of approximately 300 households or houses. The neighborhoods association or *Rukun Warga* (RW), one level up, consists of 10-15 households associations, followed by sub-districts/villages and thereafter districts. They form the local authority or the local government. At the provincial level there are the municipalities and the governor.

4.3 Housing Settlements in Kampung

In the case of Jakarta, Budiarto (2005) defines a *kampung* to be "originated from hundreds of indigenous settlements which were inhabited by local natives and other non-European people during the colonial era". Jakarta is inhabited by people with different levels of economic capacity. The Hoyt (1939) theory defines only those who are well off and who can afford living in an appropriate settlement or high graded land. Such land has good access to urban infrastructure, for example to drinking water and a sanitation network. Those with medium to low incomes will either stay in between the high and low rent areas or in the lowest rent rate areas. This sub-chapter will continue to discuss only the medium to low income people.

Many schemes have been tried by the local authority to organize *kampung* settlements in Jakarta, such as eradication or resettlement to suburban areas with accompanying action to prevent the former residents from returning back to the original settlement. However such activities have not stopped the growth of *kampung.* Rather, they have slowed down their development (Budiarto 2005, p.2). Harjoko (2004) collected 39 cases of evictions which happened in Jakarta between period of 1996 to 2002 bringing a total of 170,352 households (families) and 8,645 houses affected. A decrease in the areas considered to be *kampung* has occurred in parallel with the development and modernization of Jakarta. This decrease of *kampung* area should not be assumed to mean that the people who are living in *kampung* are also decreasing but it shows the increase in *kampung* coverage of people in square meters (Budiarto 2005, p.1).

The Indonesian Ministry of Housing (*Menteri Negara Perumahan Rakyat*) has grant provisions for the poor people to help them improve the quality of their housing or to build a new house or public community facility. Some conditions of this provision are to at least own a piece of land which either does not yet have a house, or that already has a house but one which is not inhabited (*Peraturan Negara Perumahan Rakyat no. 14 2011*).

Generally there are two types of poor people who are legally registered in Jakarta. Both types inhabit the *kampung* settlements. The first are the poor people who have low wages and do not own land. These people live in other people's houses and pay the rent to the owner. Consequently, they cannot afford to buy land. These people are normally new comers or immigrants to Jakarta and are considered as inhabitants of Jakarta after they have registered to the municipality. In addition to this first group, a second type of poorness, that is the poor people who own a piece of land legally, have low wages and live a low quality of life. However, based on regulations, this second type of poor are not considered as poor and are not eligible for the housing provision.

4.4 Waste Management in Jakarta

The Indonesian government experienced community protests against the decision to implement new waste treatment technologies. The community often went to the streets to protest against the government's plan to build a new waste management facility. They pointed to health issues as the main problem (Harian Umum Pelita 2012 and Warta Kota 2011). Basically, the absence of community assistance and lack of supervision are the main motivations of such protests.

In 2008, a team named "Special Assistance for Project Formulation Jakarta Solid Waste Management" (SAPROF) from the Japan Bank International Cooperation (JBIC) did an assessment of waste management for Jakarta. This team continues to assist the Jakarta provincial government and team to establish the latest waste management master plan (Tambun and Dahono 2012).

The study looked at the waste generation by source and showed that the household sector contributes the biggest share (53%) to Jakarta's' waste generation, followed by offices (27%) and other sources. Dividing the waste by composition, the organic fraction is the highest (55.37%), followed by the non-organic waste fractions which consists of paper (20.57%), plastic (13.25%), wood (0.07%), and textile (0.61%), rubber (0.19%), metal (1.06%), glass (1.91%), rubble (0.81%), hazardous materials (1.52%) and also other fractions which are composted of materials such as stones and sands (4.65) (JBIC Japan 2008). The study found that the average generation of solid waste in Jakarta is 6,525 ton/day (JBIC Japan 2008).

4.4.1 Waste Treatment Technologies

Currently only a small amount of the waste generated in Jakarta is treated inside the Jakarta area whereas the biggest portion is transferred to the Bantar Gebang landfill in Bekasi, in the South-eastern part of Jakarta Province, and the rest remains uncollected.

Table 4-1 Current development of Jakarta waste treatment technologies

Facility	Technology and Location	Status	Task	Capacity
Transfer Station	Transfer Station, Sunter	Operating	Accommodate the waste before being transported to the final treatment plant (landfill)	Current capacity 800-1000 ton/day, built by Jakarta Provincial Government (1)
	Transfer Station, Cakung	Operating	Accommodate the waste before being transported to the final treatment plant (landfill)	Current capacity 400 ton/day and built by Provincial Government (1)
Composting Center	Composting Plant, Cakung	Operating	Composting organic waste from traditional market	Current capacity 300 ton/day and built by Provincial Government (1)
Landfill	Sanitary Landfill, Bantar Gebang	Operating	Landfilled the waste, collect the gas generation and transfer the gas to electricity 10.5 MW(2)	Current capacity 4,500 to 5,500 ton/day (1)

Source: (1). JBIC Japan (2008), (2). Advertorial (2012)

Jakarta has 3 different waste facilities. These are transfer stations in Sunter and Cakung, a composting plant in Cilincing and the Bantar Gebang landfill in Bekasi. Table 4-1 shows the treatment facilities which currently are operating in Jakarta.

4.4.2 Waste Collection System and Informality

Solid waste management relates to both the formal and informal sectors. In Indonesia, the formal sector consists of municipal agencies and other formal businesses. The informal sectors consist of individuals, groups and small-and-medium enterprises (SMEs) which take part in activities but are not registered in the municipality and not formally regulated. This includes for example the scavengers and waste pickers (Aprilia et al. 2012, p.71).

Figure 4-3 shows the general scheme of the waste collection system in Jakarta. In general there are three important points in Jakarta's waste collection system (1) the source of waste generation points, (2) temporary collection storage points and (3) the landfill or treatment facility location point such as composting plant. This system is divided into two collection sub-systems, (I) the first sub-system, from the source of waste generation points to the temporary collection point, and (II) the second sub-system, from the temporary collection storage points to the landfill location point.

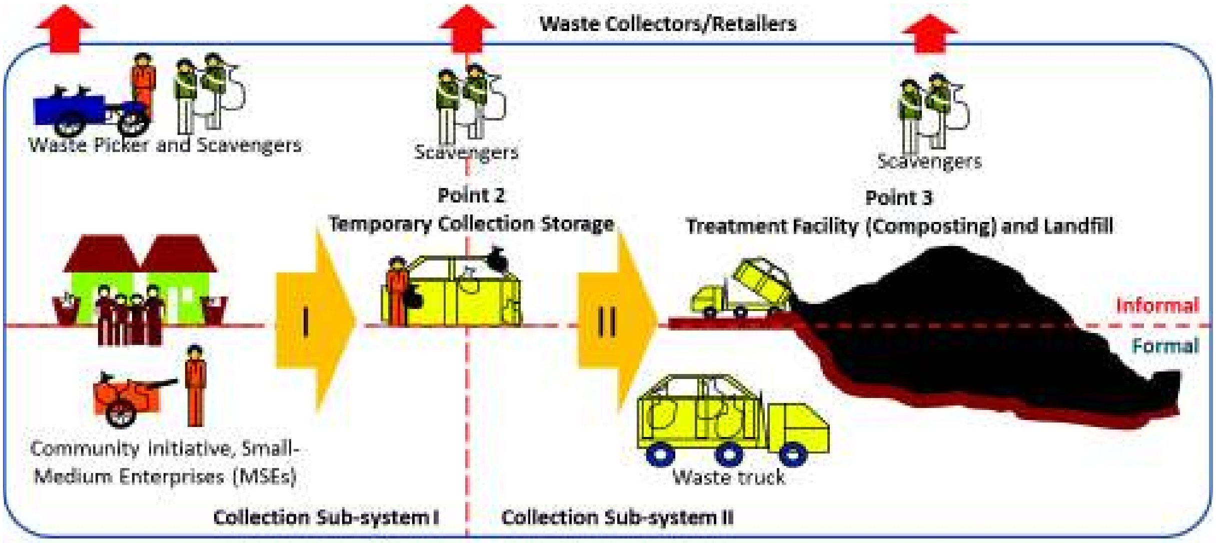


Figure 4-3 General scheme of the waste collection system in Jakarta

The Indonesian Waste Management Law No. 18 Year 2008 gave the authority and initiative to organize waste from the source of generation in the first sub-system. The law set the governments' intervention to start at the second sub-system. Therefore the first sub-system has more variety, with different mechanisms and vehicles whereas the second sub-system is more universal. The waste is transferred to the treatment facility or landfill location by waste trucks. Nevertheless the first and the second sub-systems are integrated and depend on one another.

In 2007, the Jakarta provincial government decided to provide rickshaw motorcycles or *becak sampah motors* to support the first sub-system, thus increasing the collection system coverage (PosKota 2011). This type of vehicle fits the *kampung* settlement characteristics with their small alleys (Figure 4-4). It has proved to be an effective vehicle for the first sub-system in a city like Jakarta.

Figure 4-4 Sample of a rickshaw motorcycle

Source: pasangiklangratis33.wordpress.com (2012)

In both sub-systems, informality is an important issue. Informality can be seen from two sides; positively and negatively. Positively, some portions of waste generated in Jakarta are recovered through informal schemes either by scavengers (*pemulung*) or waste pickers (tukang loak). Meaning, the government would not have to pay these workers to collect the waste from the source of generation points.

A scavenger is a person who searches for recyclables from anywhere such as streets, vacant lands, waste bins and landfill and then sells the recyclables to waste collectors (*pengepul*). A waste picker is a person who comes to houses to buy recyclables such as old newspapers, any metal containing items like a broken air conditioner/bicycle/refrigerator/fan, glass and plastic bottle and who then also sells them to waste collectors. The waste collector or the 'big boss', who mostly be the common collector for many waste pickers, is a retailer who will then sell the recyclables to companies.

Both scavengers and waste pickers are independent workers. They save the government a lot of money by cleaning up and recycling the waste (Sartika 1993). Negatively, the scavengers endanger their lives and live in critical hygienic conditions. They often work with insufficient equipment and make the work more dangerous.

Sembiring and Nitivattananon (2010) emphasized the important role of the informal sector in diverting recyclable materials from waste as many as 3000 people could be involved within one municipal system. Together they manage to reduce 13% of the waste generated in a city with around a population of two million. Yet, the decision makers often have negative prejudices regarding the informal sector and they tend to reject the integration of the informal sector into the formal sector (Sembiring and Nitivattananon 2010, p.809).

4.4.3 Some of the Unsolved Waste Management Problems

One of the main problems in municipal solid waste management in Jakarta comes from household waste, and particularly in urban *kampung* settlements. These settlements are more likely to be disconnected from municipal solid waste management systems. Or if a municipal solid waste management system exists, the service is often insufficient (Figure 4-5).

Figure 4-5 The disconnected municipal solid waste services in the *kampung* settlements, Jakarta

Bellow, some of unsolved problems related to waste management in Jakarta are described:

- **Illegal dumping and the river of waste** Often the waste generated from the *kampung* settlement area is poorly self-managed and there is illegal dumping inside and outside the *kampung* as well. It is common to hear that the river in Jakarta is the lengthiest disposal site in the world. During the rainy season, often the waste in the river blocks the water flow and makes the water overflows on to the land.

- **Single and far away landfill** Jakarta has no landfill on its own land and this is one of the biggest problems of waste management in Jakarta. Bringing the waste to distant landfills outside of the city means not only a high transportation cost for the Jakarta Provincial government but also a tipping fee of IDR 103,000 which is equal to 8 Euro or 10 US$ per ton of waste to the owner of the land (Decilya 2012b).

- **Annual flood** Jakarta is well-known for its annual floods; waste is one of the most important causal factors (see the river of waste above). Although the government has finished with the *Banjir Kanal Timur* (BKT), the East Flood Channel project which is a mega project to prevent annual flooding in Jakarta, the floods will still be a threat if the community does not change their habit of throwing waste into the river, said the manager of BKT projects who works for the Ministry of Public Work, Indonesia (Widyoko 2007, p.33).

- **Unimplemented and inconsistent regulation** Key factors on waste management strategies such as waste reduction, community active involvement and the service coverage have been dispatched as a legal framework. The Jakarta Provincial Government enacted the Regional Regulation in 1998 (Perda no. 5 Tahun 1998), about environmental cleanliness in the Jakarta Province. The regulation states restrictions on littering waste and on disposing of waste except in waste storage containers. For example, based on the regulation the government will jail the person who disobeys the regulation, 2 months and 6 months respectively or fine IDR 5 Million (500 Euro) and 2 Million (200 Euro) respectively. Nevertheless none of Jakarta inhabitants has ever been jailed or fined based on this law.

4.4.4 Jakarta's Waste Management Master Plan and Perspectives of Waste Treatment

A road map for waste management in Jakarta is still under development: The Jakarta Waste Management Master Plan 2012-2032. The road map starts with waste reduction and ends with high and environmentally friendly technology (Berita Jakarta 2012). The main concept is to leave the approach of treating "waste as having no valuable materials the remaining should be collected, transferred and thrown away" and move to the approach of "waste as a resource material to be collected, transferred and utilized'.

As for a long-term approach, Jakarta's waste management policy is to minimize its dependency on landfills. Jakarta is focusing on waste utilization by developing an intermediate treatment facility (ITF) and 3R centers (Berita Jakarta, 2011). By reducing waste generation by 15% and utilization at source by each neighborhood association, the highest efficiency would be achieved, according to the Jakarta Governor 2008-2012, Mr. Fauzi Bowo (Berita Jakarta 2012). Table 4-2 shows the future development expectations of Jakarta's waste treatment.

Table 4-2 Future development of Jakarta's waste treatment technology

Facility	Future Development Technology and Location	Status	Task	Capacity (Future)
Intermediate Treatment Facility (ITF)	ITF - Incineration, Sunter	In-progress	Reduce the waste volume into 10% residue and energy recovery 14MW per 1000 ton waste[2]	Future capacity 1200 ton/day, built by Private investor [1, 3]
	Mechanical Biological Treatment (MBT), Cakung-Cilincing [3]	Planned	Recycle and process the organic waste to produce compost	Future capacity 1300 ton/day, built by private investor[2,5]
	Marunda	Planned	Specifically for the treatment of waste from rivers and the sea	Built by public private partnership [3]
Composting Center	Cakung	Planned	Composting organic waste	See ITF / MBT Cakung-Cilincing
Integrated Final Treatment Plant	Sanitary Landfill - Bantar Gebang [3]	Operating and In-progress	Landfilling the waste, covering with soil and trapping the leachate and methane so it can be treated. Includes a small composting unit (300 MW). Electricity generation is targeted at 26 MW in 2023 [5].	30% of Jakarta waste generation
	Ciangir	Cancelled from preceding as the land use function is changed by Bekasi Government in 2011 [6]		

ITF Intermediate Treatment Facility, IFTP Integrated Final Treatment Plant

Souce: (1). Decilya (2012a), (2).Decilya (2012b), (3). Berita Jakarta (2012),(4). Berita Jakarta (2011), (5). Advertorial (2012), (6). Joniansyah (2011)

4.5 The Policy and Legal Framework to Waste Management

Policies and legislation on waste management, in the provincial, national and international contexts, are elements that cannot be separated from waste management practice. Initially waste management policies were focused on the waste collection system and disposal, but gradually elements of source reduction, waste minimization, and sustainable patterns of production and consumption have been incorporated.

Some key policies and legislation related to household waste management in Jakarta will be examined in this section to describe the current situation and future possibilities for waste management. Specifically on the Waste Management Law No. 18 Year 2008 about Waste Management *(UU no.18 tahun 2008 tentang Pengelolaan Sampah),* the Ministry of Internal Affair's Guidance of Waste Management, Regulation 33 (2010) *(Pemendagri 33 tahun 2010,* and the Ministry of Public Work's regulation, Policy and National Strategy on the Development of Waste Management System No.21/PRT/M/2006 *(Permen PU No.21/PRT/M/2006)* will be considered. As Jakarta is currently awaiting the publication of the waste management master plan, this will be only discussed briefly. For additional information, Table 4-3 describes what these policies and regulations are about.

Waste Management Law no. 18 (2008) defines the waste as a national problem. In this law, the community's contribution as part of the waste management process is mentioned twice, once in terms of its rights and once as a specific expectation in chapter IX. The Ministry of Internal Affairs 33 (2010) underlined the main task of the authority to plan and target future achievements related to waste management in its respective areas, including initiating partnerships between the community and small medium enterprises (SMEs) in waste management. This regulation manages the waste activity at the local level. It describes the role of community involvement in detail, including the role of BLUD, a working unit at the local level which is set up to assist the community in activities concerning waste management. The waste service fee is to be determined by the local authorities.

The Ministry of Public Works launched Ministry of Public Work's Regulation No.21/PRT/M/2006. It promotes the involvement of women; community-based waste management, and regional waste management. This is now the the legal basis for the proliferation of community-based waste management in Indonesia.

Table 4-3 National and provincial waste management law and regulation

National	
Policy/Legislation	About
Waste Management Law No. 18 Year 2008 about Waste Management, or *Undang-Undang No.18 tahun 2008 tentang Pengelolaan Sampah*	• Requires comprehensive waste management from the upstream to downstream where **the needs of government authorities, community contributions and corporate support are combined** to achieve effective and efficient waste management (Background p.1) • Defines some of **the terms related to waste management** such as the waste as an end result from daily life in solid forms, the origin of the waste as the source, any individuals who generate the waste as the generators, the process involved on a waste management scheme, including the collection system and treatments, the governor, city major and regent the authority (Chapter I General Provisions p.1). • Clarifies **the rights and obligations of each community member**, for example, to receive the municipality services for ecological waste management, to contribute to the decision making process, implementation and monitoring of waste management, to gain information related to waste management and also compensation for the negative impacts of waste management treatments, to treat the waste in a 3R (reduce, reuse and recycled) and ecological manner (Chapter IV Rights and Obligations, p.5). • Regulates waste management implementation in **terms of reductions and treatments**, including the waste amount limitation and its target, recycling and reuse of waste, and the government's and local authorities roles and responsibilities in facilitating environmentally friendly technology, recycling activities and supporting the marketing of the products derived from waste (Chapter VI Waste Management Implementation, P.6).

National	
Policy/Legislation	About
The Regulation of Ministry of Internal Affair no. 33 year 2010 about The Guidance of Waste Management , or *Permendagri 33 tahun 2010 tentang Pedoman Pengelolaan Sampah*	• Defines solid waste as the end result of daily life activities and/or natural process. This includes **waste from households, waste coming from housing settlements, commercial areas, industry, public and social facilities which mainly contain organics but no human excreta,** elements in waste management processes such as waste collection points and waste treatment and a working unit -a nonprofit- service (BLUD) which is set up at the local level to assist the community on waste management, such as providing some materials and goods (Chapter I General Provision, p.2). • Describes **the task of local authorities to plan the waste reduction and treatment strategies** including providing the facility, supervision, and monitoring towards environmentally friendly methods, and the community and corporate' role which funding will be fulfilled from both, the government and the community. The activities include separation (*pemilahan*), collection (*pengumpulan*), transfer (*pengangkutan*), management (*pengolahan*) and treatment (pemrosesan akhir sampah) (Chapter 2 *Pengelolaan Sampah*, p.3). • Underlines **roles at the community level, including providing waste storage containers and vehicle for the collections of waste and the importance of BLUD in supervising waste management activities at the local level**, such as providing temporary collection points and integrated waste management facility locations and the collection fees for waste collection, facility allocation and treatments (Chapter 2 *Pengelolaan Sampah*, p.6).
Ministry of Public Work's Regulation No.21/PRT/M/2006, Policy and National Strategy on the Development of Waste Management System , or *Permen PU No.21/PRT/M/2006 tentang Kebijakan dan Strategi Nasional Pengembangan Sistem Pengelolaan Sampah*	• Requires recapitalization of sustainable housing as an integrated, efficient and effective plan to **achieve clean and healthy housing settlements**, and thus increase productivity (Background, p.2) • Underlines the commitment towards sustainable waste management, to **increase service coverage and the service quality, to involve the community and corporate world** (Chapter II appendix, Visi Misi Pengelolaan Sampah, p.3). • Targets the first 3 waste management system development policies at the community level (appendices p.11): 1) **Waste reduction at source** as much as possible, which no longer depends on end-of-pipe systems such as land filling, by increasing community understanding about 3R, securing hazardous waste from household waste, for example through promoting the step-wise value of waste reduction from the source and impact for the environment, by developing incentive and disincentive systems in 3R implementation, by stimulating cooperation with the industrial and trading sectors. 2) Increasing **community active participation and corporate partnership**, by introducing an understanding of the importance of waste reduction from school age, by regularly spreading knowledge of waste management to the public with guidance and mass media, by directly training women in waste management and stimulating community-based waste management with an incentive system. 3) Increasing **waste service coverage and the management system**, by the optimization of waste infrastructures, by planning coverage, increasing the capacity of the waste infrastructure, rehabilitating contaminated landfills and converting them into sanitary landfills, increasing regional waste management and strengthening research.
Provincial	
Waste Management Master Plan for DKI Jakarta, or Master Plan Pengelolaan Sampah di DKI Jakarta 2012-2032	• This master plan is created as a guide to achieve environmentally friendly waste management, energy efficiency and directly achieve the targeted user. • This master plan underlines modern, **high-tech, environmentally friendly waste management, uses concept of waste as-a-resource** (Berita Satu, 2012). • This document is the main basis for waste management actions in Jakarta in the future. As it is not yet widely published, it will not be discussed further in this study.

Chapter 5 The Development of the Model

5.1 The Decision Making Boundary

The term "waste" in this study refers to solid waste collected from households, as well as from small enterprises and community facilities located in densely populated urban settlements, the so-called *kampung* settlements. Antschütz (1996) did a study of community based waste management in eight cities in developing countries including Indonesia. This study proposed that housewives are key players to successful waste management and that children are the messengers of lessons for the next generation (referring to section 3.4).

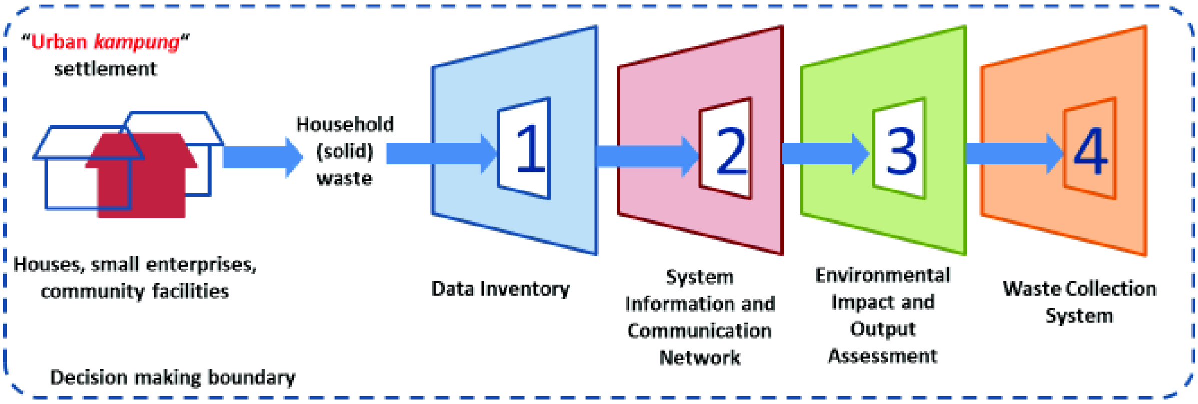


Figure 5-1 Decision making boundary

Figure 5-1 shows the decision-making boundary of a newly developed model of stepwise-interaction, where each goal is composed of one module and the result of a previous module contributes to the work of the next module. It consists of four modules and each corresponds to a specific goal.

The first module is the inventory module, containing the basic information on geographic conditions (the physical map), waste characteristics, and the list of existing collective actions and social organizations with the participants. **The second module** is the module for establishing the system information and communication network. This module also assists the decision making process by selecting the local leader from the active community members. **The third module** assists with the decision making process based on an assessment of the environmental impact, potential outputs and economic costs and benefits. **The last module** assists the process of deciding on a collection system. Further work on these modules is described in section 5.4

5.2 Field Research in *Kampung* Settlements

This research focuses its attention on low-to-middle-income communities in a densely populated urban area or *kampung* settlement. The field research was conducted in order to appreciate better the actual situation in *kampung* settlements and use this information to develop a new waste management model appropriate for such areas.

5.2.1 Indicator Formation

Indicators were used to determine which field sites to consider and become model input (see Figure 2-1). A preliminary assessment of candidate field research sites was made to consider whether or not the area needs assistance to improve its existing waste management system. The chosen indicators are described in Table 5-1.

Table 5-1 Indicators of field research

No.	Indicator	Types of Preliminary Assessment Results
1	**Waste Management Services**	*Sufficient/Insufficient* Municipal Waste Management System services
2	**Source Separation**	*Experienced/Inexperienced* in applying source separation
3	**3R Implementation**	*Experience/Inexperienced* in applying the 3R concept in everyday life.
4	**Woman Community Based Organizations**	*Availability/Unavailability* of self-help initiative programs, such as a Woman Community (housewives) Based Organization, indicating social capital.
5	**Community Involvement**	*Willingness/Unwillingness* to participate in collective action/community based organizations.
6	**Status of Ownership**	The sense of belonging to the neighborhood correlated to the length of inhabitation: *Owned/Rented* houses
7	**Women as Drivers / Role Model**	*Presence/Absence* of active community members

5.2.2 Team Building

A small team was organized in order to assist with the field research. The team consisted of the author and the initiator of this research, a scientific employee from the host institution with similar interests and backgrounds and students to assist in conduction surveys and as facilitators. The number of the students necessary was determined according to the scope of tasks and responsibilities.

Steps in team building:

Step 1 Selecting Host Institution: Department of Architecture, University of Indonesia (December 2011)
Requirement for the Host Institution:
Provides student assistants, preferably 3rd or 4th year bachelor students, with training in the research methods used
Enables the scientific employees to do action-based research

Step 2 Selecting one scientific employee as the person in charge at the host institution: Mr. Ahmad Gamal, MUP., M.Si., S.Ars. (December 2011)

Step 3 Publicizing the study, among students and departments to find suitable team members at the host institution (January-March 2011)

Step 4 Open Recruitment for the Surveyors and Facilitators (April 2011)

Step 5 Workshop for Surveyors and Facilitators (May 2011)

This study was done with the cooperation of Hamburg University of Technology, Germany (hereafter called home institution) and University of Indonesia (hereafter called host institution). The host institution offered courses in field research methods and has a ‘Community Service Program’, which provides funding for action research for its employees.

Table 5-2 shows the team needed to start the field research and develop a model. The field work was scheduled to start by the semester break which was between June-September 2011. The students were expected to read the Terms of Reference (TOR) before they applied for the position. The TOR explained their responsibilities and the requirements of participation (see Appendix B3).

Table 5-2 The composition of team members

No.	Team Component	Role	Responsibility	Specific Requirement
1	**Researcher**	Author, Initiator and Field Manager I (Ova)	Structure the research activities and conduct the training for the Surveyors and the Facilitators of IMPACT and GEO Team	Have good contact with both the host university and the community
2	**Scientific Employee**	Field Manager II (Gamal)	Review the research activities and conduct the training for the Surveyors and the Facilitators of SOCECO Team	Familiar with community based development programs
3	**Student 1**	Surveyor and Facilitator Group I (Fera, Medina, Silvya, Ando, Tria)	SOCECO Team: Conduct research activities and collect and evaluate data related to practice of everyday life activities, demography	Familiar with the social community survey method
4	**Student 2**			
5	**Student 3**			
6	**Student 4**			
7	**Student 5**	Surveyor and Facilitator Group II (Yuni and Asri)	IMPACT Team: Conduct research activities and produce about household waste generation, environmental and economic impact	Familiar with the social community survey method, high mobility
8	**Student 6**			
9	**Student 7**	Surveyor Group III (Gita, Osmar, Risha, and Karin)	GEO Team: As surveyors: produce data related to geographic and physical conditions	Familiar with the GIS program, Google Map and able to use GPS

Note: Term "SOCECO" represents the work group I which focuses on social and economic aspects, "IMPACT" represents the work group II which focuses on the impact of waste management, and "GEO" represent the work III which focuses on geographic condition. These 3 terms help the team to remember the scopes of their work.

5.2.3 Starting up the Field Research

The researcher wrote a letter asking for permission to the leader of the community organization before any research actions were taken (see Appendix B1, B2, and B4). The field research started officially only after the team receives a positive response from the leader of the research area. The letter is a legal basis to conduct such activities in certain territories. Following the positive response from the local authority, a public hearing was held before sending the research team to the field work (Figure 5-2).

(a) Among the leaders of Household Association (RW) in Cipedak

(b) Amoung the housewifes of the Household Association (RT) in Cipedak

Figure 5-2 Public hearing about the field research

In general all interviews and surveys follow a set procedure:

(1) Self-Introduction: The interviewer should introduce his/her self to the community members and show his/her student ID and copy of the TOR. This is to avoid any misunderstanding among the community members and at the same time also to build trust during the interviews.
(2) Asking Permission: The interview will be recorded during the survey but only if the interviewee or surveyed person agrees to it, otherwise minutes should be written stepwise.
(3) Clarity: The survey can be started only after the student explains the purpose of the interview and no objections are raised. Otherwise the sample is counted as a failed sample.

Steps in approaching the field research:

Step 1 Selecting the field research site based on the indicator on Table 5-1 (April 2011)
Step 2 Sending (1) a formal letter from the university and (2) the TOR to the neighborhood community level leader, and a carbon copy to household community level leaders (May 2011)
Step 3 Training the surveyors and facilitators while waiting for the responses (May 2011)
Step 4 Public Hearings and Discussions at the Neighborhood Associations, selection of the Household Association (May 2011), Figure 5-2a
Step 5 Public Hearing and Discussion at the Household Association, with housewives (June 2011), Figure 5-2b

5.3 The Case Studies

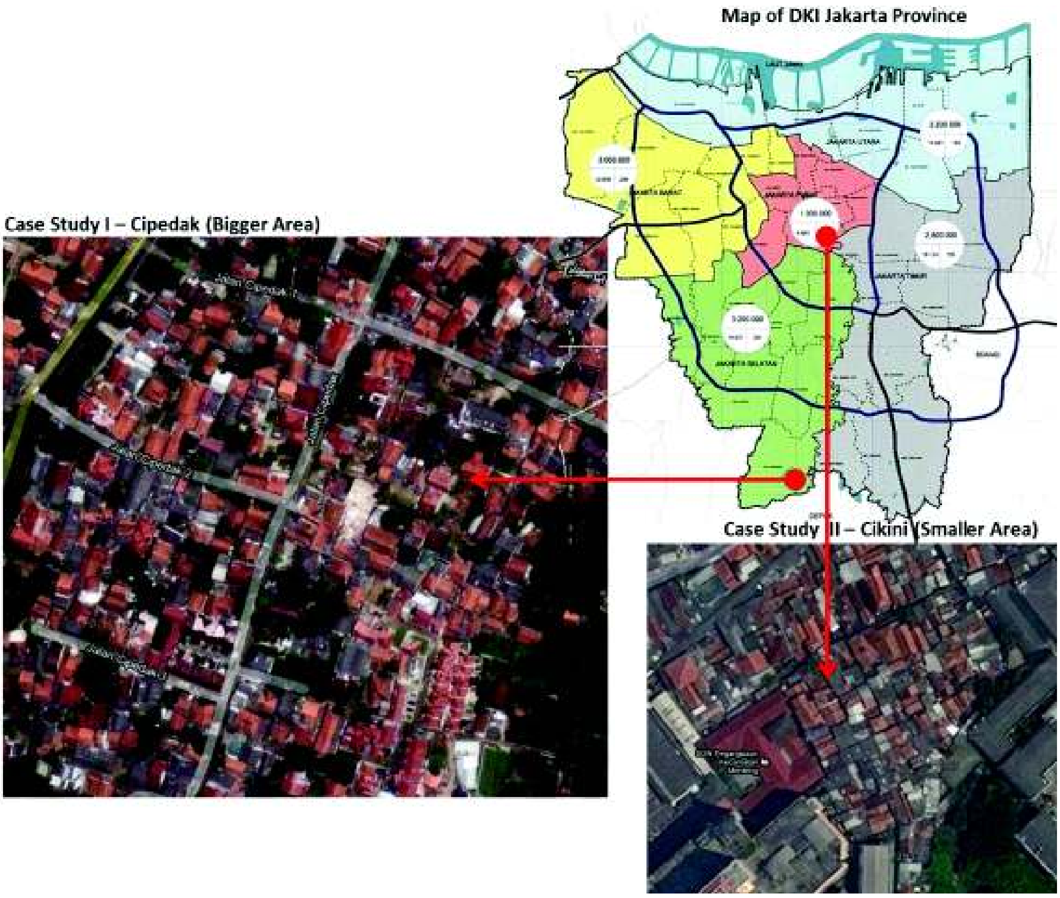


Figure 5-3 Map of DKI Jakarta Province, Case Study I and II (unscaled)

Source: Pemprov DKI (2010) and Google Maps (2013)

Two case studies, one area in South Jakarta and another one in Central Jakarta, were selected in Jakarta Municipality. Both are *kampung* settlements. Figure 5-3 shows where the two case studies are located on the map of DKI Jakarta Province.

5.3.1 The Case Studies Profile

Table 5-3 describes the profile of each case study area. The case study was conducted in two selected Kampung Settlements in Jakarta. Case study I, Cipedak, is located in the South Jakarta and the case study II, Cikini, is located in Central Jakarta (Figure 5-3).

Table 5-3 The Case studies profile

Profile	Case Study I - Cipedak	Case Study II - Cikini
City Authority, District and Sub-District	South Jakarta, Jagakarsa, Srengseng Sawah	Central Jakarta, Menteng, Pegangsaan
Code of Neigborhoods Association (RW)/Households Association (RT)	009/04	001/13
Area (m^2)	53,500	2,800
Density (person/km^2)	22,037	153,571
Number of houses (unit)	295	86

5.3.2 Characteristics of the Case Studies

Physical Conditions

The *kampung* settlement Cipedak, the bigger area, (referred to hereafter as Case Study I) is located in the peripheral city area. It is located around 2.5 km from the University of Indonesia, which was the host university for this field research. This settlement represents a typical urban *kampung* settlement in peripheral Jakarta. In this settlement, most of the houses are one story and single land houses, many houses own a small garden, many streets have different widths some are accessible one-car, others two-cars, and others no-cars (Figure 5-4)a-c.

(a) One-car access (b) Two-car access (c) No-car access

Figure 5-4 The physical forms of kampung settlement, Case Study I

The *kampung* settlement Cikini, the smaller area (referred to hereafter as Case Study II) is located in the city center. This area has unique characteristics, since it is a settlement located in the middle of a region that is growing economically. Open spaces and trees are hard to find here and most of the houses are multi-story and single-land houses with minimal open space (Figure 5-5). The settlement is surrounded by developed business and service areas. The people who inhabit this area are legally stay on their own land, but they must compete with high rise and urban infrastructure developments. As the area is considered a "KUMIS KUPAT" (*kumuh miskin and kumuh padat* or rundown-poor and rundown-crowded) area, it is difficult to describe the area by only pointing to the respective case study area alone. It is therefore important to include the vicinity as well.

(a) Face-to-face houses, ground floor (b) Face-to-face houses, upper floor (c) Direct access to river

Figure 5-5 The physical forms of *kampung* settlement, Case Study II

Picture of everyday life

Figure 5-6 shows some of the routines during the working day in case study I. During the day, many mobile street vendors come to sell things. In this area, 53 of 295 houses were taken as a sample to give information on their everyday life by being interviewed. From this sampling, it was found that 70% of the women are housewives. The status of house ownership is 73% self-owned and 27% rented.

(a) Mobile street vendor: cloths (b) Children play bicycle on the one-car access (c) Mobile street vendor: vegetables

Figure 5-6 Everyday routines, Case Study I

In case study I, the morning is the busiest time of the day. In the morning some people meet to buy prepared-foods in a store while others wait at home for the mobile street vendors to pass their houses. Many stores open early in the morning and provide various cooked-foods for breakfast, including rice and fried snacks. Such stores can be found primarily on the main streets in this area.

Figure 5-7 shows some of the routines during the working day in case study II. In this area, 39 of 86 houses are taken as a sample to give information about their everyday life routines. From this sampling, it is found that 67% of the women are housewives. The status of house ownership is 77% self-owned and 23% rented.

The daily activities in case study I are mostly similar with case study II. The difference is in the location of some activities like washing, cooking and defecation. While in case study I such activities occur in private facilities, in case study II, such activities occur in public facilities.

(a) Woman washing in public facility (b) Woman sells food and drinks in an alley (c) Children play in an alley

Figure 5-7 Everyday routines, Case Study II

Table 5-4 describes a summary of the daily life, based on the occupation of the housewife, school children and workers. In general, case study II is dominated by late-stage rather than productive age inhabitants. Young married couples are hard to find. Some community members said they prefer to leave the area after they marry and move to peripheral areas.

Table 5-4 Summary of the everyday life, Case Study I and II

Time	Occupation	Activity	
		Case Study I	Case Study II
Morning	**Housewives**	Staying at home, doing the household chores, mostly buying some cooked-foods and vegetables for daily use	
	Schooling aged children	Preparing and going to school	
	Workers (men and women)	Going to the office	
Day	**Housewives**	Staying at home, doing household chores, taking care of the non-schooling aged children and/or participating in community activities, sharing and communicating with other community members	
	Schooling aged children	Coming back from school, playing with friends within house vicinity	
	Workers (men and women)	Remaining at the office	Some workers coming back from the office and stay at home
Night	**Housewives**	Staying at home	
	Schooling aged children	Staying at home	
	Workers (men and women)	Staying at home	Staying at home, Working as security (men)

Infrastructure Conditions

Table 5-5 describes the existing infrastructure conditions in case studies I and II. In case study I, all houses are equipped with a private kitchen, private bathroom and private toilet using a septic-tank black water system. For drinking water, each house has its own well and uses groundwater. This is a typical infrastructure for an Indonesian settlement. There are no centralized sewerage and drinking water networks available.

The most critical issue for case study II area is the infrastructure. This is an area where land is limited and this is the main explanation for the absence of gardens and trees; highly reduced access to ground water for wells and the small number of septic tanks. Houses in this area seldom have private toilets with the exception of the houses beside the small river on the boundary. The community uses public toilets which are located on the back side of the area. All existing toilets have direct access to the river and no sewerage and drinking water networks are available. Community members are using water for washing and other purposes from the public well which belongs to a mosque in the area and they have to are buy mineral water for the consumption of drinking water.

Table 5-5 Infrastructure conditions, Case Studies I and II

Infrastructure	**Conditions**	
	Case Study I	**Case Study II**
Access to drinking water	100% of houses have access to drinking water from ground water for daily needs (water well system).	Only 10% of the communities members have direct access to a groundwater well, these are houses near a public facility or a Mosque. These wells are the only groundwater source used. The other groundwater well, which are near the river is not used for drinking water consumption since the water turns yellow and has a bad smell. Other members have to store the water from the public well in a private tank/bottle and transport it to the house.
Access to sanitation	100% of houses have access to private toilets and private septic tanks.	Less than 10% of the community has access to private toilets with a septic tank system. The others use public toilets which are located at the side of the river. All human excreta goes directly to the river and contaminates the ground water
Physical access (accessibility)	Small, smaller and very small area can be assessed respectively by two cars, one car and only on foot.	None of the area can be accessed by car, only on foot

Existing Waste Management Systems

Case study I. Municipal Solid Waste Management Systems are absent from this area and also from surrounding neighborhoods. The nearest temporary collection point is located around 20-30 minutes by car, at a U-turn which is very close to one of the major areas for traffic jams. The study of Illeperuma (2007) suggests that the ideal collection point should be just 100 m away by foot or 300 m away by car.

Waste collection is poorly managed and is not legally controlled (Figure 5-8). As a result, whether or not the community members decide to participate or pay the service fee is "optional" and participation is also voluntary.

(a) Waste collector (up) and waste picker (down) (b) Illegal dumping in the vicinity where the waste is stored

Figure 5-8 Activities related to waste management, Case Study I

Table 5-6 gives an overview of waste management practice case studies I and II. As additional information for case study II, the Municipal Solid Waste Management Service serves the community with temporary storage (a container of 6 m^3). As this container also covers the waste from the market and is often picked-up late, waste is often scattered in its vicinity.

Table 5-6 Existing waste management, Case Study I and II

Waste Management Sub-System	**Existing Condition**	
	Case Study I	**Case Study II**
Waste Generation	No data available	
Waste Collection System	Waste collection is done by some of the community members in an unorganized way. This person collects the waste in the morning with a handcart going door to door (pick-up system). The waste is then brought to the nearest illegal dumping site. No municipal collection system service reaches the area. Some recyclables are directly sold to the waste pickers for a fluctuating price. These recyclables are exchanged for plates, glasses, instant noodles, etc.	Waste collection is done by one of the community members voluntarily. This person collects the waste early in the morning, using a handcart, going door to door (pick-up system). The waste is then brought to the nearest municipal collection storage, about 2-3 minutes walking. The mineral water bottles are collected and sold to the waste collector
	No waste separation at source, waste remains unsorted.	
	Once a month the community member pays the person but there is no standard service fee.	
	Note: at the time this survey was conducted, the collector observed a middle-aged and unemployed person. Since there is no legally binding contract for the waste collection and payment for the service, some community members refuse to join this collection or those who join seldom pay the service fee.	Note: at the time when this survey was conducted, the collector was a young and unemployed person. Since there is no legal binding contract for the waste collector and the service fee, some community members refuse to or seldom pay. As a consequence, this person stops picking up the waste from the respective house.
Waste Treatment/Disposal	There is no waste treatment, except illegal dumping on one of community member's land who wants to dam his pond. This land is located outside of the case study I area. Other community members are burning their waste and sometimes throw it into the river.	The community joined the municipal waste management system by the existence of the Municipals' waste container. The waste in the container will be transported to the landfill
Special Issue on Waste Management	Several Workshops on composting and 3R have been conducted for the community, or at least for the community members. The workshop normally takes place at the Neighborhood (RW) level. Note: at the time this survey was conducted there is one household practicing home composting. The housewife from this household is the representative of the household association (RT) and joined the workshop at the Neighborhood Association (RW) level.	The nearest temporary collection point is not sufficient to cover all the waste generated within the vicinity of the area. The waste container (6m^3) serves the settlements, including some traditional markets. Often the waste is scattered on certain points and nobody takes care of it. Due to limitations of the availability of drinking water, the community buys plastic bottled mineral water for daily consumption and therefore produces a lot of plastic bottles. This used plastic is normally sold to the waste pickers or directly to the collector (*pengepul*). As the waste joins the municipal system, none of the community members knows what happens with the waste after collection.

Case study II. Waste collection is voluntarily managed by one of the community members. This young person collects the waste every day and transfers it to the nearest temporary collection points. As there is no clear regulation of the collection system, the community members are free to choose whether to join or not join and whether or not to pay the service fee. Some who do not join put their waste to any points which are 'vacant' lots (Figure 5-9). As a consequence, the waste stream in this settlement cannot be easily tracked.

(a) Waste picker and/or collector (b) Collection of waste in a 'vacant' place

Figure 5-9 Activities related to waste management, Case Study II

5.3.3 Preliminary Assessment of the Field Research

Table 5-7 summarizes the preliminary findings from the field research case studies based on the indicators in found in Table 5-1. Both cases show the necessity to improve the existing waste management and therefore further research is continued in both settlements.

Table 5-7 Summary of preliminary findings from the case studies

<table>
<tr><th>No.</th><th>Indicator</th><th>Case Study I</th><th>Case Study II</th></tr>
<tr><td>1</td><td>Waste Management Services</td><td>Insufficient.
A collection system which shows a disconnected link with MSWMS; there is illegal dumping</td><td>Insufficient.
Mainly temporary collection storage; has connection with the MSWMS</td></tr>
<tr><td>2</td><td>Source Separation</td><td colspan="2">Not existent</td></tr>
<tr><td>3</td><td>3R Implementation</td><td>Experienced: they sell some recyclables such as empty glass bottles, cardboard packaging, beverage packaging from metal and plastics</td><td>Experienced: they sell some recyclables, mainly empty plastic bottles from mineral water.</td></tr>
<tr><td>4</td><td>Woman Community Based-Organizations</td><td colspan="2">Existent</td></tr>
<tr><td>5</td><td>Community Involvement</td><td colspan="2">Existent</td></tr>
<tr><td>6</td><td>Status of Ownership</td><td>Owned: 73% Vs. Rented: 27%</td><td>Owned: 77% Vs. Rented 23%</td></tr>
<tr><td>7</td><td>Woman as Drivers</td><td>70% Housewives</td><td>67% Housewives</td></tr>
</table>

5.4 The Structure of the Model

Figure 5-10 provides an overview of how the 4 modules are structured in this model. The stepwise interaction in this model goes from Module 1 to Module 2, Module 3 and then Module 4. Module 1 feeds the other three modules with the information from the database. Module 2, 3 and 4 are each the host of one decision making process which employs different methods to come to the output.

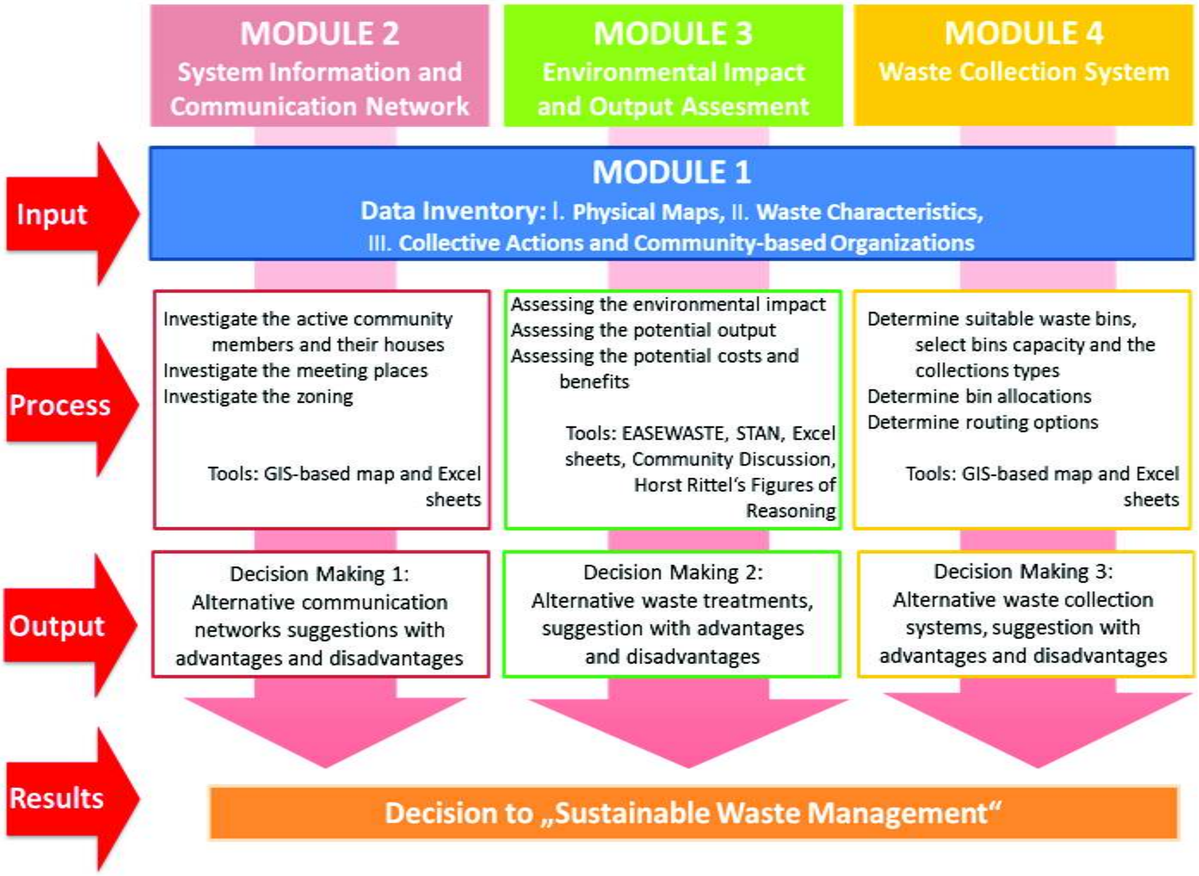


Figure 5-10 The model overview

Each module in the newly developed model focuses on a different goal (Tab. 5-8). Every module consists of 3 sub-modules that contribute to the decision making steps. The stepwise interaction between the modules and the sub-modules are illustrated in Section 6.1.1. The detail structure and relation among the sub-modules are described in section 5.5 Module 1 – Data Inventory.

Table 5-8 The focus of the modules of the model

Module	Name	Focus
Module 1	Data Inventory	Focus on establishing a database system at the location, waste generation and the community's activities
Module 2	System Information and Communication Network	Focus on establishing the communication network between the community members
Module 3	Environmental Impact and Output Assesment	Focus on educating the community about environmental awareness and economic impact, advantage and disadvantage of waste disposal and treatment options
Module 4	Waste Collection System	Focus on reducing the un-collected waste by collection, advantage and disadvantages collection system options

5.5 Module 1 – Data Inventory

Table 5-9 describes how the 3 sub-modules in Module 1 are structured and what content is used in each sub-module. This is the most important module in order to confront the weaknesses of database/documentation systems. The goal of this module is to provide basic information as a database which supports the work of all the other modules. In this module, the community is assisted to create a database management system which should be updated regularly. At this early phase, the community has to be assisted by the facilitator to run the module (by way of university students). In this module, no decisions are made. This inventory module considers aspects, tools and time consumption.

Table 5-9 Structure and product - Module 1

Sub-module	Name	Considered Aspect	Supporting Sub-modules, Modules	Used Media/Tools	Time Consumption
1-1	**Physical Map Inventory**	Environmental, Economic	-	Survey: GIS; Observation	Approximately 2 Weeks
1-2	**Waste Characteristics Inventory**	Environmental, Economic	1-1	Survey: Form A*, Form B*	
1-3	**Collective Action and Social Organization Inventory**	Social	1-1	Survey: Interview, Observation Form C*	
Product Module 1: Database System					
*) see Appendix C1.1 for Form A, Appendix C1.2 for Form B and Appendix D1.1 for Form C					

5.5.1 Sub Module 1-1 Physical Map Inventory

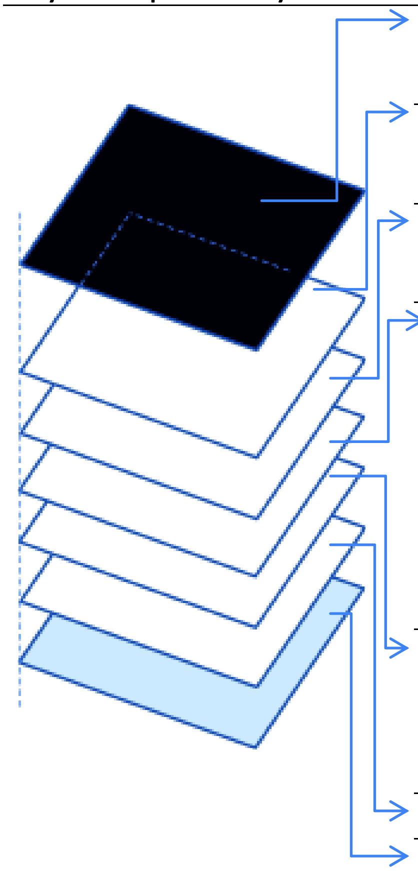
A physical map inventory is a map-based inventory which maps the physical condition of the area. It consists of six layers which contain different elements and one layer which summarizes all general elements (Table 5-10). This sub-module deals with the documenting of necessary information about the *kampung* by category: e.g. ownership, sizes of dwelling, and type of dwelling, which were done by the GEO and SOCECO team. This information is necessary for program implementation. Additionally rented house is made under a specific layer in order to give the message that the sense of belonging for the inhabitants of the house is only for a temporary period. Therefore it is necessary to contact the owner of the rented houses.

5.5.1.1 Methodology

This section describes the mapping procedure used and the methods for information collected related to the urban *kampung* inhabitants. A map-based inventory can be done manually as a community owned and developed map, by drawing the map directly on a sheet of paper with the help of proper writing and measurement tools. In some cases, the distance between each point can also be estimated. The most important issue is to check and re-check the contents of the map and this should be done together with the community members. The methodology below is written for the standard case. The following are the methodologies to conduct sub-module 1-1:

- **Digitizing**. The information of the houses, streets, and infrastructure as shown on Google Maps (version 2011) is added to the map of area, using Geographic Information System (ArcGIS) software. Each element of information was made in a different layer (Table 5-10).
- **Informal Interview**. It is necessary to ask the community members about the boundary of the area and the status of house ownership.
- **Observation**. Observation is needed to check some uncertainty, especially to check the ground area which cannot be seen clearly on Google Map, for example in the case of big tree canopies.
- **Georeferencing**. The boundaries of the research area are marked. The Global Positioning System (GPS) helps the team to digitize some points which are considered to be the outer points of the location. The location of the points should be confirmed by the community.
- **Numbering and Coding**. The house numbers, public and social facilities are coded and added

Table 5-10 Database set for Physical Map Inventory, Sub-module 1

The Layered Information in Physical Maps Inventory	No.	Elements and Components	Category
	**1**	General Elements: elements no. 2-7 and neighborhood boundary	-
	2	One story houses: Self-owned houses, rented houses	House numbering: *1,2,3…* Code for rented house: *r* Code for owned house: *o*
	3	Multi-story houses: self-owned houses, rented houses	
	4	Infrastructure: street networks, bridges, public facilities, social facilities and commercial facilities	Public, social and commercial facilities: *A, B, C, … AA, BB, CC, …* Streets and Bridges Category: I. possible access for two-cars and more II. possible access for two-cars maximum III. possible access for 1-car only IV. possible access only on foot River: Boat
	5	Trees and open spaces: trees, paved yards, grass yards, soil yards, water bodies, wastewater storages, sanitation networks	Note: wastewater storage in this context is an open/on earth surface pond (not a septic tank)
	6	Rented houses	-
	7	House Façade	-

5.5.1.2 Results

Figure 5-11 and Figure 5-12 summarize the map-based inventory results for case studies I and II. The physical information in both case studies I and II were collected and presented in 7 layers of information and arranged based on Table 5-10. The information is collected in the database to assists further decision making steps for case I and case II. The maps which have more detailed results can be found in Appendix A1.1 for case study I and Appendix A2.1 for case study II.

Case Study I

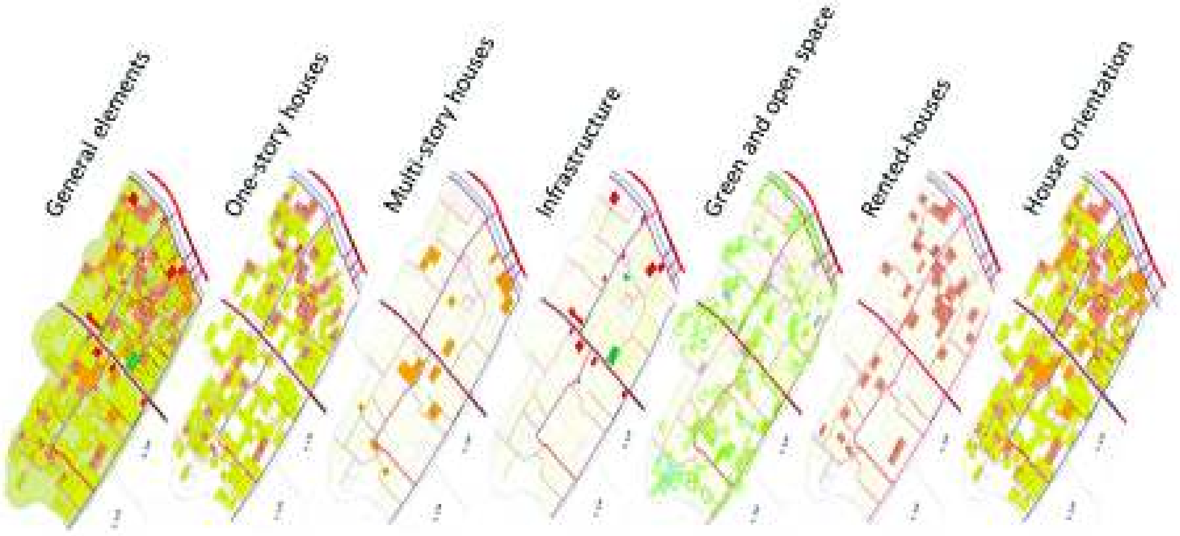


Figure 5-11 Physical Maps Inventory - Case Study I (un-scaled)

Case Study II

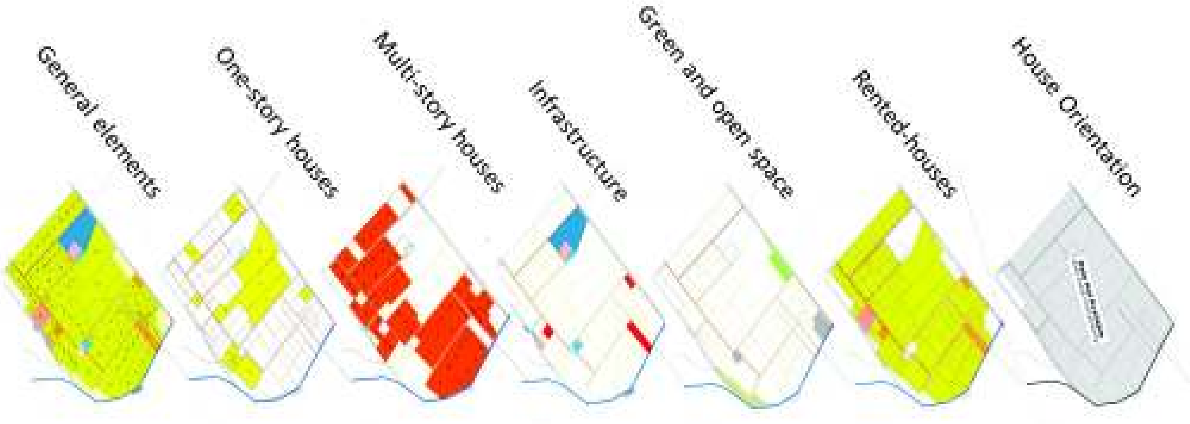


Figure 5-12 Physical Maps Inventory - Case Study II (un-scaled)

5.5.2 Sub Module 1-2 Waste Characteristic Inventory

5.5.2.1 Methodology

There are three terms to describe the separated waste, which is commonly collected from the community. These terms have been used in several waste programs in Indonesia and they are:

(1) Wet and dry waste (*sampah basah dan kering*)
(2) Organic and non-organic waste (*sampah organik dan non organik*)
(3) Kitchen waste and non-kitchen waste (*sampah dapur dan bukan sampah dapur*)

Of these, two were selected for this research project's focus, numbers (1) and combined with (3) due to their clearer meaning for the community. The terms used are kitchen and non-kitchen waste with additional information on wet waste which should be added to the kitchen waste and dry waste which should be added to the non-kitchen waste. To reduce confusion, examples of waste types that should be included in each type are written on the surface of the plastic bags, which were distributed to selected community members and to collect waste samples.

Table 5-11 and Table 5-12 describe the elements and the daily activity for the waste characteristic inventory, which was done by the SOCECO and IMPACT team. To carry out the waste inventory in case studies I and II, this sub-module provides assistance needed for the documentation of the amount of generated waste and its composition. In doing inventory, this information from the physical map is used to mark the houses for sampling waste. Here, the cooperation of the community is necessary. Using the service from the waste collector including existing waste collection tools will increase the effectiveness of this inventory.

Table 5-11 Database set for waste characterization inventory

No.	Elements	Type	Media*
1	**House number**	Personal data	FORM A
2	**Name of the family**	Personal data	FORM A
3	**Total inhabitants**	Personal data	FORM A
4	**Status of ownership (Owned/Rented*)***	Personal data	FORM A
5	**Waste iata input**	Collective data	FORM B

*) see Appendix C1.1 for Form A and Appendix C1.2 for Form B

Table 5-12 Daily Activities during Waste Characteristic Inventory

Activity	Day 1	Day 2	Day 3	Day 4
Selection of the houses for sampling	√	√	√	-
Delivery of plastic bags in the morning	√	√	√	-
Collecting the plastic bags from the previous day and bringing them to the weighing center	-	√	√	√
Separating the collected waste samples into fractions	-	√	√	√
Weighing the waste fractions and documenting the results	-	√	√	√

Table 5-12 gives an overview of the sampled related activities for the waste characteristic inventory. The sampling lasted for four days in which one household would not have been chosen more than once for sampling. A total of 15 houses in case study I and 22-23 houses in case study II were selected randomly for one day's collection. The determination of the number of houses was considered to be a full day activity, as it includes the process of selection, delivery, collection, weighing, separation and documenting. The procedure for determining the composition of unprocessed municipal solid waste was done using the American Standard Test Method ASTM D 5231-92 (Re-approved 2008). The vehicle used in this inventory is a human powered 4-wheel handcart with a volume of 1 m^3. The following are the methodologies used in more detail:

- **Proportioned random sampling.** The houses are selected randomly throughout the area and each house has the same chance of being selected as any other house. The selection should consist of a proportionally representative share of owned-rented houses.

- **Visiting and tutoring**. Each selected house is visited and two plastic bags were given directly. This visit is also the chance to introduce the research activities and to demonstrate how to conduct the waste separation of kitchen and non-kitchen waste to the household members.

Figure 5-13 Plastic bags distributed to households for waste separation and collection

Note: the two plastic bags are white colored for non-kitchen waste (the bigger) and black colored for kitchen waste (the smaller) as seen in Figure 5-13 above. On the surface of the plastic bag is written the type of waste and some samples from each type, the house number X and address, the duration of 24 hours waste filling by the inhabitants and the pick-up time

- **Pick Up in 24 hours.** After a 24 hour time period, the bags should not be filled anymore (normal procedure) and the house member should wait until the bags are picked up. These bags were brought to the weighing center by assigned community members.

Figure 5-14 Weighing Scale, KERN Model CXP

- **Weighing**. Figure 5-14 shows the weighing scale used in this research, KERN CXP (3 decimal numbers and maximal 150 Kg) which was borrowed from the host institution. All weighing activities were done in the weighing center located in the vicinity, provided by the community member. The weighing procedures of actions are described in (Table 5-14).

Table 5-13 Categories of Waste Components Considered in the Waste Inventory

No.	Categories	Description
1.	**Compostable Waste**	Kitchen towels, yard waste, animal food waste, wood waste
2.	**Recyclable Waste**	
a.	**paper**	Advertisements, books/phonebooks, dirty paper, juice cartons, magazines, newsprints, office paper, other clean paper, paper and cardboard container
b.	**plastic**	Plastic bottle, plastic product
c.	**glass**	Brown glass, clear glass, green glass
d.	**metal**	Beverage cans (aluminum), aluminum foil and container, food cans
3.	**Residuals**	Ash, diapers, rubber, shoes, leather, textiles, other combustibles

Source: EASEWASTE Model Database System

Table 5-14 Weighing Procedure

No.	Procedure
1	Secure a flat and level area for the discharge of vehicle load. The surface should be swept clean or covered with a clean, durable tarp prior the discharge of the load.
2	Position the scale on a clean, flat and level surface and adjust the level of the scale if necessary. Determine the accuracy and operation of the scale with weights.
3	Weigh all empty storage containers and record the weight.
4	Determine the number of samples to be sorted.
5	Create a comprehensive list of waste components to be sorted and including the description from one of the waste categories given in Table 5-13 which fits best.
6	Direct the designated vehicle containing the load of waste samples to the secured area for the discharging of the load and for collection of the sorting samples.
7	Collect any required information from the vehicle operator (the assigned community members) before the vehicle leaves the discharging area.
8	Position the storage containers around the sorting sample bags. Empty all bags from the previous sorting sample. Segregate each waste item from the sampling bag and place it in the appropriate storage container.

Note: Any procedures regarding the multi vehicles and composite items in ASTM D 5231-92 (Re-approved 2008 method) are excluded from the work in this inventory, since the inventory runs in a small scale area (household settlements) and only one vehicle was available. Additionally there is typically less composite waste from household waste.
The waste fractions were taken from all bags and put together in the designated area. After the calculation the waste is given to the community member who does the waste collection work.

Source: ASTM D 5231-92 (Re-approved 2008)

5.5.2.2 Results

Table 5-15 shows the waste generation and Figure 5-15 shows composition, Case Studies I and II. More detailed in Appendix C2 for a detailed result in Case Study I and Appendix C3 in Case Study II.

Table 5-15 Result from waste generation, Case Studies I and II

No.	Component	Case Study I	Case Study II	unit
1	**Number of sampled houses**	67	60	person
2	**Average number of inhabitants**	4	5	per house
3	**Average of waste generation**	0.315	0.273	kg/person and day
4	**Average of waste generation**	138.135	43.56	Kg per year

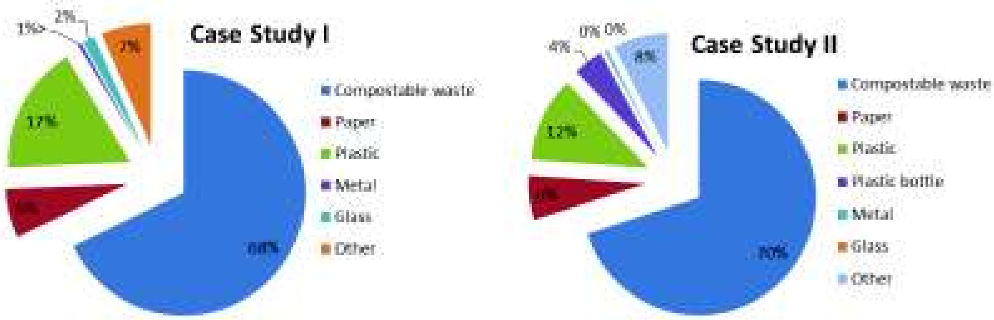


Figure 5-15 Waste Composition, Case Study I and II

Both in case study I and II, the waste generation are dominated by the compostable waste. The average of waste generation per day in case study I is bigger compared to case study II.

5.5.3 Sub Module 1-3 Collective Actions and Community-Based Organization Inventory

5.5.3.1 Methodology

Table 5-16 describes the elements of the collective action and community-based organization (CACBO) inventory, thereafter collective action inventory which was done by SOCECO. This sub-module provides assistance for documenting the activities, including participants and places.

Table 5-16 Database set for Sub-module 1-3 Collective Actions Inventory

Element	Type	Media*
Respondent Number	Personal data	Form C
House Number	Personal data	Form C
House Function	Personal data	Form C
Status of Ownership	Personal data	Form C
Year in which They Started to Stay in the House	Personal data	Form C
Data of the Inhabitant	Personal data	Form C
Status in the Family	Personal data	Form C
Gender/Age	Personal data	Form C
Occupation	Personal data	Form C
List of Activities, Coomunity/based organizations currently or previously involved in the community	Personal data	Form C
Motivation to join	Personal data	Form C
See Appendix D1.1 for Form C		

Figure 5-16 shows the informal interview and survey conducted at the case study sites. The activities lasted for four days. Each household was only chosen once; housewives were the interviewees. A total of 53 interviewees were conducted in case study I and 38 in case study II, or about 10-15 interviews for a given day (each 25-35 minutes). The following are the methodologies used to conduct this sub-module:

- **Informal Interview.** As housewives are anticipated to be the initiators of any community-based waste management program, it is necessary to gather information related to women and their everyday life practices related to the research topic. The informal interviews and surveys were done in parallel in order to collect sufficient information. The interviews targeted the leader of household association (RT) and the leader of other community-based organizations.
  These interviews were conducted to investigate information concerning:
  (1) The existing collective actions and initiators of those actions,
  (2) The leader or controller of the named collective actions,
  (3) The type of contribution (donation/human power) or funding resources,
  (4) The time (day and hour) and the intensity of the named collective actions, and
  (5) Additionally, the local leader of the neighborhood association was presented with a list of inhabitant data and (if existing) the location map.

- **Snow Ball Sampling Survey**. Since it is not possible to visit and interview all housewives, a snow ball sampling method survey was chosen. In this sampling method, a person who is surveyed is asked to indicate another person to be surveyed. The selection was based on who the interviewee thought was an active community member. This survey was concerning:
  (1) The house ownership status, whether rented or owned, and when the inhabitants started to live there
  (2) The number of the inhabitants who live in the house and their occupation
  (3) The activities that the household member previously was/currently is a part of and
  (4) The motivation for joining the specific collective actions and organization.

(a) Case Study I (a) Case Study II

Figure 5-16 Informal interviews and survey

- **Observation.** Observation was focused on the daily life activities of the people of the research area. It discovers points where people meet regularly. These data points collect information where collective actions and community-based organization activities normally take place. This data was merged into the physical map, sub-module 1-1.

  The information observed included:
  (1) The place where the collective actions occurs
  (2) The meeting/strategic/attractive points for housewives during the morning, day and noontime
  (3) The entrance and exit points to the area from the general everyday life practices for adults and school children.

5.5.3.2 Results

The summary of case study I are described in Table 5-17 and of case study II in Table 5-18. These CACBO are ofthen the most said by the community (see Appendix D2 for detailed result in Case Study I and Appendix D3 in Case Study II). Table 5-19 summarizes the finding from sub-model 1-3 in both case studies.

Table 5-17 Summary of Collective Actions Inventory, Case Study I

No.	Collective Actions and Community-based Organizations	Intensity
1	Quran study for women/*Pengajian untuk ibu-ibu*	Once per week
2	Social gathering/*Arisan*	Once per week
3	Regular donation/*Jimpitan*	Once per week
4	Freewill donation (ex.mourning fee)/*LAZIS*	Once per month
5	Community work in cleaning (for Women)/*Kerja bakti untuk Ibu-Ibu* or *Jumat bersih*	Once per week
6	Gymnastic at RT/*Senam RT*	Twice per week
7	Badminton/*Bulu tangkis*	Once per week
8	Security/*Keamanan (Hansip)*	Once per month
9	Recreation RT/Rekreasi RT	Once per year
10	Meeting of woman’s organization for fostering family welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	Once per month
11	Community integrated service/*Pos Pelayanan Terpadu (Posyandu)*	Once per month
12	Gymnastic at RW/*Senam di RW*	Once per week
13	Independence day celebration/*Perayaan hari ulang tahun Republik Indonesia (HUT RI)*	Once per year

Note: The selected activities are based on women’s’ activities and are mentioned at least 3 times by the respondents.

Table 5-18 Summary of Collective Actions Inventory, Case Study II

No.	Collective Actions and Community-based Organizations	Intensity
1	Community work in cleaning (for Women)/*Kerja bakti untuk ibu-ibu*	Once per week
2	Independence day celebration/*Perayaan hari ulang tahun Republik Indonesia (HUT RI)*	Once per year
3	Quran study for women/*Pengajian untuk ibu-ibu*	Four time per week
4	Quran study for all/*Pengajian untuk umum*	Once per month
5	Events for religious days/*Perayaan hari besar keagamaan*	Three times per year
6	Gymnastic/*Senam*	Once per week
7	Social gathering for women/*Arisan ibu-ibu*	Once per month
8	Community savings/*Tabungan warga*	Once per week
9	Exercise rebana/*Latihan rebana*	Twice per month
10	Community integrated service/*Pos Pelayanan Terpadu (Posyandu)*	Once per month
11	Meeting of Woman's Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	Once per month
12	Stewardship of the Mosque/*Kepengurusan Masjid*	Once per week

Note: The selected activities are based on women's' activity and are mentioned at least 3 times by the respondents.

Table 5-19 Resume of Sub-Module 1-3 Collective Actions Inventory

No.	Parameter	Case Study I	Case Study II	Unit
1	**Number of interviews**	53	39	**Persons**
2	**Number of Housewives from the interviews**	37	26	**Persons**
3	**Status of ownership (Owned: Rented)**	39:14	30:9	**Houses**
4	**Total number of activities**	13	12	**Activites**

Information about what the activities above are can be found in Appendix D4 for more description about the collective activities and the communiy-based organizations.

5.6 Module 2 – System Information and Communication Network

Module 2, the communication network provides assistance for establishing and maintaining the proliferation of information at the community level and documenting the results as map-based information. It builds an information system and a communication network for all community members. The work in this module is based on the information collected in sub-modules 1-1 and 1-3.

Table 5-20 Structure and product - Module 2

Sub-Module	Name	Considered Aspect	Supporting Sub-Modules	Used Media/Tools	Time Consumption
2-1	**Active Person Map**	Social	1-1;1-3	FGD, GIS	Approximately 2 Weeks
2-2	**Meeting Point Map**	Social	1-1;1-3	FGD, GIS	
2-3	**Cluster- or Alley- Based Neighborhood Map**	Social	1-1;1-3	FGD, GIS	
	Product: Established Communication Network				

Note: FGD = Focus Group Discussion; GIS = Geographic Information System

Module 2 results in a fundamental tool to establish effective communication among the community members as well as between the community and outsiders. Each community member has the equal right to contribute and to be involved in any kind of decision making process occurring in the community and to say what is on her/his mind and to hear what is on other people's minds.

Table 5-20 describes how the 3 sub-modules of Module 2 are structured and describes what are the media/tools used in each sub-modules. The first decision making process in the community will be taken during this module through a Focus Group Discussion (FGD) which is attached to the existing discussion among the community members. In this FGD, the decision making addresses the formulation of system information and communication network. All the information in sub-modules 2-1, 2-2 and 2-3 is integrated and carried out as the system information and communication network.

Table 5-21 describes principles which are adapted from the Empowerment Family Welfare or *Pemberdayaan Kesejahteraan Masyarakat* (PKK) and replicated in Module 2. This module is derived from the PKK organization's strategy. PKK is the most established women's community-based organization in Indonesia. To increase the coverage of community involvement, PKK formed *Dasa Wisma*[1], which enables the community to create smaller groups (consisting of 12-20 houses) and an appointed local leader as the role model. These local leaders will be trained through workshops and have the responsibility to transfer the knowledge to other community members. The role models can come from outside the community. This strategy is well-known even in the remote villages in Indonesia.

Table 5-21 Adaptation of existing principles on site to the newly developed model

No.	Replicated Principle	Adaptation	Included in the model as
1	**Appointing the Local Leaders**	The contribution of the local leader here is similar with the one in PKK, but in this model she should be the active member from the community in order to best serve the localities. Using the current local leader, if existing, is the preferable option. Otherwise the community shall use the sub-module 2-1 to select the local leaders. The collective buffer areas are created to distribute the influenced area of the local leaders. The size depends on convenience walking distance.	Active Person Map (Sub-Module 2-1)
2	**Choosing the Meeting Points**	The inventory of community member activities in sub-module 1-1 shows public facilities or the community member's houses which are regularly used for community gatherings, for example for internal discussions or other community based-organizational meetings. This is the main indicators to determine meeting points to discuss waste management activities. The collective buffer areas are also created to distribute the influenced area of the meeting points. The size depends on the scope of the area.	Meeting Point Map (Sub-Module 2-2)
3	**Defining the Zoning**	Zoning divisions are based on proximity. The area is divided into several zones in order to build up an effective system information and communication network. In this model, the existing zoning divisions are preferably used, such as those from the implementation of existing *Dasa Wisma*. Otherwise, the community shall form the new zoning division themselves. For this work, the sub-module 2-3 shall assist the community in doing this.	Cluster- or Alley based Neighborhood Map (Sub-Module 2-3)

[1] Dasa Wisma: a strategy from PKK to form a small group in the community, consisting of 12-20 houses, to increase the community involvement (See Appendix D4).

The sub-modules 2-1, 2-2 and 2-3 are adapted from the proliferation of information principles in PKK. In this case, it is easier and consumes less time for the community to understand and to apply the principles as they already familiar with the principles.

Figure 5-17 shows the concept of the buffer zones or the area of influence for the active person in sub-module 2-1 and the meeting point used in sub-module 2-2. The buffer zone is established based on the wider area and based on convenient distances for walking and is divided into several zones. In the case of the active person, the influence should be an active influence. This means that all influence should originate from the active person and affect the surrounding area (in the direction of the outside arrow). The active person should be active in approaching other community members and in communicating with them. Both the active person and the meeting points are the center of influence.

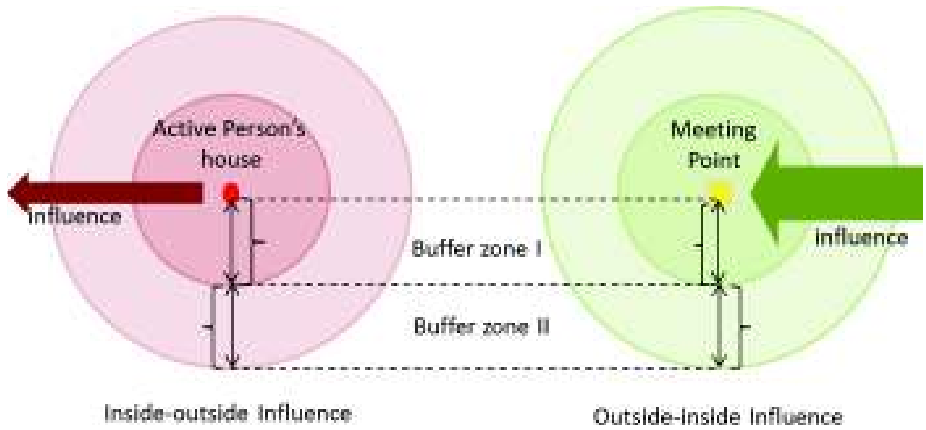


Figure 5-17 the active and passive influence concept for the buffer zone

Meanwhile in the case of the meeting point, the influence should be a passive influence. This means that all influences should come from the surrounding points (inwardly directed arrow). The community members should be actively receiving and updating information through the activities at the meeting points. Additionally, a notice-board should be prepared and located at the meeting point for the community members who occasionally could not attend the activities. In this way people who are interested can also get the latest information. A convenient walking distance for both is up to maximum of 100 m (Illeperuma 2007).

5.6.1 Sub Module 2-1 Active Person Map

The sub-module 2-1 provides assistance to show where exactly the active persons' houses are located. An active person is considered to be a person who is regarded as being the most involved in many collective actions and community-based organizations (CACBO), in sub-module 1-3, and later considered as the potential local leader in the community. The number of persons to be considered as active persons is determined according to need. This individual may also act as the community representative of the respective area.

5.6.1.1 Methodology

The active persons are identified based on the quantitative and qualitative values given for each CACBO. Two parameters, the qualitative score and quantitative score, and 5 criteria were constructed in this sub-module to discover the potential local leader.

The following steps were used:

Step 1	Scoring the candidates based on participation in the joined activities (defined in sub-module 1-3), quantitative- and qualitatively.
Step 2	Ranking the candidates based on the quantitative score (QnS) and qualitative score (QlS).
Step 3	Defining the intersection of the quantitative and qualitative ranking of the participants.

Step 1 Scoring and Step 2 Ranking the Community Members

To discover the most active person in the community, the surveyed candidates are ranked based on qualitative and quantitative scores (See Appendix E1 for the list and score each of activities). Double scoring, qualitatively and quantitatively is done to minimize uncertainty. For example, it would not make any sense to select a community member who joined three activities which occurs only once in a year instead of a community member who joined one activity which occurs every week. Therefore the qualitative score is important to determine the respondents' rank.

The intersection theory (SetTheory) is used in the assessment process. In mathematics, the intersection (denotes as ∩) of two sets of data forms the new data set which contains elements which exist in both data sets. In this sub-module, the first data set -(QnS)- contains a list of the participants ranked based on their quantitative score (Eq. 1). The second data set -(Qls)- contains a list of participants ranked based on their qualitative score (Equation 2).

Table 5-22 Parameters for local leadership selection

No.	Parameters	Value	Symbol	Notes	Example
1	Quantitative Score	One score per one collective action	QnS	Shows the total amount of activities joined	If the person joined 3 out of 10 collective actions, then QnS=3, minimum score=0, maximum score=10
2	Qualitative Score	One score per day of activities in a year (the frequency)	QlS	Shows the total days of activities joined in a year	If the frequency of the collective action is weekly, then the QlS=52, monthly= 12, minimum score=0, maximum score is 365

Table 5-22 shows the parameters considered to determine the participants rank. The quantitative score (QnS) represents the total number of collective actions and the community-based organization that the women community members take part in (Sub-module 1-3 Collective Actions). The more activities she joins, the higher the score and the higher the rank (see Eq.1).

QnS =Activity1+Activity2+Activity3+…+Activity(n)=∑ activity………………………………………………………………(Eq.1)

The qualitative score (Qls) represents the frequency of the collective actions, determined in sub-module 1-3, that the women community members take part in (see Eq.2). The more frequently a woman joins activities, the higher the score and the higher the rank.

Qls =Frequency of activity1+Frequency of activity2+Frequency of activity3+…+Frequency activity(n) = ∑ frequency of activity……(Eq.2)

Step 3 Defining the intersection data of the quantitative and qualitative ranking of the participants

The active community member will be discovered based on the data set for quantitative and qualitative scores (the data set (QnS) ∩ data set (QlS)). The new data set (Qns∩Qls) gives a ranking order to support the decision to choose the community members who are suitable to act as local leaders (see Eq. 3).

$$Qns \cap Qls = (Qns) \cap (Qls) \quad \text{(Eq.3)}$$

Table 5-23 shows further criteria to select the suitable local leaders. These criteria are set to re-evaluate the ranking results as to whether or not the selected person is able to perform her task as the local leader. These criteria are important, moreover if more suitable persons available. These criteria are the next selection for the candidates. The selection of the local leader is the first decision making step in this model.

Table 5-23 Supporting criteria for selection of the local leaders from the ranking list

No.	Criteria	Notes
1	Obtained the high scores in the "Table of Participants Rank", both qualitatively and quantitatively	See the new data set (QnS∩Qls) in Appendix E2.
2	A woman who is a housewife	verifies unemployed and spends almost all of the day at the settlement during working days
4	Experienced in initiating at least one collective action and/or community-based organization	This information was obtained during the informal interview and survey
4	Willing to share with other people and willing to take the responsibility to act as a local leader	Should be stated in writing or orally
5	House's location	determines the community members who are included in the candidate's buffer area

Mapping the active person's houses and their buffer zones

The houses of active community members are marked on the physical map. The buffer zones are added to the surroundings in order to define the area of influence of the respective active community members. See Figure 5-17 and the description to find how these buffer zones were determined.

5.6.1.2 Results

Table 5-24 shows a list of active community members in case study I and II in case study II, which were determined from Eq.3 and based on quantitative score in Eq.1 and qualitative score in Eq.2. The table ranks the potential local leaders in the respective area. Other elements in the table; the status of ownership, the year of habitation, and the occupation are all elements to support any kind of decision making process. For example, in case study I the highest rank was given to the respondent no. 42. This person joined nine activities which from them 1 is twice a week, 5 are weekly, 2 are monthly and the last one is yearly activities. Additionally she has been staying for more than 30 years in the settlement. The second rank was given to the respondent no. 24 with also nine activities, which from them 1 is twice a week, 4 are weekly, 2 are monthly and 2 others are yearly activities. Although both respondents no. 42 and 24 were involved in nine activities, but the qualitative score of respondent no. 42 was higher. This makes respondent no. 42 as the first rank. The same reasons apply in for the result of the others of respondents rank.

Table 5-24 List of active community members, Case Study I

Rank	Respondent No.	House number	Quantitative Score (QnS)	Qualitative Score (QlS)	House Ownership	Starting year of inhabitation	Occupation
1	42	38	9	389	O	1980	Housewife
2	24	21A	9	338	O	1985	Housewife
3	10	63	8	337	O	2004	Housewife
4	22	51	7	325	O	2010	Housewife
5	53	25	7	314	O	1985	Housewife
6	39	40A	7	222	O	1984	Housewife
7	31	70B	6	221	O	2009	Housewife
8	13	93	5	264	O	1990	Housewife
9	45	78A	5	261	O	1987	Housewife
10	44	33	5	221	R	2000	Housewife
11	33	9A	5	209	O	1996	Housewife
	37	9E	5	209	R	2008	Housewife
	34	9B	5	209	O	1996	Housewife
	35	6C	5	209	O	1997	Housewife
	36	9D	5	209	R	2008	Housewife
	52	40	5	209	O	1985	Housewife
Note: O: Owned ; R: Rented. See Appendix E2 for detailed results.							

Table 5-25 List of active community members, Case Study II

Rank.	Respon-dent No.	House number	Quantitative Score (QnS)	Qualitative Score (QlS)	House Ownership	Starting year of inhabitation	Occupation
1	9	44	7	391	O	1960	Housewife
2	8	37 A	3	364	O	Since long time	Housewife
3	3	46	5	336	O	1972	Housewife
4	10	C3	3	327	O	Since long time	Housewife
5	15	C2	5	325	O	1995	Housewife
6	39	34	4	273	O	1993	Housewife
7	18	H5	3	261	O	1988	Housewife
8	2	22	2	260	O	1950	Housewife
	28		2	260	O	1960	Housewife
9	27	H4	2	209	O	1988	Housewife
Note: O: Owned ; R: Rented. See Appendix E2 for detail results.							

Figure 5-18 visualizes the same information in Table 5-24 and was transformed into map-based information. The figures mark the community members' houses by the dark blue points in the physical map which was produced in sub-module 1-1. These points are the center of influence ranges of active persons. The circles, marked with red color, surrounding the houses identify the buffer zones and the radiuses, multiple of 25 m in case study I and 10 in case study II, were taken based on the convenient distance for walking.

The circles with rose color show the first three persons who have the highest rank. In case study I these 3 persons influence covers almost 50% of the area whereas in case study II covers more than 80%. It shows the connection, the wider the area the more local leaders are needed to cover the whole area. It is also necessary to consider the effective distribution of these potential local leaders (see Appendix E2 for a detailed community members'rank and Appendix A1.2.1 active person map in Case Study I and Case study II.

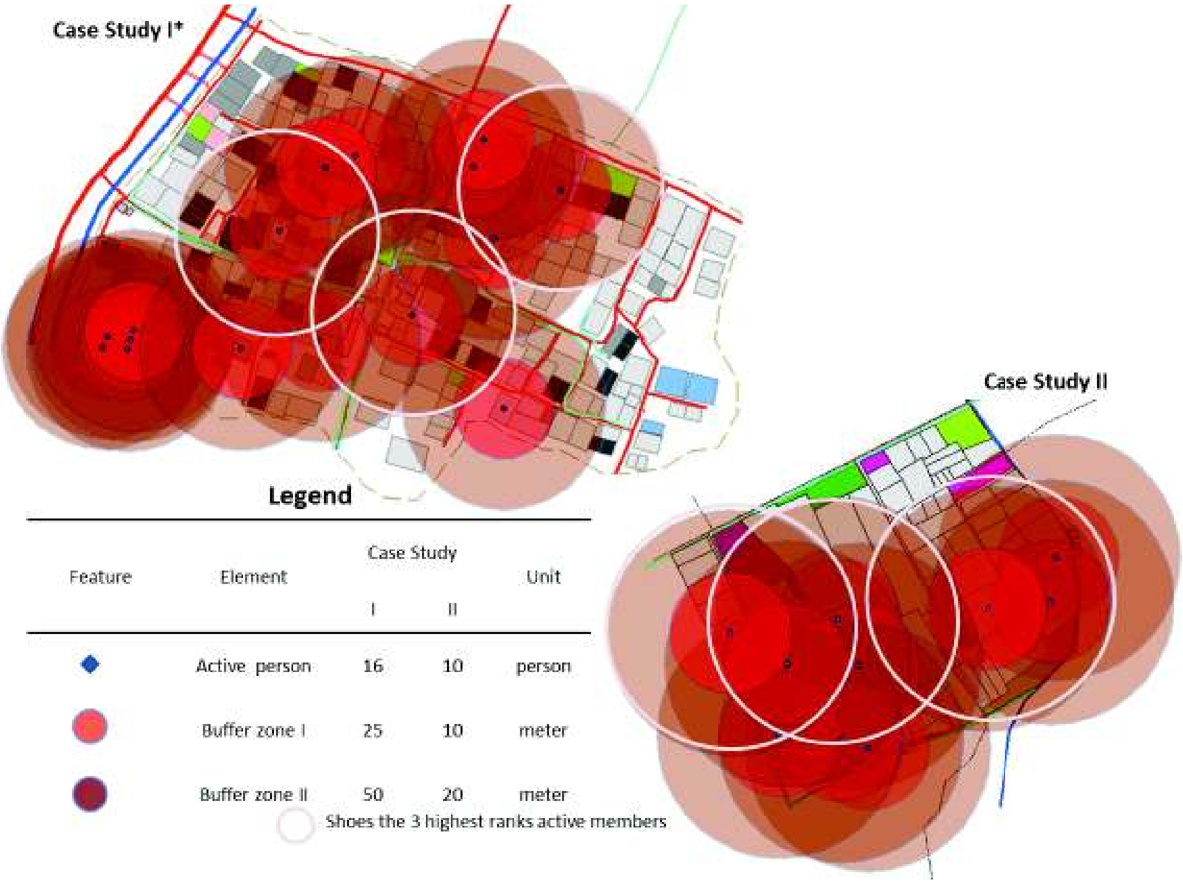


Figure 5-18 Maps of active person and suggested buffer zones

5.6.2 Sub Module 2-2 Meeting Point Map

The sub-module 2-2 provides assistance to show exactly where the places of collective actions and the meeting activities are located. These places are considered as meeting points for all community members. The number of points to be considered as meeting points is determined based on the actual activities.

5.6.2.1 Methodology

The meeting points assumed to be the place where the collective action activities happen, were identified based on the information collected in sub-module 1-3. These meeting points are the center of influence of the meeting places and the radius is flexible, based on community agreement and within convenient walking distance. The selections of the meeting points are based on the places of the most mentioned activities by the respondents (see Appendix D2 and D3 for detailed result of the Collective Actions and Community-based Organization Inventory in Case Studies I and II). These meeting points should be a place which can be identified inside the settlement's boundary and it can be public facilities or private properties. They are also supposed to cover the areas which are not included in any of the buffer zones from the active community members.

In this sub-module information about potential meeting points from sub-module 1-3 were transformed into map-based information, using the physical map, which was produced in sub-module 1-1. The buffer zones were added to the surrounding points. These buffer zones show the area of influence of each meeting point under certain radius, according to the coverage of the area. The radius and the buffer zones are dependint of the total area of the case study.

5.6.2.2 Results

Figure 5-19 shows map-based information of the meeting points in case studies I and II, where a radius of 50 m in case study I and 30 m in case study II were chosen as examples for the buffer zone. The meeting points (marked with yellow color) are surrounded by several buffer zones (marked by the green color). The greater the area which should be accommodated by the meeting point, the more buffer zone is needed. Detailed results can be found in Appendix A1.2.2 for Meeting Point Map in Case Study I.

In case study I, two potential meeting points were identified from the most mentioned collective actions. Those are house no. 93 (the gathering place after the "Clean Friday Activity" which was mentioned 40 times) and the mosque (a place for the study of the Quran for women who are mentioned 34 times). In both potential points, as the locations are more in the center, by giving the radius of 50 m to the buffer zone, it could cover 15% of the area and around 80% by adding 2 more buffer zones (multiplies of 50 m).

In case study II, the only potential meeting point is the mosque. By giving the radius of 30 m to the buffer zone, it could cover more than 50% of the area. Additionally since the case study II is only a small area, the coverage area is already reaching 100% by adding 1 more buffer zone (multiply of 30 m). Detailed results can be found in Appendix A2.2.2 for Meeting Point Map in Case Study II.

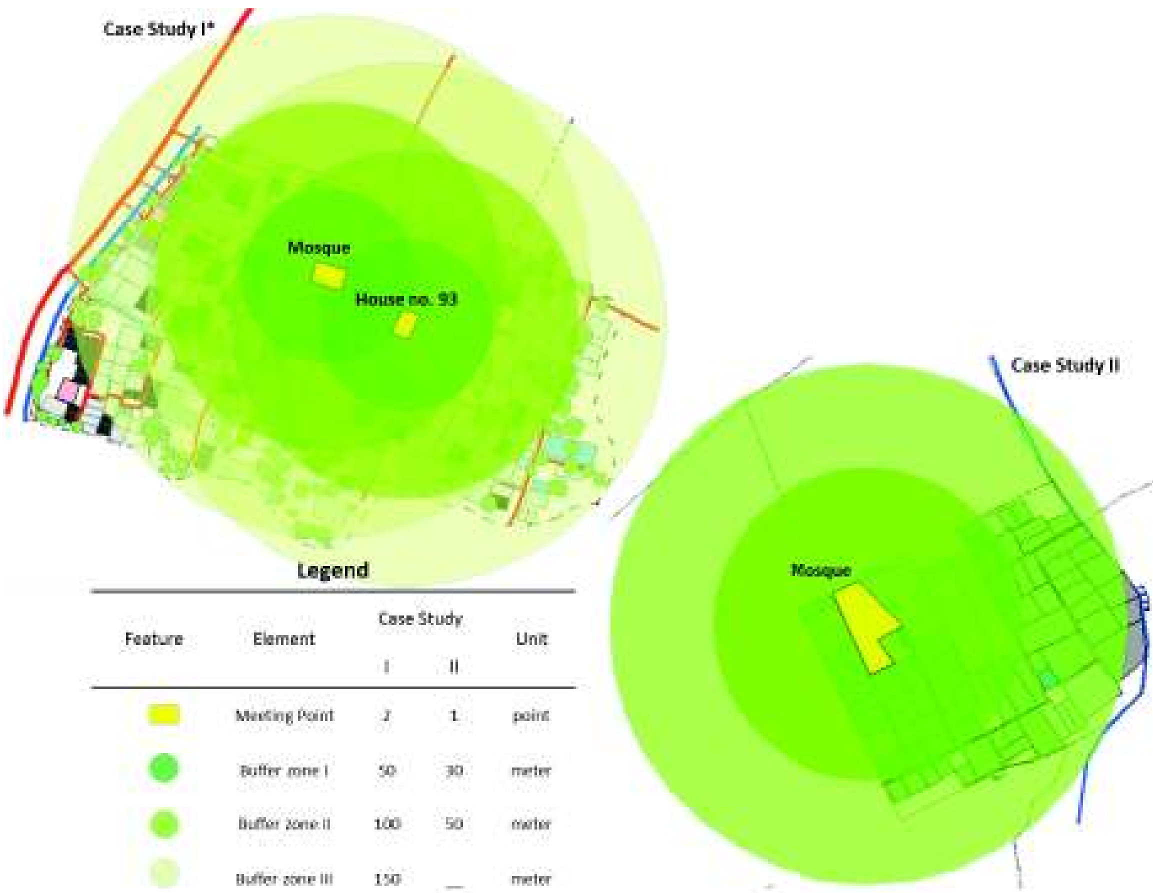


Figure 5-19 Maps of meeting points and suggested buffer zones

5.6.3 Sub Module 2-3 Cluster- or Alley- Based Neighborhood Maps

The module 2-3 provides assistance in grouping the area into several smaller areas. The cluster or alley based neighborhood map offers information on how the community in this area is grouped into zones, thus making the proliferation of information effective. In several areas where the PKKs exist, the communities are already grouped into several zones. Unfortunately, due to the ineffective and unclear structure of the communication systems in place, this community zoning is often useless.

5.6.3.1 Methodology

The principle in theory of propinquity is used in sub module 2-3 to identify the invisible zoning in the area. This theory relates to the spatial and geographical proximity among people and their corresponding likelihood to form friendships. This kind of relationship is termed the propinquity effect since there is a tendency for people to form friendships with those whom they encounter (Festinger 1950). Additionally the theory of George Thomas is also applied in this module to identify the smaller group in an area. This theory underlines the principle that the more shared activities that people have, the higher the power of sharing-with-others will be (Homans 1959). Developed based on these theories and the PKK's principle, in particular Dasawisma (see Appendix D4 for more information about PKK and Dasawisma), the houses in the area are grouped into a small alley or cluster based neighborhoods based on the house orientation and common access.

The methodology in this sub-module for both cluster and alley based neighborhood maps is simply collecting information combined with direct observations. In this sub-model the research area is divided into several zones based on social groups within the neighborhood. In both neighborhoods, the cooperation of community members is a really necessary aspect of this part of the study as community acceptance is needed related to which grouping houses are put in to

To define the cluster based or alley based neighborhood, following procedures were used:

- Step 1 Identifying the commonly used access and the single fragmented streets (segment) based on the house orientation
- Step 2 Checking and re-checking the validity based on immediacy or propinquity of the connected area to make sure the distribution of houses is equally divided

Cluster based Neighborhood Map

The street category (presented in the map no.4 – infrastructure, sub-module 1-1) consists of three larger street categories (street type I-III) and one smaller category (street type IV - only non-foot). These larger streets and the area boundary (presented in map no. 1 – general elements, sub-module 1-1) are taken into consideration to create the zoning in a cluster based neighborhood. The zones are formed when these elements are met. Additionally the smaller street can also be used to sub-divide one big zone.

Alley based Neighborhood Map

The alley based neighborhood map is a special case of zoning that is in the case of the areas if only street type IV (only on-foot) available. Here the alley based neighborhood is formed based on the commonly used access of street type IV (presented in the map no.4 – infrastructure, sub-module 1-1) and the house orientation (presented in map no.7 – house orientation, sub-module 1-1). Additionally, the area boundary (presented in map no. 1 – general elements, sub-module 1-1) is also used to define the zones. The smaller groups can be defined from the common access used by the community member, the nearby location, and the house orientation.

5.6.3.2 Results

Figure 5-20 shows the products of the sub-module 2-3 for case studies I and II. The figure shows the cluster based neighborhood map of case study I. The cluster based neighborhood type best fits the case study I since different street categories. Each zone consists of 24 to 59 houses, including both owned and rented houses and each zone covers 6,000 m^2- 9,500 m^2. The case study I is divided into 8 zones and based on former sub-division of Dasawisma. Here the zoning existed but it was seldom used, it needed time to discover the zoning.

Figure 5-20 also shows the alley based neighborhood map of case study II. The alley based neighborhood best fits the case study II since the only streets available is street type IV (no-car). Therefore no other options for dividing the area are possible based on this physical constraint, except using information from this type of street, house orientation and the area boundary. Each zone consists of 5 to 24 houses and each zone covers 175 m^2- 800 m^2, also including owned and rented houses. The case study area II is divided into 7 zones based on 7 existing single fragmented streets in the area where in each zone, all houses are facing the same street (commonly used street).

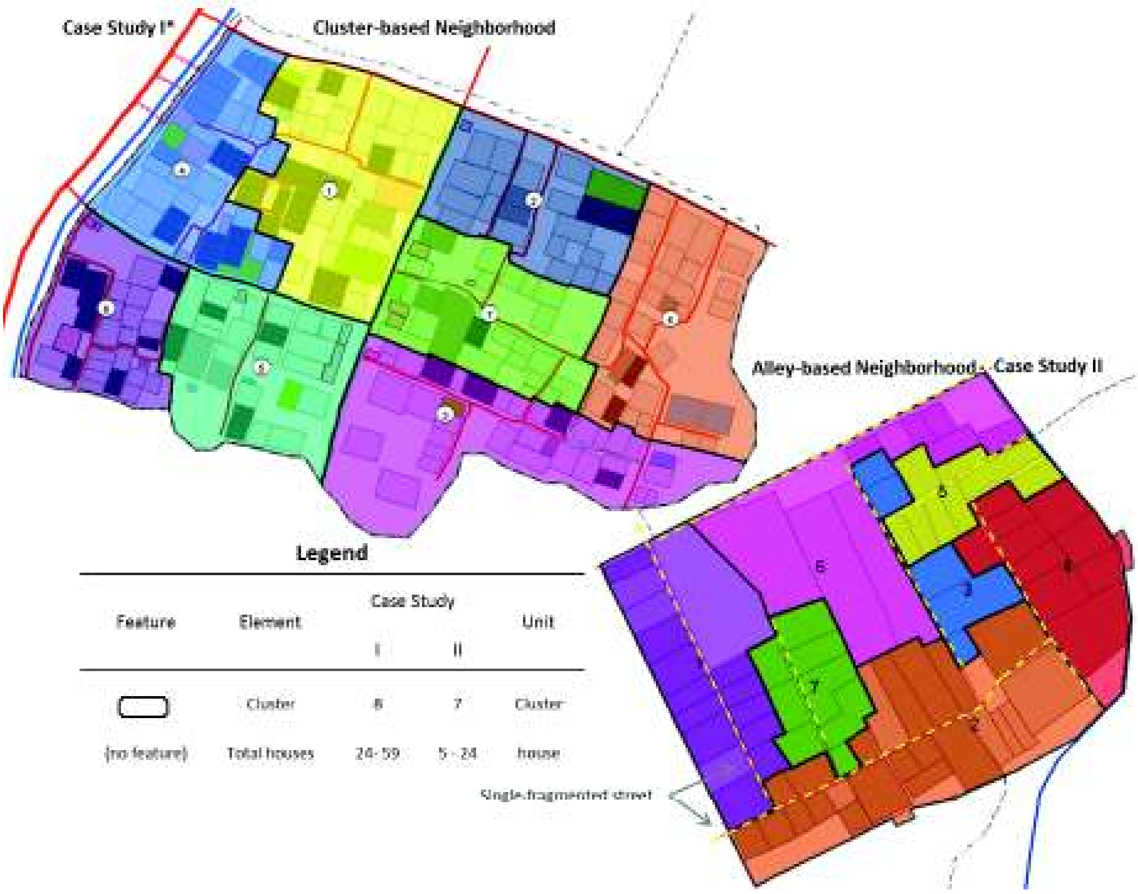


Figure 5-20 the cluster based (Case Study I) and alley based (Case Study II) neighborhood map

This zoning is an alternative which should be discussed among the community members whether or not they agreed on this sub-division neighborhood. Detailed results can be found in Appendix A1.2.3 for a detailed map in case study I and Appendix A2.1.2.3 in case study II.

5.7 Module 3 – Impact Assessment

5.7.1 Overview

Figure 5-21 gives an overview of the considered waste management possibilities. 13 types of disposal and treatment technologies were compared. In the urban area, waste can be divided into seven waste fractions. 3 types are considered assessments in module 3. Those are Environmental Impact Unit (Sub-module 3-1), which involves five impact categories; Output Unit (Sub-module 3-2) for waste disposal and technology options; and Cost-Benefit Unit (Sub-module 3-3), which is considered as an area for further study.

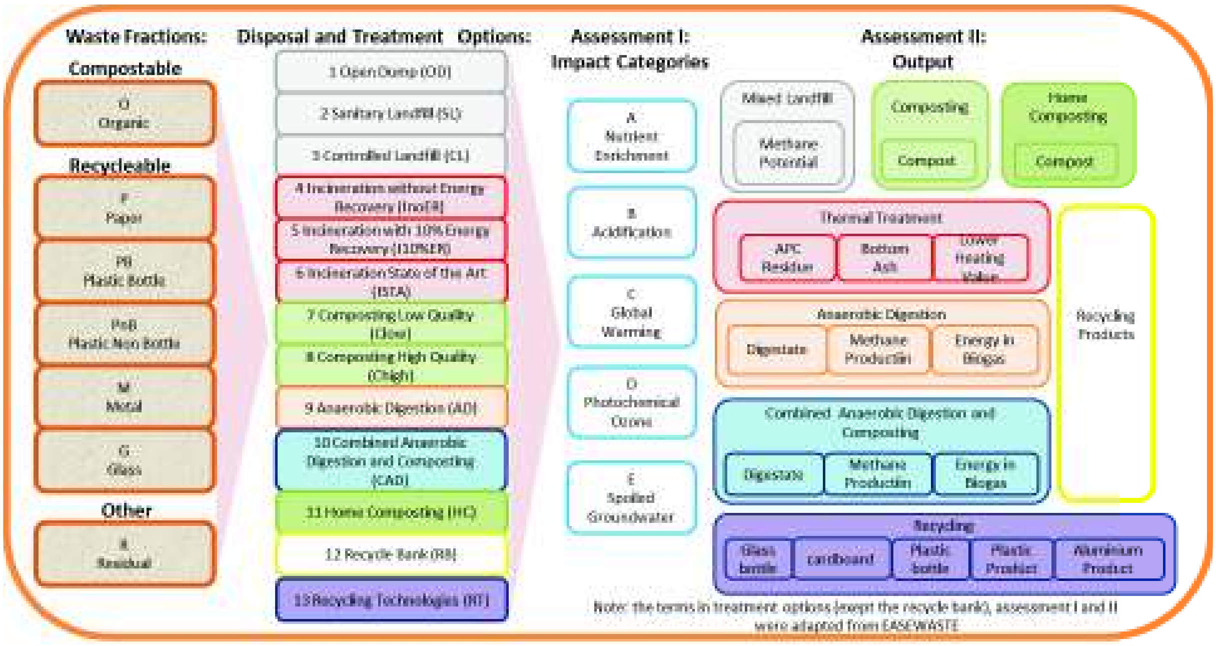


Figure 5-21 Waste fractions, disposal and treatment options, and the assessments involved in the model

In Figure 5-21, the same color is used for treatment options and output to indicate the relationship between the technology involved in the model and the output. Beyond these output categories, five impact categories were selected for environmental impact analysis in sub-module 3-1 (Table 5-26).

Table 5-26 The selected impact categories

No.	Potential Impact Category (PIC)	Original Unit	Physical Basis	Direct Impact (Example)
Non-Toxic				
1	**Nutrient Enrichment**	kg NO_3^--eq./person/yr	Regional	Decreasing harvest product
2	**Acidification**	kg SO_2-eq./peron/yr	Regional	Water pollution
3	**Global Warming**	kg CO_2-eq./person/yr	Global	Increasing temperature
4	**Photochemical Ozone Formation, High NOx**	kg H_2H_4-eq./person/yr	Regional	Respiratory disease
Toxic				
5	**Spoiled Groundwater Resources**	m^3 water/person/yr	Local	Groundwater contamination
All original units are normalized into PE (Person equivalent). 1 PE is the impact factor of one person in a reference year (Kikerby et al., 2006. p.7)				

Source: Damgaard et al. (2011), p. 1533

These impact categories were adapted from EASEWASTE which is based on Environmental Design of Industrial Products (EDIP) 1997. To increase community understanding, only impact categories with direct impacts (damaging the land) are selected. These direct impacts are easier to be understood by the people. Using this dataset, the community can simulate the results of their goal oriented scenarios.

Module 3 is the most advanced module in this newly developed model. It involves calculations, scenario developments, visualizations and Focus Group Discussions (FGDs). FGD is a discussion between the research team and the local leader and can occur more than once, based on necessity. Through FGD, the various waste management technologies and their respective impacts are introduced to the local leader. The module 3 provides assistance in delivering information on environmental impact, potential outputs and the costs and benefits assessment for selected technologies. For the implementation, neither the community members nor the facilitators do the scientific work because the datasets were already prepared by the author et al. as templates and attached to the model (see Appendix F5 for Environmental Impact Unit (EIU) and Appendix F6 for Output Unit (OU).

Table 5-27 Structure and products - Module 3

Sub-module	Name	Considered Aspect	Supporting Sub-modules,	Used Media/Tools	Time Consumption
3-1	**Environmental Impact Unit (EIU)**	Environmental	1-2; 2-1; 2-2; 2-3	FGD; Workshop	Approximately 8-12 Weeks
3-2	**Output Unit (OU)**	Environmental	1-2; 2-1; 2-2; 2-3	FGD; Workshop	
3-3	**Cost Unit (CU) and Benefit Unit (BU)***	Economic	1-2; 2-1; 2-2; 2-3	FGD; Workshop	
Product: Environmental Impact, Output and Economic-Benefit Assessment					

Note: *) considered as an area for further study
FGD = Focus Group Discussion

Table 5-27 gives an overview of the structure on how the three sub-modules in Module 3 and lists the media used in each sub-module. Parallel to the FGD, workshops are attached to this module as the media for technology and transfer of knowledge. The workshops are an educational tool to empower the community.

The contents from the FGD and the workshops are then proliferated through the products of module 2 (the communication network) to the other community members. The local experts, such as NGO or environmental activists on community-based waste management are invited to introduce their work and share their knowledge with the community, for example on home composting and recycling banks. At the workshops, the local leaders from sub-module 2-1 are trained and experienced to do the practical work themselves. These local leaders can deliver the information within her buffer zone (sub-module 2-1), meeting points (sub-module 2-2) and based on the cluster alley based neighborhood zone (sub-module 2-3). Module 3 is the most time consuming as the community should go through various phases of understanding the training and implementation. Final decision after finding out the results.

As it is important to involve the community members in all sub-modules, in this module all original units from impact categories are normalized as Person Equivalents (PE), where the impact is illustrated to represent the impact on one person. Therefore, the only consideration for the community or other users is to compare the units (fewer or more) to show smaller or bigger impacts in sub-module 3-1 (EIU), outputs in sub-module 3-2 (OU), and cost and benefit in sub-module 3-3 (CU and BU).

5.7.2 Sub-Module 3-1 Environmental Impact Unit and 3-2 Output Unit

Basically the sub-module 3-1, Environmental Impact Assessment, and sub-module 3-2, Output Assessment, are using the same data input. Therefore these two sub-modules are described together in one sub-chapter.

Developing Calculation Templates

The calculation templates allow the user, the community and the facilitator team, to put data regarding the waste characteristics and the amount of waste as input factors. These inputs are then processed automatically in excel spreadsheets. The summary of these inputs is used for material flow visualization. 3 templates are available – the input template, the scenario summary template and the goal oriented scenario template.

1) The Input Template

Table 5-28 shows the input template. In this template, the input column of total waste generation and the waste composition are considered as 'user defined' inputs whereas the waste amount will appear accordingly. This data is taken from the result of sub-module 1-2 (waste generation per year) and again from sub-module 1-2 (waste composition).

Table 5-28 Input template

Total Waste Generation* (ton in a year)	waste composition* (%)	Waste Fraction	Waste Amount (ton)[3]
0,000	0	Organic Waste (O)	0,00
	0	Paper (P)	0,00
	0	Plastic Bottle (PB)	0,00
	0	Plastic non-Bottle (PnB)	0,00
	0	Metal (M)	0,00
	0	Glass (G)	0,00
	0	Residual (R)	0,00
Total % = 100%	(%)	Note: appear accordingly; and User defined input	

2) The Scenario Summary Template

Table 5-29 shows the scenario summary template. The sub-modules work with two types of group scenarios (Group A, B, C and Group I, II, III) and present in total 16 scenario variations. The groups A, B, and C are based on the waste fractions: unsorted, compostable and non-compostable, and compostable, recyclable, and unsorted. Groups I, II and III are based on suitable waste disposal and treatment method for the given kind of materials included in the waste.

In this scenario summary template only the column of 'Description' is considered as a 'user defined' column whereas the other columns are giving specific information. All percentage numbers in Table 5-29 are given as examples for the calculation in this study. The results in this module were all done under 100% of each waste fraction.

Table 5-29 Scenario summary template

Groups for STAN Material Flow	Groups for EASEWASTE suitable waste treatment and disposal	Scenario (S)	Description
Group A Unsorted waste	**Group I** **Disposal** (OD) and **Landfill** (SL, CL)	S1	Y % OD
		S2	Y % SL
		S3	Y % CL
	Group II **Compostable**: Composting (Clow, Chigh), Anaerobic Digestion (AD, CAD), Home Composting (HC) **Non-compostable and unsorted waste**: Incineration (InoER, I10%ER, ISTA)	S4	Y % InoER
		S5	Y % I10%ER
Group B Compostable and Non-Compostable Waste		S6	Y % ISTA; Y % Clow
		S7	Y % ISTA; Y % Chigh
		S8	Y % ISTA; Y % AD
		S9	Y % ISTA; Y % CAD
		S10	Y % ISTA; Y % HC
Group C Compostable, Recyclable and Residual	**Group III** **Compostable**: Composting (Clow, Chigh), Anaerobic Digestion (AD; CAD), Home Composting (HC) **Recyclable**: Recycling Technology (RT, RB) Residual: Landfill (CL)	S11	Y % Recycling; Y % Clow; Y % CL
		S12	Y % Recycling; Y % Chigh; Y % CL
		S13	Y % Recycling; Y % AD; Y % CL
		S14	Y % Recycling; Y % CAD; Y % CL
		S15	Y % Recycling; Y % HC; Y % CL
		S16	Y % RB; Y % HC%; Y % CL
Note: "Y" = user-defined input % and the sum should be 100%			

3) The Goal-oriented Scenario Template:

Table 5-30 shows the goal oriented scenario template. Using this table, the community may design scenarios for waste disposal and treatment. During the FGDs and workshops, the community determines where a certain waste fraction should be disposed or treated. What the community should consider is to make sure that 100% of each waste fraction ends up being treated by one or several of the waste technologies found in each scenario. The term "n.a." in this table means, such waste fraction is not allowed to be treated in the selected technology due to technology constraints or specific purpose. Therefore no input should be given under "n.a".

Table 5-30 Goal oriented scenario template

Waste Fraction (x)	OD %	SL %	CL %	InoER %	I10%ER %	ISTA %	Clow %	Chigh %	AD %	CAD %	HC %	RB %	RT %	Sum %	Con-troll (%)
Organic (O)	Y	Y	Y	Y	Y	n.a	Y	Y	Y	Y	Y	n.a	n.a	0	100
Paper (P)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Plastic Bottle (B)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Plastic non-Bottle (PnB)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Metal (M)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Glass (G)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Residual (R)	Y	Y	Y	Y	Y	Y	n.a	n.a	n.a	n.a	n.a	Y	Y	0	100
Note: n.a.= not allowed, Y= user defined input; = appear accordingly; control is the expected sum (100%)															

5.7.2.1 Material Flow Work with STAN

5.7.2.1.1 Methodology

The waste flows refer to the goal oriented scenarios in sub-module 3-1 and 3-2, and also waste bin capacity in sub-modul 4-1. The data used is based on waste characterization inventory (sub-module 1-3). The work on material flow was done through a material flow analysis (MFA)-software – STAN 2.5 (2012), developed by the Vienna University of Technology (TU-Wien). The software provides a tool to present material flow, where "I" is input and "E" is export data and the process from "I" to "E" can be balanced in a systematic way. The STAN team also provides assistance for anyone who works with the software and it is a freeware.

Equations for material flow:

Group A = Sum amount of total unsorted waste
= amount O + amount P + amount PB + amount PnB + amount G + amount M + amount PnB + amount R ………..(Eq.4)

Group B = Sum amount of compostable waste + Sum amount of non-compostable
= (amount O) + (amount P + amount PB + amount PnB + amount G + amount M + amount R)......(Eq.5)

Group C = Sum amount compostable waste + Sum amount recyclable waste + Sum amount residual waste
= (amount O) + (amount P + amount PB + amount PnB + amount M + amount G) + (amount R)....(Eq.6)

Note: O = organic; P = paper; PB =plastic bottle; PnB = plastic non bottle; M = metal; G =glass; R =residual
The unsorted waste in group B and C might also contain portions of O, P, PB, PnB, G, and M

The STAN software helps the facilitator team to transform the input from Table 5-30 in the form of a waste flow diagram in order to increase the understanding of the community. In the case where the software is not available, facilitator team can use Eq.4, Eq.5, and Eq.6. See Appendix F1.1 for Material Flow Template.

5.7.2.1.2 Results

Material Flow Analysis for Case Studies I and II

Figure 5-22 shows the material flows for the unsorted waste generated in case studies I and II (Treatment Group A) for unsorted waste. Further disposal or treatment regarding S1 through S5 was considered for the EIU. The visualization shows that the total waste can go to disposal (OD) or landfill (SL and CL) or incineration. The incineration options for this group are incineration with no energy recovery (InoER) or incineration with 10% energy recovery (I10%ER).

In case study I, the waste fraction, 'plastic non-bottle (PnB)' includes plastic bottles (PB). In case study II, since the community buys bottled mineral water, the plastic bottle contributes significantly to the number of the total waste amount and therefore a specific waste fraction for plastic bottles is given separately, PB and PnB.

Figure 5-23 shows the material flow for the compostable and non-compostable waste generated in case studies I and II (treatment Group B). The focus of this treatment group is to treat the compostable and non-compostable waste in S6 through S10. Treatment Group B excludes the recycling process. Here, the organic waste fraction is directed for specific organic treatments such as composting (Clow, Chigh, and HC) or anaerobic digestion (AD) or the combination of both (CAD). Other non-compostable goes to incineration state of the art (IStA). It includes portions of compostable which cannot be organically treated such as tree trunks. IStA consider no or less organic waste entering the treatment plant. In this calculation, 100% organic is assumed to be processed in organic treatment plants and this is the reason why the arrow relating the compostable and non-compostable shows no value or number "0.00".

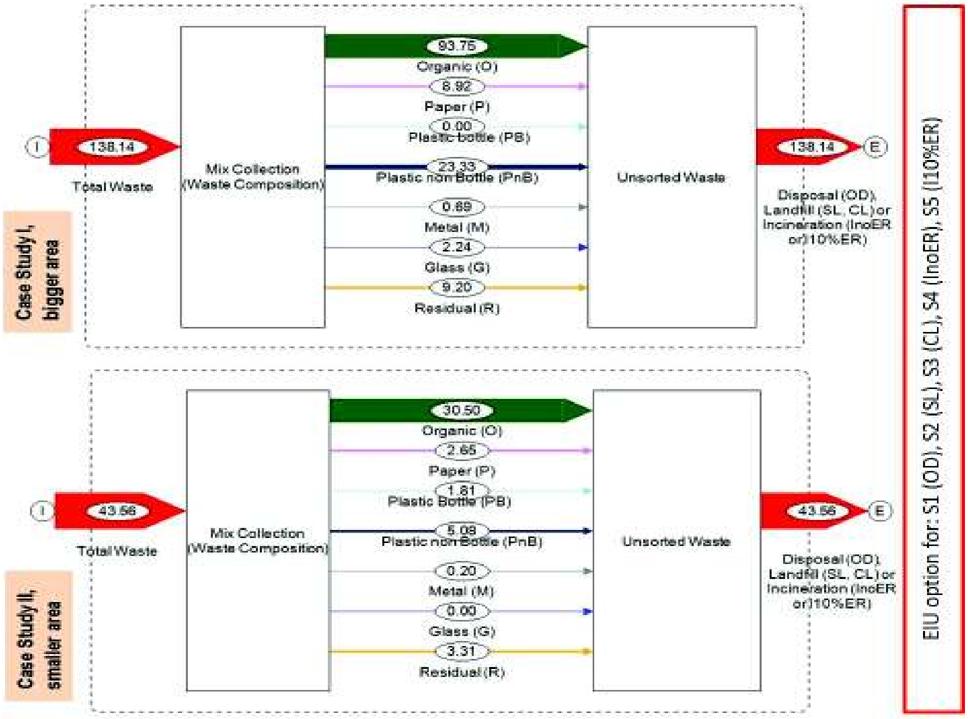


Figure 5-22 Material flow, Group A for S1-S5 (ton)

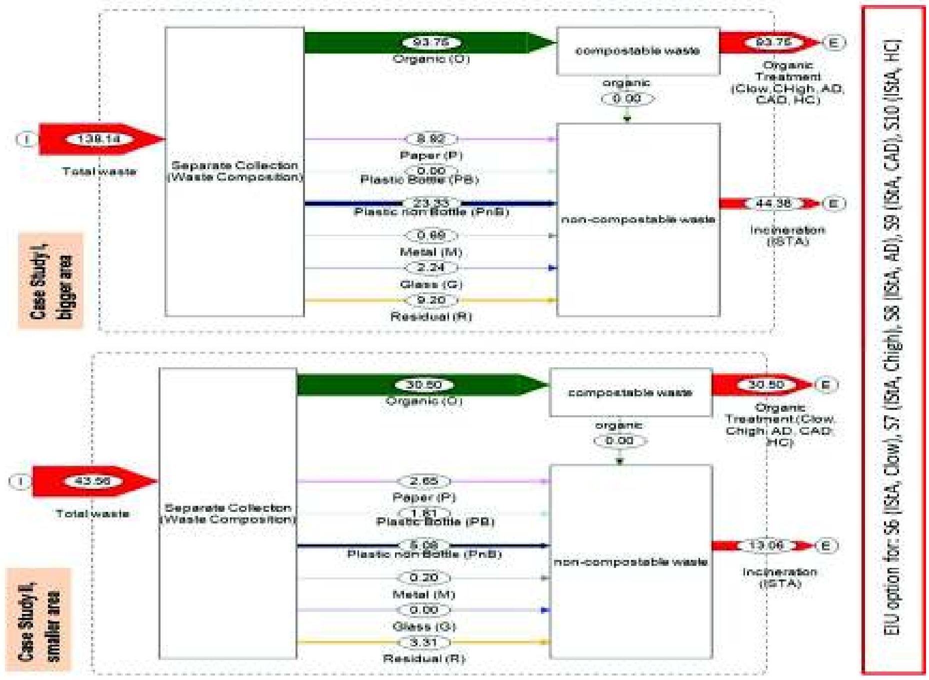


Figure 5-23 Material flow, Group B for S6-S10 (ton)

Figure 5-24 shows the material flow for the compostable, recyclable and unsorted waste (the rest) generated in case studies I and II (Treatment Group C). Here, the organic waste fraction is also directed to the specific organic waste treatment. The difference compared to the previous group is all recyclables will be recycled in specific recycling technology such as paper recycling technology, plastic recycling technology (RT) and also the “recycle bank (RB)”, instead of incinerated. Only small amounts of compostable and recyclable waste go to the unsorted waste and are then together with the residual waste sent to disposal or to the landfill. This group shows the processed amount in scenario 11 (S11) - scenario 16 (S16). In this calculation, 100% organic is assumed to be processed in organic treatment plants and 100% recyclables is assumed to be recycled. This is the reason why the arrow relating the compostable and unsorted waste, and also the recyclable and the unsorted waste show no value or “0.00”.

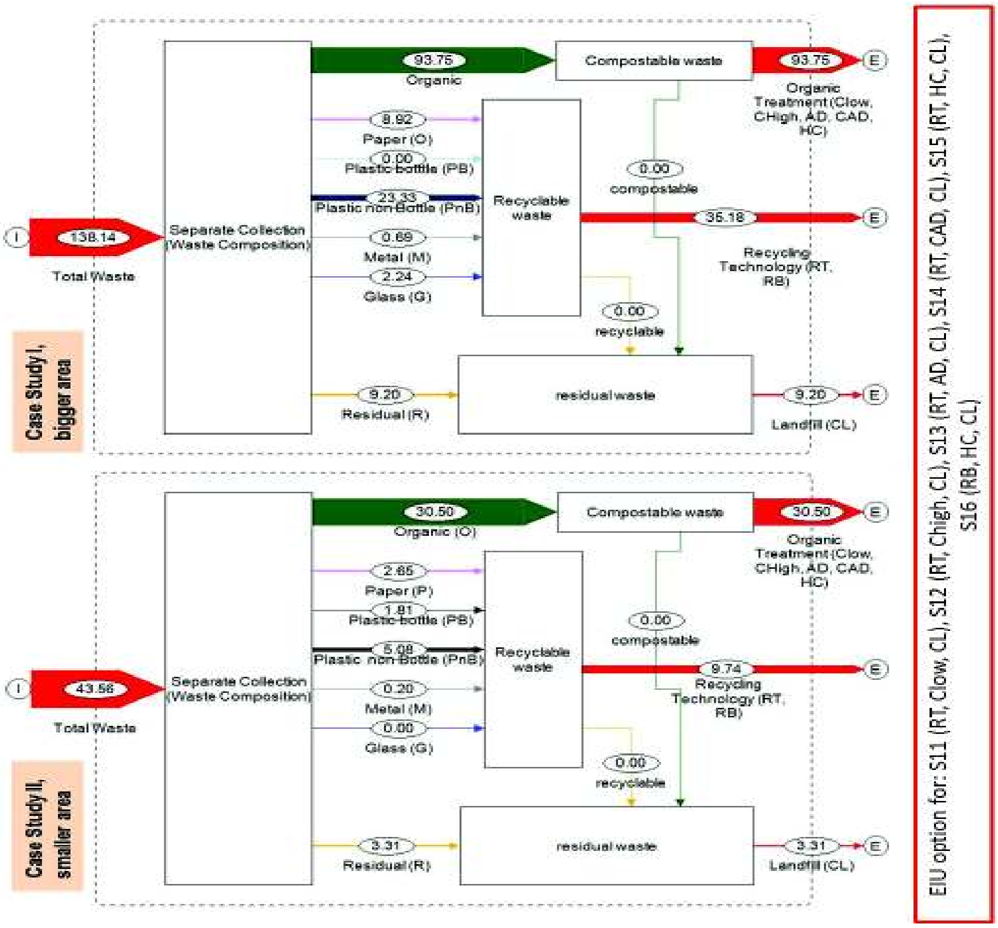


Figure 5-24 Material flow, Group C for S11-S16 (ton)

5.7.2.2 Environmental Impact work with EASEWASTE

5.7.2.2.1 Methodology

This and the next sections describe the development of Environmental Impact Unit (EIU) and Potential Output Unit (OU). The calculation template for EIU and OU in this sub-module were done through a Life Cycle Assessment Model – EASEWASTE (2012), developed by the Denmark University of Technology (DTU). The units used measure advantages and disadvantages of selected scenario. Both lead to the purpose of setting priorities for waste management in their neighborhood. The calculation of EIU and OU was developed under the supervision of the 3R Group, DTU. The results are expected to increase environmental awareness from any kind of waste treatment options. The calculation was done separately for the three groups (I, II, III) described in

Table 5-29 based on the material flow described in previous section (Section 5.7.2.1). The export data (E) from material flow groups are the input values for the work in this section.

In this calculation, some contextualization has been done in order to get results that fit better with the actual condition in Indonesia. Some settings were adjusted in the EASEWASTE model to simulate Indonesian, particularly Jakarta's condition as close as possible. The adjustments are on the data of groundwater contamination in Indonesia, Jakarta's precipitation rate and tropical climate condition for methane generation (See Appendix F5 for Environmental Impact Unit Data Set).

Environmental Impact Calculation

The Environmental EIU shows the impact of the selected impact categories. The EIUs are differentiated based on the impact categories in Figure 5-21 (nutrient enrichment, acidification, global warming, photochemical ozone formation and spoiled groundwater) and the waste fraction (organic, paper, plastic bottle, plastic non bottle, metal, glass and residual). Each EIU only represent 1 impact category and 1 fraction. The calculation of environmental impact should be done one by one, based on the waste fraction. Therefore the total environmental impact is known from the sum of the environmental impact from each waste fraction. (See Appendix F2).

Equation for Environmental Impact:

EI (X) = waste amount [X] * EIU (X)……………………………………………………………………………………………………(Eq.7)

Total Environmental Impact = (EI O + EI P + EI PB + EI PnB + EI M + EI G + EI R)……………………………………………(Eq.8)

Note: EI = Environmental Impact; EIU = Environmental Impact Unit; X = waste fraction(O, P, PB, PnB, M, G, or R)

Bellow, the equations 7 and 8 were used to demonstrate how to know the environmental impact from S1 (to dispose all unsorted waste in open dump (OD)):

From Figure 5-22, it is known that E = 138.14 ton (consist of 93.75 ton of O; 8.92 ton of P; no ton of PB; 23.33 ton of PnB; 0.69 of ton M; 2.24 ton of G, and 9.20 ton of of R). From Appendix F5, it is known that EIU-OD (per 1000 ton) for Organic are 0 PE nutrient enrichment; 0.1410 PE acidification; 201.8360 PE global warming; 36.6660 PE photochemical ozone formation; and 2068.0090 PE spoiled groundwater. Using Eq.7 it is known that the actual environmental impact for 93.75 ton of organic waste are 0 PE nutrient enrichment; 0.0038 PE acidification; 18.9226 PE global warming; 3.4375 PE photochemical ozone formation; and 193.8804 PE spoiled groundwater. In doing the same way to the other fractions and in the end the summing-up of all those results as in Eq.8 will bring the total environmental impact of S1.

5.7.2.2.2 Results

Environmental Impact

The calculation for impact assessment was done using the EASEWASTE model. The first impact assessment was done for treatment group I – disposal and landfilling for S1 through S3. Methane and leachate are important emissions in these 3 scenarios. The precipitation rate was adjusted to be 1706 mm annually (WMO 2102). For open dump (OD) scenario, it is assumed that no electricity and diesel are used and the soil and clay movements are zero. No gas and leachate are collected in the OD scenario. In the sanitary landfill (SL) scenario, it is assumed that the compactor makes use of electricity and diesel and there is soil and clay movement. There is no gas collection but there is leachate collection for SL. In the controlled landfill (CL) scenario, it is assumed that the use of electricity and diesel exist for the compactor and there is soil and clay movement. Gas and leachate collection occur in CL.

The methane calculation was done based on IPCC First Order Decay (see Appendix F3.1), within the period of 100 years, and divided into four time periods: time period 1 (the first 2 years), period 2 (the next 3 years), period 3 (the next 35 years) and period 4 (the last 60 years) for all 3 scenarios. The methane calculation was contextualized based on tropical climate. The operational parameters (the percentage of gas collected, the percentage of gas oxidation, the leachate generation and percentage of leachate generated) are based on the work of Damgaard (2011) and Tränkler (2005). (See Appendix F3.2 and Appendix F3.3 for detailed parameters used in calculation).

Figure 5-25 shows the environmental impact assessment for S1 through S3 (OD, SL, CL), which involve disposal and landfill in case studies I and II (see

Table 5-29). The results shown in the figure are expected to help the community gain a common understanding of effects of open dumping (shown by the blue line in the first rows) especially on ground water resources and global warming. This figure shows that those two impact categories are the most powerful factors in environmental degradation. Of the 3 scenarios, only scenario 3 has good results (a negative value) from global warming perspective. This is because it was assumed the generated gas is collected and transformed into heat and electricity. The leachate was assumed to be collected too, which brought positive effect on acidification and nutrient enrichment.

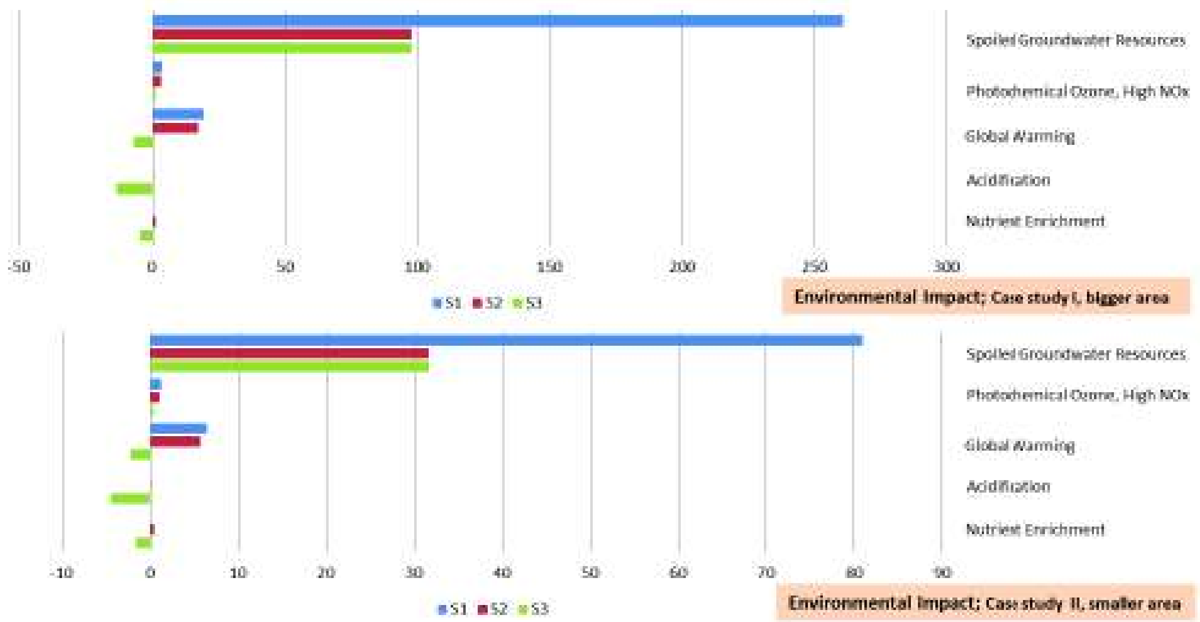


Figure 5-25 Result from the environmental analysis in S1-S3 (in PE)

Figure 5-26 shows the environmental impact from S4 through S10, which involves incineration (InoER, I10%ER or IStA) and organic waste treatment (Clow, Chigh, AD, CAD or HC) (see

Table 5-29). The results show significant impact on nutrient enrichment and acidification from the S6 and S7, which involves composting. These high values result from the substitution of fertilizer from composting. No spoiling of the ground water occurs in treatment group II since all treatments were considered to have no contact with the soil. In S4, the global warming impact is shown as being major in Incineration with no energy recovery (InoER) and this is because no emission control exists. By recovering 10% of energy in Incineration I10%ER, this impact can be reduced significantly (S5). However by integrating the Incineration state of the art (IStA) technology and composting, the global warming factor is still significant. The integration of both IStA and Anaerobic Digestion (AD) leads to a significant lowering of the global warming potential impact (a negative value). However AD could also be a problem for global warming if the emissions were not treated.

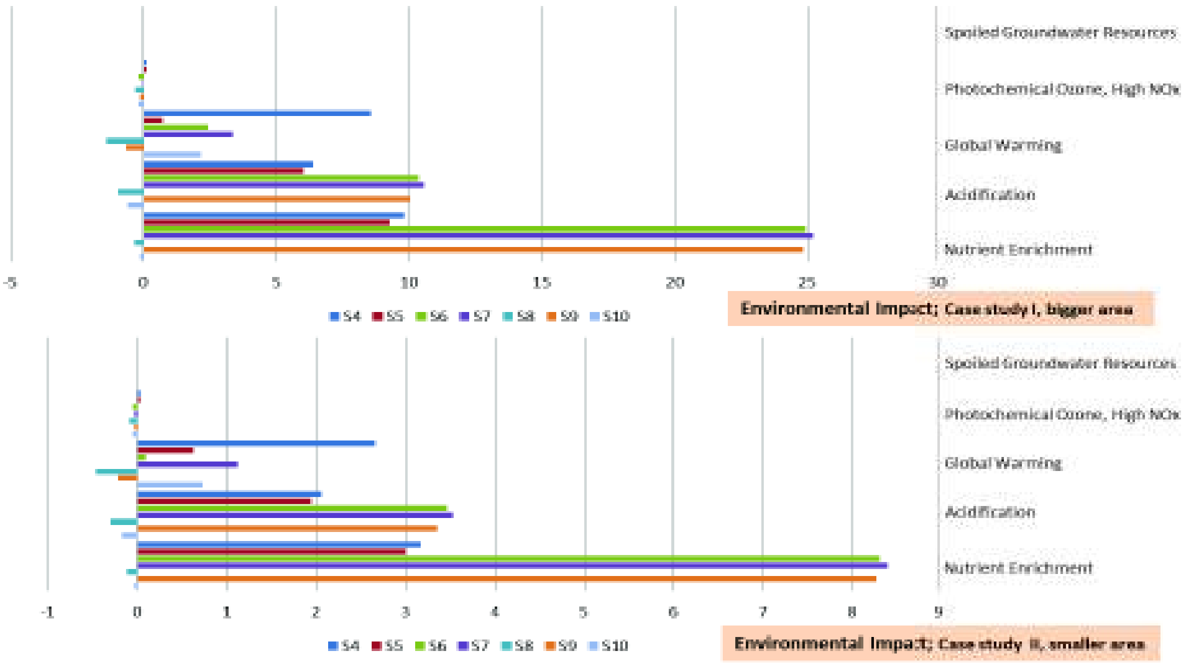


Figure 5-26 Results from the environmental impact analysis in S4-S10 (in PE)

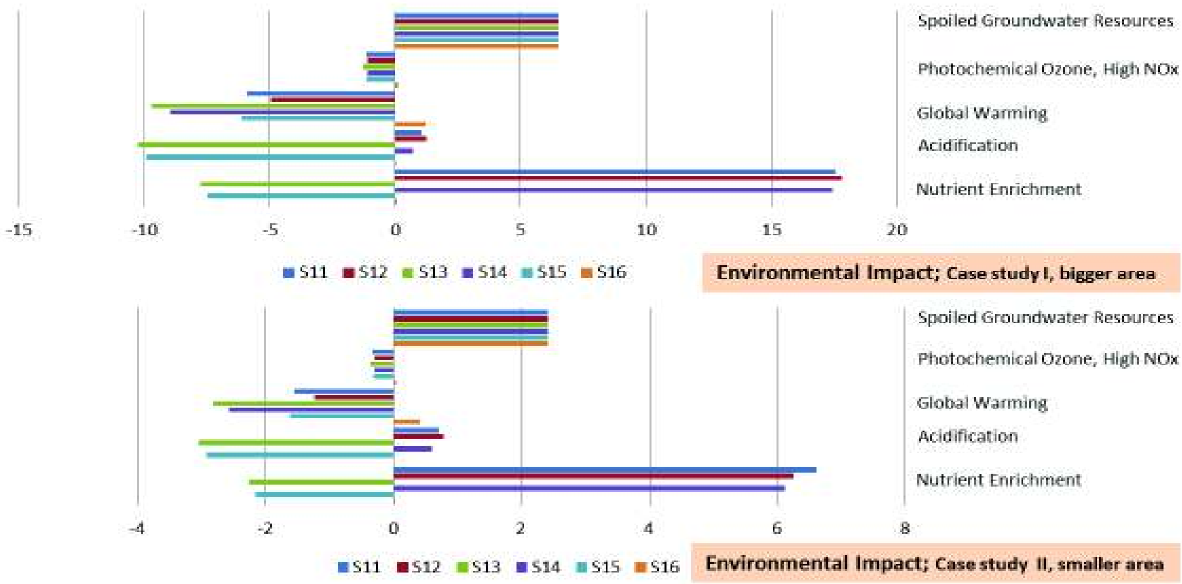


Figure 5-27 Results from the environmental impact analysis in S11-S16 (in PE)

Figure 5-27 shows the environmental impacts from S11 through S16 which involve recycling (RT), organic waste treatment (Clow, Chigh, AD, CAD, or HC), and landfill (CL) for the residual waste in case studies I and II (see

Table 5-29). Since the waste composition from both case studies are mainly organics, only landfilling of the residual waste reduces the global warming potential (a negative value). The significant impact in terms of spoiled ground water was the result of the landfill option. Nutrient enrichment was the result of the composting. In treatment group III, the most interesting aspect is the good impact (negative values) due to the utilization of recycling technologies had on reducing the contributions of waste management to global warming. In this calculation, substitution of approximately 90% of virgin material recycled materials was considered.

Summary Assessment for Environmental Impact

Figure 5-28 shows the summary results of the environmental impact for all scenarios (Figure 5-25 through Figure 5-27). This presentation of the findings clearly shows that the first three scenarios (S1 through S3) are the most critical regarding environmental degradation. This figure can give a lot of very complex information in a “simple-way-to-understand” form. It can shape the strong set of reasons to community members to leave behind their culture of illegal dumping or open dumping since many community members consume groundwater. Also the findings represented in the figure could give a strong reason for rejecting proposals to build a landfill within the vicinity of their neighborhood. However, the repetition of results is necessary to help the community really internalize the findings shown here and to understand how their everyday waste management related activities influence their environment.

Figure 5-28 indicates only the general trends on environmental impact on waste management as many simplifications and assumptions have been taken, but the information is enough to build opinions through the decision making process. This information can be proliferated through the product of Module 2 – Information System and Communication Network (see section 5.6) and through media workshops and FGDs.

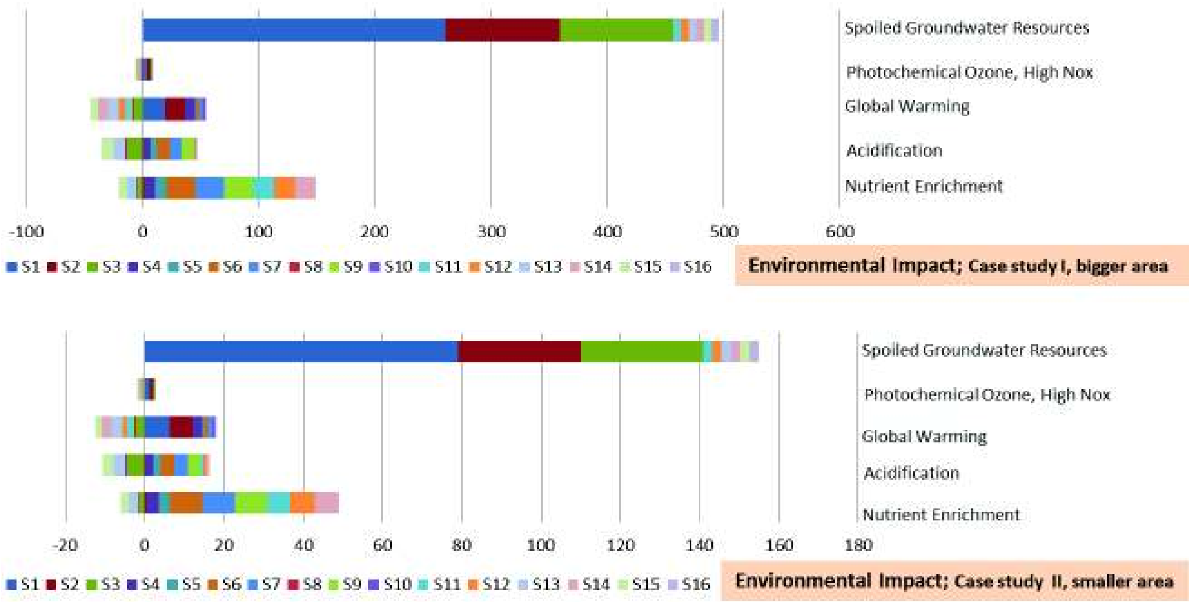


Figure 5-28 Result from the environmental impact for S1-S16 (in PE)

5.7.2.3 Potential Output work with EASEWASTE

5.7.2.3.1 Methodology

Output Calculation

The calculation of potential outputs was done with the EASEWASTE model. The Output Unit (OU) in this model is to inform the decision makers, particularly the community members, of the potential products from the selected scenario. The output calculation is similar with environmental impact calculation. The OUs are differentiated based on the waste fraction and the potential products. 7 groups of products were designed to demonstrate the information in a simple way. (See Appendix F2 for detailed technical measures of the treatment technologies)

The **first** product group is addressed for disposal (OD) and landfills (SL, CL), which potentially produce methane emissions from organic and paper waste. The **second** group is addressed for incineration technologies (InoER, I10%ER, IStA), which potentially produce APC residue, bottom ash and lower heating value from all waste fractions. The **third** product group is addressed for composting technologies (Clow, Chigh), which potentially produce compost from organic waste. The **fourth** product group is addressed for anaerobic digestion technology (AD), which potentially produces digestate, methane and energy in biogas from organic waste. The **fifth** product group is addressed for combined composting and anaerobic digestion technology (CAD), which potentially produces composted digestate, methane, and energy in biogas from organic waste. The **sixth** product group is addressed for home composing (HC), which potentially produces compost from organic waste. The **seventh** (last) product group is addressed for recycling technology which potentially produces recyclables (glass, cardboard, plastic bottle, plastic product and aluminum). In the case of recycle bank (RB), it should be included in the last product group. Currently there is no available data related to the RB activities and therefore there is no OU for RB. (See Appendix F6 for the Output Unit – Emissions and other products)

In output calculation, paper waste is not considered for composting. In the case of Indonesia, more than 50% of waste is organic waste and it is enough for composting activities. Paper waste in this study is assumed to be consisting of 10% news prints, 70% of paper and cardboard container and only 10% clean paper and therefore it is addressed for new cardboards (see Appendix F1).

Equation for Output:

O (X) = waste amount [X] * OU [X]………………………………………………………………………………………………(Eq.9)

Total Output = (OU O + OU P + OU PB + OU PnB + OU M + OU G + OU R)…………………………………………………(Eq.10)

Note: O = Output; OU= Output Unit; X : waste fraction (O, P, PB, PnB, M, G, or R)

See footnote for more information about EASEWASTE[2]

[2] The EASEWASTE Model is a complex model which manages the waste from the generation point until the treatment and focuses on the Life Cycle Analysis. The EASEWASTE team holds every year a PhD-course for students from all over the world. This course gave the chance for the author of this research to understand more about the model in 2010. Furthermore, the team committed to assisting the author to work further with the model. The terminologies used for environmental impact and the output were adapted from EASEWASTE model (http://www.easewaste.dk).

5.7.2.3.2 Results

Potential Output

The first assessment of potential output was done for the methods which generate Methane emission (OD, SL, CL, AD, and CAD) and energy from biogas (AD and CAD). Figure 5-29 shows the summary output in the form of methane emissions and the energetic utilization of biogas from these scenarios. Anaerobic digestion (AD) shows the most potential in generating the energy due to biogas generation compare to CAD. S8 and S13 involved 100% organic waste treatment in an anaerobic digestion (AD) plant, whereas both S9 and S14 combined the composting and anaerobic digestion (CAD) processes. The potential emissions from all scenarios in Figure 5-29 were produced from controlled landfill (CL).

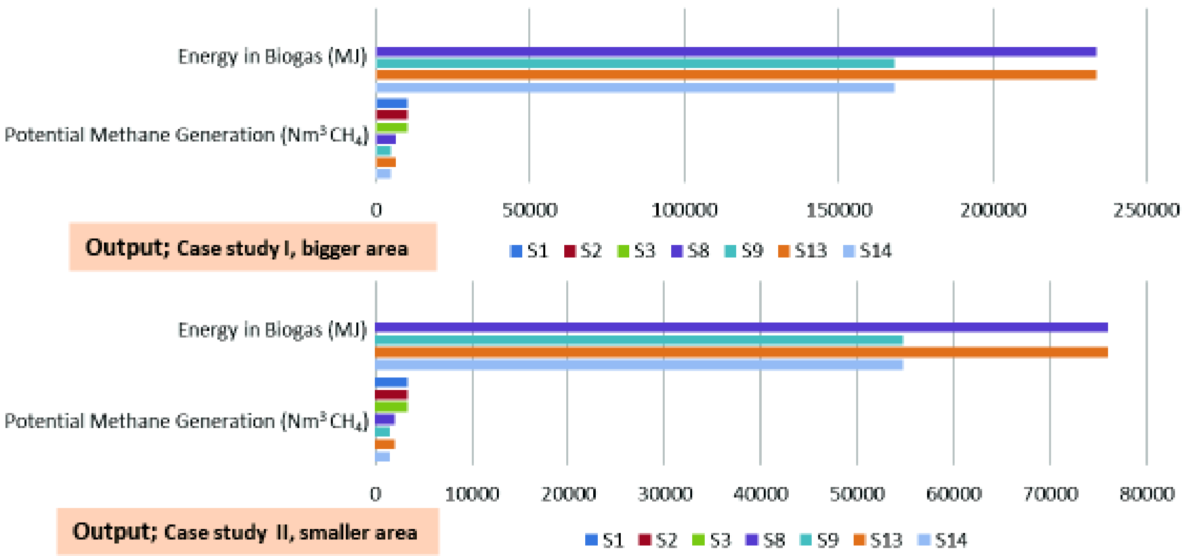


Figure 5-29 Scenarios which involve methane generation due to landfill gas and biogas

Figure 5-30 gives a summary of the S4 through S10, which potentially generate Air Pollution Control (APC) residue, bottom ash and the lower heating value. These are the products from an incineration plant (InoER, I10%ER or IStA) (see Figure 5-21). In terms of their respective outputs, the scenarios which involved incineration of unsorted waste (incineration with no energy recovery (InoER) in S4 and incineration with 10% energy recovery (I10%ER) in S5) generated the highest amount of bottom ash, heating value and residue. Scenarios which involve incineration state of the art (IStA) could reduce the generation of the outputs due to the absence of organic waste. Since IStA should be combined with other methods of compostable waste treatments (Clow, Chigh, AD, CAD or HC), scenarios which involved IStA (S5 through S10) will have other outputs from those combined methods (see Figure 5-31).

Figure 5-31 summarizes the outputs from compostable waste treatment in S6 through S16, which potentially generate compost (Clow, Chigh, or HC), digestate (AD) and composted digestate (CAD) from organic treatment (see Figure 5-21). Based on weight (ton), the digestate is the biggest output. The digestate contains a lot of water (liquid form). By means of compost product, the scenarios with home composting (S10, S15 and S16) have the potential to produce more compost. Additional output from non-compostable waste treatment can be seen in Figure 5-30 for S4 through S10 and Figure 5-32 for S11 through S13.

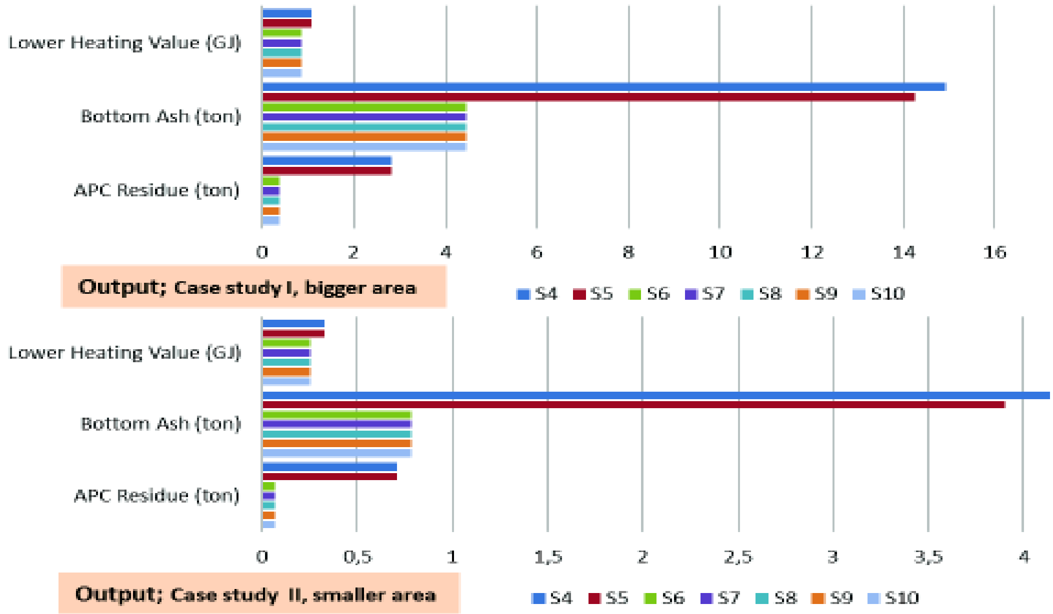


Figure 5-30 Scenarios which involve APC residue, bottom ash and heating value

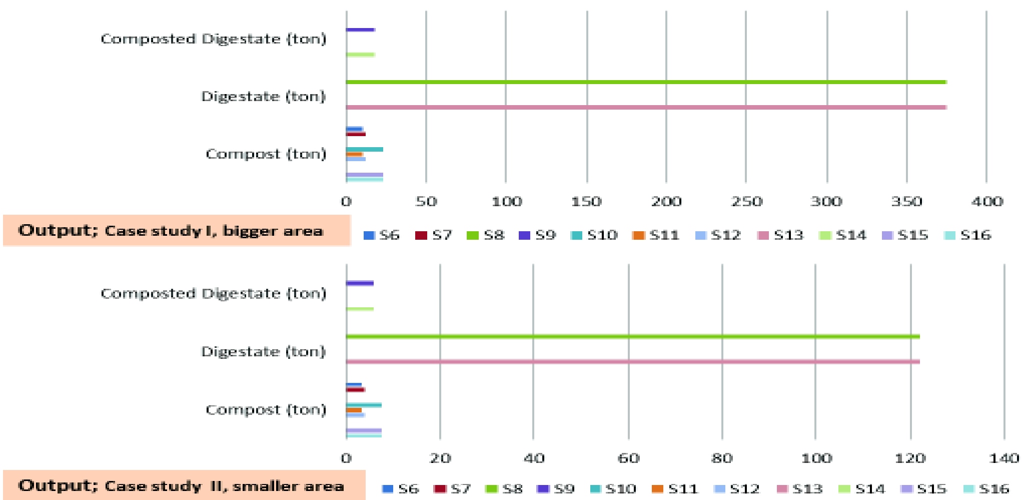


Figure 5-31 Scenarios which involve compost, digestate and composted digestate

Figure 5-32 shows the summary output from scenarios which involve recycling technologies (S11-S16) from the non-compostable waste (see Figure 5-21). All recyclables can be potentially used to generate recyclable products. In recycling industries, these recyclable products will substitute for a significant portion of virgin material. However, as there is no database for recycle bank (RB) products, the products of S16 cannot be calculated. In case study I, the larger area, the plastic bottles were assumed to be processed together with the other plastics. In case study II, the plastic bottles and other plastics were assumed to be processed separately. Other products from S11 through S6 can be seen from Figure 5-31.

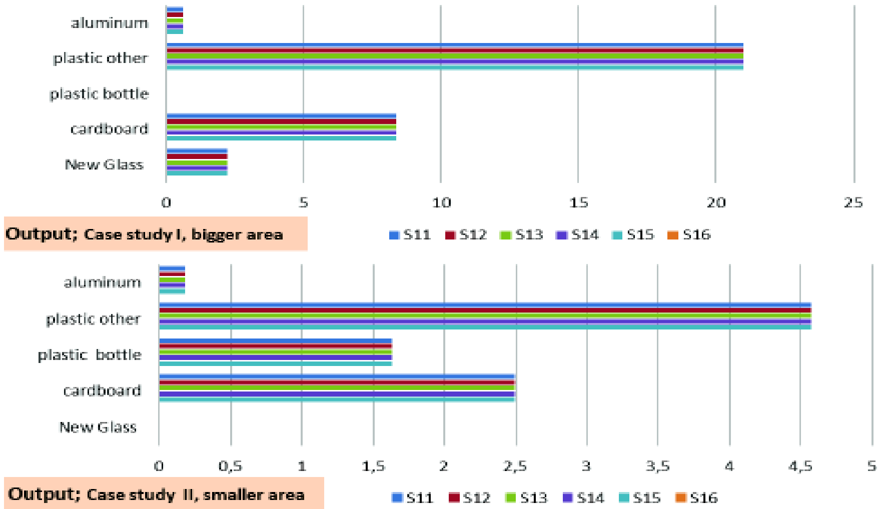


Figure 5-32 Scenarios which involve recyclables (excluding the recycle bank)

Summary Assessment for Potential Output

It is not possible to make all OU has the same unit like PE in EIU and for this reason the summary figure like Figure 5-28 was not created. The summary of the 7 group products can be seen in Appendix SS. The treatment group I (S1-S3) involves disposal and landfill treatments and the potential output is methane emissions (OD, SL, CL) (see Figure 5-29). The generation of methane is the same for each type of landfill and disposal methods as they processed the same amount of waste (unsorted waste).

The treatment group II (S4-S10) involves incineration for the non-compostable waste (InoER, I10%ER, IStA) and composting (Clow, Chigh, or HC), anaerobic digestion (AD) and combined composting-anaerobic digestion (CAD) for the compostable waste treatment (see Figure 5-29). In this treatment group, the incineration state of the art (IStA) shows a significant reduction in APC residue and bottom ash and a lower heating value, compared to other incinerations (InoER and I10%ER). This incineration group generates other products from compostable waste treatment such as compost, digestate, composted digestate and energy in biogas.

In terms of recycling in treatment group III (S11-S16), all recyclables have the potential to become new products made out of materials recovered from recycling activities. Having recyclable products could be preferable to the community.

Additionally, for both in compostable waste treatment groups II and III, the compost product from home composting (HC) potentially produces more compost compared to other composting processes (Clow and CHigh). On the other hand, anaerobic digestion has the potential to generate energy as biogas although the large amount of the digestate produced could be a problem as it is not easy to transfer to locations that are at a great distance from where it is produced.

As the complement finding of the environmental impact, the presentation of outputs in this section add new information for the community. The community can have a better picture of the potential output and the use of those outputs. This information can be proliferated through the product of Module 2 – Information System and Communication Network (see section 5.6) through media workshops and FGDs.

5.7. 3 Sub Module 3-3 Economic Cost and Benefit

The economic cost and benefit analysis provides assistance in calculating the costs and benefits from selected technologies. The cost benefit analysis presents data on expenditures, represented by the Cost Unit (CU) and revenues, represented by the BU (Benefit Unit). Unfortunately, due to time limitation associated with the development of this model, only a framework for this kind of assessment is given. The input as cost and benefit units of this assessment are based on assumptions. Further research in this area is needed and could be the focus of future work.

5.7.3.1 Methodology

The methods presented below are for consideration for future development of the model. In general the cost assessment includes all technology options, different supplier's profile (investment and the operational cost), and the CU based on certain currency (Euro (€), Dollar ($), or Indonesian Rupiah (IDR)). The benefit assessment includes cost on the international market and the price of the potential products such as energy, compost, and recyclables.

Equation for Cost Assessment:

Cost (X) = waste amount (X) * CU (X)……………………………………………………………………………………………..(Eq.11a)

Total Cost = Cost O + Cost P + Cost PB + Cost PnB + Cost M + Cost G + Cost R ………………………………………(Eq.12a)

Note: CU = Cost Unit; X : waste fraction (O, P, PB, PnB, M, G, or R)

Equation for Benefit Assessment:

Benefit (X) = waste amount (X) * BU (X)………………………………………………………………………………………….(Eq.11b)

Total Benefit = Benefit O + Benefit P + Benefit PB + Benefit PnB + Benefit M + Benefit G + Benefit R ……(Eq.12b)

Note: O = Output; X : waste fraction (O, P, PB, PnB, M, G, or R)

5.7.3.2 Results

Since prices are strongly varying related to time and location, no value was obtained in this study during the field research.

5.8 Module 4 – Collection System

Module 4, the collection system, consists of 3 sub-modules. It provides users with assistance on how to manage the collection system based on the selected scenarios in sub-module 3-1. The calculation of bins capacity in sub-module 4-1 and the bin allocation in sub-module 4-2 helps the community to figure the waste stream from the generation points to the temporary collection points.

5.8.1 Overview

Table 5-31 gives an overview on how the three sub-modules. In this way the community should be aware of where the temporary collection points are located and where the points that have the most convenient access are. The community can, for example, decides where to locate any waste bins depending on what paths are used to go to the public transport stations, to regular events going on within the area, to buy some vegetables or other items in grocery or other stores.

Table 5-31 Structure and product - Module 4

Sub-module	Name	Considered Aspect	Related Sub-Models	Media	Time Consumption
4-1	**Bins Capacities for Drop-off Systems**	Economic	1-2; 2-1;2-2;2-3;3-1	FGD, GIS	Approximately 2 Weeks
4-2	**Bins Allocation and the Service Coverage Map**	Social, Environmental	1-1; 2-1, 2-2; 2-3; 4-1	FGD, GIS	
4-3	**Collection Route Map**	Economic	1-1; 2-1; 2-2; 2-3; 4-2	FGD, GIS	
		Product: Waste Collection System			

FGD = Focus Group Discussion, GIS = Geographic Information System

Many factors are involved in designing an effective waste collection system, such as the size of the waste bins, suitable locations for their placement, and the collection vehicles.

Table 5-32 shows the parameters which are developed to assist the work on Module 4. The value for some parameters was assumed based on the previous work of collection systems and mainly from research which has been done in developing countries. Some input parameters have to be defined by the users and should be discussed among the community members. The safety factor was added to accommodate the increasing waste generation in the future. The sensitive area buffer shows the area which is off limits for waste bins.

Table 5-32 Parameters used in Module 4 for collection system

No.	Parameter	Specifications	Assumption	Source and Note
1	**Waste Amounts**	See material flows (Section 5.7.2.1)		
2	**Waste Density**	Compostable	250 kg/m^3	EnvirosRIS 2001
		Recyclable	55 kg/m^3	EnvirosRIS 2001
		Residual	90 kg/m^3	Ahmed 2006
		Unsorted waste	190 kg/m^3	UNEP 2005
2	**Safety Factor**	All waste fractions	40%	Chalkias 2009 and Ahmed 2006
3	**Convenience Distance to Waste Bins in Drop-off System**	Personal walking	100 m (max)	Illeperuma 2007
		Car driving	300 m (max)	Illeperuma, 2007
4	**Sensitive Area Buffer**	Religious facilities (surrounding)	20 m	Ahmed 2009; Chalkias 2009, and Illeperuma 2007
		Cemetery (surrounding)	20 m	
		River, and	15 m	
		Other water bodies	15 m	
5	**Required Waste Bins Capacity**	To be defined by the user		See Table 5-36 for available bins
6	**Number of Waste Collection Points**	To be defined by the user		Consider the nodes
7	**Collection Frequency**	To be defined by the user		Consider weekdays and weekends

In sub-module 4-3, two scenarios (Table 5-33) for the collection system are developed under two set of conditions: outside treatments (join the municipality treatment) for unsorted or source separated waste and inside treatments (combined self-managed and the municipality treatment) for source separated waste. These scenarios (SA and SB) are designed for drop-off system.

There are two options of waste collection, a drop-off or a pick-up system. In a drop-off system, the community members have to deliver their waste to temporary waste collection point whereas in a pick-up system the waste operator does door-to-door waste collection. This study will not discuss a pick-up system as an option specifically, since the accesses and houses in *kampung* settlements may quickly change and therefore the door-to-door waste collection route is too flexible. Moreover, the pick-up collection system does not involve bins at the temporary collection point within the area and therefore calculation of the bin sizes is not necessary. In the case where a pick-up system is inevitable, the collection route in the drop-off system can be used as the main route for door-to-door collection or applied together with the pick-up system.

Table 5-33 Scenarios considered in Module 4 for collection system

Scenario	Collection Type	Waste Type	Treatment Possibility
Scenario A (SA)	Drop-off	Unsorted waste and source separated waste	Outside, join the municipality's treatment
Scenario B (SB)	Drop-off	Source separated waste	Combined self-managed and municipality treatment

5.8.2 Sub Module 4-1 Bin Capacity

The waste bin capacity sub-module provides assistance to determine the number and the size of bins (based on volume) which are needed for the on-site drop-off collection systems. Community decisions done through the product of Module 2 will define whether or not the community is ready to separate the waste at the source and what they want to do with the waste.

5.8.2.1 Methodology

The bin size depends mainly on the number of inhabitants living in the connected households and the specific waste generation rate for the respective area. The calculation for the bin size is only done under the scenario which involves a drop-off collection system that is scenario A (SA) and scenario B (SB). Three calculation templates were prepared for the calculation.

1) The Generate Waste Amount (TWA) Template

The data source for the 'waste amount' is taken from material flow group A and C in sub-module 3-1 (see

Table 5-29). It is important to know whether the selected scenario involves unsorted waste or separated waste (compostable, recyclables and residual waste). Those two possibilities determine the waste streams differently and thus also influence waste bin size. The decision is done by the community based on the product of module 2.

Table 5-34 shows the waste streams and the collection frequency template. The collection frequency is a 'user defined' column. It defines the collective days of the waste on weekdays and weekends for each collection time. In Table 5-34 the accumulation of the collection days is every 2 days during the week and every 3 days at the weekend (Monday + 2 days in a weekend) are givens as an example for the calculation in this study. The 3 days for accumulation after the weekend is simply to consider the weekend as non-working days. The total waste amount (TWA) in the weekday and weekend will appear accordingly based on Eq.15.

Table 5-34 Waste flows and the collection frequency template

Calculation of Total Generated Waste Amount						
Waste Type		Waste Amount (kg/day)	Accumulation of Collection Day (days)		Total Waste Amount (TWA) (kg)	
			weekday	weekend	weekday	weekend
SA	Unsorted Waste	[Material Flow A]: 365	2	3	#VALUE!	#VALUE!
SB	Compostables	[Material Flow C]: 365	2	3	#VALUE!	#VALUE!
	Recyclables	[Material Flow C]: 365	2	3	#VALUE!	#VALUE!
	Residuals	[Material Flow C]: 365	2	3	#VALUE!	#VALUE!

Note: ▢ = user defined input; ▢ = appear accordingly

Equation for the total amount of waste:

TWA (weekday or weekend) = Waste amount * accumulation of collection day……….(Eq.15)

Note: TWA= Total Waste Amount

2) The Total Waste Amount per Temporary Collection Point (TWATCP) Template

Table 5-35 shows the template to calculate stored waste per collection point. The number of collection points is a user defined column. It shows the number of temporary collection points which are designed to be placed in the area. In Table 5-35 the number of 5 is given as an example. The total waste amount per collection will appear accordingly based on Eq. 16.

The stored waste amount per collection points is assumed to be the same for each point. In the case that every collection point is not designed to serve the same amount of waste, the calculation of TWATCP should be done for each collection point separately and the ipit number for the collection point in Table 5-35 should be given as 1.

Table 5-35 The stored waste per collection points template

The Stored Waste Amount per Collection Point				
Waste Type		Number of Temporary Collection Points (TCP)	Total Waste Amount per Collection Point (TWATCP) (kg)	
			weekday	weekend
SA	Unsorted Waste	5	#VALUE!	#VALUE!
SB	Compostables	5	#VALUE!	#VALUE!
	Recyclables	5	#VALUE!	#VALUE!
	Residuals	5	#VALUE!	#VALUE!

Note: ▢ = user-defined input; ▢ = appear accordingly

Equation for the amount of waste per temporary collection points:

TWATCP = TWA weekday or weekend/TCP………………………………………………………………………………………………….(Eq.16)

Note: TWATCP= Total Waste Amount per Collection Point; TCP= number of Temporary Collection Points

3) The Waste Bin Number and Size (N) Template

Table 5-36 shows examples of waste bins available on the market which are usable for drop-off and pick-up collection system. The table provides information on the waste bin's capacity (l) and dimension (m^3) and also plastic bags. Table 5-36 will assist the community to select the preferable bin size and the requirement area to allocate the bins. Waste bins type A-E were chosen for the calculation in this study. Additionally, the plastic bag was given as type F to accommodate a special case for example; no places are available, unclear waste generation amount, and no available collection vehicles. There are more alternative waste bin types and sizes available from regional producers.

Table 5-36 Waste bins available at the market (example)

Type	Photo	Dimension (H*W*D) (mm)	Capacity (l)
A		1370*1260*990	1100
B		1370*1260*730	660
C		1100*665*880	360
D		1100*740*580	240
E		1075*555*505	120
F		various	various

Source: (A)-(E). Merton (2012) and (F). St. Catharines (2012)

The total waste volume per collection point (R) and number of bins based on the type of bins (N) will appear accordingly based on Eq. 17 and Eq. 18 respectively. The bin size can also be modified using Table 5-38.

Table 5-37 shows the template to determine the bin size required. The required waste density parameter (WD) and the safety factor (SF) were taken from Table 5-32's parameters which are necessary for module 4. At this level there will be no 'user defined' column anymore. The community may select which types and the number of bins is appropriate for their neighborhood as described in Table 5-38. The total waste volume per collection point (R) and number of bins based on the type of bins (N) will appear accordingly based on Eq. 17 and Eq. 18 respectively. The bin size can also be modified using Table 5-38.

Table 5-37 The requirement of bin size template

Waste Volume per Collection Point Requirement							
Waste Type		Waste Density (WD) (kg/m³)	Waste Volume per Collection Point (l)		Safety Factor (SF) (%)	Total Waste Volume per Collection Point (R) (l)	
			weekday	weekend		weekday	weekend
S1	Unsorted Waste	190	#VALUE!	#VALUE!	40%	#VALUE!	#VALUE!
S2	Compostables	250	#VALUE!	#VALUE!	40%	#VALUE!	#VALUE!
	Recyclables	55	#VALUE!	#VALUE!	40%	#VALUE!	#VALUE!
	Residuals	90	#VALUE!	#VALUE!	40%	#VALUE!	#VALUE!

Note: = appear accordingly

Table 5-38 The bins number and size possibilities template

Bins Size Possibilities						
Waste Type		Number of Bins based-on Bin Types (N)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	Unsorted Waste	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
SB	Compostables	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
	Recyclables	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
	Residuals	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!

Note: = appear accordingly

Equation for the bins size:

R = TWATCP*1000 /WD*(1-SF) .... (Eq.17)

N = R maximum value/ capacity of the bins... (Eq.18)

Note: In this calculation, 100% is considered is the condition of the bins capacity. R= required bins size;

R weekend is chosen as maximum value because it shows a larger amount compared to R weekday. The larger waste requirement is chosen for the calculation since it guarantees that a lower requirement also fits into the calculation.

Additionally, in the case of bins with size variation, the calculation of N waste should be done separately. .

Table 5-39 gives an example of bins with size variation. The table shows bins of type of D, C, and E. The total bin's calculation for compostable appears accordingly after the required bin size (R) for compostable is divided by the required size or based on Eq. 19.

Table 5-39 The option for waste bin with different sizes template

Alternative Bins Variation			
Waste Type		Bins type	Number of Bins based-on Bin Types (N)
SB	Compostable	D (240 l)	#VALUE!
	Recyclables	C (360 l)	#VALUE!
	Residuals	E (120 l)	#VALUE!

Note: = user-defined input; = appear accordingly

Equation for bin size with variation:

N = R maximum value (waste type) / capacity of the bins……………………………………………………………………….(Eq.19)

Note: N= number of bins based-on bin types

5.8.2.2 Results

Table 5-40 shows the calculation results for required bin volume and sizes per collection point for case study I and Table 5-41for case study II (detailed results in Appendix G). The results gives possibilities for different bin sizes but the calculated value have to be rounded up to the amount with decimal number bigger than 9. They have also been given with decimals to see the tendency regarding the optimum number. The bigger the volume, the smaller the number of bins is required.

Table 5-40 Bin size possibilities, Case Study I

Bin Size Possibilities						
Scenario	Waste Type	Number of Bins based-on Bin Types (N)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	Unsorted Waste	0.75 (1)	1.26 (2)	2.31 (3)	3.46 (4)	6.92 (7)
SB	Compostables	0.39 (1)	0.65 (1)	1.19 (2)	1.78 (2)	3.57 (4)
	Reyclables	0.66 (1)	1.11 (2)	2.03 (2)	3.04 (3)	6.08 (6)
	Residuals	0.11 (1)	0.18 (1)	0.32 (1)	0.49 (1)	0.97 (1)

Note: the given temporary collection point number in this calculation was "12" (see entry of Table 5-35).
The number between brackets or '(number)' resulted after it was rounded up for decimals > 0.09.

Table 5-41 Bin possibilities, Case Study II

Bins Size Possibilities						
Scenario	Waste Type	Number of Bins based-on Bin Types (N)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	Unsorted Waste	1.43 (2)	2.38 (3)	4.36 (5)	6.54 (7)	13.09 (14)
SB	Compostables	0.76 (1)	1.27 (2)	2.32 (3)	3.48 (4)	6.96 (7)
	Reyclables	1.10 (2)	1.84 (2)	3.37 (4)	5.05 (5)	10.11 (11)
	Residuals	0.23 (1)	0.38 (1)	0.70 (1)	1.05 (1)	2.10 (3)

Note: the given temporary collection point number in this calculation was "2" (see entry of Table 5-35).
The number between brackets or '(number)' resulted after it was rounded up for decimals > 0.09.

For example in case study I, if the community decided to select Scenario A and bin type A (drop off system, unsorted waste bin volume of 1100 l in each collection point, from total 12 points), one bin in each temporary collection point is enough to serve the area.

In both cases, the less 'rounded up' gap can be taken as consideration for decision making as it shows the most effective waste bin volume. This will result, for example in case study I for SA, option of one waste bin A, and for SB two waste bins with D for compostable, two waste bins C or three waste bins D for recyclables, and 1 waste bin E for residual waste.

Another consideration would be the least number of bins with the smallest size, for example in case study II for SA, option of 2 waste bins A, and for SB one waste bin A for compostable, 2 waste bins B for recyclables and 1 waste bin D for residual waste. However, in all cases, the community should consider the sizes for the available area and the available capital.

5.8.3 Sub Module 4-2 Bins Allocation and Service Coverage Maps

Selecting suitable locations for waste bins is important. The bin's allocation and service coverage map sub-module provides assistance to determine the map-based bin locations. The waste bins should be located in a convenient walking distance and/or located at a node. Under these conditions the habit of putting the waste into the waste bins can be learned more easily and done in parallel with other activities (see Table 5-4 for daily life activities in case studies I and II).

Often the allocation of waste bins is related to the socio-cultural values and the geographic conditions of a neighborhood. Some restrictions on waste bin locations may also apply and be shown by the sensitive buffer area. This is mainly in places which are related to religious activities.

5.8.3.1 Methodology

The sensitive buffer area and the nodes are the necessary components for defining the suitable places for bin allocation. The following describes the stepwise procedure in finding suitable locations for bins:

1) Determining the sensitive buffer area

Sensitive buffer area is a buffer which covers the surroundings of a sensitive area. It corresponds to the area which is restricted to waste bins and therefore the bins must be in places outside the buffer area. The sensitive area may include religious facilities, sacred places such as cemeteries, rivers and other water bodies, and any places which are not considered as a suitable place for waste bins allocation as the result of the FGD (through the product of module 2). Each sensitive area may have a different size buffer. The examples of the sizes are given in Table 5-32.

2) Determining the nodes

Table 5-42 describes the node characteristics, which were used to define the meeting points (see section 5.6.2, sub-module 2-2). A node in this study is defined as a meeting point of human activities and a redistribution point for information. Since a node show places which are often circulated by the community members, in this study the nodes are used to show the potential or a 'magnet' for locating the waste bins. Each location is designed to serve the surrounding area, based on a convenient distance for walking or driving. The examples of the sizes are given in Table 5-32.

There are two types of nodes, big and small nodes; the terms big and small are keys to referring to the scope of the users. The big node is normally a public facility which has limited capacity but can be used by all the community. It will have many purposes. The smaller nodes are normally private and provide services and therefore are only used by the community in the vicinity with specific purposes. Typically, the collection of nodes forms attractive and strategic locations. For this reason, the information of house façade (presented in map no.7-house orientation, sub-module 1-1) and the type of access (presented the map no.4 infrastructure, sub-module 1-1) is necessary. Both, big and small nodes are considered for placing the bin allocation.

Table 5-42 Nodes characteristics

General Characteristics	Big Nodes	Small Nodes
Visited regularly or periodically	Public facilities (places for religious duties), Social facilities (meeting rooms or local community organizations offices), Entrances and exits to and from the settlement, Crossroads	Stores (vegetable stores, cooked-food stores), Workshops (car washing, motorcycle repair, etc.), vacant land

5.8.3.2 Results

Figure 5-33 and Figure 5-34 shows the suitable areas for placing the waste bins as the outputs of sub-module 4-2 in case studies I and II. Figure 5-33 shows the sensitive buffer area map. The red colored buffer surrounds the religious facility in the middle and the blue colored buffer surround the river and other water bodies, such as a grey water pond and fish pond. The buffers have signs to mark that no waste bins are allowed there. (see Appendix A1.3.1 and A2.3.1 for detailed map of sensitive area buffer in case studies I and II)

Figure 5-34 is the waste bin allocation and the service coverage map, which corresponds to the sensitive area buffer map as well. The waste bins are located outside the buffer area and nearby the nodes. The different colors in the bin allocation map in case study I is a sign that the bins are only accessible by foot. This information is necessary for the next sub module, the collection route map. More detailed results can be found in Appendix A1.3.3 and Appendix A2.1.3 for bin allocations and the service coverage in case studies I and II.

Twelve collection points in case study I and two in case study II were selected and these points represent the suitable location for the bins. They cover the service area until 50 m of accessibilities and cover approximately 80% of the area in case study I and 100% in case study II. The yellow marked-bins indicate the restriction of access by car and therefore the bins in this point should be treated differently as they also have to join the collection network in module 4-3.

The most important consideration is to be sure that none of the waste bins is located in the sensitive buffer area. These points are one alternative, other alternative concerning the number of points and their location are discussable through the product of Module 2.

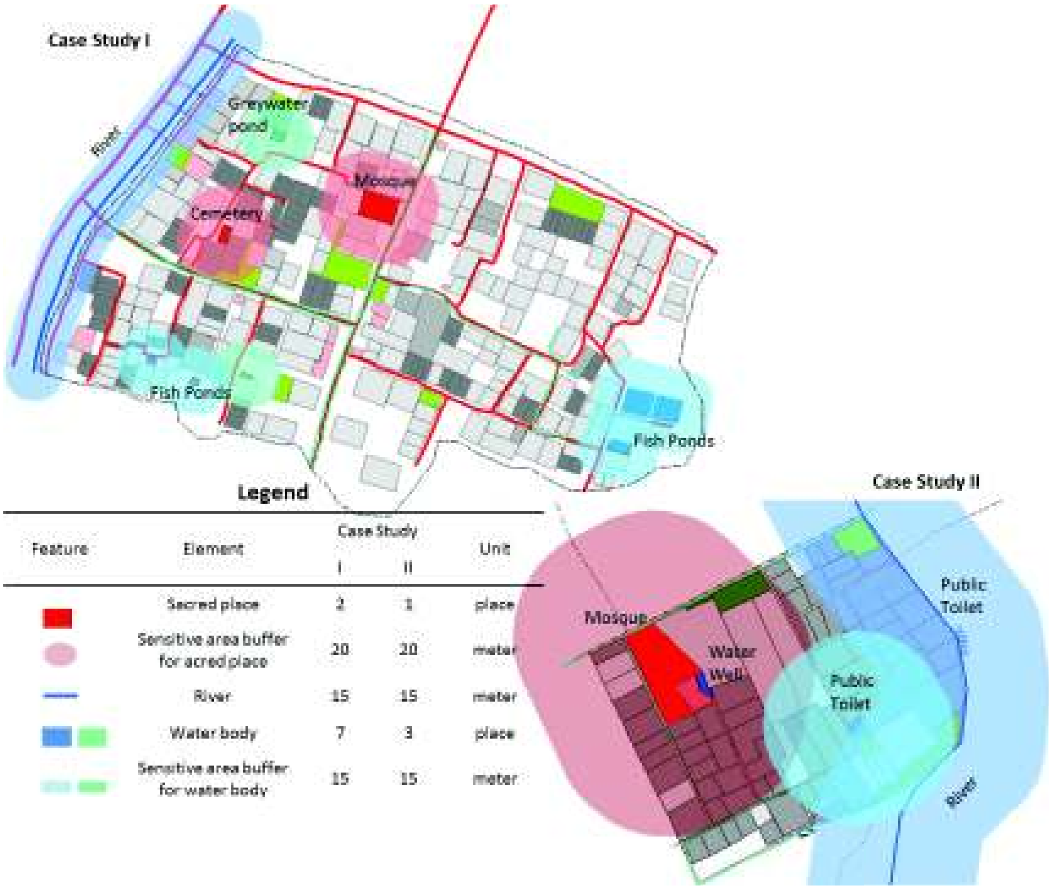


Figure 5-33 Maps of sensitive buffer area, Case Studies I and II

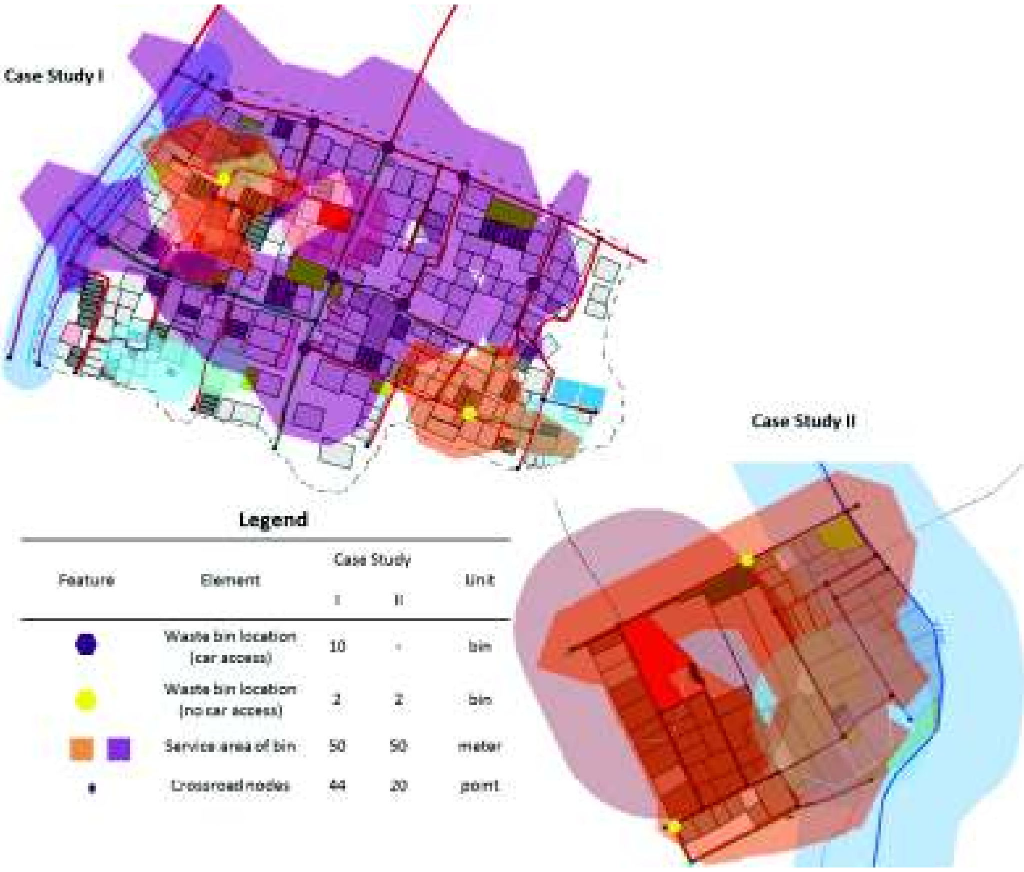


Figure 5-34 Maps of bins allocation and the service coverage, Case Studies I and II

5.8.4 Sub Module 4-3 Collection Route Maps

The main challenge for designing an effective collection route in an area like the *kampung* settlement is that the houses tend to be overcrowded and the buildings are unplanned; thus there is only limited accessibility. The collection route sub-module provides assistance for finding a suitable route for the collection system, including the tools for the collection, the person who will be responsible for the system and how the payment management system will function. Precondition for finding an effective collection route are the knowledge on the bin allocation, presented in sub-module 4-2 (see Section 5.8.2).

5.8.4.1 Methodology

(1) Designing an effective collection route

The principle from Dijkstra's algorithm is replicated in defining an effective collection route. Dijkstra's algorithm is a graphical search algorithm that assists in finding the shortest path from the given points in order (Dijkstra 1959). This algorithm is used by GIS under the 'Network Analysis (GIS-NA)' tool. Below is the illustration on how this algorithm works in a conventional way or in the absence of GIS software.

Figure 5-35 illustrates the implementation of Dijkstra's algorithm which involves 6 collection points (a-f) with the red dot as the starting point. The main principle of this algorithm is to find the shortest way to the connection points. In the figure, route AC is chosen instead of AB or AE since AC performs the shortest connection route. In the next connection, route CB is chosen instead of CD or CF for the same reason. The route BF is chosen since the connections from point b only consider point F as the next destination point. The route BF continues to route FD and then to route DE. This results in the collection route ABCDE as the shortest route.

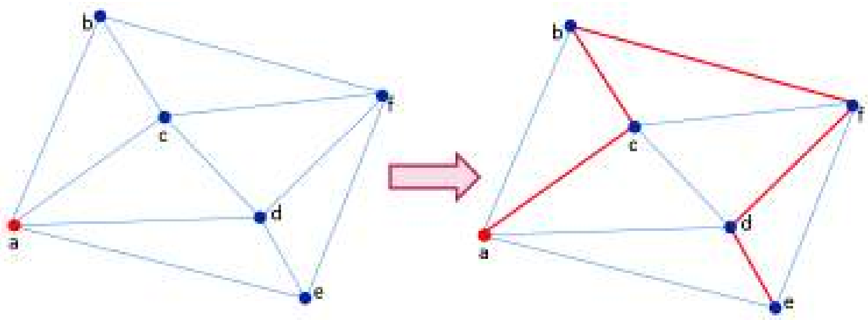


Figure 5-35 Illustration of Dijkstra's Algorithm

(2) Screening the accessibility of collection transport and vehicle into different street categories

Table 5-43 shows the alternative collection transport and vehicles usable for the street and bridges categories I-IV (presented in map no.4-infrastrcuture, sub-module 1-1). The most flexible vehicles in term of accessibilities are the handcart, the rickshaw handcart, and the rickshaw motorcycle. These vehicles can access many types of streets and bridges, including car-free types. The difference is that human power is needed for the handcart and rickshaw handcart, while machine power is used for the rickshaw motorcycle. The limitation for these vehicles is that they are not ideal for big waste volume, especially waste bin type A and mainly due to their capacity for loading and unloading the waste.

Table 5-43 Collection and transport vehicle options

No.	Collection Vehicle	Name	Street Alternative	Property of Ownership		Possible Bin Sizes*
				Private	Municipal	
1		Handcart	I, II, III,IV	✓	✓	Waste Bin Type C-D and bags
2		Pick-up van car	I, II, III	✓	-	All
3		Medium truck	I, II	-	✓	All
4		Big truck	I	-	✓	All
5		Rickshaw handcart (*Becak sampah*)	I, II, III, IV	-	✓	Waste Bin Type C-D and bags
6		Rickshaw motorcycle (*Motor sampah*)	I, II, III, IV	-	✓	Waste Bin Type C-D and bags

*) example from waste bins in Table 5-36
Picture source: (1-2). author, (3-4) Hino (2012), (5) DikoNews (2011), (6) Jasa-Raharja (2011)

In general, waste trucks are owned by the municipality; they can access two-car or two-car-and-more types of roads. A pick-up van car, which is normally owned privately, and also other vehicles collect the waste from generation points and transfers it to the nearest municipal temporary collection points.

Screening the access to certain collection vehicles means that signs are needed to explain access. It is not necessary to limit the access if the handcart, rickshaw handcart or rickshaw motorcycle is chosen as they can fit to all street and bridge categories.

5.8.4.2 Results

Figure 5-36 shows the collection route which represents the shortest route for case studies II. Since there is only one street category in case study II, that is street type IV/no-car street (presented in map no.4 – infrastructure, sub-module 1-1) the only option is to select the handcart, rickshaw handcart or rickshaw motorcycle for collection vehicles. Additionally there is no other collection route alternative for case study II since only two points of collection are available in the area. More detailed result can be found in Appendix A2.3.3 for collection route map in case study II.

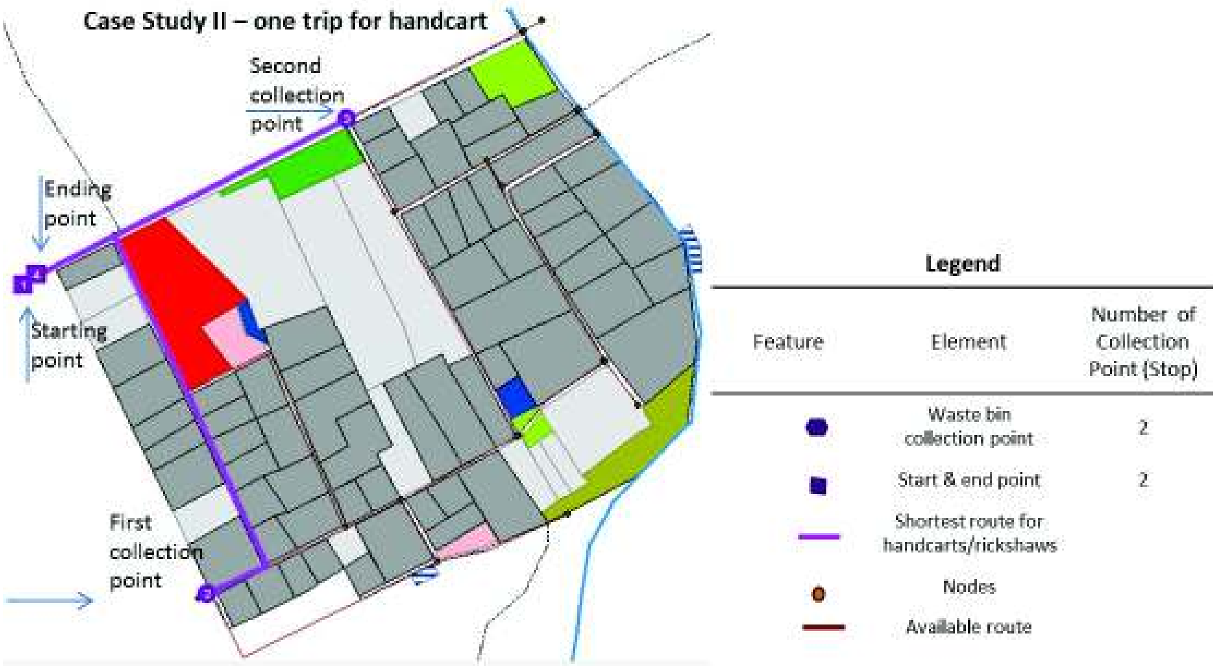


Figure 5-36 Map of collection route alternative, Case Study II

In case study I, more alternatives for the collection routes are available since the streets and bridges have more than two alternatives (presented in map no.4 – infrastructure, sub-module 1-1). In Figure 5-37a and Figure 5-37b it was assumed a handcart, rickshaw handcart or rickshaw motorcycle for the collection vehicles. The difference between these two options is that Figure 5-37a was designed for a collection involving just one trip and Figure 5-37b for one involving two trips (divided into the left and right areas). Figure 5-37c was assumed to select a pick-up van car for the collection vehicle. The crosses indicate the street types which cannot be accessed by a car. More detailed result can be found in Appendix A1.3.3, A1.3.4, and A1.3.5 for collection route map in case study I.

In case study I the collection route for handcarts, rickshaw handcart or rickshaw motorcycle is 930 m km long in Figure 5-37a, 530 m and 703 m long in Figure 5-37b and 733 m long in Figure 5-37c. The use of rickshaw motorcycle will reduce the time consumption significantly, moreover in the case of Figure 5-37b when the left and right areas are done by different person. In case study II the collection route is 161 m long.

In this study the collection route was only done within the respective area. Both in case study I and II, all collection routes should have the possibility to join the Municipality's collection network. In the case of Jakarta, these networks are using big or medium truck (see

Table 5-43). In Figure 5-37c, the beginning and end point is the street category I (accessible for trucks).

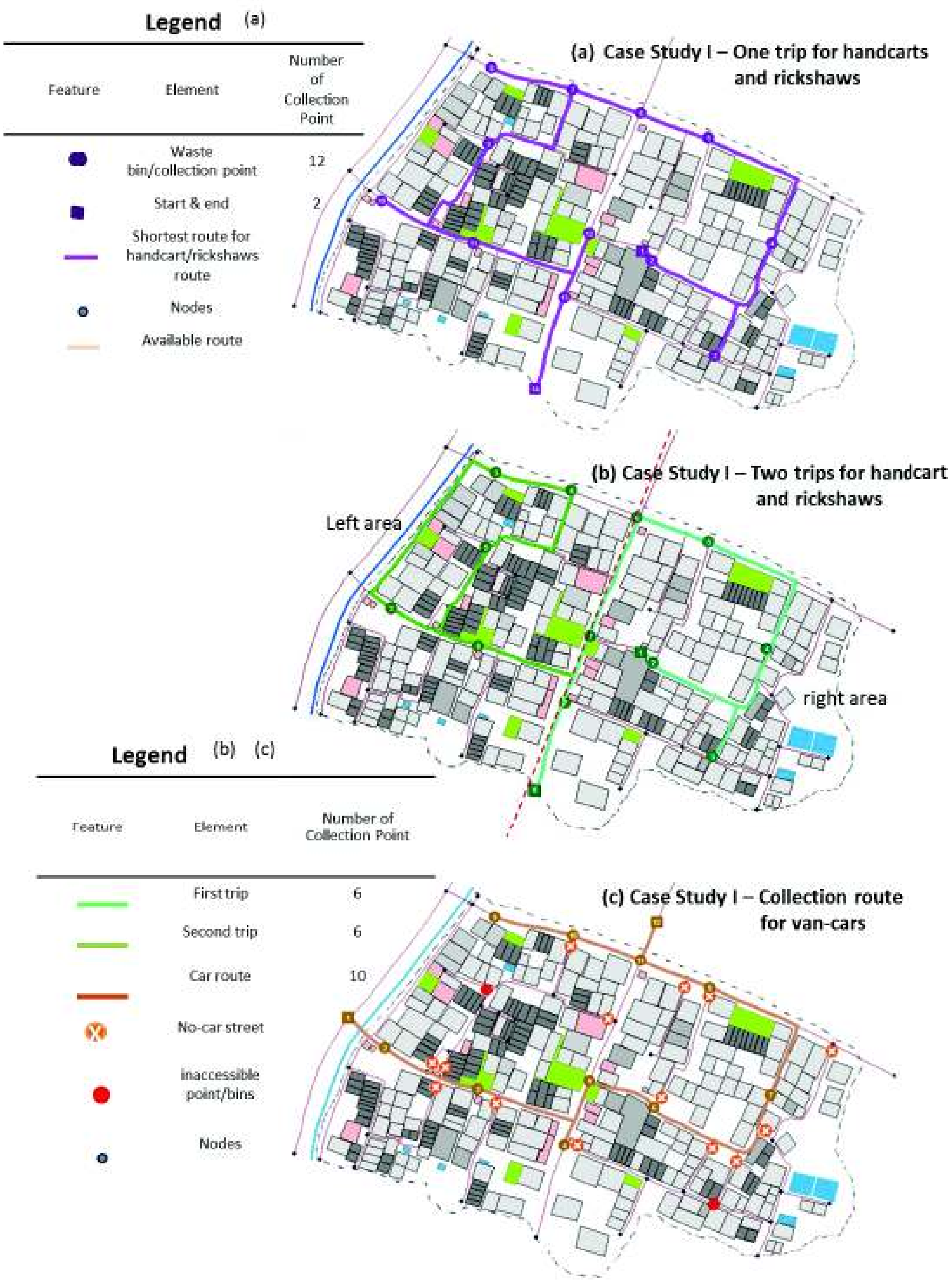


Figure 5-37 Map of three collection route alternatives, Case Study I

Designing a good collection system is not an easy task. It is a complex task that needs different tier of pre-conditions in order to determine the suitable bins and their locations, effective collection routes and the collection vehicles. These pre-conditions were described in sub-module 1-2, 1-3, 3-1, 3-2 and 3-3. The transfer of knowledge and the information proliferation can be maintained through the product of sub-module 2-1, 2-2 and 2-3 based on the physical map which was produced by sub-module 1-1.

Chapter 6 The Applicability

6.1 Media Support for Model Application

6.1.1 Overview

Case studies I and II are both *kampung* settlements, but both areas have different physical conditions and social structures. Also for this reason, the media support is set up on the model application, to accommodate the differences.

Community and Focus Group Discussion (FGD), workshops, flowcharts (Figures of Reasoning, Waste Collection System are the chosen supporting media). These media help community members to go through the decision making process. Figure 6-1 illustrates the concept of technology and knowledge transfer in the newly developed model.

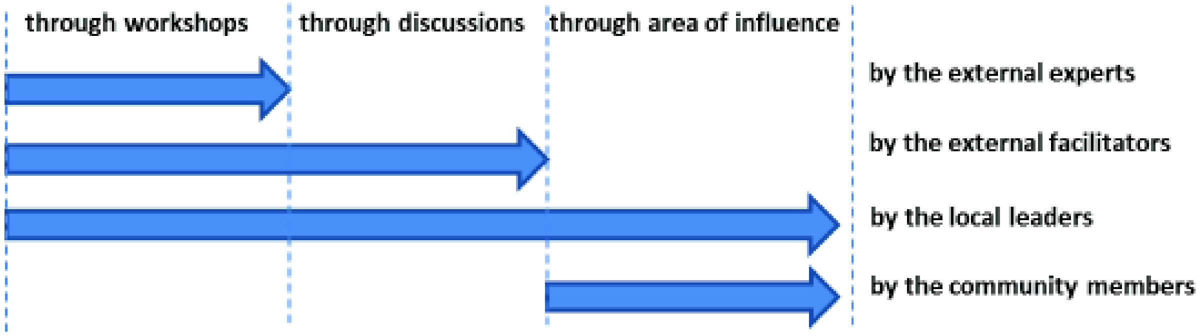


Figure 6-1 The concept of technology and transfer of knowledge in the model

6.1.2 Community and Focus Group Discussions

The *kampung* communities are familiar with democratic structures and the term and tasks of a "community leader". *Kampungs* tend to have developed considerable social capital, which is critical for providing with self-help management in times of a crisis (Sihombing 2010 p.309). Such social capital is very important. This also helps during the community discussions, as there tends to be trust in leaders. This is helpful for selecting appropriate local leaders in sub-module 2-1. Depending on the topic, such discussions can also be structured in a focus group discussion (FGD) format with the help of the facilitators as is done in module 3 and module 4. In the future, using facilitators as assistants during the discussions should be replaced by having the local leader take on this role.

By conducting a FGD session to explain this issue, the community members are expected to understand the message contained in the program. This can occur in the form of FGD or general community discussion.

6.1.3 Workshops

Module 3 involves workshops concerning waste management treatments, the impact (sub-module 3-1) and the output assessments (sub-module 3-2). All the community members need to be informed of the advantages and disadvantages of any waste treatment possibility. Workshops are organized in order to give the chance to the community to experience the activity themselves and increase their level of understanding. This experience helps develop the understanding and social capital necessary for making the program sustainable.

The external experts are invited to the workshop to share their knowledge and to train facilitators and local leaders. During implementation, the facilitators help the local leaders, e.g. in practicing home composting and developing a recycle bank within the neighborhood. In this case, the local leaders have the responsibility to transfer the knowledge to other community members in their area of influence. In case studies I and II, the workshops on Home Composting (HC) and Recycle Bank (RB) were held in different days for the local leaders.

For the workshop, the experts from *Pok Lili* (*Kelompok Peduli Lingkungan*) were invited to conduct the workshop on the recycle bank. The *Pok Lili* is a non-profit and local-based organization which cares about the environment. It has been promoting and initiating a recycle bank in many areas, including the area where the members of *Pok Lili* stay.

The experts from *Ciliwung Merdeka* were invited to conduct the workshop on home composting. The *Ciliwung Merdeka* is also a non-profit and local-based organization, which is located in one of the *kampung* settlements in Jakarta. They commit to and concentrate on improving low-income communities with the provision of knowledge and skills. In their place of origin, the organization has produced tons of home compost as a result of community-based activities.

Figure 6-2 Workshops in case studies I (above) and II (below)

Figure 6-2 shows the impressions of the workshops in case studies I and II. The workshops were done with local leaders (small group workshop) and allowed the opportunity for the participants to be actively involved. This was the chance for local leaders to meet each other and learn about how to multiply their efforts by working within their neighborhood.

6.1.4 Schematic Decision Making Step I: Figures of Reasoning Flowchart

Figure 6-3 shows the schematic decision making steps developed by Horst Rittel; "The Figures of Reasoning". This flowchart assists the user in summarizing the results of module 3 in order to recheck the selected waste management scenario. The given "A" in the figure stands for the selected scenario. To make sure whether or not the scenario suits the community, five steps of reasoning are conducted.

The first step is the question of whether the community is confident that the scenario will run and whether any effort can be done to make it run better. **The second step** is to question the conditions for the given scenario and whether conditions can be created to support the scenario. **The third step** is to question whether the scenario might change something which exists in the community and whether this change can be eliminated when it is undesirable. **The fourth step** is the question of whether the advantages of the selected scenario outweigh the disadvantages and whether the expectations of this scenario are too high. **The last step** is to question whether any other options can achieve the expectation and what the alternatives are. These five questions should be discussed and answered by the community in a FGD.

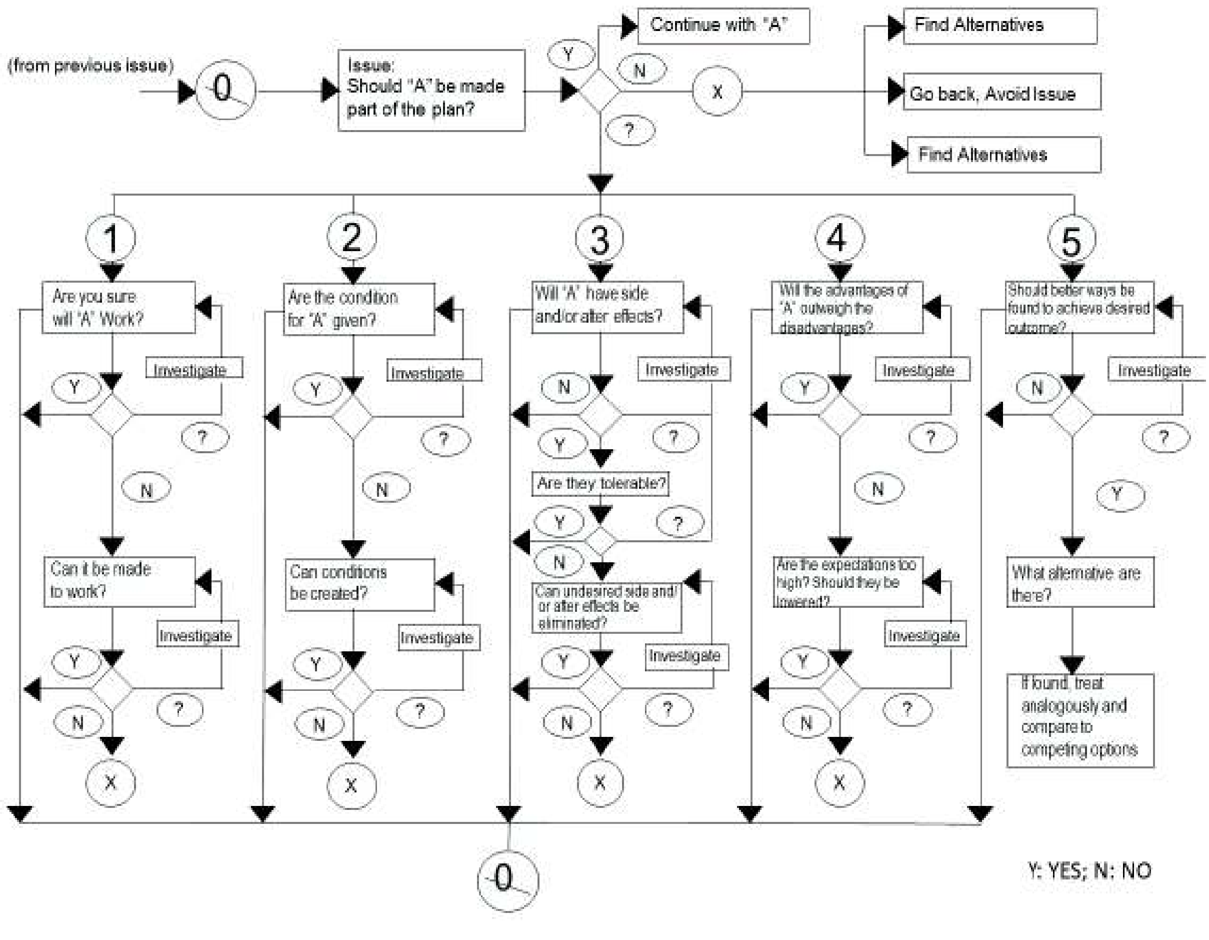


Figure 6-3 Flowchart "Figures of Reasoning" – developed by Horst Rittel

Source: Protzen and Harris (2010)

Based on the field research in 2011 for case studies I and II, the local leaders agreed to continue their experience by establishing their own community home composting and recycle bank center in their neighborhoods. Due to the limitation of time, the field research in both case studies had to stop at this stage by the author of this thesis. It is expected that enough knowledge was transferred and therefore home composting and the recycle bank project will be developed positively.

This study assists the community members to deliver what they want to do with their waste. The focus on implementation of the selected scenario is outside the realm of this study. A research group, which was formed by the student facilitators who previously were involved in the field research, won a grant for their community service project. This grant allowed the group to continue the activities in case study I. This group assisted the community in case study I from February – Augustus 2012 to implement the home composting and the recycle bank, using the newly formed communication networks and the selected local leaders (module 2), and the selected waste management scenario (module 3). Now home composting and recycle bank exist in case study I and the community has started to earn benefits from marketing the products. The community also participates in several homemade products exhibitions where they introduce their products. In case study II further development was brought at the higher level that is Neighborhood Associations (RW) level.

6.1.5 Schematic Decision Making Step II: Waste Collection System Flowchart

Figure 6-4 shows the flow chart to assist the community in summarizing the results in sub-module 4-1 until 4-3. Ali (2012) developed a systematic flowchart of the decision making steps for the module 4 on waste collection system. The flowchart addresses the drop-off system possibilities for the collection only (SA and SB, sub-module 4-1). This flowchart helps the community to check and re-check whether the collection route covers the respective area well enough, whether all collection points and bin allocation fulfill the requirements, and whether the bin locations are acceptable to the community members.

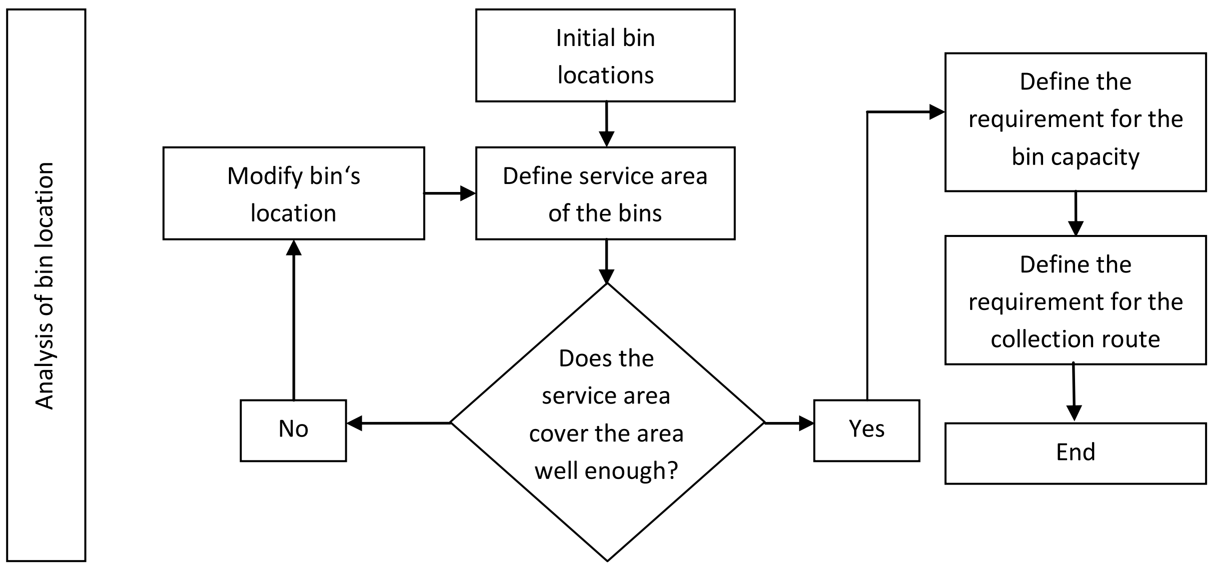


Figure 6-4 Flowchart: Waste Collection System

Source: Ali (2012)

6. 2 Application Guideline

The newly developed model is a Multi-Criteria Decision Model. It considers environmental, economic and social sustainability. To develop a decision support model is one thing and to make use of it is another. In order to make a model that is useable in poor urban communities or *kampung* settlements, it must be as simple but interesting as possible. The challenge is to design a model that is both systematic and still delivers results in a conventional way. Even in the absence of computers and software, such as the GIS and Microsoft package, the new model must be able to provide the necessary information and be used as a basis for decision making.

Table 6-1 and Figure 6-5 show the application guidelines for the newly developed model. Table 6-1 summarizes the 16 steps from the modules for the application guideline. However, before using the guidelines to apply the module, the team of facilitators should be prepared and the site should have been decided by the stakeholders (the facilitators and the community leader).

Figure 6-5 illustrates the stepwise interaction between the modules and sub-modules. It includes 16 steps. The database in module 1 leads the decision making step in other modules. The first steps result in an inventory and a communication network. This network will be repeatedly used in a decision making process on waste treatment selection (module 3) and the collection system selection (module 4). The selected waste treatment, a result of module 3, is used for the collection system in module 4.

Table 6-1 The application guideline, the steps and the obtained results

STEP	Formulation of Module / Sub-module	Supporting Module/ Sub-module	Activity and Media	Result
1	1-1	-	Mapping the area	Physical Map Inventory
2	1-2	1-1	Waste generation survey	Waste Characteristics Inventory
3	1-3	1-1	Survey collective action and community-based organization and the participants	Collective Action and Community-based Inventory
4	**Module 1**	**1-1, 1-2, 1-3**	**Summarizing database**	**Database System**
5	2-1	1-1, 1-3	Investigate the active community members and their houses	Potential Local Leader Map
6	2-2	1-1, 1-3	Investigate the meeting places	Potential Meeting Point Map
7	2-3	1-1, 1-3	Investigate the zoning	Cluster-/Alley-based Neighborhood Map
8	**Module 2**	**2-1, 2-2, 2-3**	**Decision Making I** **Media: Community Discussion**	**Information System and Communication Network**
9	3-1	1-2	Assessing the environmental impact	Potential Environmental Impact
10	3-2	1-2	Assessing the potential output	Potential Output
11	3-3	1-2	Assessing the potential economic cost and benefit	Estimated Cost and Benefit
12	**Module 3**	**3-1, 3-2, 3-3 and Module 2**	**Decision making II** **Media: FGD, Workshops, Flowchart Figure of Reasoning**	**Selected Waste Treatment**
13	4-1	1-2, 3-1	Determine the waste bins and selected bins capacity for drop off system	Alternative Number of Waste Bins and Their Capacity
14	4-2	1-1, 4-1	Determine the possible bins allocation for drop off system	Alternative Bin Allocations
15	4-3	4-2	Determine the possible routing	Alternative routing
16	**Module 4**	**4-1, 4-2, 4-3, Module 2 and Module 3**	**Decision making III** **FGD, Flowchart Waste Collection System**	**Selected the Waste Collection System**

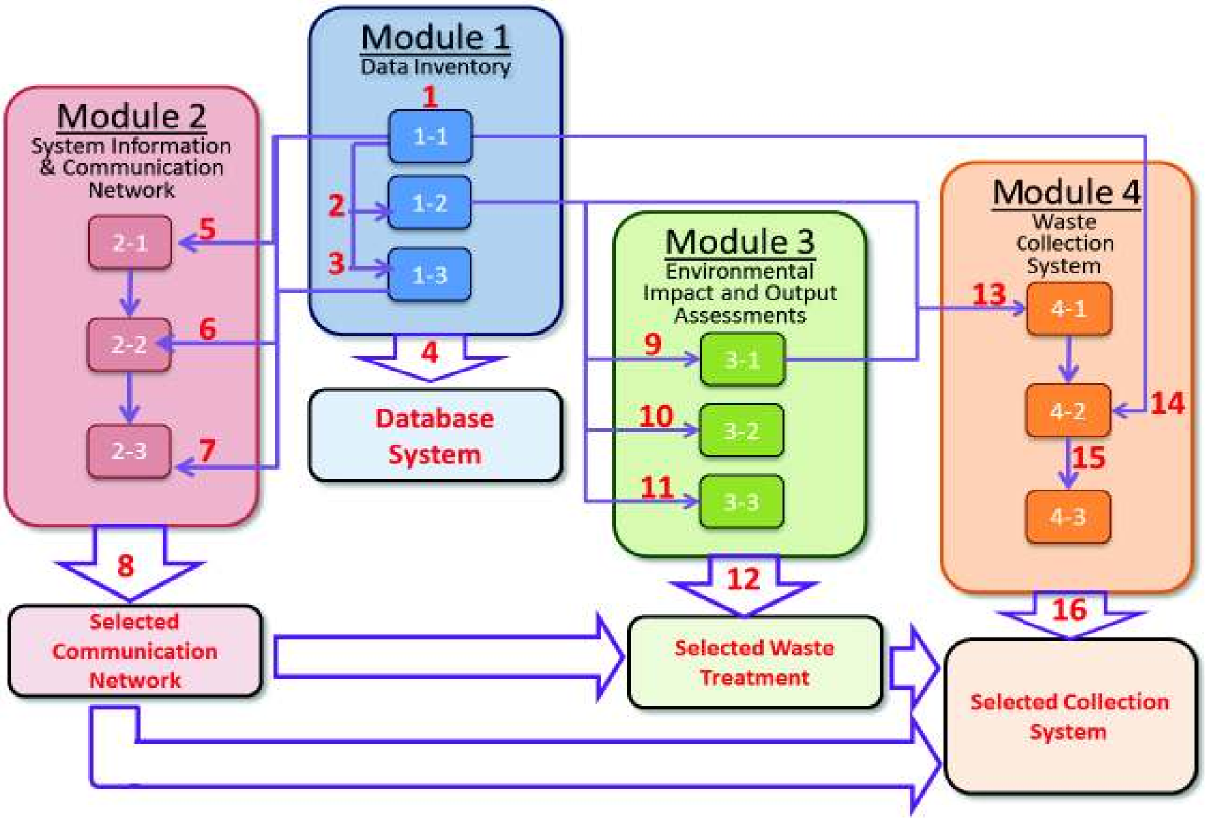


Figure 6-5 The application guideline, the stepwise interaction between modules and sub-modules

6. 3 The Flexibility of the Model

In this study a newly developed model that focuses on comprehensive waste management was proposed. The model can also be used for other purposes, such as choosing between centralized or decentralized wastewater treatment, specific waste treatment technologies and other types of implementation which involve community participation.

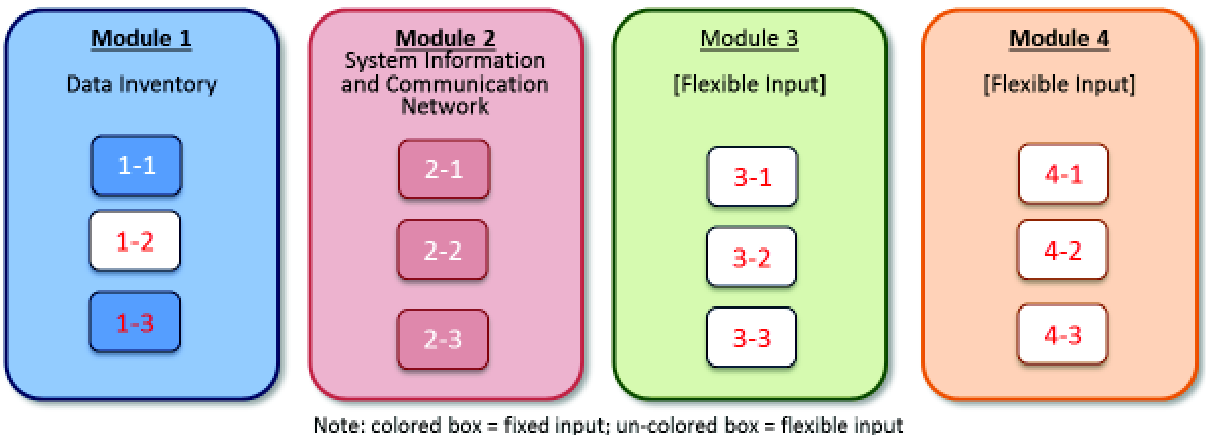


Figure 6-6 Flexibility of the model

Figure 6-6 shows the flexibility of the model. For other purposes, some sub-modules will remain the same whereas some will need to be contextualized according to the addressed proposal. Colored small boxes in the figures refer to sub-modules, which contain the same methodology and information as those proposed here. The uncolored small boxes mean the sub-modules will need new input, but have the same characteristics with the methodology and information used for this study. All database information should be added in module 1, knowledge transfer, FGD and the workshop or other activities with community involvement should be added to module 3 and all implementation-related actions should be added in module 4.

6.4 What the Community can do to Contribute to Low Carbon and Eco-Region

The Indonesian government is finding it impossible to solve waste management problems alone. Community participation is needed to fill the gap. In Indonesia, one of the world's most populous nations, the size of our communities can be made into strength for waste management.

The Indonesian government is familiar with community protests, including those related to waste management. Problems related to waste management, such as the development of new treatment technologies and the improper treatment of existing waste, have forced communities several times to organize and protest. This study suggests that, community contribution is needed for any proposed waste management program. A community must support its local waste management program. There are many things that community members can do:

- When landfill treatment is the option, the easiest thing for a community to do now is to dispose of waste properly. A landfill is a common means of waste treatment; avoiding contamination of groundwater and soil is critical. Landfills create odor and invite rodents, birds and insects and also create leachate, or the noxious liquid created when water seeps through trash, taking chemicals along with it. Even using the best technology, landfills liners might not stay impermeable and thus leachate may contaminate groundwater.

- The most common issue plaguing landfills is greenhouse gas emissions, which has the potential to increase global temperatures. Methane, the main anthropogenic emission from landfills, is mainly comprised of organic compounds. With advanced technology, methane gas can be converted into electricity and heat, thus becoming useful for human and industrial activities. To achieve the best results, organic compounds must be free when they arrive at the landfill, meaning that they stand alone and are not enclosed in plastic bags or packaging. However, many people collect their waste in plastic bags, which bundle and trap gas, hindering the collection of organic compounds from the landfill.

- In thermal treatments such as incineration, avoiding the formation of lethal toxins such as dioxin is critical. These gases might be created when people use insufficient technology to burn waste that contains chemicals such as chlorines and heavy metals. Incineration is the most effective way to treat waste. While the problem of toxins is reducible, high investment is required to develop the technology to reduce toxins remains. Technologically, the heat from the thermal process can be transformed into energy as well. The residue can also have other uses, for example as road material.

- Incinerators designed for unsorted waste require only a small community contribution. The separation of organic waste and fireproof material may also help to increase the efficiency of incineration, leaving a role for the community. However incinerators burn off many recyclable materials and for this reason separation is recommended. It saves virgin material and may also be able to reduce transportation costs and electricity consumption. Through recycling treatments, the community can contribute directly to do source separation, as in a recycling bank scheme.

- For compostable waste treatment, more options are available and all options are a way to increase the world's carrying capacity. The main concept is to return materials to nature as fertilizer and therefore improve the ecological footprint. Composting and anaerobic digestion are the most common technologies used to process organic waste. The critical issue related to compostable waste treatment is whether the product can safely be included in the consumption chain. Therefore, goods such as medicine and heavy metals must be excluded from the treatment, thus also creating a role for the community to separate the waste at source.

- Home composting, the smallest scale organic treatment available to a community, uses fresh organic waste from households. However, organic materials should be selected with care to ensure the quality of the compost. Home composting allows the community to take direct action. On a large scale, composting and anaerobic digestion may also generate energy. As safety is the critical issue, the organic compounds should be separated from the beginning at the source. This is where the community shall contribute as well.

Table 6-2 Background, potential and adaptation on the model development

Existing Limitation	Existing Advantage	Connection	Goals
Unsupported database system	**Various collective actions** **Established self-help and organized structure**	Community involvement on the system to start/improve the existing database system (Inventory)	To address the sense of belonging and the community acceptance
Low Capacity in terms of knowledge	**Existing women-community based organization**	Education for waste management impacts through a workshop and focus group discussion (FGD) Establishing an information network to make sure all community members can hear the message and to be heard	To sustain the socio-cultural aspects (localities)
Low Capacity in terms of economic power	**High proportion of women as housewives**	Knowing own economic capacity Observing potential revenue from existing waste management which stimulate economic benefit Note: this could be a source for additional income and creation of employment	To improve the capacity of the local people
Wide range of data variables	**Positive response to improve the waste management**	Using a normalization unit on the environmental impact assessment. With this normalization, the community only need to compare the impact on each impact categories	To increase the level of understanding
Insufficient waste management collection system	**Existing collective actions and commu-nity-based org.**	Designing systematic but clear guidelines for taking actions	To improve the collection coverage area

Table 6-2 summarizes the highlighted findings and the direction of the newly developed model. Since unsupported databases were found to be the main limitation for the implementation of existing models in under developed areas, this study highlights the development of a database system. Also to sustain the selected waste management program, the database system, the information system and communication network should support and be used as the main tool in the decision making process.

One of the facts to be revealed by the case studies is that although the communities can do a lot for themselves, it is not possible for the community to improve the waste management situation completely alone, especially given the specific characteristics of *kampung* communities. Financing is needed to provide sufficient collection tools and waste bins. In addition, the waste management system of *kampung* settlements should be integrated with a municipal waste management system. This is because even in the home composting and recycle bank scenarios, some portions of waste cannot be treated by the community.

Another fact learned from implementing the newly developed model in the case studies is that by integrating municipal solid waste management and community-based waste management, both the government and the community will benefit. It is not possible for the government to solve the waste management problems alone; community participation is needed to fill this gap. The community benefits from improved environment quality, better public health conditions, and chances to earn additional income.

Chapter 7 Summary and Outlook

Summary

Many sophisticated decision support models for waste management towards sustainable regional solutions have been focused on technological improvements and lack adequate socio-cultural considerations. This is quite a serious problem for applying such models to low-income and densely populated *kampung* settlements in Indonesia. In order to work properly, models must be sensitive to the social capital that exists in a community. They must also pay attention to the social, geographical and demographic context of a community, as well as their environmental and economic situation. In urban management and planning, public participation is a prerequisite for successful urban intervention to provide supports that allow the planning participation by the public. Essential is not only the general public participation in project implementation but also their active involvement in programs design through well-informed decision-making processes.

The benefits of a planned development action must be fully communicated at both the community and personal level. In this study, a decision support model was developed in 5 chapters. The review of existing models, the theoretical backgrounds, and the field research defined the direction of the newly developed model. These addressed waste management improvement in urban *kampung* settlements. The goal of the study is to contribute to the development of a low carbon- and eco-region that focuses on sustainable waste management in *kampung* settlements.

In **chapter 2** the review of the existing dominant models highlighted the lack of adequate attention to social sustainability. Existing models have difficulties coping with different social-cultural contexts. Often the models are addressed to countries with established waste management systems and high economic level. They focus on increasing the efficiency of waste management technologies. Also, such models use a wide range of data variables which require a certain level of knowledge and understanding. In general, there are not many models that are addressed to developing countries and none are particularly suited to addressing the needs of urban poor settlements, or what are called urban *kampung* settlement in this study. However, as the urban poor population dominate the urban areas in terms of number and inhabit marginal areas or less desirable areas, they must be taken into consideration in developing a sustainable regional waste management system.

The theoretical backgrounds on waste management presented in **chapter 3** highlighted the strong encouragement of Reduce, Reuse and Recycle (3R) with community participation in Indonesian policies and legislation. Community protest in Indonesia stresses the importance of community involvement for fostering community acceptance. The chapter also highlighted the positive impacts of community-based waste management initiatives in terms of filling the gap created by the insufficient Indonesian municipal waste management system. It showed that women, particularly housewives, are the main persons to promote sustainable waste management system in their neighborhood. Also, the previous instances of the reduction in amount of waste generated at its source or source separation, is the first element in the waste hierarchy. Community participation, an element at the household level, is crucial and plays an extremely important role in the implementation of a sustainable regional waste management program. In developing such a program, the community should be incorporated into the decision making processes, primarily to consider what methods are most acceptable and suitable for them.

In the study, the decision support model was developed under consideration of the situation in two typical Indonesian *kampung*s. The general data on geography and demography of Jakarta, where the case studies were located, is presented in **chapter 4**. Also in this chapter, the administrative conditions as well as the existing regulations and laws related to housing and waste management were highlighted. The Indonesian government, in particular the Jakarta Municipality, intensified planning efforts to improve policies on waste management. What is lacking in these laws and regulations is the consistent reward and punishment from the implementation. The field research focused on the observation of the actual social-life in the two selected urban *kampung* areas. Case study I was conducted in Cipedak – South Jakarta; and case study II in Cikini – Central Jakarta. These researches showed that insufficient and poorly managed waste management systems are currently in place. In case study I the area was disconnected from municipality's waste management system and in case study II an insufficient level of waste management service from the municipality was observed. This research highlighted the necessity of supervision and assistance in waste management in order to gain improvements. In both areas, various community-based organizations of women and various forms of self-organized collective actions were already established and could be used for waste management purpose as well. In these settlements, women's community-based organizations are expected to be the main driving factors in promoting new waste management approaches. In both case studies, the communities responded positively to the suggestion to participate in improving the waste management situation in their neighborhoods.

The field research and the development of the models are described in **chapter 5**. The model consists of four modules and each module has 3 sub-modules.

- The **first module**, the **Data Inventory**, is the core of the model. It provides basic information of physical data, collective actions and community-based organizations and the waste characteristics to support the work of the other modules.

- The **second module**, the **Information System and Communication Network**, is the most communicative module. It is used for information proliferation among the community members, and helps to identify the most potential community members to play a role as local leader under certain criteria. Furthermore, the module helps to identify meeting points and to form zones of influence. These elements were added to increase the efficiency of the information system and the communication network.

- The **third module**, the **Environmental Impact and Output Assessment**, is the most advanced module. It gives the community members the opportunity to know what waste treatment options are available, and to find out which advantages and disadvantages they have. It also enables the community members to improve their knowledge and to collect practical experience on their own, e.g. in home composting and recycling activities. The transfer of the knowledge to other community members is possible through the previous module.

- The **fourth module**, the **Waste Collection System**, is the summarizing module. It is based-on the waste management scenario selected in the previous module. For this scenario the module helps to develop suggestions for the establishment of a sustainable regional waste collection system.

The different physical conditions and social structures in *kampung* settlements propose the need for supporting media support to improve the usability and flexibility of the model. This media support is workshops, focus group discussions (FGDs), and flowcharts which assist the decision making processes in different ways. They are presented in **chapter 6**.

As the key conclusion, the following important messages are emphasized in the model:

- The focus should be on a program, not a project, which can be sustained over time.
- Local key players from the community members who can act as the main driving forces should be identified.
- The model should be assisted in looking at its own capacity carefully and to manage a combined bottom-up and top-down approach which involves stakeholders.
- An independent program, where all efforts are community-based and the associated impacts benefit the community, should be the aim.
- The model should be useable without direct incentives from outside, but when incentives come from the government they should be to improve/build infrastructure (not as salary).
- Community members should be encouraged in such a way as to increase their willingness to join the program. They should be able to participate in different ways, from simple to complex contributions.
- There should be a comparison of actual with future scenarios. It is not a program which produces changes instantly.
- A sense of belonging and responsibility that contributes to social bonding should be fostered.

Outlook

Using this model is one step on the way to establishing low-carbon and eco-regions. The model is designed to assist communities in a densely populated urban settlements or *kampung* settlements. In order to do so, external facilitators are needed to assist e.g. to establish the database system in module 1 and to apply the other modules. The transfer of knowledge from the external experts to the local leaders can be conducted through workshops. The applications of this model will assist the communities to decide what they want to do with their waste and take the real actions to implement their decisions.

Any local community with the wish to improve their waste management system can use the model. External experts, facilitators and also government are needed for support. The model application can be hosted by a university, a non-government organization (NGO) or a local authority. The role of facilitators can be determined by these hosts. As government is one of the most important stakeholders responsible for waste management, it needs to assist, support and observe the communities' waste management advancements. The author of this study is always ready to provide advise regarding the model's application.

In the near future, the model, which is now mainly computer based, will be designed as a portable model that does not require computer techniques. This will increase its applicability. All applications will be structured systematically as guideline or manual and wrapped interactively in a tool box, together with an example of the results to give the background of the expected results.

Suggestions for application of the newly developed model in an optimum way are as follows:

- For an effective result, attention must be given to educational aspects, such as public hearings, community involvement actions and training programs.
- For sustainability background, the housewives should be addressed as the driving factor behind the system for the short-term, and the children should be addressed as the intergenerational multiplier for the long-term.
- For a highly efficient result in all waste management scenarios, source separation should be addressed.

Reference

Advertorial, K. (2012). *Pengelolaan Sampah Jakarta or Waste Management Jakarta*. Retrieved November 30, 2012, from Kompas: http://megapolitan.kompas.com/read/2012/10/07/12055328/Pengelolaan.Sampah.Jakarta

Ahmed, S. M. (2006). *Using GIS in Solid Waste Management Planning: A Case Study of Aurangabad, India.* Linköpings University, Master Thesis, self published, Linköping.

Ali, M. (2012). *Investigation of Effective Routing for Collection System and Suitable Facility Siting Using GIS-NA.* Hamburg University of Technology, Project work, self published, Hamburg.

Allaway, D. (2012). *Briefing Paper: Sustainable Consumption and Waste Prevention.* Retrieved August 23, 2012, from Department of Environmental Quality-State of Oregon: http://www.deq.state.or.us/lq/pubs/docs/sw/2050vision/BriefingPaperSustainableConsumptionWastePrevention.pdf

Amliger, F., & Cuhls, C. (2008). *Green House Gas Emission from Composting and Mechanical Biological Treatment*. Waste Management and Research *26* , pp. 26-47.

Andersen et al. (2011). *Mass Balances and Life Cycle Inventory of Home Composting of Organic Waste*. Waste Management 3*1* , pp. 1934-1942.

Angelidaki, I., & Batstone, D. J. (2011). *Anaerobic Digestion: Process*. In T. H. Christensen (Ed.), *Solid Waste Technology & Management, Volume 1*, pp. 583-600. West Sussex, UK: Blackwell Publishing Ltd.

Antschütz, J. (1996). *Community Based Solid Waste Management and Water Supply Project: Problems and Solutions Compared - A Literature Study, UWEP Working paper 2.* Retrieved May 20, 2012, from waste.nl: http://www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_policy/@invest/documents/publication/wcms_asist_5125.pdf

Aprilia, A., Tezuka, T., & Spaargaren, G. (2012). Household Solid Waste Management Jakarta, Indonesia: A Socio-Economic Evaluation. In L. F. Rebellonn, *Waste Management - An Integrated Vision*, pp. 71-100. Rijeka, Croatia: Intech.

Bagghi, A. (2004). *Design of Landfills and Integrated Solid Waste Management* (Third ed.). New Jersey, USA: John Willey and Sons, Inc.

Bani, M. S., Rashid, K. H., Hamid, M. E., Harbawi, A. B., & Aris, M. J. (2009). The Development of Decision Support System for Waste Management; a Review. *World Academy of Science, Engineering and Technology 49, pp. 161-168* .

Barlishen, K. D., & Baetz, B. W. (1996). Development of a Decision Support System for Municipal Solid Waste Management System Planning. *Waste Management and Research 14* , pp. 71-86.

Berita Jakarta. (2012). *"Agustus 3 pengolahan sampah mulai dibangun* or *August 3 waste treatments starts to be built"*. Retrieved August 28, 2012, from http://beritajakarta.com/2008/id/berita_detail.asp?idwil=0&nNewsId=50492

Berita Jakarta. (2011). *Jakarta Focuses on Waste Utilization in the City*. Retrieved August 28, 2012, from Berita Jakarta: http://www.beritajakarta.com/2008/en/newsview.aspx?idwil=0&id=19957

Bhuiyan, S. H. (2005). *Benefits of Social Capital, Urban Solid Waste Management in Bangladesh.* Berlin, Germany: LIT Verlag Münster.

Boldrin, A., Christensen, T. H., Körner, I., & Krogmann, U. (2011). Composting: Mass Balances and Product Quality. In T. H. Christensen (Ed.), *Solid Waste Technology & Management* (pp. 569-582). West Sussex, UK: Blackwell Publishing Ltd.

BPS. (2012). *IHK, Indeks Upah Nominal dan Riil Buruh Industri Berstatus di Bawah Mandor Menurut Wilayah or Index Nominal Wage Labor based on Region, 2004-2009*. Retrieved August 09, 2012, from Badan Pusta Statistik: http://www.bps.go.id/menutab.php?tabel=1&kat=2&id_subyek=19

BPS. (2011). *Jakarta Dalam Angka or Jakarta in Numbers, Katalog BPS No.112001.31.* Retrieved August 09, 2012, from Biro Pusat Statistik Provinsi DKI Jakarta: http://jakarta.bps.go.id/flip/jda2011/index.html

BPS Provinsi DKI Jakarta. (2012). *Jakarta Dalam Angka or Jakarta in Numbers*. Retrieved December 2012, from Badan Pusat Statisitik Provinsi DKI Jakarta, or " Statistic of DKI Jakarta Province": http://jakarta.bps.go.id/flip/jda2012/index.html

Brunner, P. H., & Lederer, J. (2011). Knowledge Base for Waste Management in Emerging Economics. *Third International Conference on Waste Management in Developing Countries and Transient Economics.* Mauritius, Africa (September, 5th-9th 2011).

Budiarto, L. (2005). Magersari: the Spatial-culture of Kampung Settlement as an Urban Strategy in Indonesian Cities and Urban Housing. *XXXIII IAHS, World Congress on Housing, Transforming Housing Environment through Design.* Pretoria, South Africa (September, 27th-30th 2005).

Burgess, E. W. (1925). The Growth of a City: an Introduction to a Research Project. In J. M. Marzluff et al, *Urban Ecology (2008)*, pp. 71-78. CHicago, USA: Springer.

Catharines, S. (2012). *City of St. Catharines.* Retrieved July 26, 2012,from http://www.stcatharines.ca/en/

Chalkias, C., & Lasaridi, K. (2009). A GIS-Based Model for the Optimization of Municipal Solid Waste Collection. The Case Study of Nikea, Athens, Greece. *WSEAS Transaction on Environment and Development* , pp. 640-649.

Chang, N., & Wang, F. W. (1996). The Development of an Environmental Decision Support System for Municipal Solid Waste Management. *Computer Environment and Urban Systems 20 (3)* , pp. 201-212.

Cheremisinoff, N. P. (2003). *Handbook of Solid Waste Management and Waste Minimization Technologies.* USA: Butterworth-Heinemann of Elsevier.

Christensen, T. H., Scharff, H., & Hjelmar, O. (2011). Landfilling: Concepts and Challenges. In T. H. Christensen (Ed.), *Solid Waste Technology & Management* (pp. 685-694). West Sussex, UK: Blackwell Publishing Ltd.

City Population. (2012). *The Principal Agglomeration of the World*. Retrieved September 09, 2012, from City Population: http://www.citypopulation.de/world/Agglomerations.html

Damgaard, A., Manfredi, S., Merrild, H., Stensoe, S., & Chirstensen, T. H. (2011). LCA and Economic Evaluation of Landfill Leachate and Gas Technologies. *Waste Management 31* , pp. 1532-1541.

Decilya, S. (2012b). *Jokowi Restui Proyek Pengelolaan Sampah Sunter or Jokowi Agreed on Waste Treatment Project in Sunter*. Retrieved November 12, 2012, from Tempo.co: http://www.tempo.co/read/news/2012/11/05/083439703/p-Jokowi-Restui-Proyek-Pengelolaan-Sampah-Sunter

Decilya, S. (2012a). *Proyek ITF Sunter Akan Memasuki Tahap Beauty Contest or ITF Project will enter Beauty Contest Stage*. Retrieved November 12, 2012, from Tempo.co: http://www.tempo.co/read/news/2012/11/03/064439532/Proyek-ITF-Sunter-Akan-Masuk-Tahap-Beauty-Contest

Den Boer, J., Den Boer, E., & Jager, J. (2007). LCA-IWM: A Decision Support for Sustainability Assessment of Waste Management System. *Waste Management 27* , pp. 1032-1045.

Dijksktra, E. W. (1959). *A Note of Two Problems in Connexion with Graphs.* Retrieved July 25, 2012, from Springer.com: http://download.springer.com/static/pdf/508/art%253A10.1007%252FBF01386390.pdf?auth66=1360772368_eb65fb65f156f2fd68c17561ac628642&ext=.pdf

DikoNews, D. (2011). Retrieved January 26, 2012, dari http://www.dikonews.com/2012/06/06/4043-desa-helvetia-terima-3-unit-becak-pengangkut-sampah

European Commission. (2008). *Directive 2008/98/EC - EU Waste Framework Directive*. Retrieved January 8, 2013, from European Commission: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0098:EN:NOT#top

Finnveden, G., Björklund, A., Moberg, A., Ekvall, T., & Moberg, A. (2007). Environmental and Economic Assessment Methods for Waste Management Decision-Support: Possibilities and Limitations. *Waste Management & Research 25* , pp. 263-269.

Franchetti, M. J. (2009). *A System Approach Solid Waste Analysis & Minimization.* New York, USA: RR Donelly; McGraw-Hill Companies, Inc.

Fukuyama, F. (2000). *Social Capital and Civil Society - IMF Working Paper WP/00/74.* Retrieved August 13, 2012, from International Monetary Fund: http://www.imf.org/external/pubs/ft/wp/2000/wp0074.pdf

Gheewala, S. H., & Liamsanguan, C. (2007). LCA: A Decision Support Tool for Environmental Assessment of MSW Management System. *Journal of Environmental Management 87 (1)* , pp. 132-138.

Gheewala, S. H., & Wanichpongpan, W. (2006). LCA as a Decision Support Tool for Landfill Gas to Energy Project. *Journal of cleaner Production 14 (18)* , pp. 1810-1826.

Ghose, M. K., Dikshit, A. K., & Sharma, S. K. (2006). A GIS Based Transportation Model for Solid Waste Disposal - A Case Study on Asansol Municipality. *Waste Management 26* , pp. 1287-1293.

Google Maps, G. M. (2013). Google Map. Retrieved January, 13, 2013 from www.maps.google.com

Gottinger, H. (1991). *Economic Models and Applications of Solid Waste Management.* Amsterdam, Netherlands: Gordon and Breach Science Publishers.

Grootaert, C., & Van Bastelaer, T. (2002). *Understanding and measuring Social Capital - a Synthesis of Findings and Recommendations from the Social Capital Initiative, Forum Series on the Role of Institutions in Promoting Growth, USAID.* Washington D. C., USA: Irish Center.

Harian Umum Pelita. (2012). *Rencana Pembangunan TPS Pulo Gebang Ditolak Warga or Community Rejects the Plan for Building TPS Pulo Gebang*. Retrieved November 30, 2012, from Harian Umum Pelita: http://www.pelita.or.id/baca.php?id=61231

Harjoko, T. Y. (2004). Penggusuran or Eviction in Jakarta, Solution Lacking Resolution for Urban Kampung. *15th Biennial Conference of Asian Studies Association of Australia (29th June - 2nd July).* Canberra, Australia.

Harjoko, T. Y. (2009). *Urban Kampung: Its Genesis and Transformation into Metropolis, with Particular Reference to Penggilingan Jakarta.*Leipzig, Germany: VDM Verlag Dr. Müller.

Hino, D. T. (2012). *Dump Truck.*Rerieved January 13, 2012, from http://dumptruckhino.indonetwork.co.id/1666251/arm-roll-truk-sampah.htm

Homans, G. C. (1961). *Social Behavior: Its Elementary Forms.* New York, USA: Harcourt Brace World, Inc.

Hoyt, H. (1939). *The Structure and Growth of the Residential Neighborhoods in American Cities,.* Washington D.C., USA: Federal Housing Administration.

Hulgaard, T., & Vehlow, J. (2011). Incineration: Process and Technology. In T. H. Christensen (Ed.), *Solid Waste Technology & Management*, pp. 365-392. West Sussex, UK: Blackwell Publisher Ltd.

Illeperuma, I. A., & Samrakoom, L. (2009). Location of Bins Using GIS. *International Journal of Engineering and Technology 2 (10)* , pp. 97-110.

Indonesian Embassy, I. (2008). *Embassy of Republic Indonesia.*Retrieved 13 October 2008, from http://indonesian-embassy.de/

Jain, A. K. (2009). *Low Carbon City, Policy, Planning and Practice.* New Delhi, India: Discovery Publishing House PVT. Ltd.

Jain, A., Kaur, H., & Khanna, S. (2005). Computer Model for Solid Waste Treatment in Developing Countries. *Environmental Science and Technology 39* , pp. 3732-3735.

Jansen, J. C. (2011). Anaerobic Digestion: Technology. In T. H. Christensen (Ed.), *Solid Waste Technology & Management* ; pp. 601-617. West Sussex, UK: Blackwell Publishing Ltd.

Jasa-Raharja, P. (2011). *Jasa Raharja.* Retrieved January 13, 2012, from http://www.jasaraharja.co.id/kelurahan-sei-kambing-medan-helvetia-terima-bantuan-becak-motor-sampah-da,77351.html

JBIC Japan. (2008). *Special Assistance for Project Formation (SAPROF) for Solid Waste Management Project in Jakarta, Final Report.*

Joniansyah, J. (2011). *Ciangir Diubah Jadi Kawasan Permukiman or Cingangir is Converted for Housing Settlement*. Retrieved January 02, 2013, from Tempo.co: http://www.tempo.co/read/news/2011/06/12/057340117/Ciangir-Diubah-Jadi-Kawasan-Permukiman

Kemendagri, K. D. (2010). Permendagri 33 Tahun 2010 Tentang Pedoman Pengolahan Sampah or The Regulation of Ministry of Internal Affair no. 33 About the Guidance of Waste Management.

Kemenpu, K. P. (2006). Permenpu no. 21/PRT/M/2006 Tentang Kebijakan dan Strategi Nasional Pemgembangan Sistem Pengelolaan Sampah or Ministry of Public Work Regulation no. 21/PRT/M/2006 About Policy and National Strategy National on the Development of Waste Management System.

Kikerby, J. T., Brigisdottir, H., Bhander, G. K., Hauschild, M., & Christensen, T. H. (2007). Modeling of Environmental Impact of Solid Waste Landfilling within the Life-cycle Analysis Program EASEWASTE. *Waste Management 27* , pp. 961-970.

Kikerby, J., Birgisdottir, H., Hansen, T. L., Christensen, T. H., Bhander, G. S., & Hauschild, M. (2006). Environmental Assesment of Solid Waste System and Technology: EASEWASTE. *Waste Management and Research 24* , pp. 3-15.

Körner, I., Saborit-Sanchez, I., & Aquilera-Corrales, Y. (2008). Proposal of the Integration of Decentralized Composting of the Organic Fraction of the Municipal Solid Waste into the Waste Management System of Cuba. *Waste Management 28* , pp. 64-72.

Krogmann, U., & Körner, I. (2000). Technology and Strategies in Composting. In H. J. Rehm, G. Reed, P. Pühler, & P. Stadler (Eds.), *Biotechnology, Vol. 11-C*, Second, Completely Revised ed., pp. 128-166. Weinheim, Germany: Willey-VCH.

Krogmann, U., Körner, I., & Diaz, F. D. (2011).*Composting Technology*. In T. H. Christensen,Solid Waste Technology & Management, pp. 533-568. West Sussex, UK: Blackwell Publishing Ltd.

Kurian, J., Esakku, S., Nagendran, R., & Visvanathan, C. (2005). A Decision Making Tool for Dumpsite Rehabilitation in Deeloping Countries. *Proceedings Sardinia 2005 (3rd-7th October).* Cagliari, Italy.

MacDonald, M. L. (1996). A Multi-attribute Spatial Decision Support System for Solid Waste Planning. *Computer Environment and Urban System 20 (1)* , pp. 1-17.

Masnelyarti, H. (2012, April 14). *Bank Sampah: Dari Sampah Jadi Rupiah, or Recycle Bank: from Trash to Cash*. Retrieved August 21, 2012, from Kementrian Linkungan Hidup Republik Indonesia: http://www.menlh.go.id/from-trash-to-cash-dari-sampah-jadi-rupiah/

McDougall, F. R., White, P. R., Franke, M., & Hindle, P. (2001). *Integrated Solid Waste Management: A Life Cycle Inventory* (Second ed.). UK: Blackwell Publishing Ltd.

Merton. (2012). *Merton Council.*Retrieved July 26, 2012, from Commercial Waste Bin Sizes: http://www.merton.gov.uk/environment/recyclingwastemanagement/commercialwaste/commercial_waste_bin_information.htm

Morrissey, A. J., & Browne, J. (2004). Waste Management Models and their Application to Sustainable Waste Management. *Waste Management 24*, pp. 297-308.

Mumford, L. (1937). What is a City? In R. LeGates, & F. Stout, *the City Reader (1996)*, pp. 183-188. New York, USA: Routledge.

Najm, M. A., El-Fadel, M., Ayoub, G., El-Taha, M., & Al-Anwar, F. (2002). An Optimization Model for Regional Integrated Solid Waste Management, I: Model Formulation. *Waste Management and Research 20* , pp. 37-45.

Pariatamby, A. (2011). Municipal Waste Management. In T. M. Lechter, & D. A. Vallero (Eds.), *Waste: A Handbook for Management* (pp. 109-126). USA: Elsevier.

Pariatamby, A., Khidzir, K. M., & Hamid, F. S. (2009). Drivers of Sustainable Waste Maangement in Asia. *Waste Management and Research 27* , pp. 625-633.

Pemprov DKI, J. (2010). Map 03 Rencana Tata Ruang Wilayah Provinsi DKI Jakarta or Map 03 Regional Planning DKI Jakarta.

Pemprov DKI, J. (2012). Master Plan Pengelolaan Sampah 2012-2032 or Waste Managemant Master Plan 2012-2032 (Draft).

Pinto, F., Andre, R. N., Dias, M., Lopes, H., & Gulyurtlu, I. (2009). Atlernative Process for Waste Management: Energetic Valorization of Waste through Gasification. In Lavelle, *Waste Management, Research, Technology and Developments.* NY, USA: Nova Science Publishers.

PosKota. (2011). *Angkut Sampah, Pemprov DKI Luncurkan 300 Gerobak Bermotor or Transport the Wast, Jakarta Municipality launchs 300 Rickshaw Motorcycle*. Retrieved August 28, 2012, from POSKOTA: http://poskota.co.id/berita-terkini/2011/12/21/angkut-sampah-pemprov-dki-luncurkan-300-gerobak-bermotor

Powell, J. (2000). The Potenial for Using Life Cycle Inventory Analysis in Local Authority Waste Management Desicion Making. *Journal of Environmental Planning and Management 43 (3)* , pp. 351-367.

Protzen, J., & Harris, D. J. (2011). *The Universe of Design: Horst Rittel's Theories of Design and Planning.* Oxon, USA: Routledge.

Rees, W. E. (1992). Ecological Footprints and Appropriated Carrying Capacity: What Urban Economics Leaves Out. *Environment and Urbanization 4 (2)* , pp. 121-130.

Register, R. (1987). *Ecocity Berkeley: Building Cities for Healthy Future.* California, USA: North Atlantic Books.

Republik Indonesia, R. (2008). Undang-Undang no. 18 Tahun 2008 Tahun 2008 Tentang Pengolahan Sampah or Waste Management Law no.18 About Waste Management.

Roseland, M. (1997). Dimensions of the Future: An Eco-city Overview. In M. Roseland (Ed.), *Eco-City Dimensions: Healthy Communities, Healthy Planet* (pp. 1-13). Gabriola, Island, Canada: New Society Publisher.

Salhofer, S., Unger, N., & Bilitewski, B. (2011). Waste Prevention and Minimization: Concept, Strategies and Means. In T. H. Christensen (Ed.), *Solid Waste Technology & Management* (pp. 183-192). West Sussex, UK: Blackwell Publishing Ltd.

Sang-Arun, J., & Heng, C. K. (2011.06). *A Guide for Technology Selection and Implementation of Urban Organic Waste Utilization Project in Cambodia,Policy Report.* Hayama, Japan: IGES.

Sartika, D. (1993, May 14). *Jakarta Scavengers Moan Loss of Scarp Trade*. Retrieved August 28, 2012, from India Environmental Portal: http://www.indiaenvironmentportal.org.in/news/jakarta-scavengers-moan-loss-scrap-trade

Scott, G. M. (2012). Recovered Paper. In T. M. Lechter, & D. A. Vallero (Eds.), *Waste: A Handbook for Management*, pp. 137-150. USA: Elsevier.

Sembiring, E., & Nitivattananon, V. (2010). Sustainable Solid Waste Management toward an Inclusive Society: Integration of the Informal Sector. *Intenational Journal of Resources, Conservation of Recycling 54* , pp. 802-809.

Sihombing, A. (2010). *Conflicting Images of Kampung and Kota in Jakarta: the Differences and Conflicts, and the Symbiotic Links between Kampung and Kota.* Saarbrücken, Germany: Lembert Academic Publishing.

Sihombing, A. (2004). *The Transformation of Kampungkota: Symbiosis between Kampung and Kota, a Case Study from Jakarta, Department of Architecture, University of Indonesia.* Retrieved August 24, 2012, from housingauthority.gov.hk: http://www.housingauthority.gov.hk/hdw/ihc/pdf/phhkt.pdf

Sprague, R., & Watson, H. (1993). *Decision Support Systems: Putting Theory into Practice* (Third ed.). Englewood Cliffs, New Jersey, USA: Prentice-Hall, Inc.

Stentiford, E., & De Bertoldi, M. (2011). Composting: Process. In T. H. Christensen (Ed.), *Solid Waste Technology & Management* (pp. 515-532). West Sussex, UK: Blackwell Publishing Ltd.

Sudhir, V., Muraleedharan, V. R., & Srinivasan, G. (1996). Integrated Solid Waste in Urban India: A Critical Operational Research Framework. *Socio-Economic Planning Science 30 (3)* , pp. 163-181.

Tambun, L. T., & Dahono, T. (2012). *Masterplan Pengelolaan Sampah di DKI Segera Ditetapkan or Waste Management Master Plant will be Launched soon in DKI*. Retrieved August 28, 2012, from Beritasatu.com: http://www.beritasatu.com/berita-utama/47744-masterplan-pengelolaan-sampah-dki-segera-ditetapkan.html

Tangri, N. (2003). *Waste Incineration: A Dying Technology.* Retrieved August 17, 2012, from scribd.com: http://de.scribd.com/doc/6867089/waste-incineration-a-dying-technology

Tchobanoglous, G., Theisen, H., & Vigil, S. A. (1993). *Integrated Solid Waste Management.* Singapore: McGraw-Hill, Inc.

The World Bank. (2012). *GDP per Capita (Current US$)*. Retrieved August 9, 2012, from data.worldbank: http://data.worldbank.org/indicator/NY.GDP.PCAP.CD

Thorneloe, S. A., Weitz, K., & Jambeck, J. (2007). Application of the US Decision Support Tool for Material and Waste Management. *Waste Maangement 27* , pp. 1006-1020.

Tränkler, J., Visvanathan, C., Kuruparan, P., & Tubtimthai, O. (2005). Influence of Tropical Seasonal Variations of Landfill Characteristics-Results from Lysimeter Studies. *Waste Management 25* , 1013-1020.

UNDESA. (2012). *World Urbanisation Prospects, the 2011 Revision, Population of Urban and Rural Areas and Percentage Urban, 2011, Table WUP2011-F01-Total_Urban_Rural.xls*. Retrieved August 17, 2012, from Economic and Social Affairs of thr UN: http://esa.un.org/unup/CD-ROM/Urban-Rural-Population.htm

UNEP. (2005). *Solid Waste Management*. Retrieved March 23, 2012, from United Nations Environment Programme: http://www.unep.org/ietc/InformationResources/Publications/SolidWasteManagementPublication/tabid/79356/Default.aspx

UNEP. (2012). *Sustainable Consumption*. Retrieved August 23, 2012, from United Nations Environment Programme: http://www.unep.fr/scp/sc/

UNFCCC. (2007). *Global Warming Potential*. Retrieved August 17, 2012, from United Nations Framework Convention on Climate Change: http://unfccc.int/ghg_data/items/3825.php

UNFPA. (2007). *Urban World 2007, Graphic by Paul Scruton*. Retrieved November 20, 2012, from The Guardian: http://image.guardian.co.uk/sys-files/Guardian/documents/2007/06/27/URBAN_WORLD_2806.pdf

US-EPA. (2012). *Reduce Waste (Waste Prevention)*. Retrieved August 23, 2012, from United States - Environmental Protection Agency: http://www.epa.gov/region7/waste/solidwaste/reduce_waste.htm

US-EPA. (2012-b). *Waste Management Options*. Retrieved August 24, 2012, from United States - Environmental Protection Agency: http://www.epa.gov/osw/homeland/options.htm

Valeo, C., Baetz, B. W., & Tsanis, K. (1998, June). Location of Recycling Depots with GIS. *Journal of Urban Planning and Development 2 (124)* , pp. 93-99.

Vallero, D. A. (2011). Green Engineering and Sustainable Design Aspects of Waste Management. In T. M. Lechter, & D. A. Vallero (Eds.), *Waste: A Handbook for Waste Management* (pp. 11-22). USA: Elsevier.

Wartakota. (2011). *Warga Protes Pengolahan Sampah or Community Protests the Waste Treatment*. Retrieved January 25, 2012, from wartakota.co.id: http://www.wartakota.co.id/detil/berita/68380/Warga-Protes-Pengolahan-Sampah

WECD. (1987). *Report of the World Commission on Environment and Development: Our Common Future.* Retrieved August 23, 2012, from UN Documents: http://www.un-documents.net/wced-ocf.htm

Widoyoko, D. (2007). Good Governance and Provisions of Affordable Housing in Jakarta, Indonesia, A Case Study. In M. Sohail (Ed.), *The Partnering Combat Corruption Series.* Loughborough University, UK: WECD.

Wikipedia Contributors. (2012). *Decision Suppost Systems*. Retrieved December 18, 2012, from Wikipedia, the Free Encyclopedia: http://en.wikipedia.org/w/index.php?title=Decision_support_system&oldid=528196050

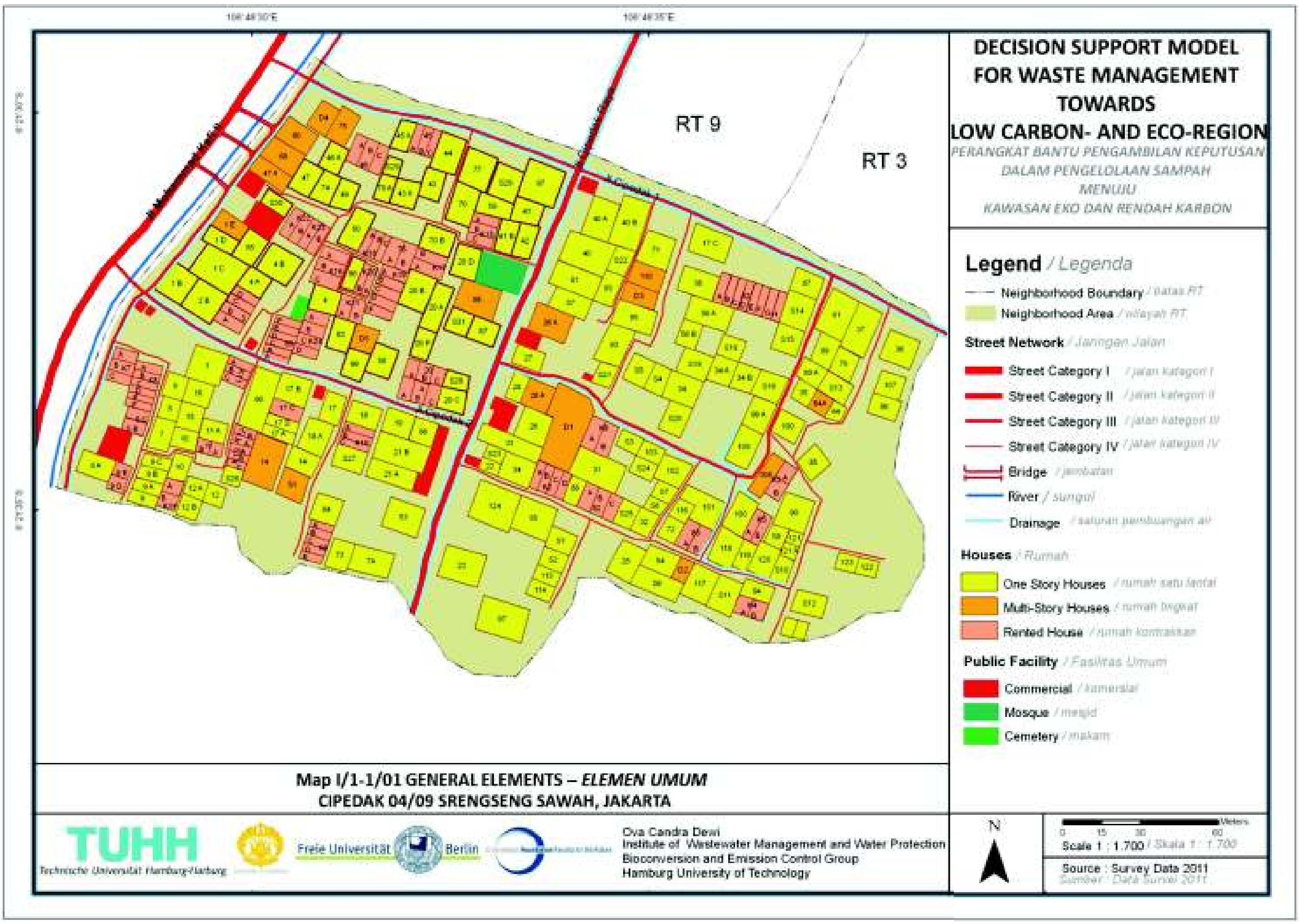
WMO. (2012). *World Weather Information Service, Indonesia*. Retrieved December 17, 2012, from World Meteorological Information: http://worldweather.wmo.int/043/c00310.htm

WWF China. (2012). *Low Carbon City Initiative (LCCI)*. Retrieved February 28, 2013, from World Wide Fund for Nature: http://en.wwfchina.org/en/what_we_do/climate___energy/mitigation/lcci/

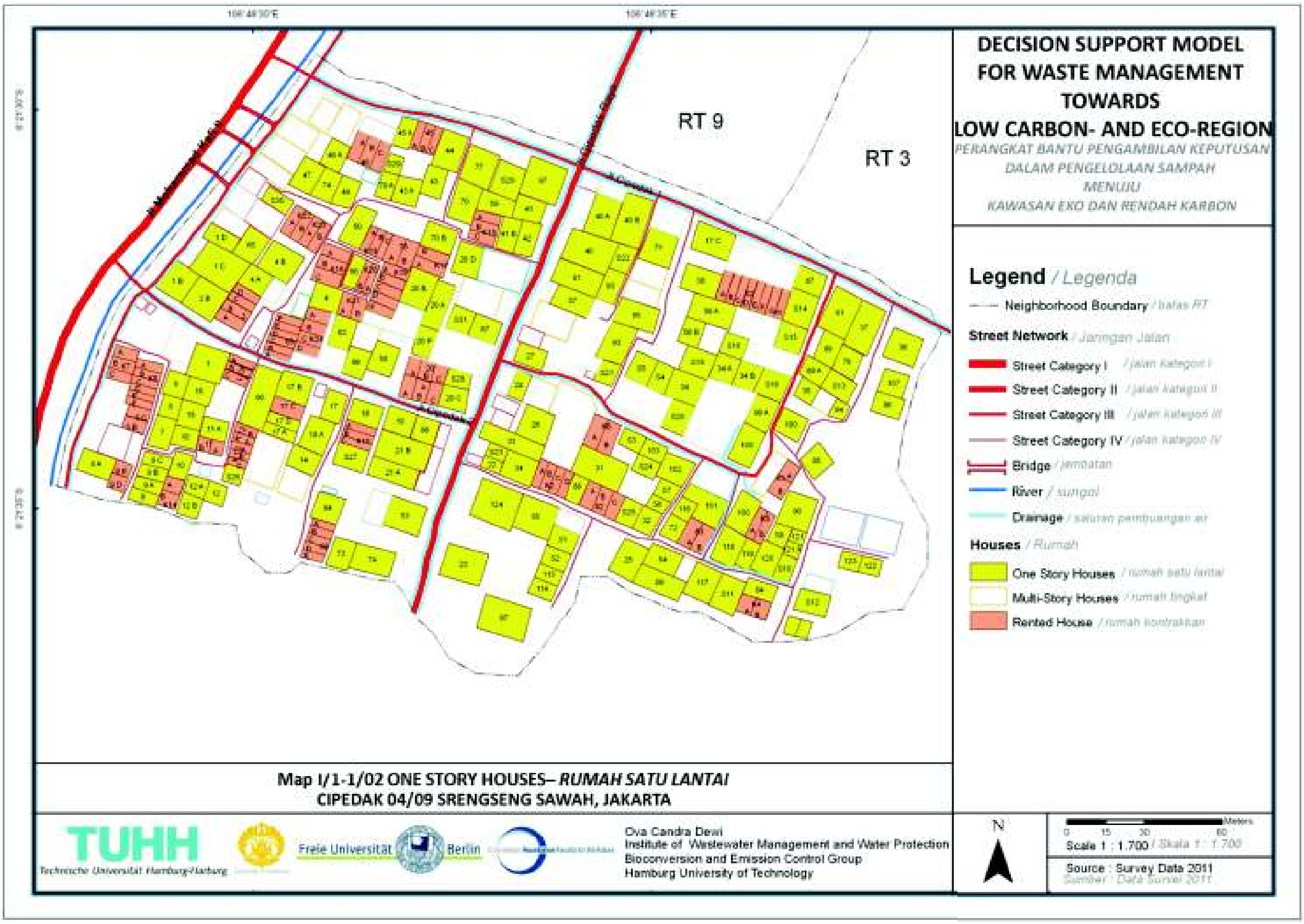
Zhu, D., Asnani, P. U., Zurbrügg, C., Anapolsky, S., & Mani, S. (2008). *Improving Solid Waste Management in India, a Sourcebook for Policy Makers and Practitioners.* Washington D.C., USA: World Bank Institute, the World Bank.

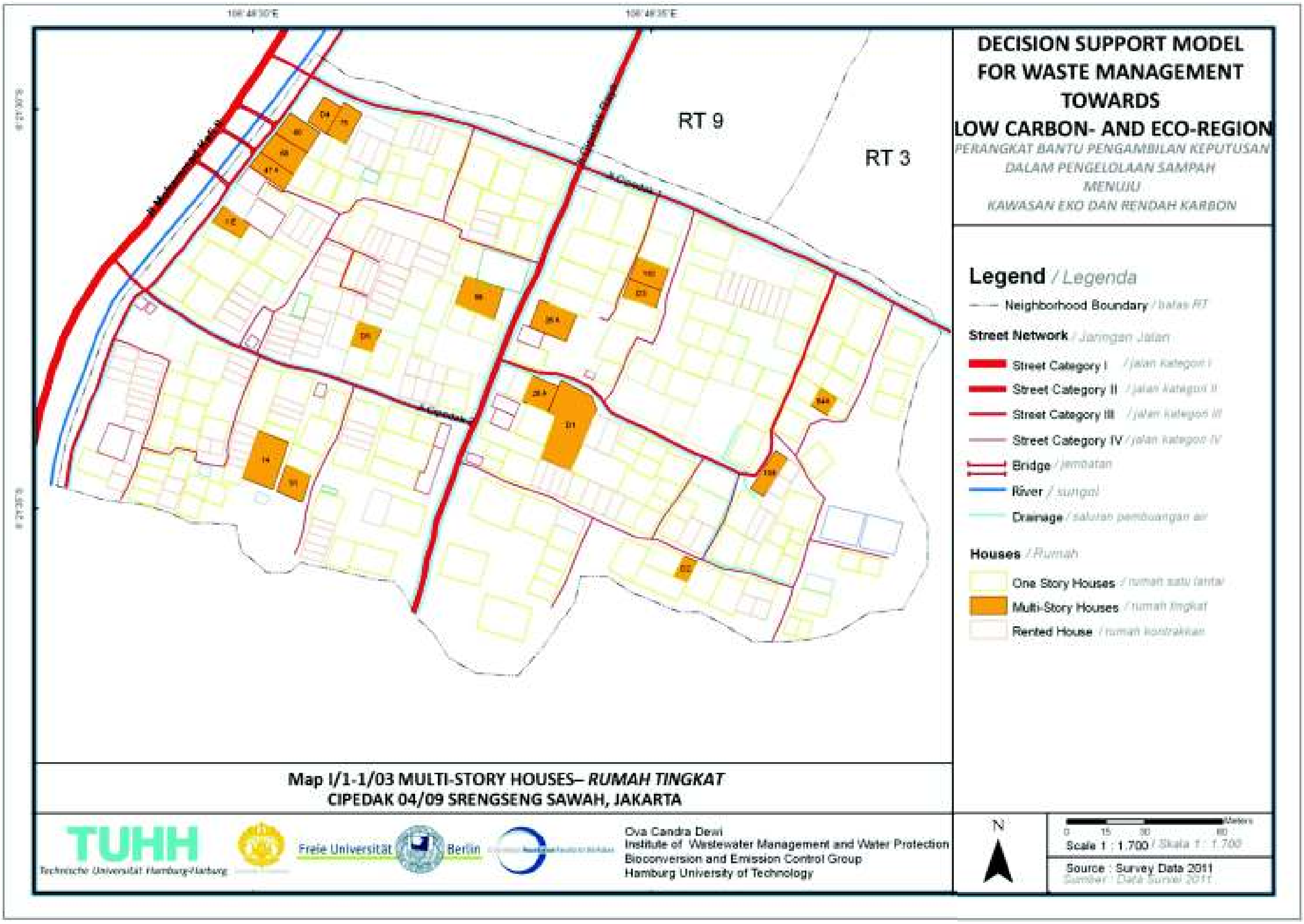
List of Appendices

Appendix A - Map Based Result



Physical Maps Inventory - Case 1





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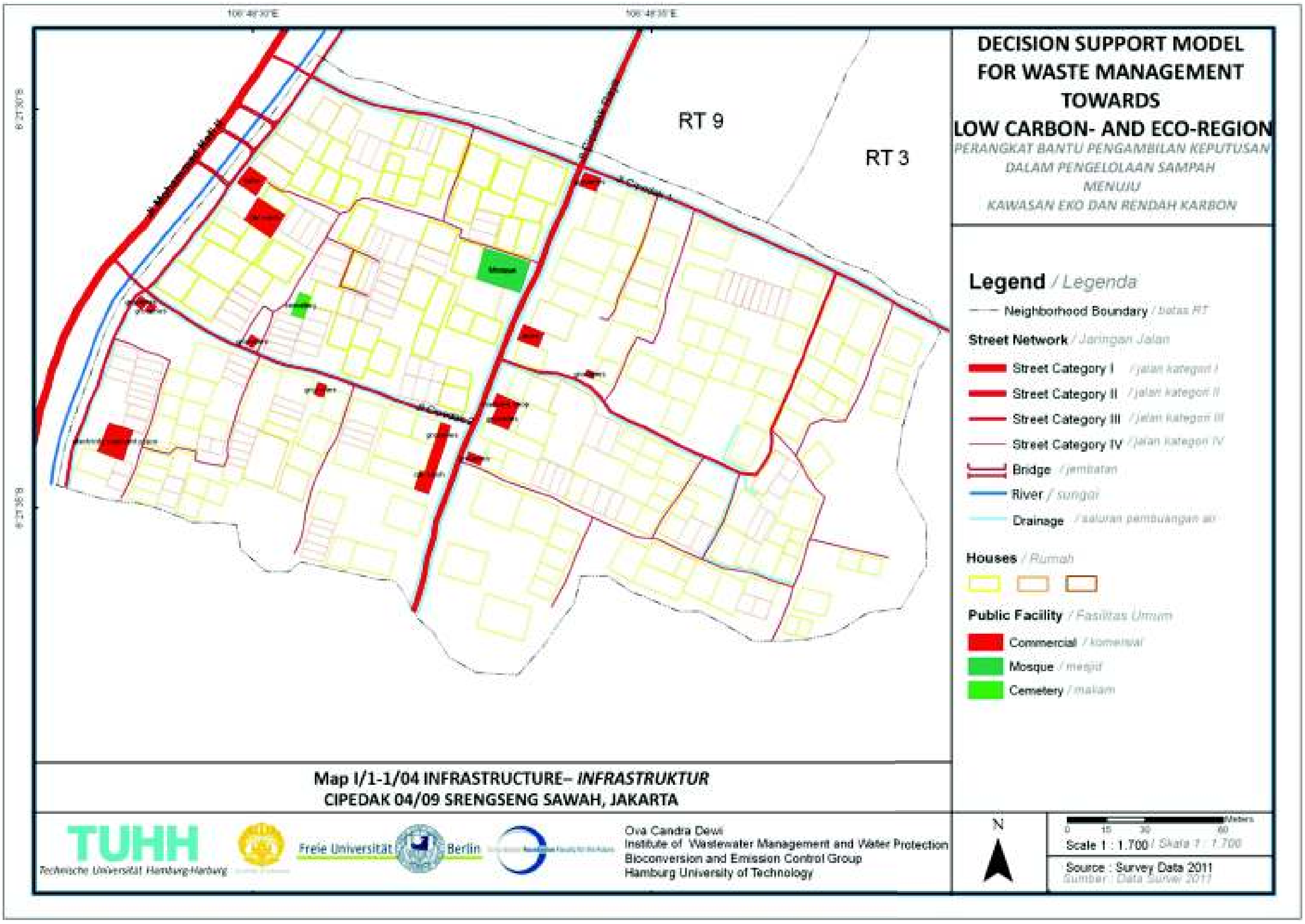

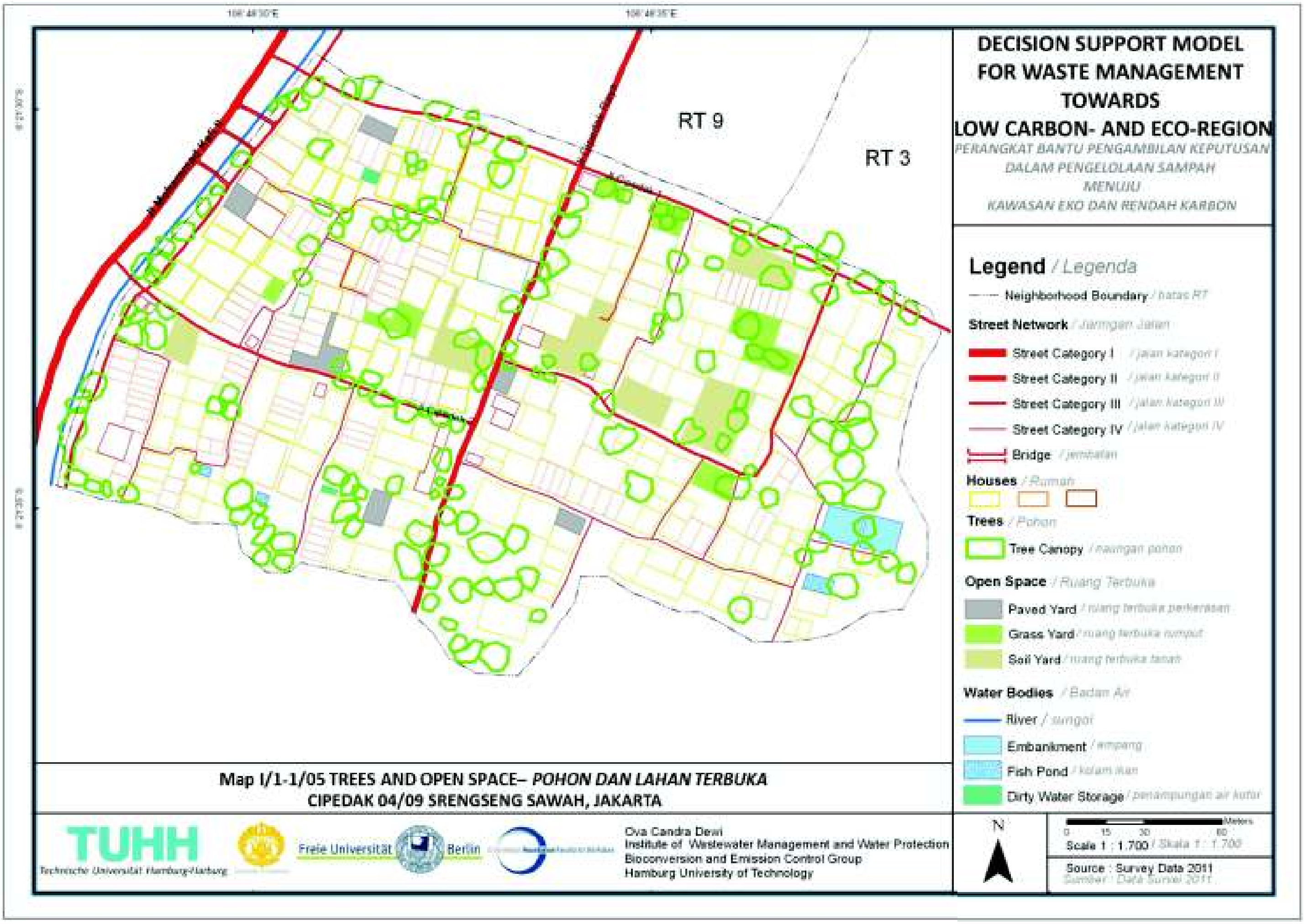

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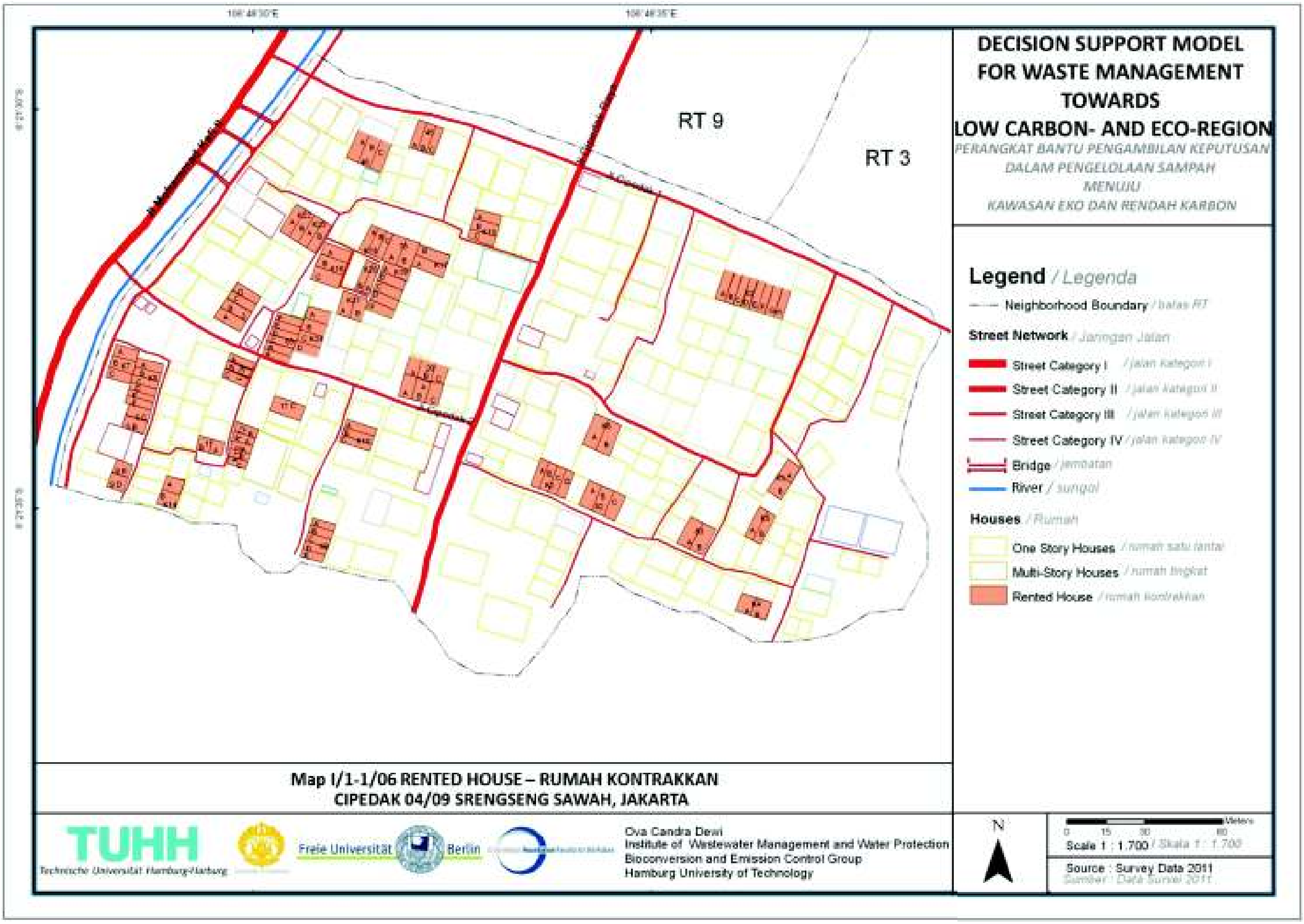

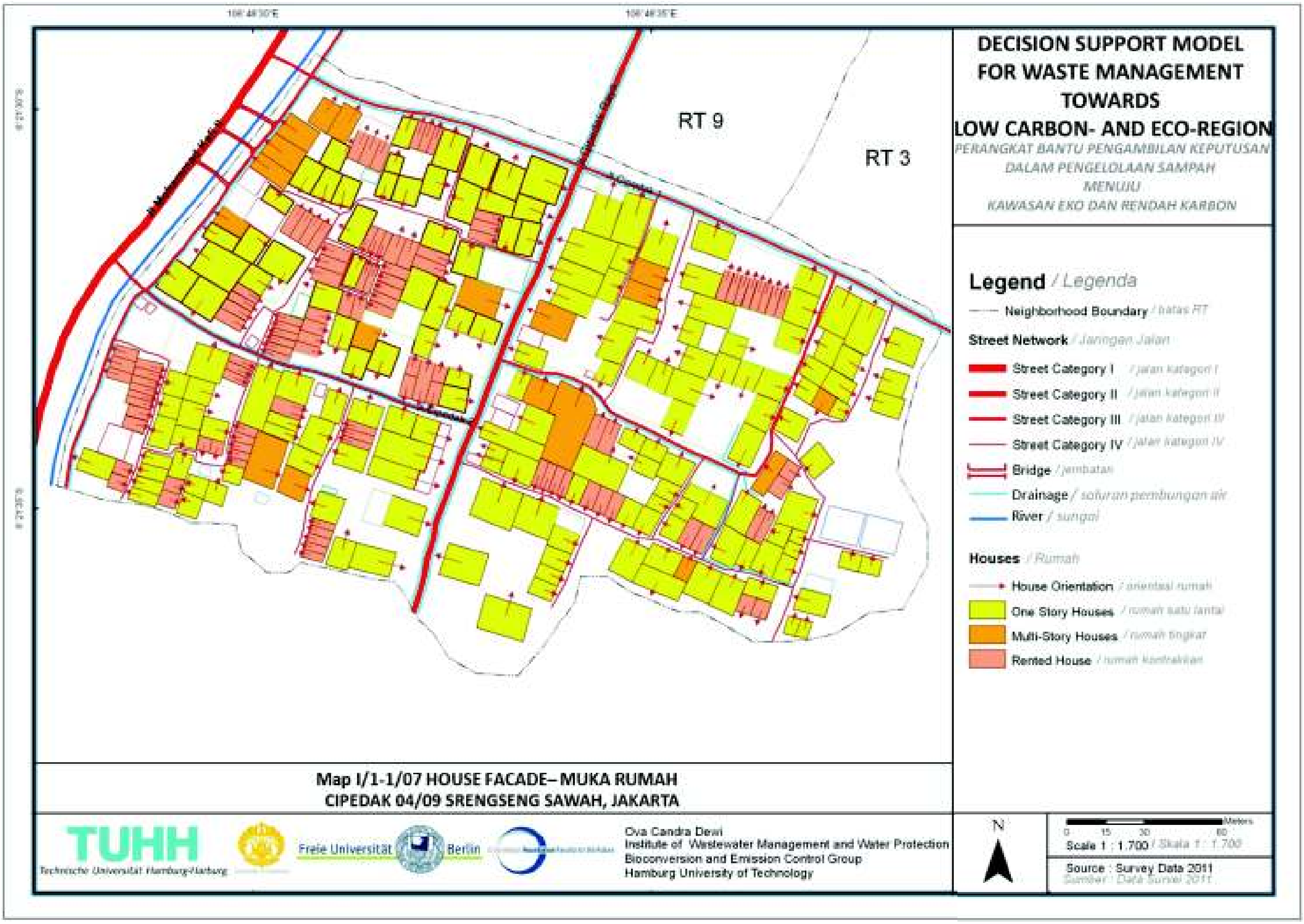

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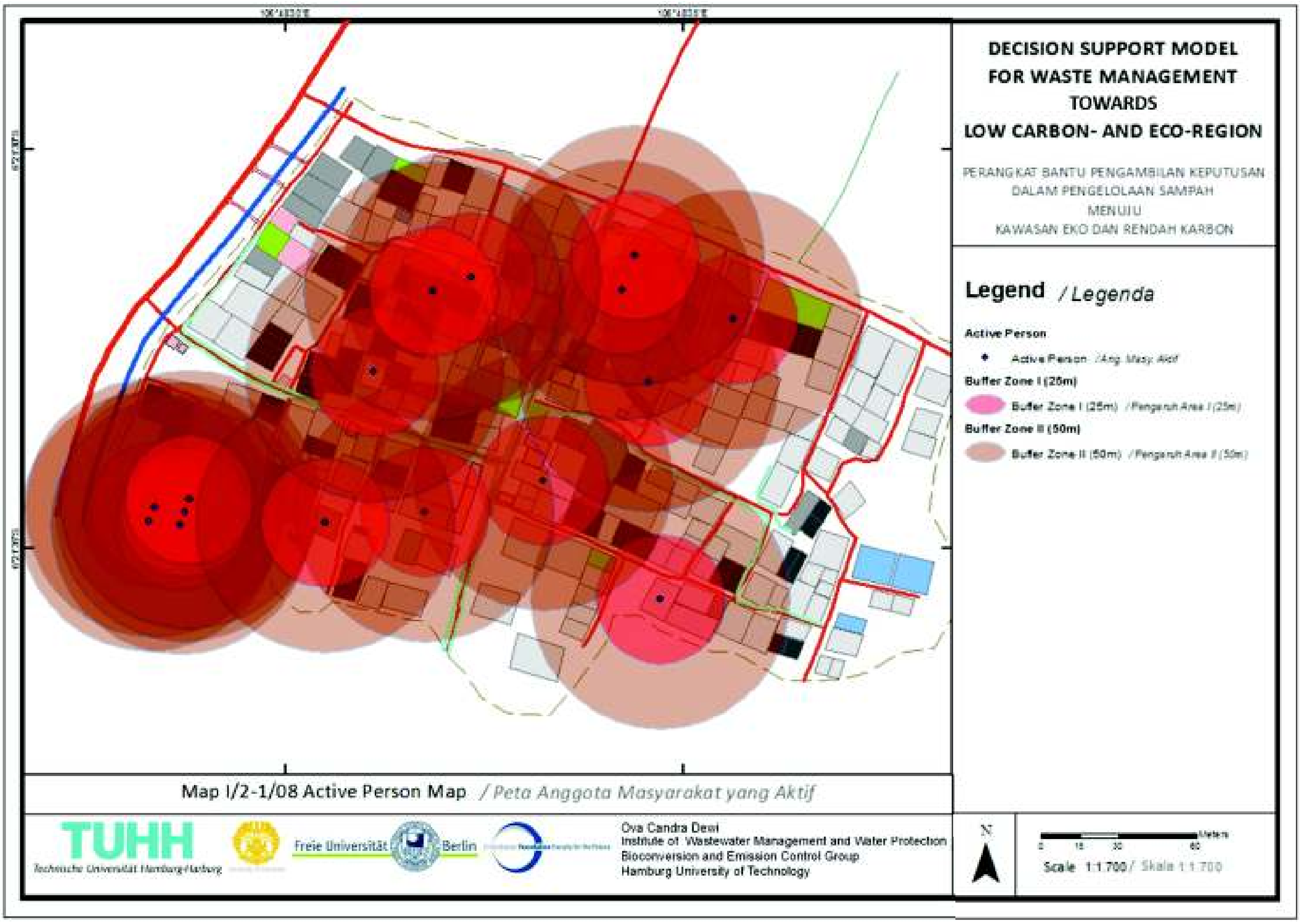

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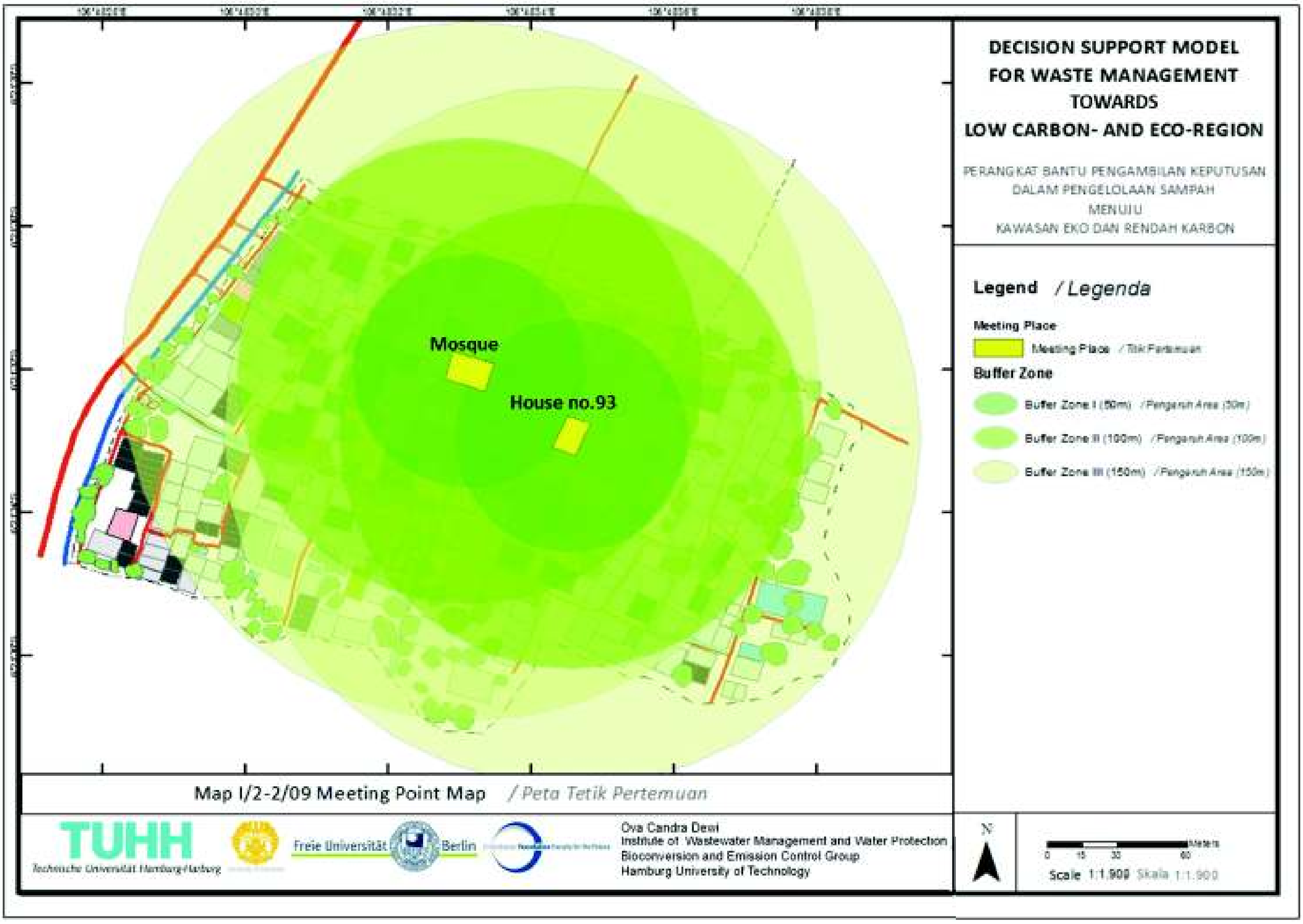

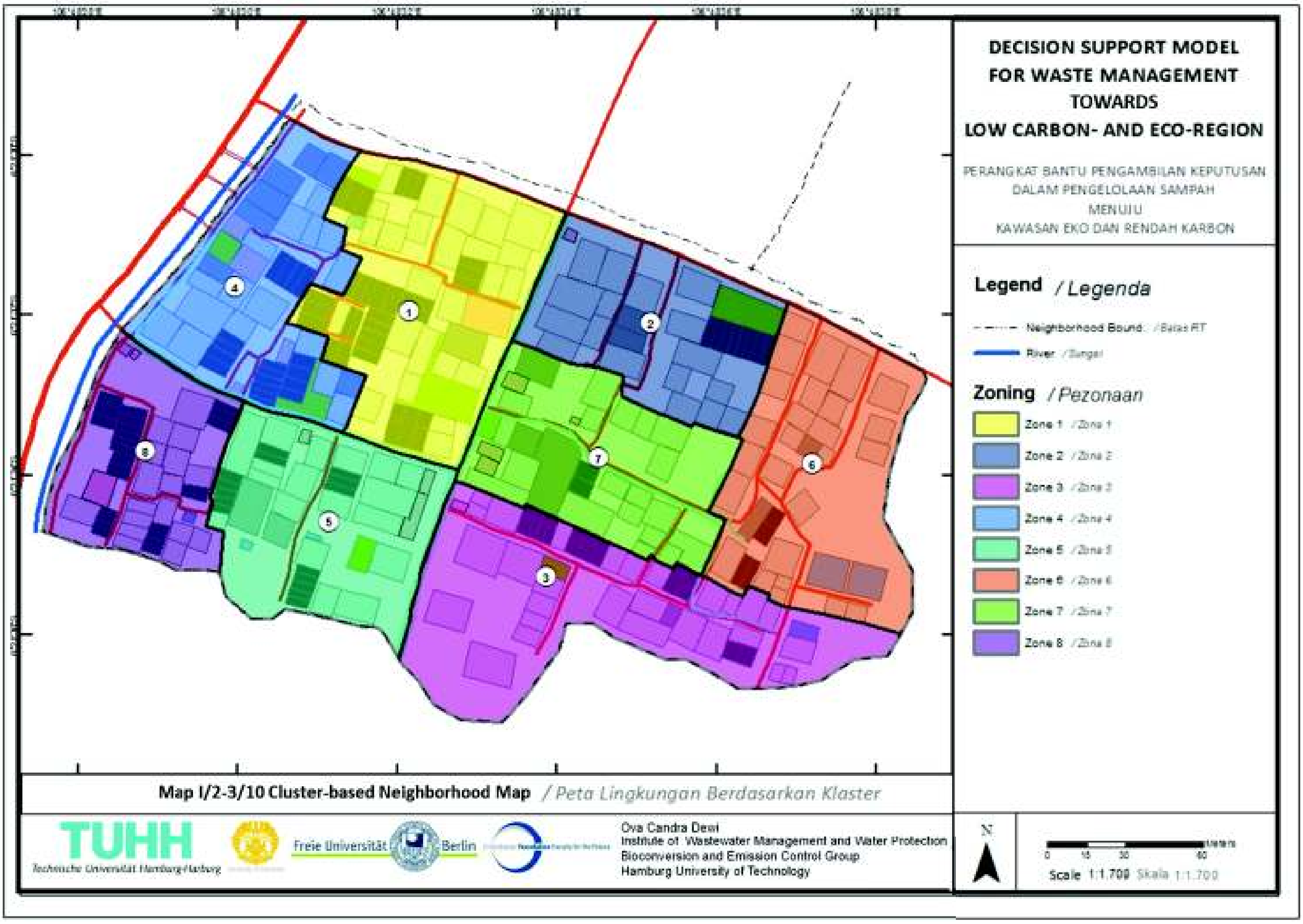

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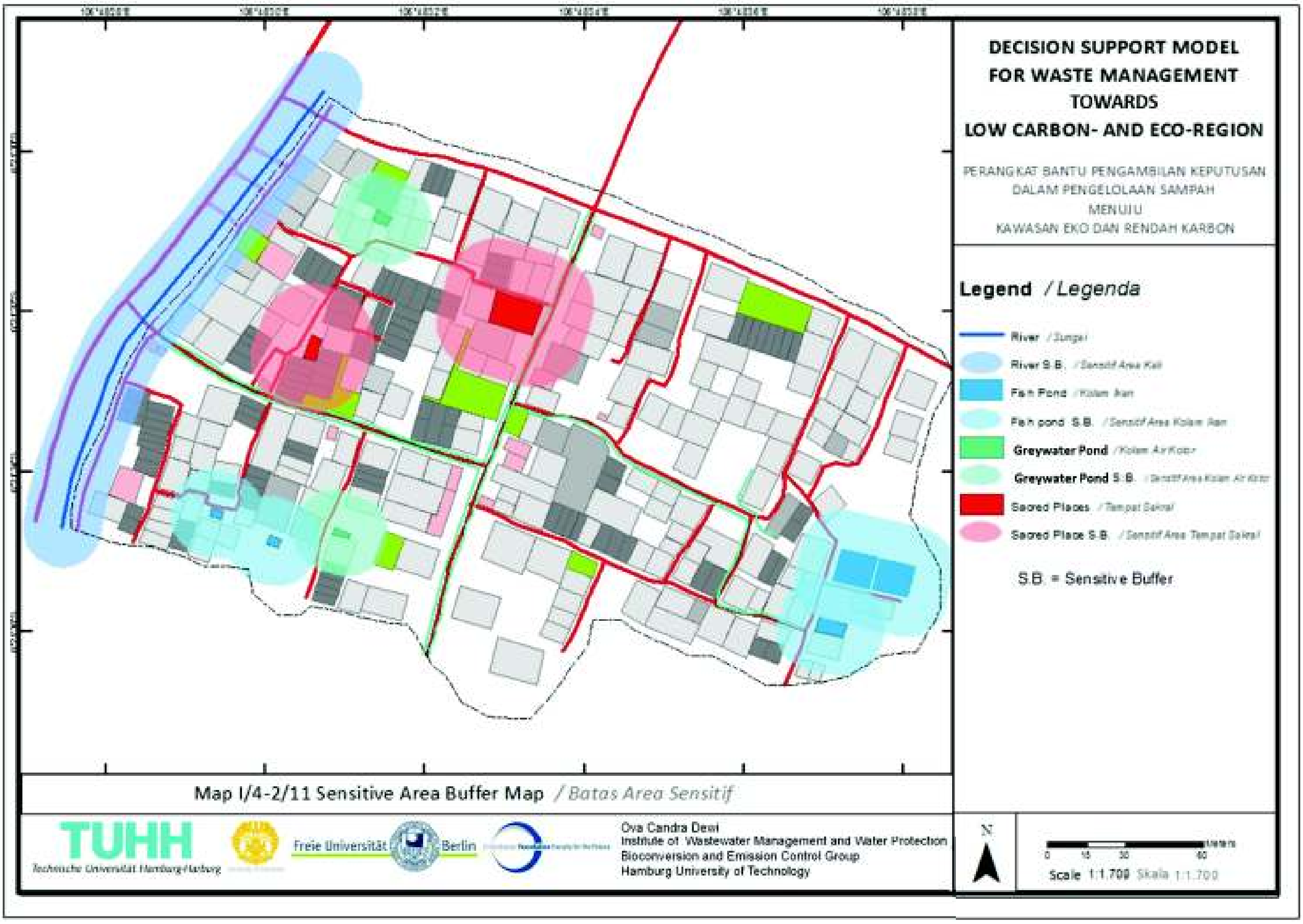

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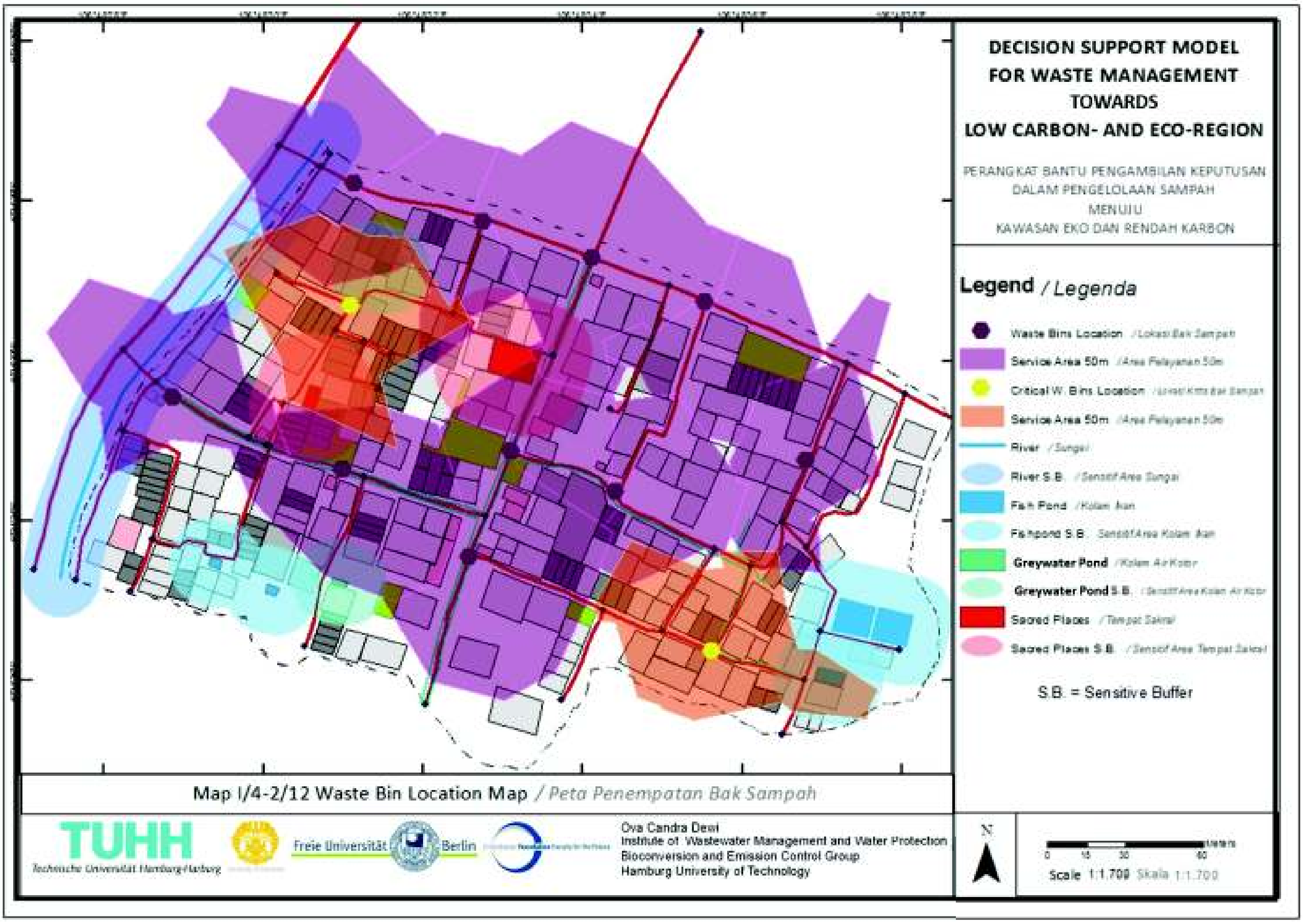

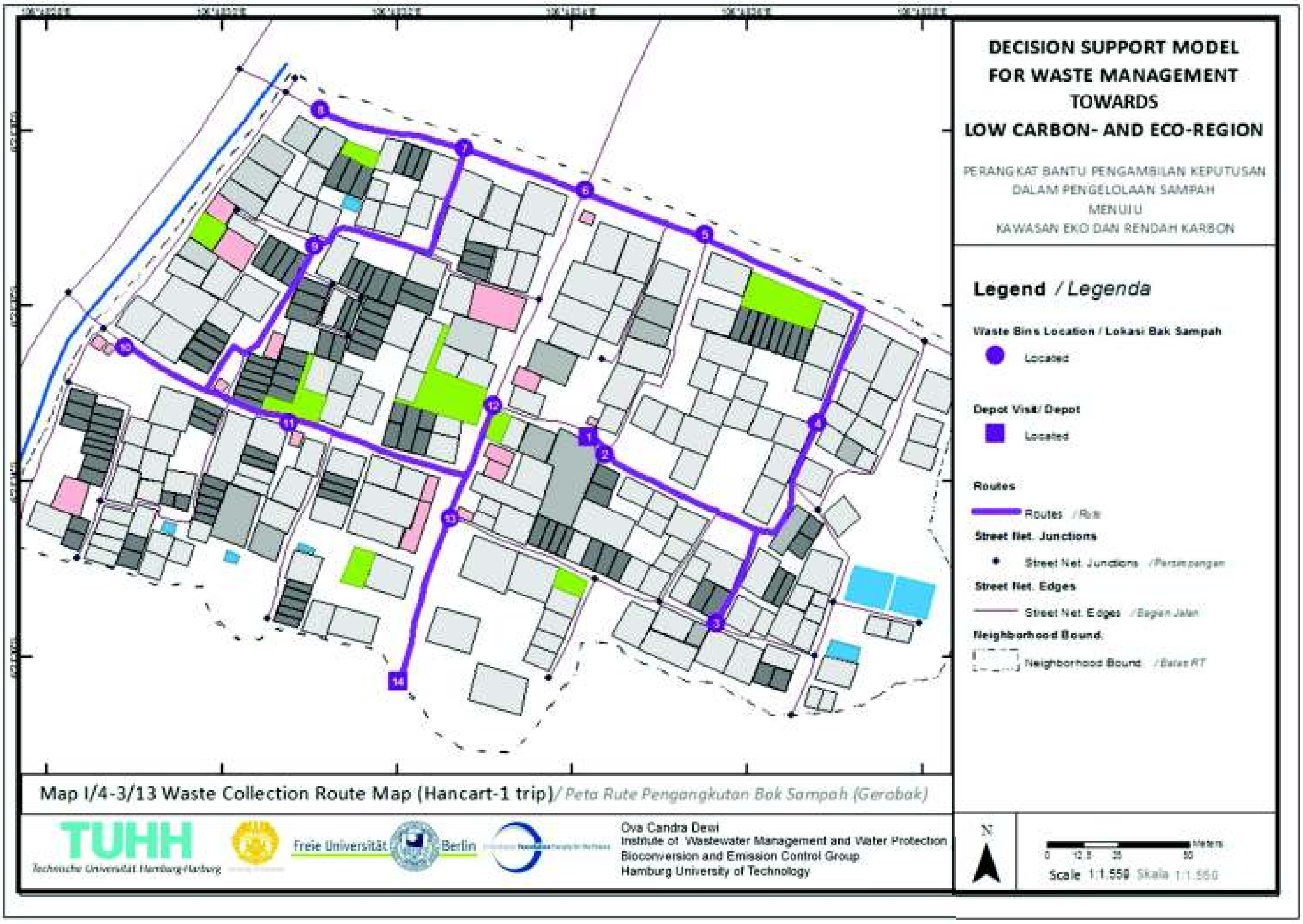

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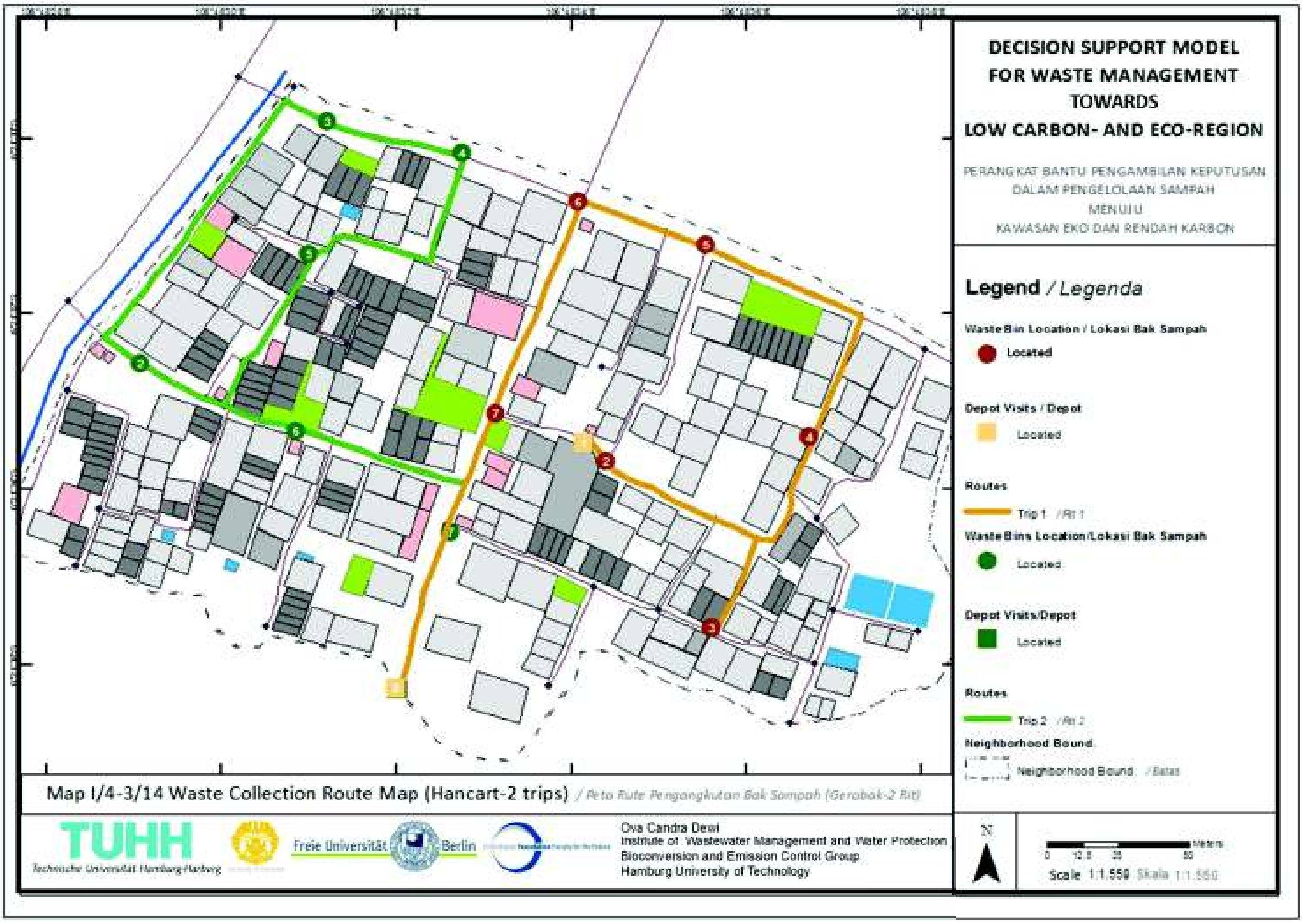

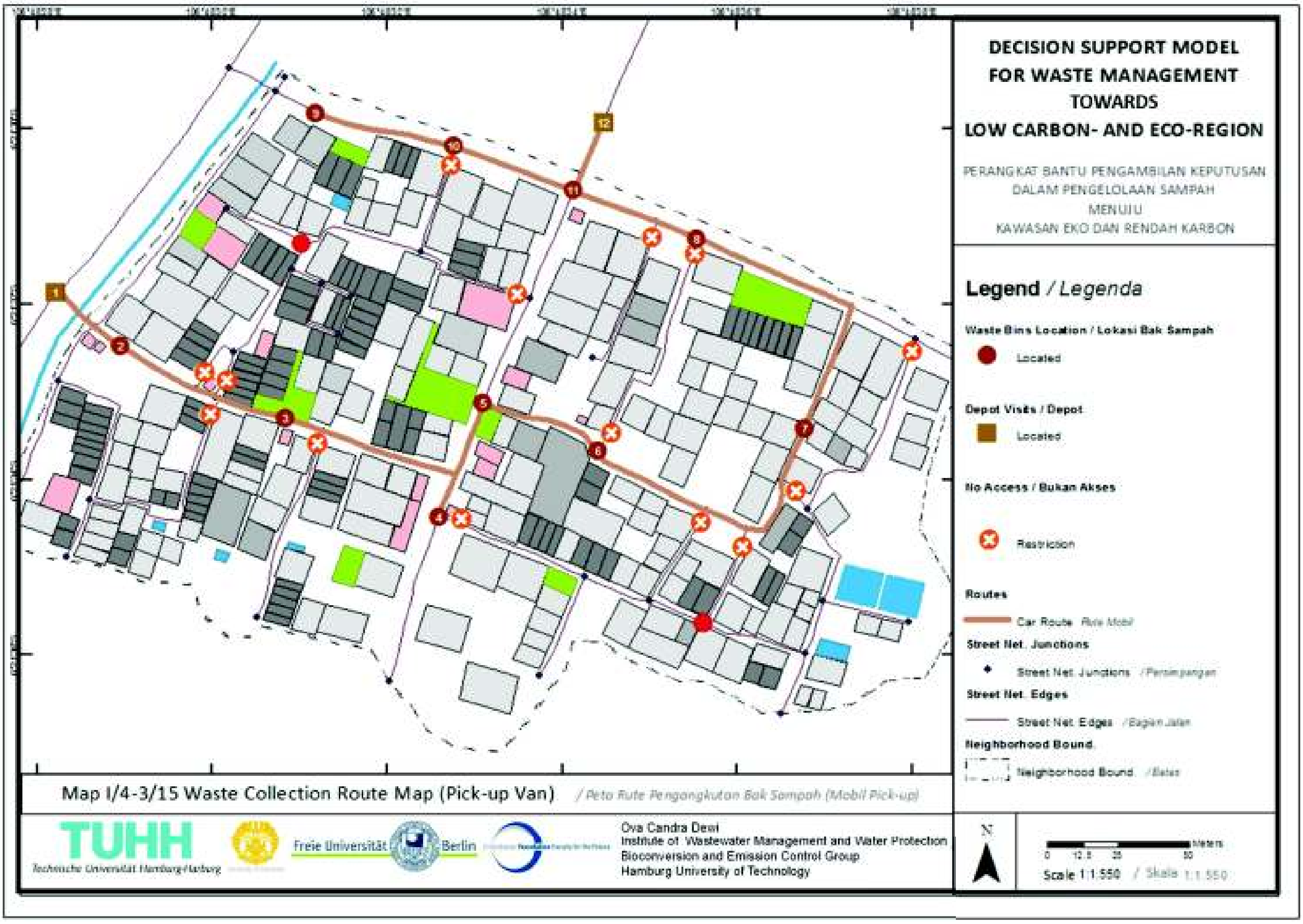

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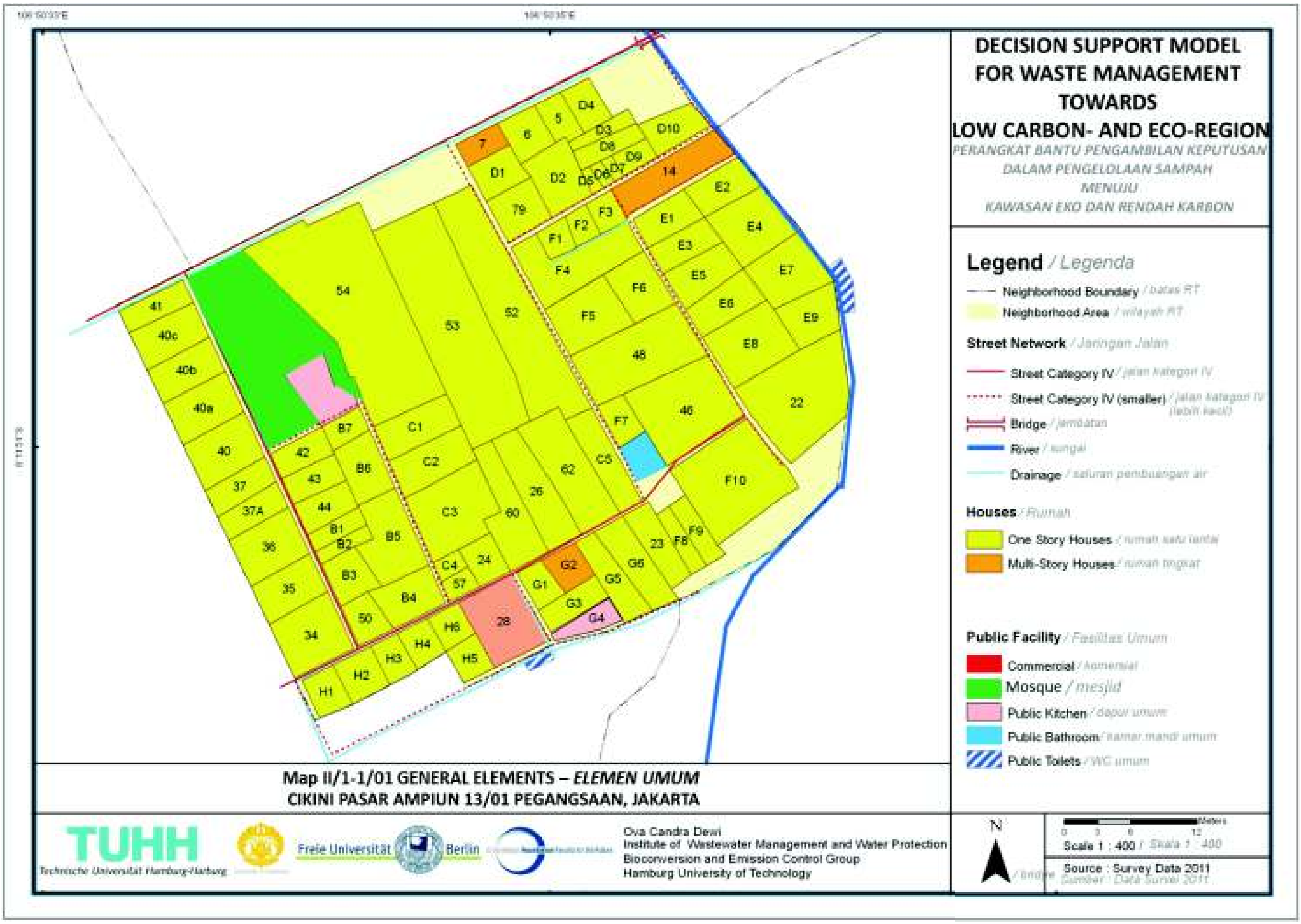

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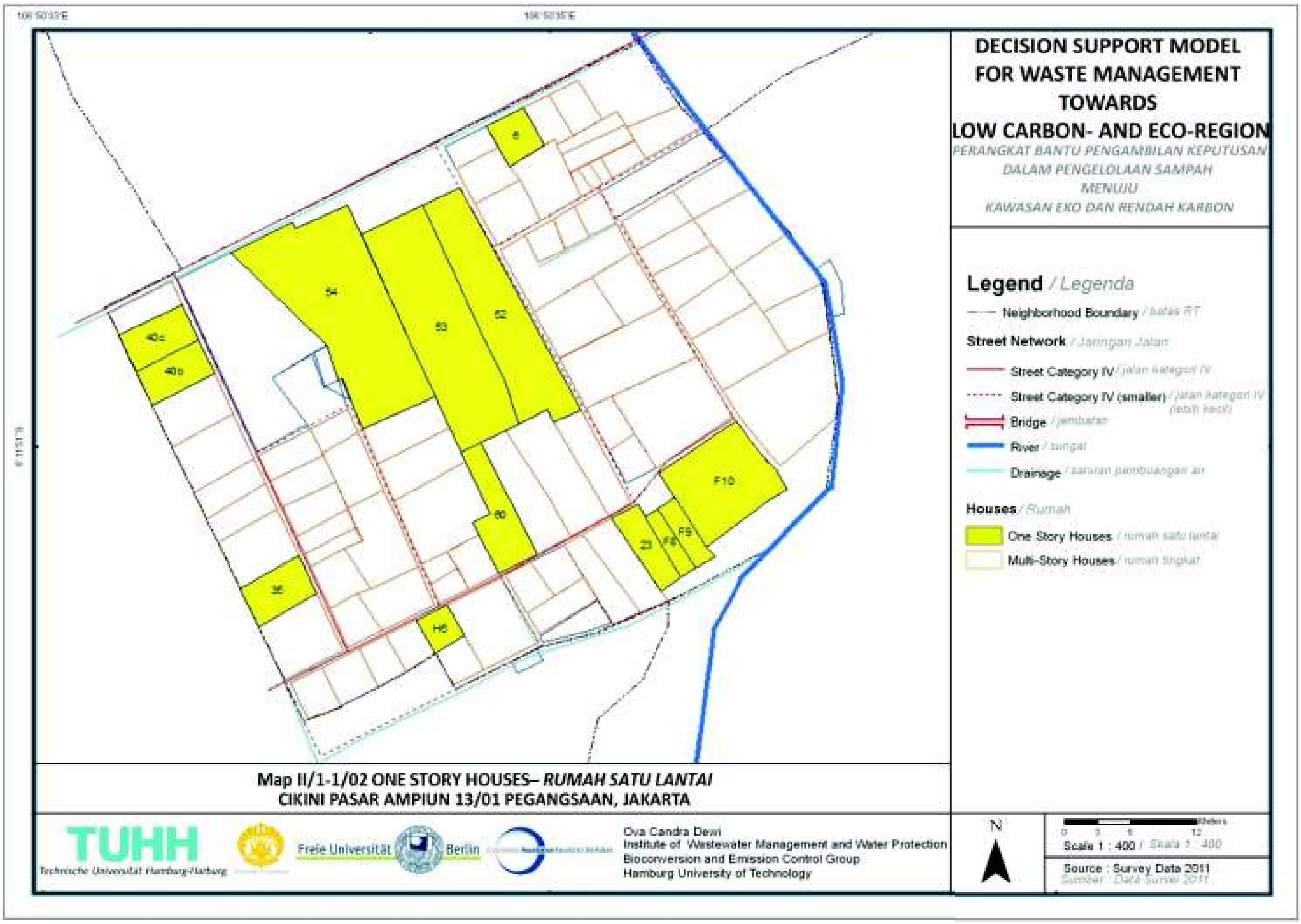

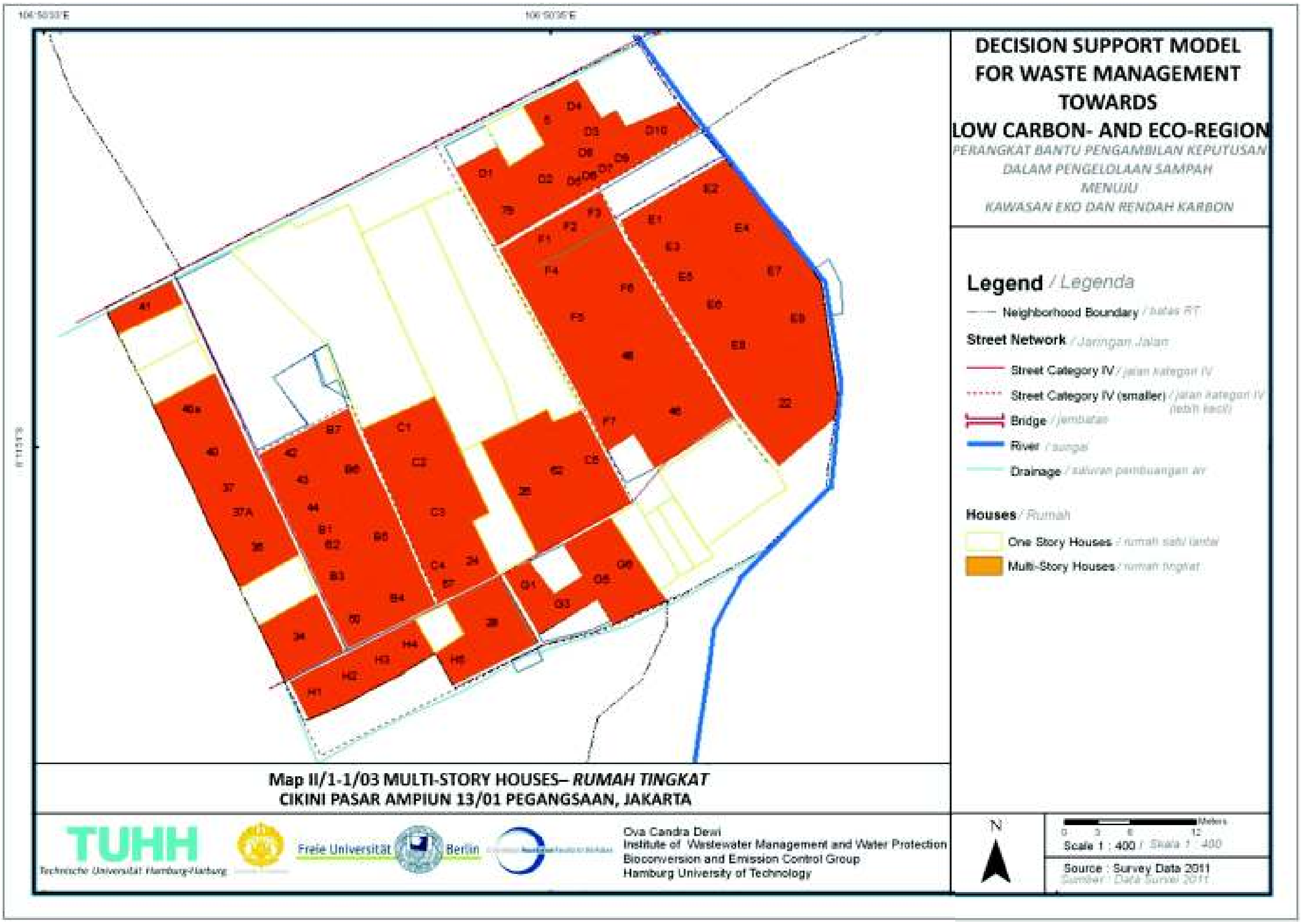

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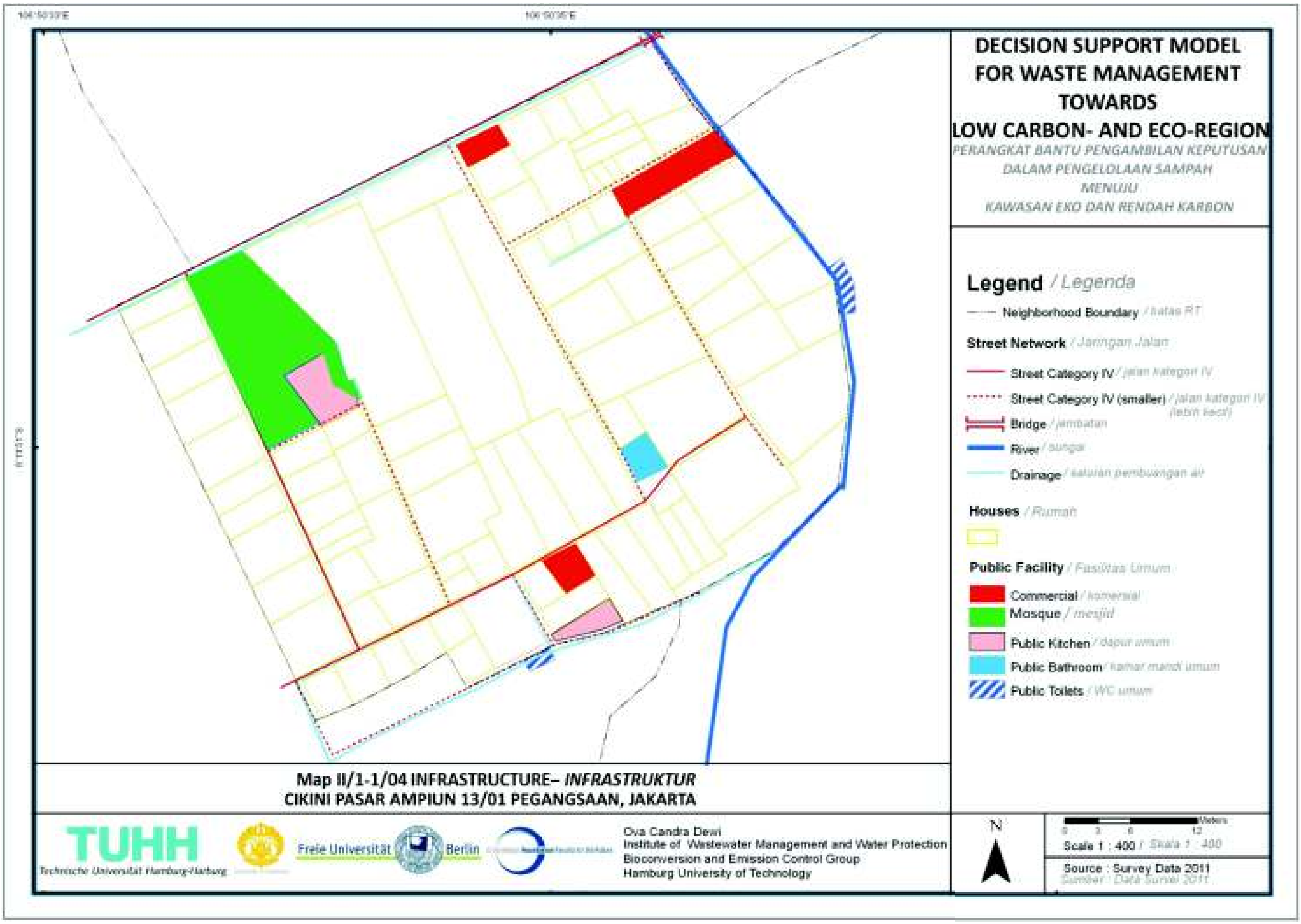

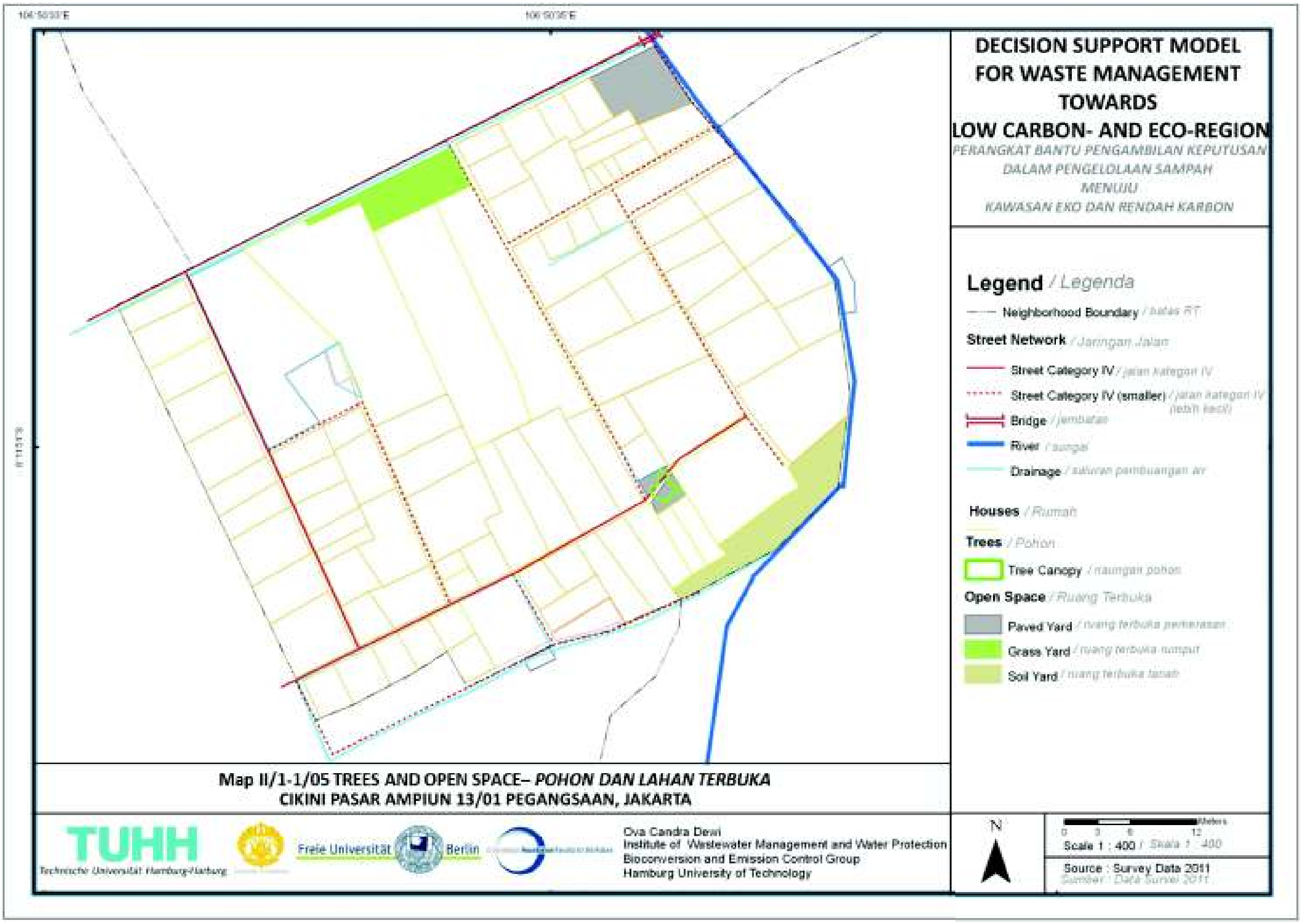

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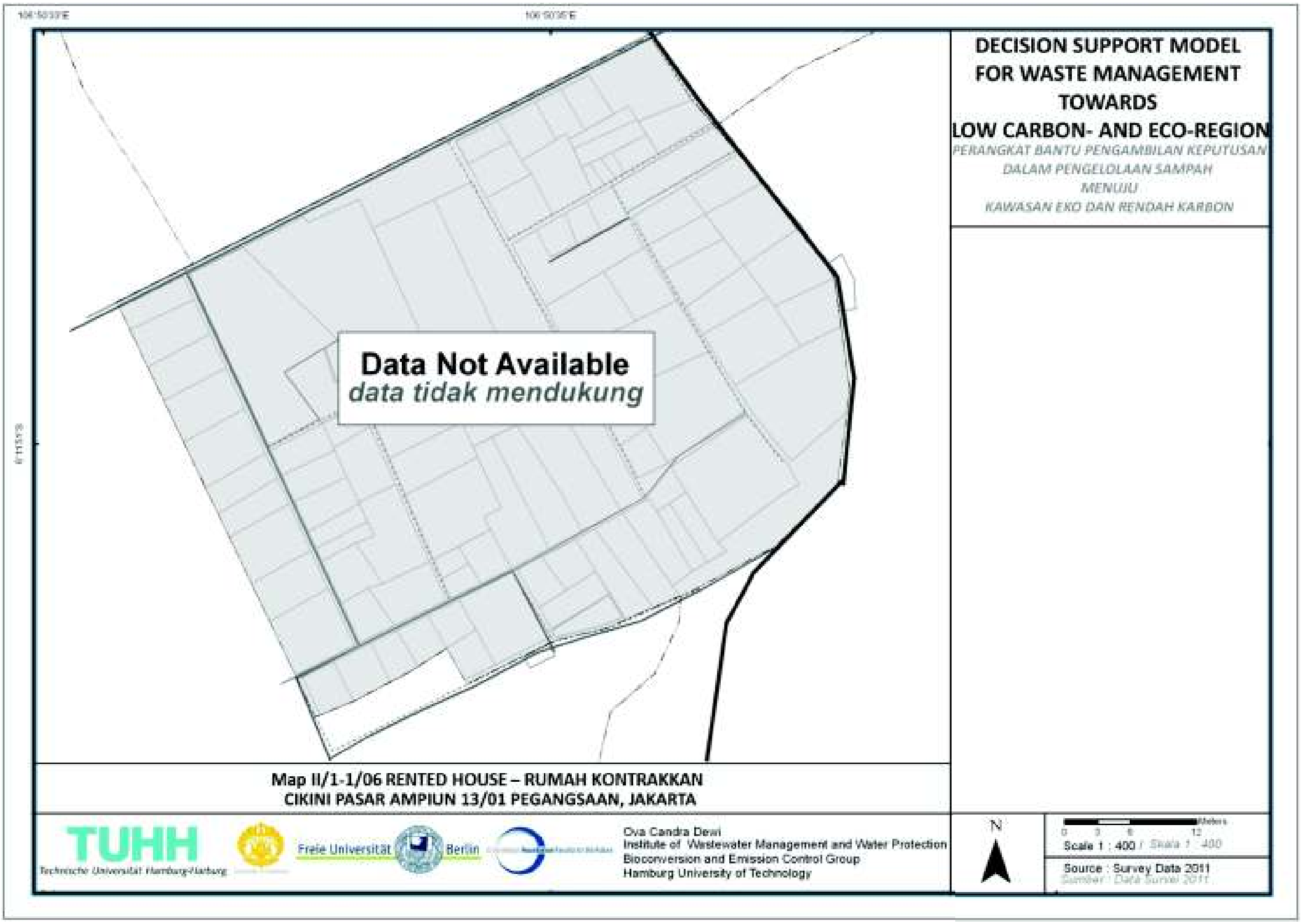

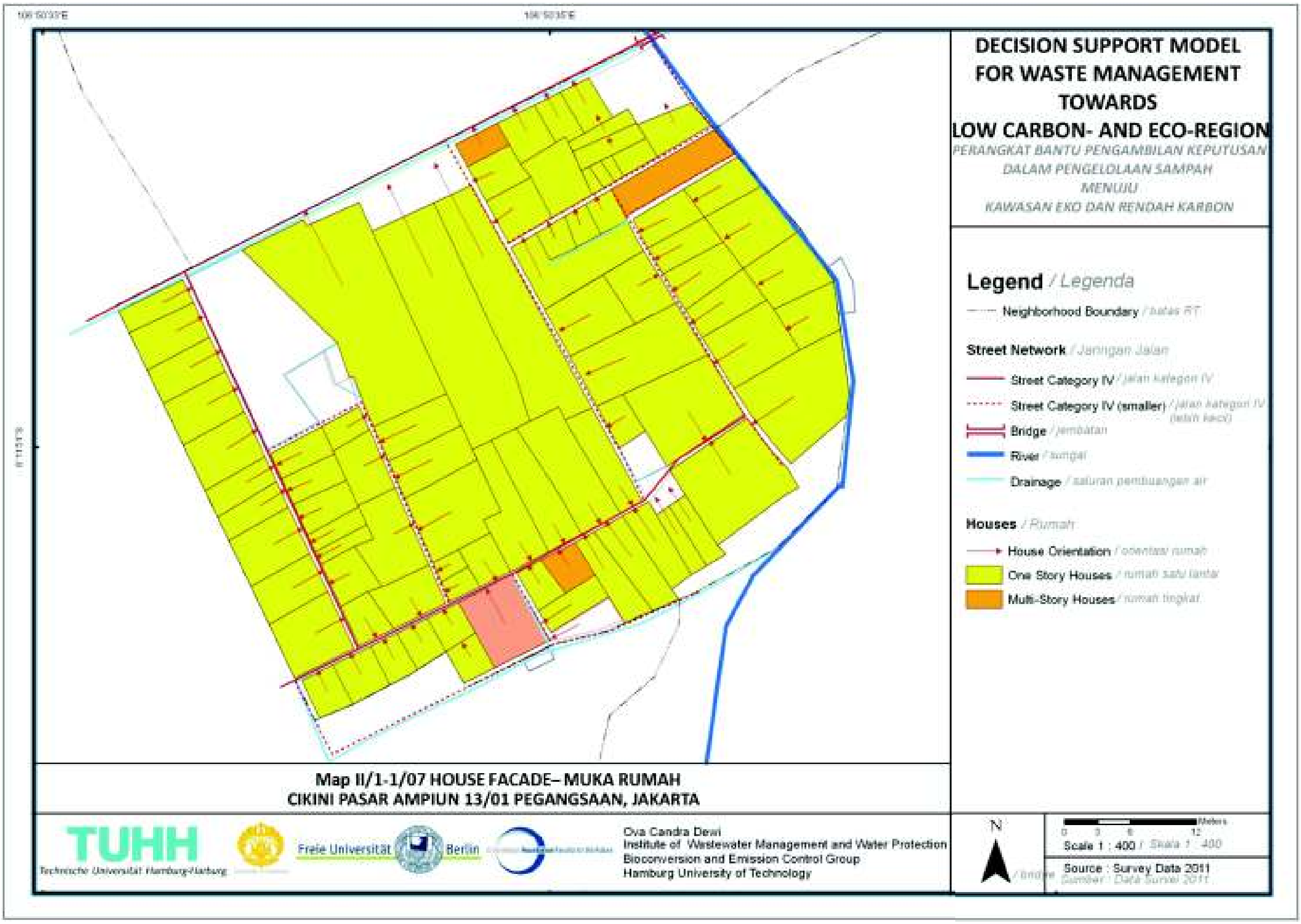

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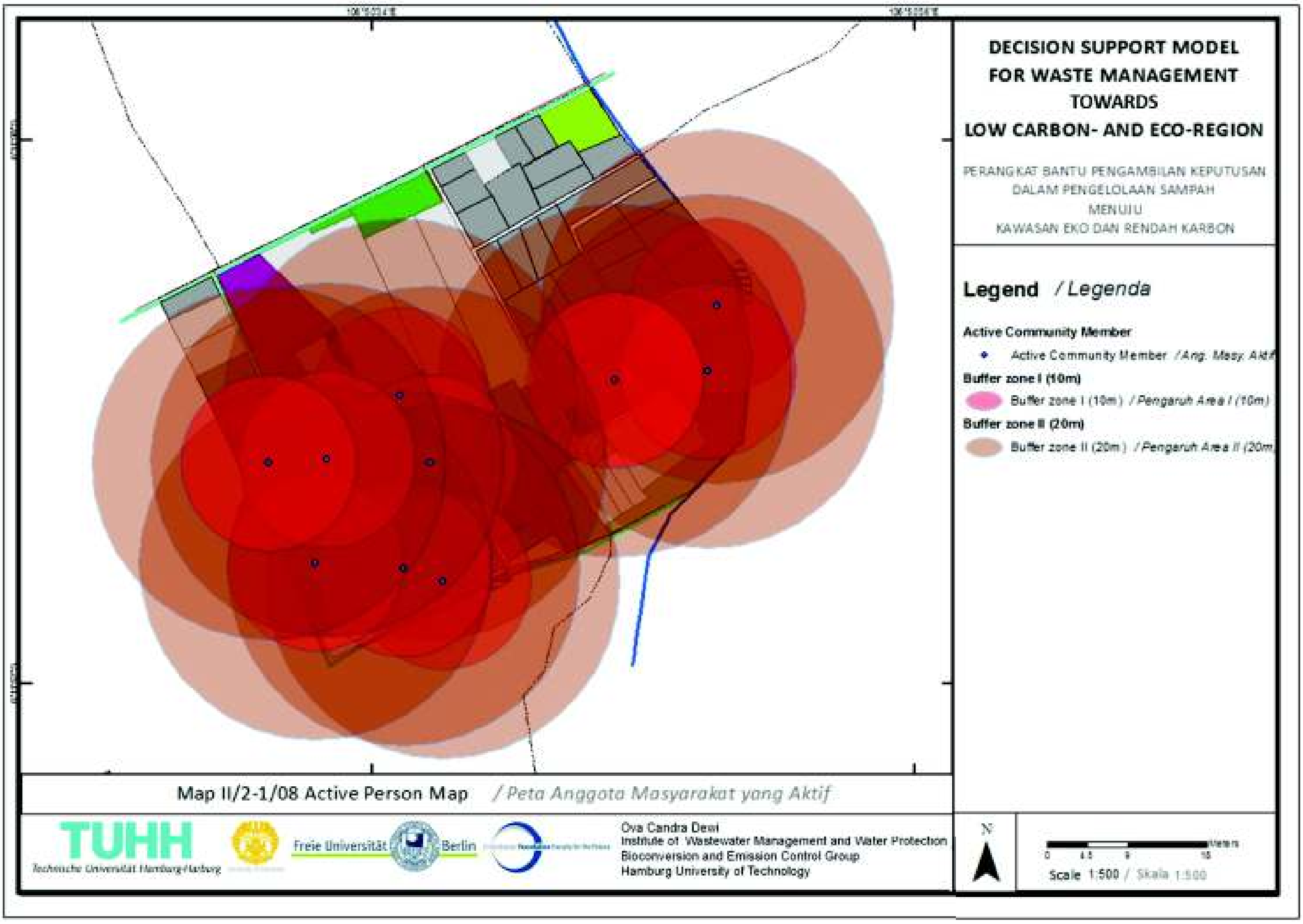
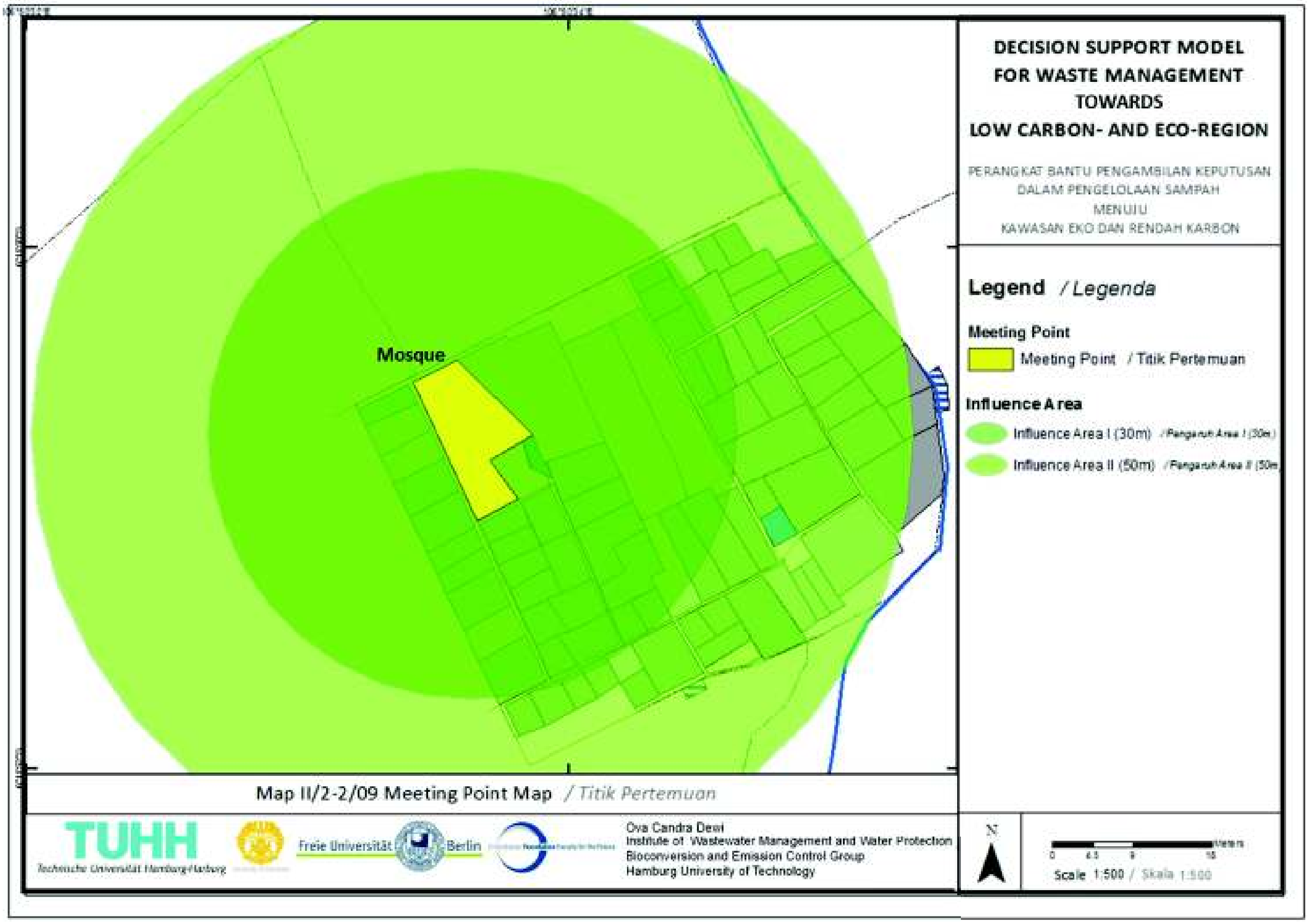
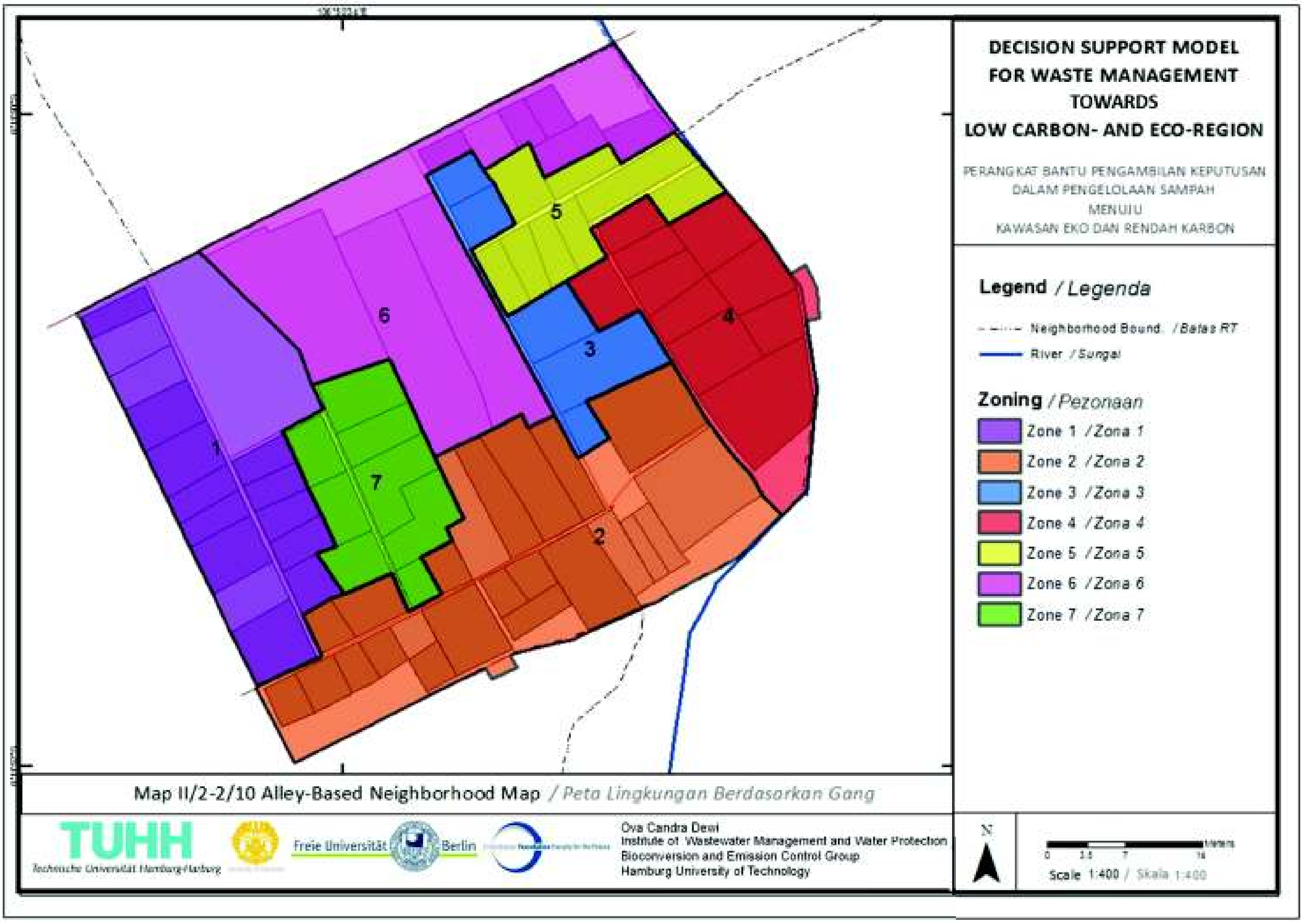


System Information& Communication Network - Case 2





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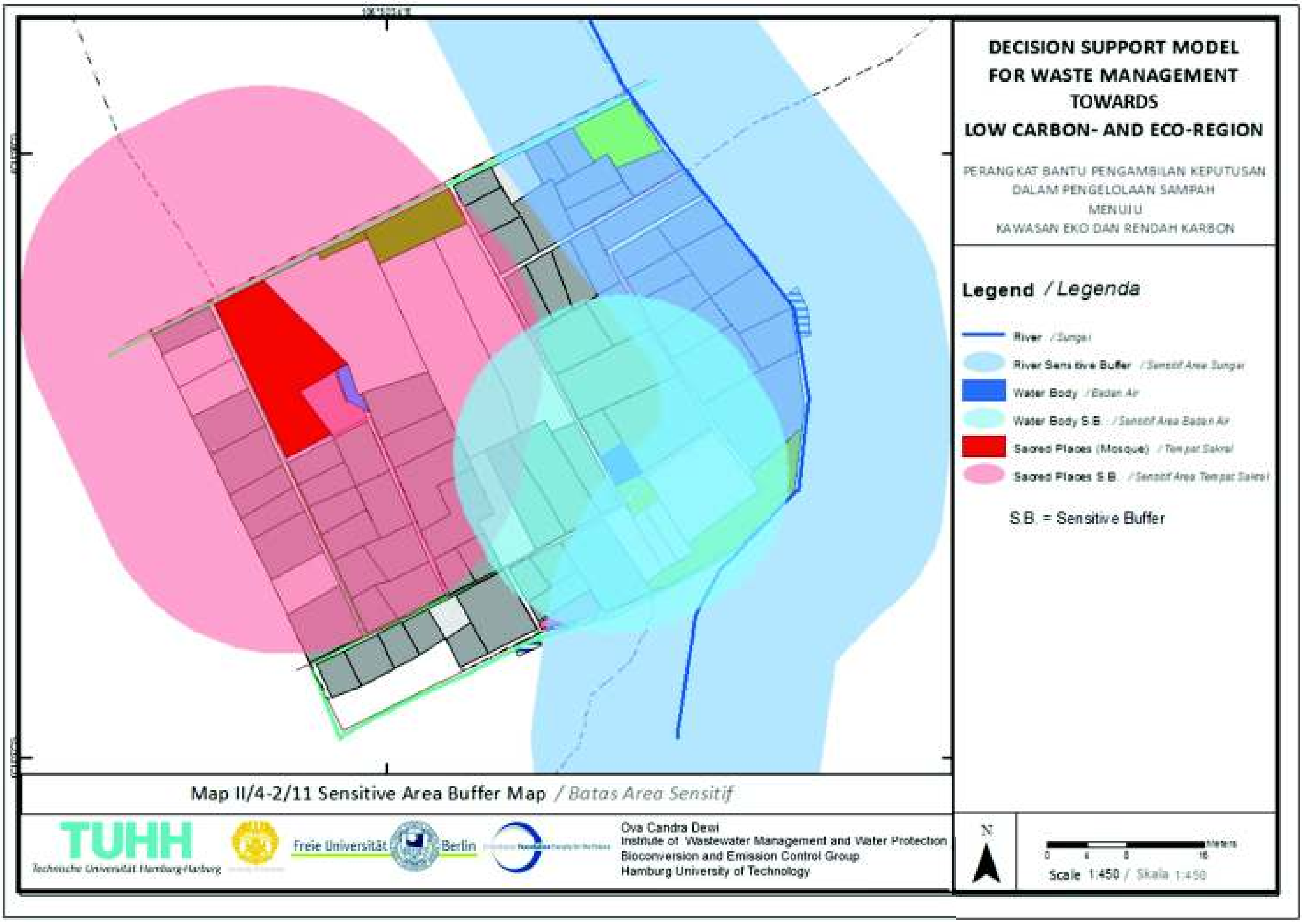

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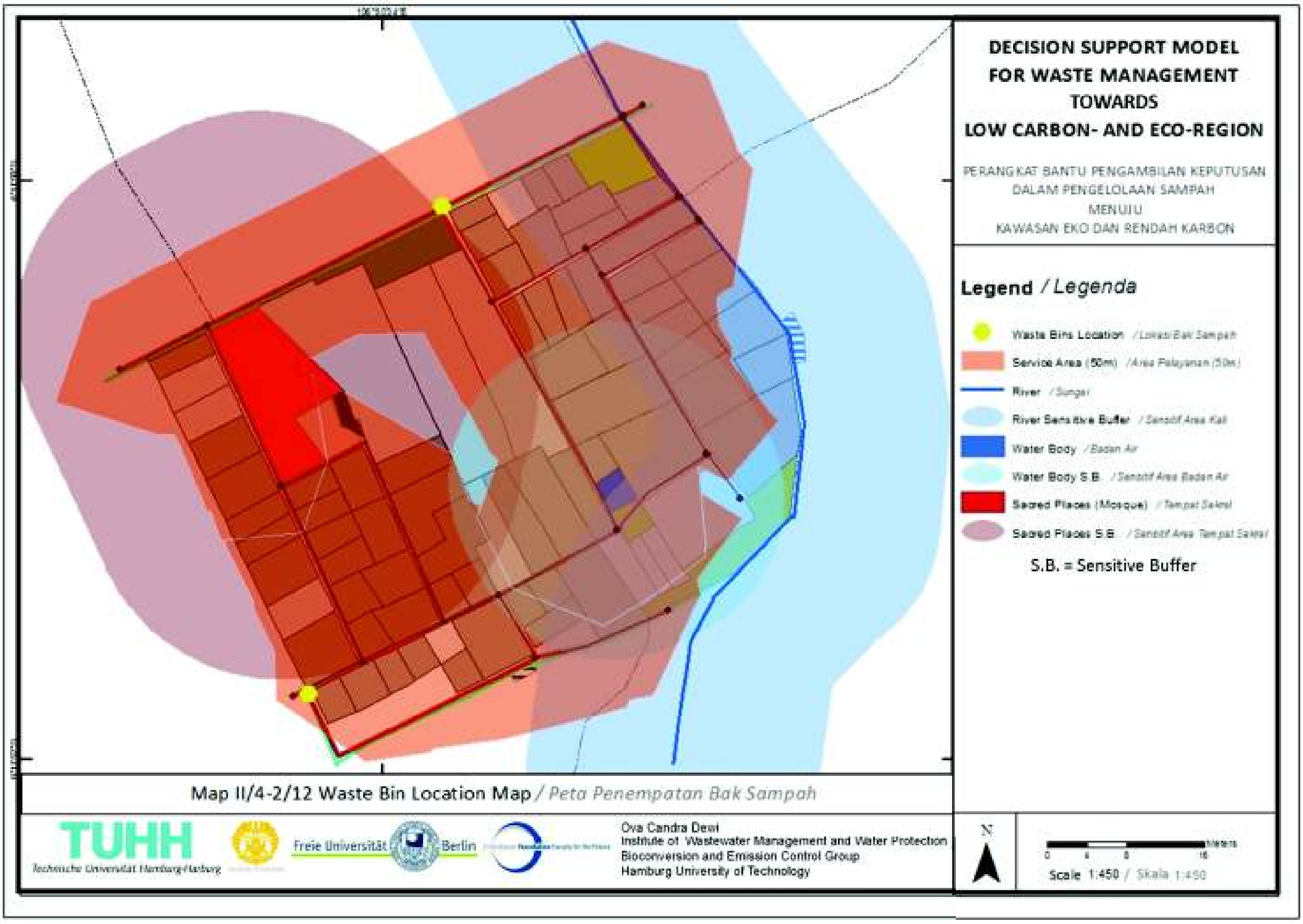
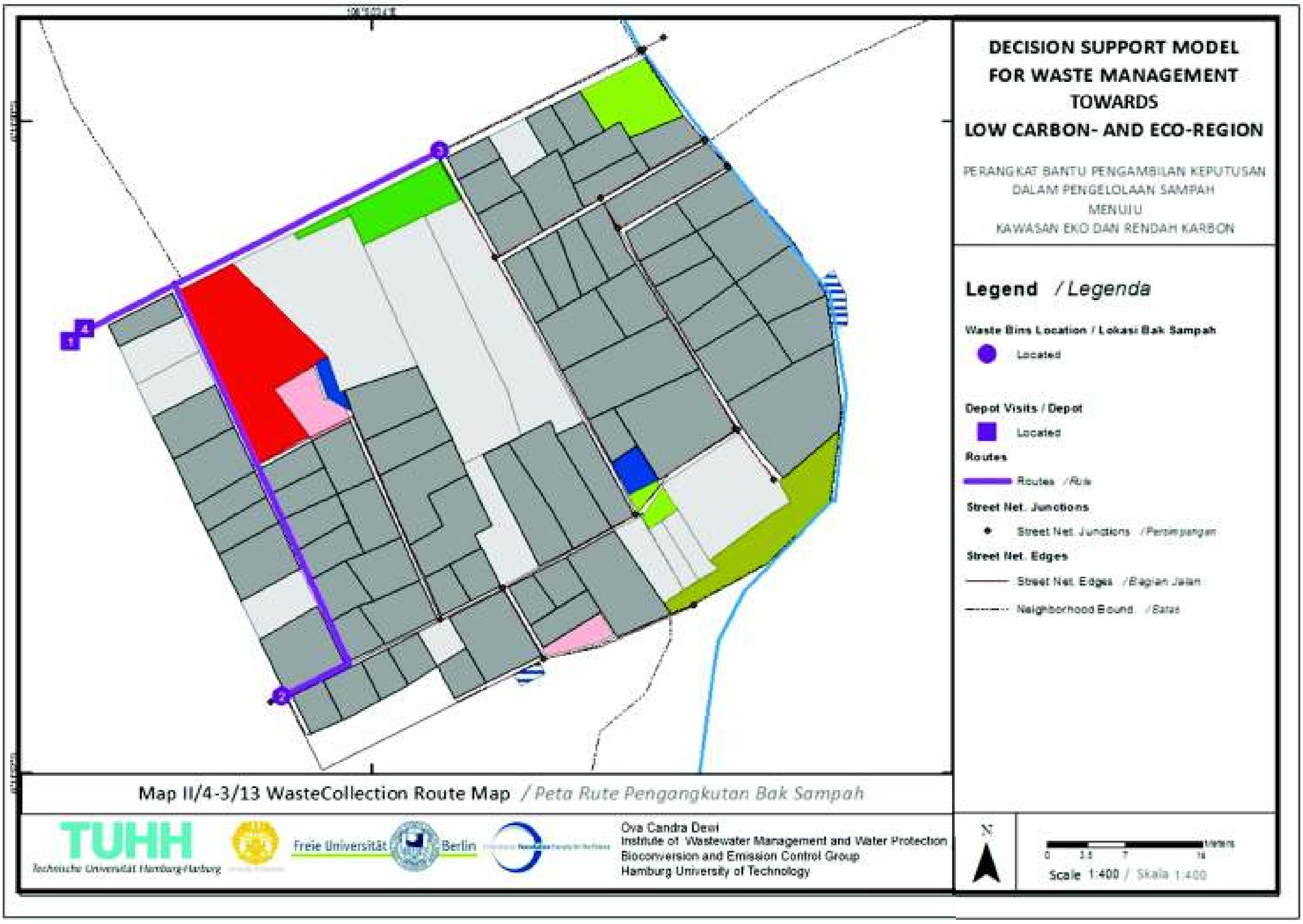




Collection System - Case 2

Appendix B Preliminary Research Supporting Kit

B1

Hamburg, February 28th 2011

IUE INSTITUT FÜR UMWELTTECHNIK UND ENERGIEWIRTSCHAFT

GRUPPE BIOKONVERSION UND EMISSIONSMINDERUNG

Gruppenleitung
PD Dr.-Ing. habil. Ina Körner

Technische Universität Hamburg-Harburg
Harburger Schloßstraße 36
D-21079 Hamburg

T +49 (0) 40 42878 - 3154
F +49 (0) 40 42878 - 2375

www.tuhh.de/iue

To Whom It May Concern

I hereby affirm that the name below:

Name : **Ova Candra Dewi**

Student Number : **41360**

Place, Date of Birth : **Jakarta, October 13th 1979**

is a doctoral student in **Hamburg University of Technology (TUHH)**, Hamburg, Germany. Mrs. Candra Dewi is working on 'Low Carbon Eco City Development Model – Sustainable Regional Decision Support Model for Waste Management'. She joined in our group since September 2009. She will be in Indonesia from end of April to middle of October 2011 in order to pursue series of field research activities. At the end of this series she will conduct a workshop there for sharing some preliminary results related to her PhD. Work.

Should you have any further question, please don't hesitate to contact me.

Thank you for your kindly help and attention.

Sincerely,

PD. Dr.-Ing. habil. Ina Körner

Host University Supervisor

TUHH Technische Universität Hamburg-Harburg

B2

UNIVERSITAS INDONESIA
FAKULTAS TEKNIK

KAMPUS BARU U.I. DEPOK 16424
Dekanat : (021) 7863504, 7863505, Fax. 7270050
PPSTD : (021) 7270011, 7863311, Fax. 7863503
Pusat Administrasi dan Humas : (021) 78888430, 78887861, 78849046, Fax. PAF 7863507, Fax. Humas 78888076

Depok, 31 Mei 2011
No.280/H2DA/PENELITIAN/2011
Perihal: Afiliasi Penelitian Dept Arsitektur FTUI/P3LB dan Sdr. Ova Candra Dewi
Lamp. : 1 lembar

Kepada Yth.
Sdr. Ova Candra Dewi
Harburger Schlossstr. 36, Hamburg Germany 21079
M. Kahfi II 04/09 No. 68, Jaksel 12640

Dengan hormat,

Menanggapi surat Saudari tertanggal 30 Mei 2011, bersama ini kami sampaikan bahwa kami dapat memenuhi permohonan Saudari untuk melakukan kerjasama penelitian "Pengembangan Kota Eco dan Rendah Karbon – Perangkat Bantu Pengambilan Keputusan Berskala Regional Untuk Pengelolaan Sampah yang Berkesinambungan."

Sesuai permintaan Saudari, kami menugaskan 5 mahasiswa yang namanya tertulis dalam daftar nama terlampir untuk membantu anda sebagai asisten peneliti untuk keperluan penelitian lapangan di lokasi penelitian (Srengseng Sawah dan Cikini) dan pengolahan data mulai bulan Juni s/d Agustus 2011.

Sebagai bahan acuan pelaksanaan riset yang melibatkan *human subject*, Saudari agar dapat mengikuti ketentuan mengenai *Provision of Human Subject Protocol*. Selain itu, kami minta agar Sdri dapat menjamin/bertanggung jawab atas keselamatan kerja para mahasiswa asisten peneliti di lapangan selama masa penelitian tersebut. Atau, sebagai alternatif, mahasiswa dapat diberikan Jamsostek (Jaminan Kecelakaan/Keselamatan Kerja) selama masa penelitian (Juni-Agustus 2011).

Untuk selanjutnya, detail dan pelaksanaan kerjasama penelitian ini selanjutnya akan berada di bawah koordinasi Pusat Penelitian Perancangan Lingkung Bangun (P3LB) Departemen Arsitektur FTUI.

Hormat kami,
Ketua Departemen Arsitekur

Kemas Ridwan Kurniawan
NIP.197101281995121001

Tembusan Kepada Yth.

- Direktur Pusat Penelitian dan Perancangan LIngkung Bangun (P3LB) Departemen Arsitektur UI, Ir. A. Sadili Somaatmadja, MSi.

B3

Term of Reference (TOR) Short Term Research
May October 2011
Low Carbon Eco -City Development Sustainable Regional Decision Support Model on Waste Management

Research Introduction*
Decision Support Model*
Problem Statement*
Location*
Objective*
*) this part is skipped for the appendix

Project Introduction Week1 and Week2, May 2011

Tools	Poster, Video, Power Point Presentation
Duration	2 Weeks plus 1-2 society meeting
Person	Team leader
Cost (IDR)	500,000 (logistic expenses)
Outcome	Activity Legality and Public Concern

Activities:

- pursuing the permission to the head of the Neighbourhood Association (Rukun Tetangga/RT) and setting the time to meet the society, spread the invitation letter
- at the society meeting - introducing the project to the community: aim, result for being the selected area, steps/phases, and expected result.
- at the society meeting - Introducing: What is waste? What is Green House Gas (GHG) and what is the relation with waste the GHG from Waste? What can we do with the waste? Who can help? Waste dumping consequences? Samples of best practices from waste utilization media: poster, video, power point

Working Group (WG) May W1. July 2011
WG GEO (Geographic Condition) Mapping

Tools	GPS, Google Earth, AutoCad Map 3D/GIS, Length Measurement
Duration	8 Weeks, continuous
Person	2 per settlement free with mentioned software and research skill
Cost (IDR)	2,000,000 (services)
Outcome	Map Location plus Supported Information

Activities:

- providing information about the research location. The information includes the boundary of the research area, houses, access (paths, streets, roads), open area, river, etc. information should be in given in different layers
- together with WG. I.2, adding information: number of inhabitants per house and mark the less dense, dense and very dense area. the range will follow-
- marking the spots where mount of waste can be seen, plus the nearest communal point (houses)
- purposing variants of routing for collection system

WG IMPACT (Waste Management Impact) Data Inventory

Tools	STAN, Weighing Measurement, GHG calculation tool, Questionnaire, Camera
Duration	6 Weeks, continuous
Person	2 per settlement student with environmental technology background
Cost (IDR)	2,000,000 (transport and logistic expenses)
Outcome	Waste Data and GHG Inventory

Activities:

- conducting waste collection for 2 weeks from households and separating the waste per fraction
- providing inventory on waste generation per total area and per person
- providing inventory on waste composition/fraction
- providing inventory on GHG generation per total area and per person

- naming the total inhabitants, composition of woman and man, children and adults
- providing different waste stream projection

Note: every activity and research subjects should be well documented

WG SOCECO (Social-Economic Aspect) Hidden Value Investigation

Tools	Questionnaire and interview equipment
Duration	4 Weeks, continuous
Person	4 persons per settlement passed the Theory and Method of Environmental Planning
Cost (IDR)	2,000,000 (transport and logistic expenses)
Outcome	Social Values

Note for investigation Case: a society group that want to decide on what they do with their waste, when illegal dumping, burning and burying are not an option

Activities:

- investigating the social system in the society (the employment, the income, the internal and communal activity per time, per age and per household), collective action and community organizations
- investigating what they want with their waste
- investigating the contribution/ability to support collection system (pay or work)

Result Collection/Finalization and Pre-Result Socialization Week3.-Week4. July 2011

Tools	Power Point
Duration	2 weeks : 1-2 meeting
Person	team
Cost (IDR)	500,000 (logistic expenses)
Outcome	Public Concern

Activities:

- Internal meeting: finalization of Working Groups (WG) I.1-I.3 outcomes
- Introducing the result of WG I.1-I.3 to the society (suitable treatment from the physic condition and suitable treatment from questionnaire, % society willing to pay/help, etc., danger area/vacant/non hygiene)
- Informing what they can do with their waste according to the waste characteristic and amount (treatment possibilities)
- Informing the next step: workshop ----- improving the actual condition

Workshop Week1.-Week3 August 2011

Tools	(prepare by the field manager)
Duration	4 Weeks, continuous
Person	Team
Cost (IDR)	20,000,000 (service plus logistic)
Outcome	Experience of doing composting, recycling and source reduction

Activities:

- Interactive discussion on doing waste reduction at source
- Public Workshop on doing community composting, grey water tower and recycling-waste bank
- Informing the next step: simulation ----- improving the actual condition

Note: focus group and home group method

Simulation Weeks and Review Week2.-Week4 September 2011

Tools	(self prepare)
Duration	4 Weeks, continuous, 1 review per 2 weeks
Person	Team and the community members
Cost (IDR)	500,000 (logistic expenses)
Outcome	composting, recycling and source reduction as daily life

Activities:

- self practicing/experiencing the community composting and recycling
- market analysis of composting and recycling product, suggest improvement
- reviewing the first 2 weeks and the second 2 weeks

Seminar: Program Sustainability: what Government should hear Week1. October 2011

Tools	Activity documents, sample of composting and recycling products

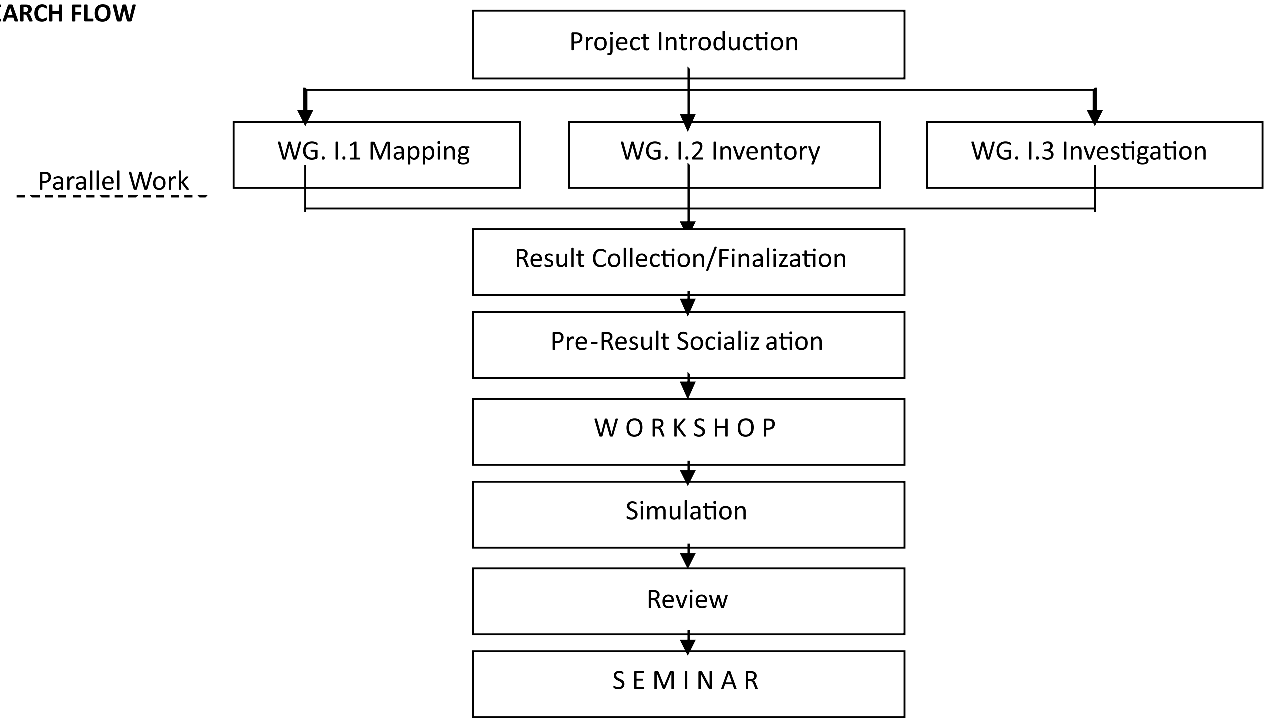
Duration	2 Weeks, continuous, preparation plus 1 day seminar
Person	Stakeholders (CBO, government, community, neighbourhood representatives)
Cost (IDR)	20,000,000 (logistic expenses and speakers transport)
Outcome	composting, recycling and source reduction as daily life

Activities:

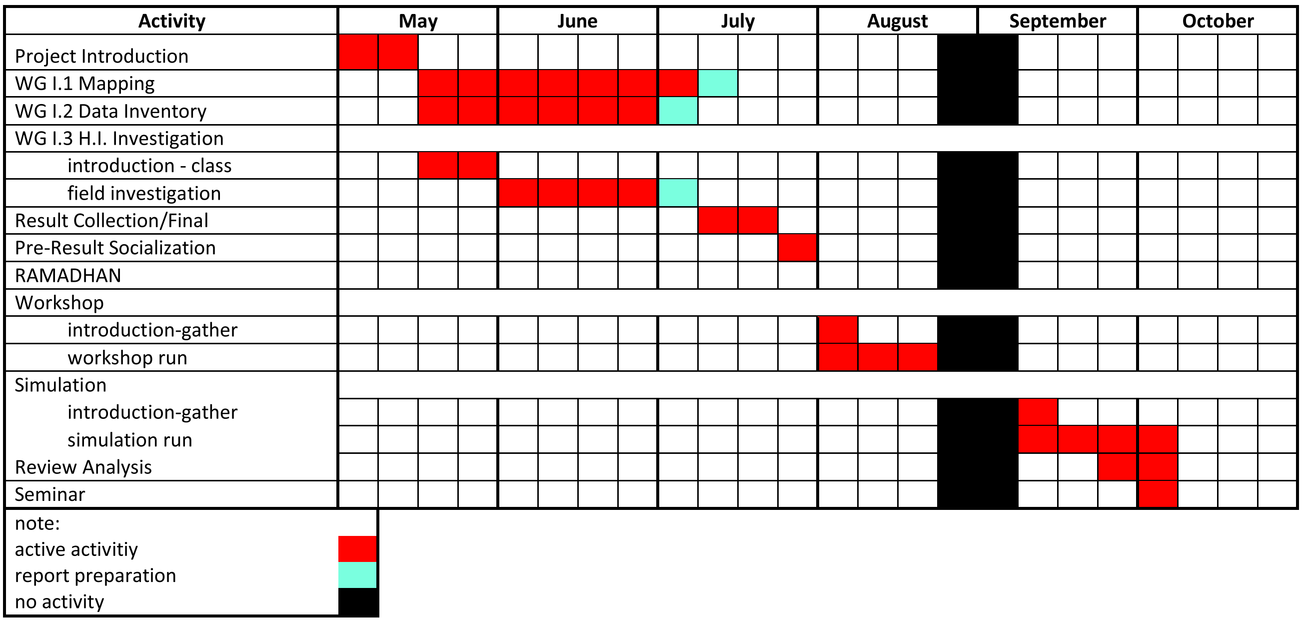
- exhibition of the last 5 months activity
- presenting the result so far by the community representative
- focus group and home group discussion: government and the community addressing sustainability

Note: W1, W2, W3 and W4= Week 1, Week 2, Week 3 and Week 4. All month will be considered to have 4 weeks. Should the beginning month placed at weekend, then the next week will be counted as the first week.

RESEARCH FLOW



D. TIME FRAMEWORK



-End-

B4

Kepada Yth.
Bapak Kemas Ridwan Kurniawan, Ph.D
Ketua Departemen Arsitektur
Fakultas Teknik, Universitas Indonesia
Di
Tempat

Jakarta, 30 Mei 2011

Dengan Hormat,

Saya yang bertanda tangan di bawah ini:

Nama	: Ova Candra Dewi
Profesi	: Mahasiswa Doktor, *Hamburg University of Technology* (TUHH) *Institute of Environmental Technology and Energy Economics* *Bioconversion and Emission Control Group*
Alamat	: Harburger Schlossstr. 36, Hamburg, Germany 21079 (Germany) M. Kahfi II 04/09 No. 68, Jaksel 12640 (Indonesia)

Mengajukan surat permohonan kerja sama penelitian dengan departemen Departemen Arsitektur UI untuk memberikan afiliasi untuk keperluan penelitian:

Judul	: "Pengembangan Kota Eco dan Rendah Karbon – Perangkat Bantu Pengambilan Keputusan Berskala Regional Untuk Pengelolaan Sampah yang Berkesinambungan"
Waktu	: Mei- Oktober 2011
Lokasi	: Srengseng Sawah dan Cikini

Afiliasi tersebut dibutuhkan untuk keperluan penerbitan surat keterangan kegiatan penelitian oleh Departemen Arsitektur FTUI. Untuk kegiatan ini saya memerlukan bantuan mahasiswa/i sebanyak 5 (lima) orang untuk mendampingi saya sebagai asisten peneliti dalam serangkaian kegiatan penelitian, sejak bulan Juni hingga Agustus. Mahasiswa tersebut akan dilibatkan dalam serangkaian kegiatan penelitian, seperti mengumpulkan data lapangan dan pengolahan data, investigasi lanjut.

Demikian surat permohonan afiliasi ini saya buat, mohon maaf atas segala kekurangan dan terima kasih atas perhatiannya.

Salam,

Ova Candra Dewi
Email: ova.candra@tuhh.de
Telp: 7869304 hp: 087882550984

Lampiran: surat pengantar dari *Host University – TUHH*

B5

Kepada Yth.
Ibu. Djuni
Promotor Bank Sampah Depok
Di Tempat

Depok, 18 July 2010

Yang kami hormati **Ibu Djuni,**

Salam kenal dari Kami, tim penelitian lapangan: **"Pengembangan Kota Eco dan Rendah Karbon – Perangkat Bantu Pengambilan Keputusan Berskala Regional Untuk Pengelolaan Sampah Berkesinambungan"**. Peneletian ini sudah dimulai sejak 2 bulan yang lalu dan mengambil lokasi 1 RT di Srengseng Sawah - Cipedak, Jakarta Selatan dan 1 RT di Cikini – Ampiun, Jakarta Pusat. Kami salut dan sangat menghargai sepak terjang Ibu dalam memperkenalkan bank sampah. Karena itu saya dan Tim ingin memohon bantuan Ibu untuk memberikan perkenalan serupa di daerah yang kami studi. Saat ini, satu dari 2 lokasi penelitian telah menyatakan kesiapan yaitu pada:

Hari dan Tanggal	: Rabu, 27 July 2010
Tempat	: Kantor RW 01 Cikini Ampiun, Jakarta Pusat
Kegiatan	: Sosialisasi/Penyuluhan (Pukul 10:00 -12:00) Pelatihan 3 orang Kader dari warga RT 13 (Pukul 13:00)

Kami berharap ilmu yang Ibu turunkan nanti akan menjadi investasi yang sangat berguna bagi masyarakat setempat dan lingkungannya, seiring dengan pengurangan dampak negatif pada lingkungan.

Demikian surat permohonan bantuan ini kami buat. Semoga dalam waktu dekat, saya bisa mengirimkan surat serupa untuk kegiatan di Srengseng Sawah, Jakarta Selatan.

Salam Kami,

OVA CD

Ova CD
a.n. Tim Peneliti
Ova Candra Dewi, Ahmad Gamal dan Wanda Supandji

Contact:
Email: ova.candra@gmail.com
Mobile: 087882550984

Appendix C – Sub-Module 1-2 Waste Characteristic Inventory

Appendix C Sub-Module 1-2 Waste Characteristic Inventory

C1. Waste Sampling Template (FORM A FORM B)

C1.1 FORM A: WASTE DATA SAMPLING/ DATA SAMPEL SAMPAH

Day X - LIST OF HOUSE SAMPLE / Hari X - *DAFTAR RUMAH UNTUK SAMPEL.* Date (mmddyy). location / *Tanggal (ttbbtt). lokasi*

No. *No.*	**House Number** *Nomer Rumah*	**Name** *Nama*	**Total Inhabitants** *Jumlah Penghuni*	**Status of Ownership** *Status Kepemilikan*
1				
2				
3				
.				
Total house				
Note: O=Owned/*milik*; R=Rented/*Kontrak*				

C1.2 FORM B: WASTE DATA INPUT/ DATA INPUT SAMPAH (SAMPLE)

location /*lokasi*

Waste Fraction/*Fraksi Sampah*	**Day/***Hari* **1** **Amount/***Berat*	**Day/***Hari* **2** **Amount/***Berat*	**Day/***Hari* **3** **Amount/***Berat*
Paper (P)/*Kertas*			
Plastic non Bottle (PnB)/*Plastik bukan botol*			
Glass (G) /*Kaca*			
Styrofoam (R) /*Styrofoam*			
Metal (M) /*Logam*			
Organic (O) /*Organik*			
Plastic Bottle(PB) /*Plastik bottle*			
Other (R) /*lainnya*			
Total waste/*jumlah sampah* (kg)			
Total Person/j*umlah orang*			
Total houses/*jumlah orang*			

C2. Detail Result: Waste Characteristic Inventory   Case Study I

C2.1 SUMMARY Sub-Module 1-2: WASTE DATA SAMPLING/ DATA SAMPEL SAMPAH

Day 1 until Day 3 - LIST OF HOUSE SAMPLE / Hari 1- Hari 3. DAFTARR RUMAH UNTUK SAMPEL. Date (061311 until 061611). Cipedak / *Tanggal (130611 sampai 160611). Cipedak*

Day 1				Day 2				Day 3			
No.	**House Number**	**Owner/Ownership**	**Number of Inhabitants**	**No.**	**House Number**	**Owner/Ownership**	**Number of Inhabitants**	**No.**	**House Number**	**Owner/Ownership**	**Number of Inhabitants**
1	17B	Ramlan (O)	3	1	38	Yuyun (O)	5	1	68	Nasir (O)	9
2	87	Tanto (O)	2	2	61	Stefani (O)	4	2	45A	Yeyen (R)	3
3	99B	Fitri (R)	3	3	35	Semah (O)	4	3	77	Dias (O)	4
4	117	Abdurrahman	4	4	85	Sarini (O)	4	4	34B	Ariwidiyati (O)	4
5	31D	Amah (R)	2	5	82	Linda (O)	3	5	31A	Ana (R)	6
6	93	Timi (O)	5	6	22	Anto (O)	3	6	108	Ati (O)	8
7	39	Rusminah (O)	6	7	20D	Pipit (O)	4	7	89A	Supatmi (O)	5
8	40	Udin (O)	2	8	28	Susan (O)	5	8	89	Yopi (O)	8
9	59	Aisyah (O)	4	9	81	Hartati (O)	6	9	56	Haji Yodah	2
10	26A	Narti (O)	4	10	40A	Latif (O)	0	10	71	May (O)	6
11	26	Sumarni (O)	4	11	45	Eka (O)	3	11	41A	Samsudin (O)	4
12	23	Vina (O)	3	12	1B	Haji Mariah (O)	5	12	41B	Tati (O)	3
13	74	Warman (O)	3	13	3A	Nino (R)	4	13	20C	Neneng (O)	3
14	19	Samsiah	3	14	17D	Haryati (O)	4	14	66*	Tikno (O)	4
15	18	Sinta (R)	3	15	17	Dini (O)	3	15	22	Tri (O)	5
16	63	Dayat(O)	3	16	58	Heri (O)	6	16	82	Nur (O)	3
17	65C	Nunung (O)	5	17	21A	Siti (O)	5	17	20B	Hendra (R)	2
18	49	Rum (R)	7	18	18	Kelly (R)	4	18	18B	Bino (O)	2
19	12A	Maknur (O)	5	19	84	Ahmad (O)	3	19	60	Sunanto (O)	6
20	1	Lina (O)	3	20	84	Umroh (R)	4	20	Warung Salim*	Salimah (O)	0
21	5	Romlah (R)	6	21	5	Sri (R)	4	21	16	Nia (O)	4
22	5	Suwondo (R)	6	22	9A	Puri (R)	4	22	6	Yuyun (O)	5
				23	9Bk	Neni (R)	4				
Note: O=Owned/*milik*; R=Rented/*Kontrak* *House No. 40 is cooked-food market*				Note: O=Owned/*milik*; R=Rented/*Kontrak* *House no. 40A is only for tailor house*				Note: O=Owned/*milik*; R=Rented/*Kontrak* *) Warung Salim (no house number) and House no 66 are vegetable Store			

C2.2 Waste Composition/Komposisi Sampah

Composition	Day 1		Day 2		Day 3		average			
	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Standard deviation	Coefficient of variation
Total Weight	31.76	100	21.72	100	32.27	100	28.58	100		
Compostable										
Organic (O)	20.47	64.45	15.12	69.61	22.44	69.54	19.34	67.87	2.96	4.4
Recyclable										
Paper (P)	3.11	9.79	1.24	5.71	1.25	3.87	1.87	6.46	3.03	46.9
PlasticnonBottle (PnB)	7.45	23.46	3.45	15.88	3.66	11.34	4.85	16.89	6.12	36.2
Metal (M)	0.24	0.76	0.12	0.55	0.06	0.19	0.14	0.50	0.29	58.0
Glass(G)	0.49	1.54	0	0	1.07	3.32	0.52	1.62	1.66	102.5
Residual										
Diapers	0	0	0.61	2.81	1.71	5.30	0.77	2.70	2.65	98.1
Syrofoam	0	0	0.12	0.55	0.25	0.77	0.12	0.44	0.40	90.2
Rest	0	0	1.06	4.48	1.83	5.67	0.96	3.52	3.07	87.3

C2.3 Waste Generation Per Capita in One Day (kg) /Produksi Sampah per Orang dalam satu hari (kg)

Person for sampling in Day 2 *Penghuni rumah untuk sampel hari 2*	**Person for sampling in Day 2** *Penghuni rumah untuk sampel hari 2*	**Person for sampling in Day 2** *Penghuni rumah untuk sampel hari 2*
86	91	96
Generation Per Capita in One Day (kg) *Produksi Sampah per Orang dalam satu hari* (kg)		
0.315		

C2.4 Total Waste Generation in One Year (ton)/Jumlah Produksi Sampah dalam satu tahun (ton)

Average Person per House *Rata-rata Penghuni per Rumah*	**Number of Houses** *Jumlah Rumah*	**Total Waste Generation in Total Waste Generation in One Year (ton)** *Jumlah Produksi sampah dalam satu tahun (ton)*
4	295	135.546
Total House Day 1 *Jumlah Rumah hari 1*	**Total House Day 2** *Jumlah Rumah hari 2*	**Total House Day 3** *Jumlah Rumah hari 3*
22	23	22

C3. Detail Result: Waste Characteristic Inventory   Case Study II

C3.1 SUMMARY Sub-Module 1-2: WASTE DATA SAMPLING/ DATA SAMPEL SAMPAH

Day 1 until Day 3 - LIST OF HOUSE SAMPLE / Hari 1- Hari 3. DAFTARR RUMAH UNTUK SAMPEL. Date (062011 until 062311). Cikini Pasar Ampiun / *Tanggal (200611 sampai 230611). Cikini Pasar Ampiun*

Day 1				Day 2				Day 3			
No.	House Number	Owner/Ownership	Number of Inhabitants	No.	House Number	Owner/Ownership	Number of Inhabitants	No.	House Number	Owner/Ownership	Number of Inhabitants
1	29	Haji Jaenah (O)	8	1	21	Mianto (O)	4	1	43	Yati (O)	5
2	16	Suyatmi (O)	1	2	15	Yeni (O)	4	2	24	Niar (O)	14
3	55A	Yati (O)	4	3	5	Rom (O)	5	3	3	Ros (O)	5
4	9	Siti Nurjanah (O)	6	4	51	Wastinah (O)	6	4	2	Zakiyah (O)	8
5	7	Rohati (O)	6	5	60	Indun (O)	3	5	14	Lan (O)	8
6	6	Kasmi (O)	7	6	61	Ati (O)	5	6	21B	Yati (O)	7
7	1	Suhana (O)	5	7	38	Nunung (O)	4	7	45	Labib (O)	3
8	50	Kia (O)	4	8	37B	Fatimah (O)	7	8	48	Eti (O)	4
9	31	Nana (O)	6	9	37A	Bachtiar (O)	4	9	23	Mulyawati (O)	6
10	34	Yana (O)	5	10	25	Ani (O)	4	10	62	Udin (O)	4
11	35	Latifah (O)	2	11	30	Hadiah (O)	3	11	49	Murtini (O)	3
12	45	Mawardi (O)	4	12	46	Haji Darno (O)	3	12	56	Suryati (O)	11
13	44	Rajiem (O)	4	13	22	Sinta Wati (O)	6	13	29	Juju (O)	4
14	40	Eli (O)	4	14	53	Hotmi (O)	5	14	32	Ana (O)	6
15	41	Sahlani (O)	5	15	10	Osih (O)	5	15	30B	Iis (O)	4
Note: O=Owned/*milik*; R=Rented/*Kontrak*				Note: O=Owned/*milik*; R=Rented/*Kontrak*				Note: O=Owned/*milik*; R=Rented/*Kontrak*			

C3.2 Waste Composition/Komposisi Sampah

Composition	Day 1		Day 2		Day 3		average			
	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)	Standard deviation	Coefficient of variation
Total Weight	18.24	100	27	100	14.41	100	19.88	100		
Compostable										
Organic (O)	13.99	76.70	21.88	81.04	7.54	52.32	14.47	70.02	15.48	22.1
Recyclable										
Paper	1.04	5.70	1.05	3.89	1.25	8.67	1.11	6.09	2.42	39.7
PlasticnonBottle (PnB)	1.96	10.75	0.62	2.30	3.16	21.93	1.91	11.66	9.85	84.5
Plastic Bottle (PB)	0	0	0.58	2.15	1.49	10.34	0.69	4.16	5.46	131.1
Metal (M)	0	0	0	0	0.2	1.39	0.07	0.46	0.80	173.2
Glass (G)	0	0	0	0	0	0	0	0	0	0
Residual (R)										
Textile	0	0	0	0	0.19	1.32	0.06	0.44	0.76	173.2
Rest	1.25	6.85	2.87	10.63	0.58	4.02	1.57	7.17	3.31	46.2

C3.3 Waste Generation Per Capita in One Day (kg) /Produksi Sampah per Orang dalam satu hari (kg)

Person for sampling in Day 2 *Penghuni rumah untuk sampel hari 2*	**Person for sampling in Day 2** *Penghuni rumah untuk sampel hari 2*	**Person for sampling in Day 2** *Penghuni rumah untuk sampel hari 2*
69	68	92
Generation Per Capita in One Day (kg) *Produksi Sampah per Orang dalam satu hari* (kg)		
0.273		

C3.4 Total Waste Generation in One Year (ton)/Jumlah Produksi Sampah dalam satu tahun (ton)

Average Person per House *Rata-rata Penghuni per Rumah*	**Number of Houses** *Jumlah Rumah*	**Total Waste Generation in Total Waste Generation in One Year (ton)** *Jumlah Produksi sampah dalam satu tahun (ton)*
5	86	135.546
Total House Day 1 *Jumlah Rumah hari 1*	**Total House Day 2** *Jumlah Rumah hari 2*	**Total House Day 3** *Jumlah Rumah hari 3*
15	15	15

Appendix D – Sub-Module 1-3 Collective Actions and Community-based organizations Inventory

Appendix D Sub-Module 1-3 Collective Actions and Community-based organizations Inventory

D1. Collective Actions and Community-based Template (FORM C)

D1.1 FORM C: SURVEY DATA INTERVIEW / DATA SURVEY - Wawancara (SAMPLE)

Date (mmddyy). location / *Tanggal (ttbbtt). lokasi*

Total House	:	**Occupation**		
Respondent	:	Housewife	:	
Status of Ownership		Others	:	
Self-Own (starting year)	:	unknown	:	
Rent (starting year)	:			

Data of the Inhabitants *data penghuni*	**Status in the family** ***Anggota Keluarga*** (Husband/Wife/children/etc.) *(Suami/Istri/anak/lainnya.)*	**Gender/Age** *Jenis Kelamin / Umur*	**Occupation** *Pekerjaan*	**Activity / Organization which have been involved** *Kegiatan / Organisasi yang pernah diikuti*
RESPONDENT *Responden*				
RESPONDENT *Responden*				
RESPONDENT *Responden*				

Note / Catatan tambahan:

COLLECTIVE ACTIONS INVENTORY / *INVENTORI KEGIATAN KOMUNAL*

Collective activities which have been or have been not involved by the respondent/*Kegiatan komunal yang pernah terjadi diikuti maupun tidak diikuti responden:*

No. *No.*	**ACTIVITY** *KEGIATAN*	**INISIATOR** *INISIATOR*	**SUPERVISOR** *MANDOR*	**TYPE OF CONTRIBUTED RESOURCES** *JENIS SUMBER DAYA YANG DIBERIKAN RESPONDEN*	**PLACE** *TEMPAT*	**INTENSITY** *INTENSITAS*

COMMUNITY BASED- ORGANIZATIONS / *ORGANISASI BERBASIS MASYARAKAT*

Social organization which have been or have been NOT involved by the respondent/*organisasi sosial pernah diikuti dan tidak oleh responden:*

No. *No*	**ORGANIZATION** *ORGANISASI*	**MEMBER** *PESERTA*	**AGE CATEGORY** *KATEGORI USIA*	**TIME (start-end)** *WAKTU (Mulai-Akhir)*	**ACTIVITY** *KEGIATAN*	**PLACE** *TEMPAT*	**FINANCING RESOURCES** *SUMBER DANA*

MOTIVATION / *MOTIVASI*

Motivation for Participating/*Motivasi keikutsertaan:*

No. *No*	**ACTIVITY/ORGANIZATION** *AKTIVITAS/KEGIATAN*	**MOTIVATION OF PARTICIPATION** *MOTIVASI MENGIKUTI KEGIATAN*

METHOD OF RESPONDENT DETERMINATION/*METODE PENENTUAN RESPONDEN*: (radom/*acak*. community recommendation/*rekomendasi warga*)

Note/*Catatan:*

------ *:* No information collected/*tidak mendapat informasi*

D2. Detail Result: Collective Actions and Community-based Organizations Inventory   Case Study I

D2.1 SUMMARY Survey / KESIMPULAN - Survei

Total House	:	295	**Occupation**		
Respondent	:	53	Housewife	:	37
Status of Ownership			Others	:	5
Self-Own (starting year)	:	33 (1965-2011)	unknown	:	10
Rent (starting year)	:	12 (1989-2011)			

INVENTORY / *INVENTORI*
Collective activities which have been or have been not involved by the respondent:
Kegiatan bersama yang pernah terjadi diikuti maupun tidak diikuti responde:

No. *No.*	**COLLECTIVE ACTION** *KEGIATAN BERSAMA*	**MENTIONED x times** *DISEBUT x kali*	**INISIATOR** *INISIATOR*	**SUPERVISOR** *MANDOR*	**TYPE OF CONTRIBUTED RESOURCES** *JENIS SUMBER DAYA YANG DIBERIKAN RESPONDEN*	**PLACE** *TEMPAT*	**INTENSITY** *INTENSITAS*
1	Clean Friday for Women/*Jumat Bersih*	40	Under the instruction of Sub-District Authority (*Kelurahan*)	Head of households *(RT)*	Power. foods and drinks. retributions	All area and gather at House no.93	Once a week (every Friday)
2	Quran Study for Women/*Pengajian Untuk Ibu-Ibu*	34	Exist since generation	-------------	Participation. food and drinks	Mosque	Once a week (every Tuesday)
3	Communal Work in Cleansing for Men/*Kerja Bakti Bapak-Bapak*	29	Exist since generation	Head of households *(RT)*	Power. foods and drinks and fine if coundt participate	All area and gather at House no.93	Once a month (every first Sunday of the Month)
4	Quran Study for Men/*Pengajian Untuk Bapak-Bapak*	26	Exist since generation	Head of households *(RT)*	Participation. food and drinks	Mosque	Once a month (every first Saturday night of the month)

5	Social Gathering for Women/*Arisan Ibu-Ibu*	25	Head of households *(RT)*	Head of households *(RT)*	money	Mosque	Once a week (every Tuesday)
6	Gymnastic for Women at RT/*SenamRT*	19	Community member	Community member	-------------	Badminton Court	Twice a week
7	Community Integrated Service/*Pos Pelayanan Terpadu (Posyandu)*	15	Under the instruction of Neighborhoods (RW)	PKK	-------------	Outside the area	One a month
8	Recreation RT/Rekreasi RT	15	Head of households *(RT).* Community member	-------------	fees	Outside the area	Once a year
9	Regular Donation/*Jimpitan*	12	Head of households *(RT)*	Community member	Donation in form of money. rice	Collected from houses	Once a week (every Friday)
10	Security/*Keamanan (Hansip)*	10	Head of households *(RT)*	Community member	money	All area	Once a month
11	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	9	Head of households *(RT).* Community member	Head of households *(RT)*	money	flexible	Once a year (August 17th)
12	Quran Study for Children/*Pengajian Untuk Anak-anak*	7	Community member	Community member	money	Mosque	Five days a week
13	Election Head or the households (RF)/*Pemilihan RT*	5	Community member	Community member	-------------	Mosque	Once in 3 years
14	Badminton/*Bulu Tangkis*	5	Community member	Community member	-------------	Badminton Field	Once a week
15	Specific Quran Study/*Pengajian Bu Tinah dan Pengajian Sebelah .Bu Shendi. RT 02*	4	Community member	Community member	-------------	Community members house	-------------
16	Freewill Donation (ex.mourning fee)/*LAZIS*	3	Community member	Community member	-------------	Collected from	One a month

						houses	
17	Gymnastic for Women at RW/*SenamRW*	3	Under the instruction of Neighborhoods (RW)	Community member	-------------	Outside of the area	Once a week
18	Specific Gymnastic/Senam Malam. RT lain. RT 02	2	-------------	-------------	-------------	-------------	-------------
19	Prepare drinks for Quran Study/Menyiapkan minuman untuk Pengajian	2	-------------	-------------	-------------	-------------	-------------
20	Exercise Marawis/*Latihan Marawis*	2	-------------	-------------	-------------	-------------	-------------
21	Activity in Ramadhan/Aktifitas Ramadhan	2	-------------	-------------	-------------	-------------	-------------
22	Communal work in combating mosquitos/*Jumantik*	2	-------------	-------------	-------------	-------------	-------------
23	Community Savings/*Tabungan Warga*	2	-------------	-------------	-------------	-------------	-------------
24	Election Committee for PEMILU/*Panitia Pemilu*	2	-------------	-------------	-------------	-------------	-------------
25	Groceries for Seniors/*Sembako Lansia*	2	-------------	-------------	-------------	-------------	-------------
26	Public Hearing on Composting/Sosialisasi Kompos	2	-------------	-------------	-------------	-------------	-------------
27	Preparation for meal when the feast/*Persiapan makan besar saat hari raya*	1	-------------	-------------	-------------	-------------	-------------
28	Visit community member who is ill/*Besuk orang sakit*	1	-------------	-------------	-------------	-------------	-------------
29	Donation to the orphans/*sumbangan anak yatim*	1	-------------	-------------	-------------	-------------	-------------
30	Mourning Fee/*Layatan kematian*	1	-------------	-------------	-------------	-------------	-------------

COMMUNITY BASED- ORGANIZATIONS / *ORGANISASI BERBASIS MASYARAKAT*

Social organization which have been or have been NOT involved by the respondent/*organisasi sosial pernah diikuti dan tidak oleh responden:*

No. *No.*	**ORGANIZATION** *ORGANISASI*	**MENTIONED in times** *DISEBUT berapa kali*	**MEMBER** *PESERTA*	**AGE CATEGORY** *KATEGORI USIA*	**TIME (start-end)** *WAKTU (Mulai-Akhir)*	**ACTIVITY** *KEGIATAN*	**PLACE** *TEMPAT*	**FINANCING RESOURCES** *SUMBER DANA*
1	Woman Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	13	women	all	flexible	varios	Area in RT	-------------
2	Youth Organization/*Karang Taruna*	7	(not active anymore)	-------------	-------------	-------------	-------------	-------------
3	Woman Organization DASA WISMA/*Organisasi Perempuan DASA WISMA*	2	women	all	flexible	sharing	House of communit y member	-------------
4	Cooperative Association/Koperasi	1	all	-------------	-------------	-------------	Neigborho ods Office /kantor RW	-------------

MOTIVATION/*MOTIVASI*

Motivation for Participating/*Motivasi keikutsertaan:*

No.	**COLLECTIVE ACTION/ORGANIZATION** *AKTIVITAS BERSAMA/KEGIATAN*	**MOTIVATION OF PARTICIPATION** *MOTIVASI MENGIKUTI KEGIATAN*
1	Clean Friday for Women/*Jumat Bersih*	A lot of community member participate. otherwise they have to pay
2	Communal Work in Cleansing	To know other community member. to have clean environment. responsibility as community member. to gain new knowledge. to make friends. to be a good sample for other people

METHOD OF RESPONDENT DETEMINATION/*METODE PENENTUAN RESPONDEN*: radom and by following community recommendation

Note/*Catatan: ------ :* No information collected/*tidak mendapat informasi*

D2.2 COMMUNITY MEMBERS ACTIVENESS/KEAKTIFAN ANGGOTA MASYARAKAT

No. Respondent	House Number	Name of Collective Actions and Social Activity x for participate and (blank)for not participate													Own /Rent	Since	Occupation
		1	2	3	4	5	6	7	8	9	10	11	12	13			
1	3A	x				x			x					X	R	2005	Hw
2	74	x	x											X	O	2004	Hw
3	47																
4	41																
5	43A																
6	78B																
7	K16B																
8	4B													X	O		Hw
9	15			x	x									X	O		Hw
10	63	x	x			x	x				x	x	x	X	O	1992	Hw
11	17	x	x			x			x					X	O		Td
12	95	x				x								X	O	2011	Hw
13	93	x	x			x	x							X	O	1990	Hw
14	K2A	x										x		X	R	1989	Hw
15	76	x	x			x				x				X	O	1976	Hw
16	54					x						x		X	O	2011	Hw
17	94	x				x								X	O	1988	Hw
18	1E													X	O	2009	Hw
19	5C													X	R		
20	5A																
21	K7C	x	x			x								X	R	2003	Tr
22	51	x	x	x		x	x		x					X	O	2004	Hw
23	19													X	O	1992	Td
24	21A	x	x	x		x	x			x	x	x		X	O	1985	Hw
25	121	x	x			x				x				X	O	2004	
26	35	x				x				x		x		X	O	1982	Hw
27		x	x			x				x				X	R	2008	Td+Tr
28	82	x	x			x				x				X	O	1995	Hw
29	22													X	O	1990	Hw
30	85	x				x				x				X	O	2009	
31	70B	x	x	x	x	x								X	O	2009	Hw

32	**K19**			x										X	O	-	
33	**9A**	x	x	x		x								X	O	1996	Hw
34	**9B**	x	x	x		x								X	O	1996	Hw
35	**9C**	x	x	x		x								X	O	1997	Hw
36	**9D**	x	x	x		x								X	R	2008	Hw
37	**9E**	x	x	x		x								X	R	2008	Hw
38	**95**	x	x				x							X	O	1965	Hw
39	**40A**	x	x	x	x	x				x				X	O	1984	Hw
40	**89**													X	O	1991	Hw
41	**89A**		x			x								X	O	1993	Msg
42	**38**	x	x			x	x	x			x	x	x	X	O	1980	Hw
43	**62/6C**													X	R	2010	Hw
44	**33**	x	x				x					x		X	R	2000	Hw
45	**78A**	x	x			x	x							X	O	1987	Hw
46	**9**	x	x			x								X	R	1993	Hw
47	**48A**															-	
48	**97**	x		x										X	O	1997	Hw
49	**62B**								x			x		X	R	2009	Hw
50	**7**						x							X	R	2010	Hw
51	**121**	x	x			x								X	R	2009	Hw
52	**40**	x	x			x		x						X	O	1984	Hw
53	**25**	x	x	x		x	x			x				X	O	1965	Hw
Total Participant		33	27	13	3	30	10	2	4	9	3	8	2	46			
Note: O = Own; R = Rent; Hw = Housewife. Td = Trader (Groceries/small market); Tr = Tailor. Msg = Massager ; CS: Cleaning Service																	

D3. Detail Result: Collective Actions and Community-based Organizations Inventory   Case Study II

D3.1 SUMMARY Survey / KESIMPULAN - Survei

Total House	:	86	**Occupation**		
Respondent	:	39	Housewife	:	26
Status of Ownership			Others	:	6
Self-Own (starting year)	:	30 (1950-2004)	unknown	:	7
Rent (starting year)	:	9 (2005-2011)			

INVENTORY / *INVENTORI*

Collective activities which have been or have been not involved by the respondent/*Kegiatan bersama yang pernah terjadi diikuti maupun tidak diikuti responden:*

No. *No.*	**ACTIVITY** *KEGIATAN*	**MENTIONED in times** *DISEBUT berapa kali*	**INISIATOR** *INISIATOR*	**SUPERVISOR** *MANDOR*	**TYPE OF CONTRIBUTED RESOURCES** *JENIS SUMBER DAYA YANG DIBERIKAN RESPONDEN*	**PLACE** *TEMPAT*	**INTENSITY** *INTENSITAS*
1	Communal Work in Cleansing for Women/*Kerja Bakti untuk Ibu-Ibu*	30	Under the instruction of Sub-District Authority (Kelurahan)	Head of Households (RT)	Power and Small tipp /*tenaga dan uang rokok*	All area	Once a week (every Sunday)
2	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	22	Local young people	-------------	Donation. idea and power	Outside the area	Once a year (August 17th)
3	Social Gathering for Women/*Arisan Ibu-Ibu*	21	Community member	Community member	Money	Mosque	Once a month
4	Quran Study for Women/*Pengajian Untuk Ibu-Ibu*	19	Community member	Community member	Donation or *amal Masjid*	Mosque	4 times a week (Thursday. Friday. Saturday Night and Sunday Morning)
5	Community Savings/*Tabungan Warga*	18	Community	Community	Money	Collected	Once a week

			member	member		from houses	
6	Events for Religious Days/*Perayaan Hari Besar Keagamaan*	14	Mosque Committee	Mosque Committee	Food.drinks. money. power and idea	Mosque	3 times a year
7	Quran Study for Children/*Pengajian Untuk Anak-anak*	12	-------------	-------------	-------------	Mosque	-------------
8	Quran Study for Men/*Pengajian Untuk Bapak-Bapak*	11	-------------	-------------	-------------	Mosque	-------------
9	Quran Study for All/*Pengajian Untuk Umum*	8	-------------	-------------	-------------	Mosque	-------------
10	Gymnastic for Women/*Senam*	8	Community member	Community member	-------------	-------------	Once a week
12	Community Integrated Service/*Pos Pelayanan Terpadu (Posyandu)*	6	Under the instruction of Head of Neighborhood (RW)	-------------	-------------	flexible	Once a month
13	Futsal/*Futsal*	5	-------------	-------------	-------------	-------------	Twice a month
14	Exercise Rebana/*Latihan Rebana*	3					
15	Quran Study for Teenage/*Pengajian Untuk Ibu-Ibu*	1	-------------	-------------	-------------	Mosque	Twice a month
16	Preparation for meal when the feast/*Persiapan makan besar saat hari raya*	1	-------------	-------------	-------------	-------------	-------------
17	Donation to the orphans/*sumbangan anak yatim*	1	-------------	-------------	-------------	-------------	-------------
18	Cooking for wedding ceremony/*Membantu masak untuk undangan pernikahan*	1	-------------	-------------	-------------	-------------	-------------
19	Mourning Fee/*Layatan kematian*	1	-------------	-------------	-------------	-------------	-------------
20	Visit community member who is ill/*Besuk orang sakit*	1	-------------	-------------	-------------	-------------	-------------
21	Communal Work in Making Wells/*Kerja bakti sumur*	1	-------------	-------------	-------------	-------------	-------------
22	Communal Work in Making Toilets/Pembuatan WC umum	1	-------------	-------------	-------------	-------------	-------------------------
23	Election Head or the households (RF)/*Pemilihan RT*	1	-------------	-------------	-------------	-------------	-------------

24	Communal work in combating mosquitos/*Penjentikan*	1	-------------	-------------	-------------	-------------	-------------
25	Extermination of waste/*Pembuangan sampah*	1	-------------	-------------	-------------	-------------	-------------
26	Other Research Activity/*Kegiatan Penelitian lain*	1	-------------	-------------	-------------	-------------	-------------
27	Election of Committee for Mosque/Pemilihan pengurus mesjid	1	-------------	-------------	-------------	-------------	-------------
28	Contribution for Meats/Iuran daging (makan bersama)	1	-------------	-------------	-------------	-------------	-------------

COMMUNITY BASED- ORGANIZATIONS / *ORGANISASI BERBASIS MASYARAKAT*

Social organization which have been or have been NOT involved by the respondent/*organisasi sosial pernah diikuti dan tidak oleh responden:*

No. *No.*	**ORGANIZATION** *ORGANISASI*	**MENTIONED in times** *DISEBUT berapa kali*	**MEMBER** *PESERTA*	**AGE CATEGORY** *KATEGORI USIA*	**TIME (start-end)** *WAKTU (Mulai-Akhir)*	**ACTIVITY** *KEGIATAN*	**PLACE** *TEMPAT*	**FINANCING RESOURCES** *SUMBER DANA*
1	Youth Organization/*Karang Taruna*	17	Young people	20-30 years	(not active anymore)	Collecting data. cleaning	Areas in RT	-------------
2	Woman Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	10	Woman	Productive age	flexible	Cleansing	Areas in RW	-------------
3	Stewardship of the Mosque/*Kepengurusan Masjid*	4	All. especially women	all	Every day	Quran study	Mosque	Treasury. donation. etc.

MOTIVATION/*MOTIVASI*

Motivation for Participating/*Motivasi keikutsertaan:*

No.	ACTIVITY/ORGANIZATION *AKTIVITAS/KEGIATAN*	MOTIVATION OF PARTICIPATION *MOTIVASI MENGIKUTI KEGIATAN*
1	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	To keep the spirit so that young generation can preserve the tradition. self-initiative or by invitation. was selected by head of Households (RT)
2	Communal Work/*Kerja Bakti*	Many people participate. form of responsibility as community member. to keep the environment healthy and away from disease especially dengue
3	Quran Study/Pengajian	To gain the knowledge. to meet other people and have invitation. because it is a must as a Moslem
4	Community Savings/Tabungan Warga	For savings due to limited/small income. in oder to organize the expenditure
5	Woman Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	Because there are no work at home. have income. can share with other members
6	Exercise Rebana/*Latihan Rebana*	It is a positive activity

METHOD OF RESPONDENT DETEMINATION/*METODE PENENTUAN RESPONDEN*: radom/*acak* and by following community recommendation

Note*/Catatan:*

------ *:* No information collected*/tidak mendapat informasi*

D3.2 COMMUNITY MEMBERS ACTIVENESS /KEAKTIFAN ANGGOTA MASYARAKAT

No. Respondent	House Number	Name of Collective Actions and Social Activity (x for participate and - for not participate)												Own/ Rent	Since	Occupation
		1	2	3	4	5	6	7	8	9	10	11	12			
1	**G2**	x	x		x	x								O	1981	
2	**22**	x		x										O	1950	Hw
3	**46**	x		x	x							x	x	O	1972	Hw
4	**25**			x										R	-	Td
5	**14**	x												R	2005	Hw
6	**13**	x	x											O	-	Hw
7	**C1**													O	1965	Hw
8	**37A**	x		x						x				O	-	Hw
9	**44**	x		x	x	x		x	x				x	O	1960	Hw
10	**C3**	x		x	x	x							x	O	-	Hw
11	**42**	x												O	-	Td
12	**21**	x												O	2001	Td
13	**E2**		x											O	1967	Td
14	**D9**			x										O	1995	CS
15	**C2**	x	x	x	x				x					O	1995	Hw
16	**52**		x									x		O	1961	Hw
17	**48**	x												O	2004	Hw
18	**H5**	x	x	x										O	1998	Hw
19	**5**													R	-	Hw
20	**50**	x												R	-	Hw
21	**B5**													R	1957	
22	**C6**		x											0	2010	
23	**48**							x	x					0	-	Hw
24	**7**	x												0	1967	Td
25	**D4**													0	1976	
26	**H3**	x							x					0	1970	
27	**H4**		x	x										0	1988	Hw

28	**E9**	x		x										0	1960	Hw
29	**F6**													R	2009	Hw
30	**H6**			x										O	1961	Hw
31	**62**													O	-	
32	**28**													O	1950	Hw
33	**G4**													R	2011	Hw
34	**E3**	x			x									0	2006	Hw
35	**D10**													R	2011	Hw
36	**D6**							x						O	1950	Hw
37	**D1**	x	x					x	x					R	2007	Hw
38	**40**	x												O	-	
39	**34**		x	x			x	x						O	1993	Hw
Total Participant		21	9	13	6	3	1	5	5	1	0	2	3			
Note: O = Own; R = Rent; Hw = Housewife. Td = Trader (Groceries/small market); Tr = Tailor. Msg = Massager ; CS: Cleaning Service																

D4. Additional Summary: List of Social Organization and Collective Actions on Urban Kampung Settlement

No.	Name of Community-based Organization (CBO) or Collective Action (CA)	Type	Description
1	Empowerment Family Welfare. original name in Bahasa: *Pemberdayaan Kesejahrteraan Keluarga* (PKK)	CBO	PKK is the first and the most wide-spread woman community-based organization in Indonesia and established since the sixties. This organization is under the inistry of Interiors referral. PKK has 10 Programs . such as underlining mutual cooperation (program no. 2). encouraging productive farming (program no. 3) and using domestic products (program no. 4). Education and skills (program no. 6). and environmental protection (program no. 10). Elements of PKK: PKK Driver team. is government partner in implementing the 10 of PKK program Working Group (*Kelompok Kerja/PokJa*). is the division of PKK which concentrate in a specific program. PKK Cadre is the local person who is trained to implement the program at the community level. The local messenger/cadre is voluntary-based work. It is un-paid and anyone has the same change to be selected. Link: PKK Headquarter: http://tp-pkkpusat.org/index.php?option=com_content&view=article&id=62&Itemid=69
2	Dasa Wisma	CBO	Dasa Wisma is one of the strategies of PKK to increase the number of family involved on its program. That is to form a smaller group. called Dasa Wisma. It consists of 10 -20 houses. where the leader of the group is selected based on the discussion. This leader responsible to monitor the member in the group. for example on illness. baby birth. etc. and reported to PKKs driver team. Link: Dasa Wisma http://tp-pkkpusat.org/index.php?option=com_content&view=article&id=63&Itemid=74
3	Youth Organization or in Bahasa: *Karang Taruna*	CBO	Youth Organization/*Karang Taruna* is organization under the households (RT) and mainly consists of the young people. Its activity can be various. such as sports. contest. communal cleansing. etc. depends on the management of the organization.
4	Community Integrated Service. original name in Bahasa: *Pos Pelayanan Terpadu (Posyandu)*	CA	Community Integrated Service/*Pos Pelayanan Terpadu (Posyandu)* is one of PKK activities. It is promoted by the women in the community and takes place once in a month. The activity concerns the toodles. especially baby and the mother with babies. Here. the cadre from PKK regularly weigh the baby and note it on a special book. This is also the program for poor people to have free vaccinations.
5	Communal Work in Cleansing/Clean Friday. original name in Bahasa: *Kerja Bhakti* or *Bersih-Bersih* or *Jumat Bersih*	CA	Communal Cleansing is one of the activities which created under the PKK Program. It might take once a week. a month. depends on agreement and promoted by the member in the community. Clean Friday (*Jumat Bersih*) is is a typical of communal work for women to clean the streets/roads/paths and the grey water/sanitation network in the neighborhood. After the cleaning. normally the women gather together in one of the community member to relax with tea/coffee and snacks. During this time. normally the community members share information or just doing normal conversation.

6	Quran Study. original name in Bahasa: *Pengajian*	CA	Quran study or *pengajian* is one of traditions which occur since previous generations. It can be only for adults. children. women. men. or general and can be done daily. weekly. monthly depends on the agreement. In this
			activity the group members recite the Holy Quran and discuss about the content together. Normally the group invites one expert who will lead the discussion. Some group initiatively coordinates voluntary-based alms. The collected money will be given to orphanage. nursing home or ill person or any special occasions.
7	Social Gathering. original name in Bahasa: *Arisan*	CA	Social Gathering or *Arisan* is also one of traditions which occur since previous generations. It can be only for woman. or man or family and can be weekly; monthly. etc. depend on the agreement. This activity is similar with deposit some money in the bank. but in this case the bank is the treasury and the amount of stored money is agreed and regularly stored and once in a while the sum of the money will be back again.
8	Gymnastic. original name in Bahasa: *Senam*	CA	Gymnastic or *Senam* is an initiative program in the community and also part of traditions. Under the agreeable time. the community members gather and do the gymnastic together in the open space or one of the community members.
9	Independence Day Celebration. original name in Bahasa: *Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	CA	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)* is one of the programs of the households (RT) to celebrate the independence day. Normally during some weeks before the community prepare for gate (gapura) and small flags to brighten up this event. Also sometimes the organizers arrange contest/games for different group of ages. This activities is normally promoted by Youth Organization/*Karang Taruna*
Note: This list describes general collective actions and social organization in the community			

Appendix E – Sub-Module 2-1 Active Person Map

Appendix E Sub-Module 2-1 Active Person Map

E1. List of Activities and Their Scores in Case Studies I and II

No.	CASE STUDY I (bigger area)		
	COLLECTIVE ACTIONS and SOCIAL ORGANIZATIONS	**Quantitative Score (QnS)**	**Qualitative Score (QlS)**
1	Quran Study for Women/*Pengajian Untuk Ibu-Ibu*	1	52
2	Social Gathering/*Arisan*	1	52
3	Regular Donation/*Jimpitan*	1	52
4	Freewill Donation (ex.mourning fee)/*LAZIS*	1	12
5	Clean Friday/*Jumat Bersih*	1	52
6	Gymnastic at RT/*Senam RT*	1	104
7	Badminton/*Bulu Tangkis*	1	52
8	Security/*Keamanan (Hansip)*	1	12
9	Recreation RT/Rekreasi RT	1	1
10	Woman Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	1	12
11	Community Integrated Service/*Pos Pelayanan Terpadu (Posyandu)*	1	12
12	Gymnastic at RW/*Senam RW*	1	52
13	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	1	1

No.	CASE STUDY II (smaller area)		
	COLLECTIVE ACTIONS and SOCIAL ORGANIZATIONS	**Quantitative Score (QnS)**	**Qualitative Score (QlS)**
1	Communal Work in Cleansing for Women/*Kerja Bakti untuk Ibu-Ibu*	1	52
2	Independence Day Celebration/*Perayaan Hari Ulang Tahun Republik Indonesia (HUT RI)*	1	1
3	Quran Study for Women/*Pengajian Untuk Ibu-Ibu*	1	208
4	Quran Study for All/*Pengajian Untuk Umum*	1	12
5	Events for Religious Days/*Perayaan Hari Besar Keagamaan*	1	3
6	Gymnastic/*Senam*	1	52
7	Social Gathering for Women/*Arisan Ibu-Ibu*	1	12
8	Community Savings/*Tabungan Warga*	1	52
9	Exercise Rebana/*Latihan Rebana*	1	104
10	Community Integrated Service/*Pos Pelayanan Terpadu (Posyandu)*	1	12
11	Woman Organization for Fostering Family Welfare/ *Organisasi Pembinaan Kesejahteraan Keluarga (PKK)*	1	12
12	Stewardship of the Mosque/*Kepengurusan Masjid*	1	52

E2. Community Members Ran in Case Studies I and II

CASE STUDY I					
Respondents number	**House Number**	**QnS**	**QIS**	**Quantitative Rank**	**Qualitative Rank**
1	**3A**	4	117	23	27
2	**74**	3	105	29	29
3	**47**	0	0	47	47
4	**41**	0	0	48	48
5	**43A**	0	0	49	49
6	**78B**	0	0	50	50
7	**K16B**	0	0	51	51
8	**4B**	1	1	40	40
9	**15**	3	65	30	35
10	**63**	8	337	3	3
11	**17**	5	169	8	18
12	**95**	3	105	31	30
13	**93**	5	264	9	6
14	**K2A**	3	65	32	36
15	**76**	5	158	10	19
16	**54**	3	65	33	37
17	**94**	3	105	34	31
18	**1E**	1	1	41	41
19	**5C**	1	1	42	42
20	**5A**	0	0	52	52
21	**K7C**	4	157	24	23
22	**51**	7	325	4	4
23	**19**	1	1	43	43
24	**21A**	9	338	1	2
25	**121**	5	158	11	20
26	**35**	5	118	12	26
27	**n.a.**	5	158	13	21
28	**82**	5	158	14	22
29	**22**	1	1	44	44
30	**85**	4	106	25	28

CASE STUDY II					
Respondents number	**House Number**	**QnS**	**QIS**	**Quantitative Rank**	**Qualitative Rank**
1	**G2**	4	68	5	16
2	**22**	2	260	10	8
3	**46**	5	336	2	3
4	**25**	1	208	18	11
5	**14**	1	52	19	20
6	**13**	2	53	11	19
7	**C1**	0	0	31	31
8	**37A**	3	364	8	2
9	**44**	7	391	1	1
10	**C3**	5	327	3	4
11	**42**	1	52	20	21
12	**21**	1	52	21	22
13	**E2**	1	1	22	30
14	**D9**	1	208	23	12
15	**C2**	5	325	4	5
16	**52**	2	13	12	28
17	**48**	1	52	24	23
18	**H5**	3	261	9	7
19	**5**	0	0	32	32
20	**50**	1	52	25	24
21	**B5**	0	0	33	33
22	**C6**	1	52	26	25
23	**48**	2	64	13	17
24	**7**	1	52	27	26
25	**D4**	0	0	34	34
26	**H3**	2	104	14	16
27	**H4**	2	209	15	10
28	**E9**	2	260	16	9
29	**F6**	0	0	35	35
30	**H6**	0	0	36	36

31	**70B**	6	221	7	9
32	**K19**	2	53	38	38
33	**9A**	5	209	15	11
34	**9B**	5	209	16	12
35	**9C**	5	209	17	13
36	**9D**	5	209	18	14
37	**9E**	5	209	19	15
38	**95**	4	209	26	16
39	**40A**	7	222	5	8
40	**89**	1	1	45	45
41	**89A**	3	105	35	32
42	**38**	9	389	2	1
43	**62/6C**	1	1	46	46
44	**33**	5	221	20	10
45	**78A**	5	261	21	7
46	**9**	4	157	27	24
47	**48A**	0	0	53	53
48	**97**	3	106	36	33
49	**62B**	3	25	37	39
50	**7**	2	10	39	344
51	**121**	4	157	28	25
52	**40**	5	209	22	17
53	**25**	7	314	6	5

31	**62**	1	208	28	13
32	**28**	0	0	37	37
33	**G4**	0	0	38	38
34	**E3**	2	64	17	18
35	**D10**	0	0	39	39
36	**D6**	1	12	29	29
37	**D1**	4	117	6	14
38	**40**	1	52	30	27
39	**34**	4	273	7	6

Appendix F – Module 3 Impact Assessment

Appendix F Module 3 Impact Assessment

F. Condition Setting for the Environmental Impact and Output Calculation

F1. 1 Material Flow Template for Processed Waste

Waste Fraction	OD	SL	CL	I no E	I w10%	IstA	C low	C high	AD	CAD	HC	RB	RT
Organic (O)	0.00	0.00	0.00	0.00	0.00	n.a.	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.
Paper (P)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00
Plastic Bottle (PB)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00
Plastic non Bottle (PnB)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00
Metal (M)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00
Glass (G)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00
Residual (R)	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00

Note: n.a. = not allowed; user defined input (Material Flow)

F1. 2 Waste Composition in detail for the calculation in EASEWASTE

Waste Fraction	Composition
Organic	100% vegetable food waste
Plastic Bottle	100% plastic bottle
Plastic Other	80% soft plastic; 20% plastic products (toys. hangers. pens)
Paper	10% news prints; 70% paper and cardboard containers; 10 other clean paper
Glass	50% brown glass; 50% clear glass
Metal	100% Beverage Cans
Residual	30% Diapers. sanitary towels and tampons; 30% textile; 10% ash and 30% other combustibles

F2. Waste Treatment Options: Technical Measure

No.	Waste Treatment	Acronym	Documentation from EASEWASTE and Contextualization to the Tropical Climate
1	**Open Dumping**	**OD**	Assumed the use of electricity. soil and clay movement is zero. The precipitation is zero. Precipitation is adjusted to 1024. 1024. 682 and 682; oxidation volume changes from 0%. 0%. 35% and 80%; methane generation potential for organics is 54.7%. 31.19%. 13.44% and 0%; and for paper is 13.06%. 16.46%. 64.37% and 5.99%; all in the first. second. third and fourth period respectively; there is no collected leachate and gas. (See EASEWASTE operational parameters for detail on tropical country context).
2	**Sanitary Landfill**	**SL**	Assumed the use of electricity and diesel exist for the compactor. soil and clay movement exists. Precipitation is adjusted to 1024. 1682. 682 and 682; oxidation volume changes from 0%. 35%. 35% and 80%; leachate collected is 95%. 80%. 60% and 0%; methane generation potential for organics and for paper remain the same as in OD; all in the first. second. third and fourth period respectively; there is no collected gas (See EASEWASTE operational parameters for detail).
3	**Controlled Landfill**	**CL**	Assumed the use of electricity and diesel exist for the compactor. soil and clay movement exists. Precipitation is adjusted to 1024. 1682. 682 and 682; oxidation volume changes from 0%. 80%. 80% and 80%; leachate collected is 95%. 80%. 60% and 0%; methane generation potential for organics and for paper remain the same as in OD; gas collected is 0%. 75%. 75% and 75%; all in the first. second. third and fourth period respectively; there is no collected gas (See EASEWASTE operational parameters for detail).
4	**Incineration without Energy Recovery**	**InoER**	Waste is incinerated a grate furnaces equipped with dry flue gas cleaning and only district heat production. The annual capacity is 50.000 tons of waste and no heat/energy is recovered. NO_x. Dioxin. and Hg were not removed by flue gas cleaning.
5	**Incineration with 10% Energy Recovery**	**I10%ER**	Waste is incinerated a grate furnaces equipped with dry flue gas cleaning and only district heat production. The annual capacity is expected to be 50.000 tons of waste and the energy production is expected to be 10% as electricity generation. NO_x. Dioxin. and Hg were not removed by flue gas cleaning. Energy substitution technology is to seen as the best available as no specific study was present. Note: the coal power is used as marginal electricity (means that the use of coal is avoided)
6	**Incineration with State of the Art**	**IStA**	Waste incinerated in three lines. all equipped with grate furnaces. Two lines have semi dry flue gas cleaning and the third line has wet flue gas cleaning. All lines have combined heat and power production. The annual capacity is 240.000 tons of waste and the energy production is expected to be 20% as electricity generation. NO_x is removed by SCNR. Dioxin and Hg is removed with activated carbon. Energy substitution technology is the best to be seen as best available as no specific study was present. Note: the state of art is signed by up to 30% organic waste content. The coal power is used as marginal electricity (means that the use of coal is avoided)

No.	Waste Treatment	Acronym	Documentation from EASEWASTE and Contextualization to the Tropical Climate
7	**Composting Low Quality**	**Clow**	A trommel screen is used to remove foreign items and impurities prior to composting process. The waste is then shredded in a horizontal hammer mill and watered to obtain moisture content around 50% (wet weight). Composting take place in aerated windrows. The windrows are occasionally turned by a windrow turner. The final compost is landfilled or used in a landfill as top cover. Rejects are landfilled. Assumed to in low quality of organic waste (input). no cleaning gas and the compost product is used and substitute the fertilizer.
8	**Composting High Quality**	**Chigh**	A MRF is assumed to remove foreign items and impurities prior to the composting process. Initially the waste is shredded in a horizontal hammer mill and watered to obtain moisture content around 50% (wet weight). Composting takes place in aerated windrows. A trommel screen is used to produce fine compost after the curing phase. Rejects are landfilled. Assumed to have less contaminant. no cleaning gas and the compost product is used and substitute the fertilizer.
9	**Anaerobic Digestion**	**AD**	The data represents a plant consisting of a reception facility and a number of 600 m3 process modules. The treatment is initiated by mixing the source-separated household waste with structure material in the form of shredded garden/park waste. The mixture is placed in the process modules under anaerobic conditions and water is sprinkled on top of the material. Hydrolyses and fermentation processes result in organic acid formation. The organic acids are transported to a process tank for methane production by pumping the percolate from the process module. The process can therefore be categorized as two-step anaerobic biogas production with acid formation and methanogenesis taking place in separate compartments. The biogas is burned in a biogas engine on the plant for electricity production to the electricity grid. The heat produced is used internally at the plant for heating the buildings. After biogas production has leveled of the process modules are turned aerobic by suction of air through the material. Thereby a rapid composting process is initiated. The exhaust air from the composting process passes through a biofilter. After biogas production and subsequent composting in the closed reactor modules the compost is placed in open windrows for maturing. Assumed to have 0% heat generation. but with electricity generation. and the digestate is use on farm land and substitute the fertilizer
10	**Combined Anaerobic Digestion and Composting**	**CAD**	Technology used is combined anaerobic-aerobic reactor treatment of source separated organic waste with energy recovery (biogas) and compost production
11	**Home Composting**	**HC**	The organic waste is added directly to the plastic composting units. The OHW is composted during one year and the compost is taken out for use as a substitute for peat. fertilizer or nothing. Assumed not to substitute any kind of fertilizer since currently the society are not buying any. also assumed not having any contact with soil (0% of output groundwater)
12	**Recycle Bank**	**RB**	Since it is the process of conventional recycling (hand-made products) and the productions are not considered as waste anymore. Therefore in this study. RB is assumed not contribute to any of the impact categories.

No.	Waste Treatment	Acronym	Documentation from EASEWASTE and Contextualization to the Tropical Climate
13	**Recycling Technology**	**RT**	**Paper** The material contains of cardboard and mixed paper. The technology is shredding and reprocessing of mixed paper and cardboard material to produces new cardboard. **Glass** The material contains of glass (including broken glass). The technology is re-melting of glass culled and forming glass bottles. The production substitute virgin bottle production **Plastic Bottle and Plastic Other** The material contains of Plastic bottle PE. The technology is re-melting of clean PE plastic to granulated plastic foam. **Metal** The material contains of aluminum. The technology is re-melting of aluminum scrap and casting of new aluminum products

F3. Environmental Impact Calculations for Disposal and Landfills

F3.1 Parameters used based on IPCC First Order Decay (FOD). 1997

Parameter	Wet Temperate		Wet Tropics	
	Organic Waste	Paper	Organic Waste	Paper
k (decay Coeffcients)	0.19	0.06	0.40	0.07
DOC(degradable organic carbon)	0.15	0.40	0.15	0.40
DOCF(fraction of DOC dissimilated)	0.75	0.25	0.75	0.25
F(fraction of CH_4 in landill gas)	0.50	0.50	0.50	0.50
16/12 (conversion of C to CH_4)	1.33	1.33	1.33	1.33
MCF	1.00	1.00	1.00	1.00
Delay time (yr)	0.50	0.50	0.50	0.50

Lo (methane potential kgCH4/kg wet waste)	0.08	0.07	0.08	0.07
Methane Potential for EASEWASTE (m^3/ton VS)	479.74	116.42	479.74	116.42

Indonesia Local Condition

Average precipitation (mm/yr)	1,706*

*) Percipitation rate for Jakarta

F3.2 Methane Generation Rate in EASEWASTE. based on FOD. 1997

Time Period	Years	Temperate		Tropics	
		Organic Waste	Paper	Organic Waste	Paper
1	2	30.88%	11.31%	54.70%	13.06%
2	3	29.38%	14.61%	31.19%	16.46%
3	35	39.54%	65.00%	13.44%	64.37%
4	60	0.06%	8.82%	0.00%	5.99%

Note: number in boxes with color were used in the calculations

F3.3 Operational Parameters in EASEWASTE. based on Dagmaard et al. 2011 and Trankler et al. 2005

Open Dump (OD)

Time Period	**Years**	**Gas Collection**	**Gas oxidation**	**Leachate Generation**	**Leachate collection**
		% of gas collected	% of gas uncollected	mm/yr	% of leachate generated
1	2	0.00%	0.00%	1024	0.00%
2	3	0.00%	0.00%	1024	0.00%
3	35	0.00%	35.00%	682	0.00%
4	60	0.00%	80.00%	682	0.00%

Sanitary Landfill (SL)

Time Period	**Years**	**Gas Collection**	**Gas oxidation**	**Leachate Generation**	**Leachate collection**
		% of gas collected	% of gas uncollected	mm/yr	% of leachate generated
1	2	0.00%	0.00%	1024	95.00%
2	3	0.00%	35.00%	682	80.00%
3	35	0.00%	35.00%	682	60.00%
4	60	0.00%	80.00%	682	0.00%

Controlled Landfill (CL)

Time Period	**Years**	**Gas Collection**	**Gas oxidation**	**Leachate Generation**	**Leachate collection**
		% of gas collected	% of gas uncollected	mm/yr	% of leachate generated
1	2	0.00%	0.00%	1,024	95.00%
2	3	75.00%	80.00%	682	80.00%
3	35	75.00%	80.00%	682	60.00%
4	60	75.00%	80.00%	682	0.00%

Note: number in boxes with color were used in the calculations

F4. Contextualization to Indonesian Spoiled Groundwater (Database)

No.	Substance	the maximum permitted amount (mg/l)	1 [Flow] = m3 spolide water/kg	Source	EASEWASTE Database. Calculated based on contamination of Danish Ground Water (Damgaard et al.. 2011)
1	Aluminium (Al)	0.2	5000.00	PMK No. 492/Menkes/Per/IV/2010	5,000
2	Ammonia	1.5	666.67	PMK No. 492/Menkes/Per/IV/2010	5,000
3	Antimony (Sb)	0.02	50000.00	PMK No. 492/Menkes/Per/IV/2010	50,000
4	Arsenic (As)	0.01	100000.00	PMK No. 492/Menkes/Per/IV/2010	200,000
5	Barium (Ba)	0.7	1428.57	PMK No. 492/Menkes/Per/IV/2010	1,429
6	Benzene	0.01	100000.00	PMK No. 492/Menkes/Per/IV/2010	1,000,000
7	Cadmium (Cd)	0.003	333333.33	PMK No. 492/Menkes/Per/IV/2010	500,000
8	Calcium (Ca)		n.a.		5
9	Chloride (Cl-)	250	4.00	PMK No. 492/Menkes/Per/IV/2010	4
10	Chloroform	0.3	3333.33	PMK No. 492/Menkes/Per/IV/2010	1000,000
11	Chromium (Cr)	0.05	20000.00	WHO. p. 340	50,000
12	COD (Chemical Oxygen Demand)		n.a.		500
13	Copper (Cu)	2	500.00	PMK No. 492/Menkes/Per/IV/2010	10,000
14	Dichloro Methane		n.a.		1,000,000
15	Dichloromethane (methylene chloride)	0.02	50000.00	WHO. p. 357	1,000,000
16	Ethyl Benzene	0.3	3333.33	PMK No. 492/Menkes/Per/IV/2010	1,000,000
17	Ethylene dichloride		n.a.		1,000,000
18	Iron (Fe)	0.3	3333.33	PMK No. 492/Menkes/Per/IV/2010	10,000
19	Lead (Pb)	0.01	100000.00	PMK No. 492/Menkes/Per/IV/2010	200,000
20	Magnesium (Mg)		n.a.		20
21	Mercury (Hg)	0.001	1000000.00	PMK No. 492/Menkes/Per/IV/2010	1,000,000
22	Methylene Chloride		n.a.		1,000,000
23	Molybdenum (mo)	0.07	14285.71	PMK No. 492/Menkes/Per/IV/2010	14,290
24	Nickel (Ni)	0.07	14285.71	PMK No. 492/Menkes/Per/IV/2010	50,000

25	Nitrate (NO^{3-})	50	20.00	PMK No. 492/Menkes/Per/IV/2010	20
26	Nitrate ($NO^{3-}N$)		n.a.		20
27	NVOC		n.a.		250
28	Phosphate (PO_4^{3-})		n.a.		6667
29	Pottasium (K)	0.04	25000.00	WHO. p. 413	100
30	Selenium (Se)	0.01	100000.00	PMK No. 492/Menkes/Per/IV/2010	100,000
31	Silver (Ag)	0.002	500000.00	WHO. p. 416	100,000
32	Sodium (Na)	200	5.00	PMK No. 492/Menkes/Per/IV/2010	5,714
33	Sulphate (SO_4^{2-})	250	4.00	PMK No. 492/Menkes/Per/IV/2010	4
34	Tetrachloroethylene (Tetrachlorethene)	0.04	25000.00	WHO. p. 421	1,000,000
35	Toluene	0.7	1428.57	PMK No. 492/Menkes/Per/IV/2010	1,00,0000
36	Trichloro ethylene	0.02	50000.00	WHO. p. 425	1,000,000
37	Vinyl Chloride	0.0003	3333333.33	WHO. p. 432	0.3
38	Xylenes	0.5	2000.00	WHO. P. 433	1,000,000
39	Zinc (Zn)	3	333.33	PMK No. 492/Menkes/Per/IV/2010	10,000

Note: number in boxes with color were used in the calculations

F5. Environmental Impact Unit (EIU) per 1000 ton (in PE)

A Organic (O)

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	OD	0.0000	0.0410	201.8360	36.6660	2,068.0090
2	SL	9.2030	2.4410	178.5950	32.9730	709.4220
3	CL	-45.2190	-123.2180	-41.1900	12.3830	709.4220
4	InoER	70.9970	46.0720	10.4350	0.7420	0.0000
5	I10%ER	69.8250	45.3190	3.2630	0.7050	0.0000
6	IStA					
7	Clow	267.2390	116.7630	15.4180	1.0710	0.0000
8	Chigh	270.2040	119.0120	25.4550	1.5640	0.0000
9	AD	-2.5800	-3.7500	-25.3650	-0.3200	0.0000
10	CAD	265.9780	113.3730	-17.4750	1.6560	0.0000
11	HC	0.0000	0.0000	12.8720	1.1670	0.0000
12	RB					
13	RT					

B Paper (P)

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	OD	0.0000	0.0380	89.0310	34.3710	2,068.0090
2	SL	9.2030	2.4380	79.4650	33.0780	709.4220
3	CL	-94.6950	-237.4530	-334.2680	-4.8640	709.4220
4	InoER	70.9970	46.0720	10.9620	0.7420	0.0000
5	I10%ER	65.1410	42.3180	-24.8020	0.5580	0.0000
6	IStA	14.8560	-0.3100	-78.8640	-3.6720	0.0000
7	Clow					
8	Chigh					
9	AD					

10	**CAD**					
11	**HC**					
12	**RB**	0.0000	0.0000	0.0000	0.0000	0.0000
13	**RT**	-156.5910	-119.9180	-212.4970	-4.7790	0.0000

C **Plastic Bottle (PB)**

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	**OD**	0.0000	0.0000	-1.6390	0.0000	2.0680
2	**SL**	9.2030	2.4000	1.6090	0.9570	709.4220
3	**CL**	9.2030	2.4000	1.6090	0.9570	709.4220
4	**InoER**	70.9970	46.0720	336.0070	0.7420	0.0000
5	**I10%ER**	54.6940	35.6030	236.2630	0.2280	0.0000
6	**IStA**	-32.3410	-36.1170	86.4030	-11.5200	0.0000
7	**Clow**					
8	**Chigh**					
9	**AD**					
10	**CAD**					
11	**HC**					
12	**RB**	0.0000	0.0000	0.0000	0.0000	0.0000
13	**RT**	-205.8420	-314.8490	-107.8230	-3.2100	0.0000

D **Plastic non Botle (PnB)**

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	**OD**	0.0000	0.0000	-14.4670	0.0000	2,068.0090
2	**SL**	9.2030	2.4000	-11.2190	0.9570	709.4220
3	**CL**	9.2030	2.4000	-11.2190	0.9570	709.4220
4	**InoER**	70.9970	46.0720	315.2680	0.7420	0.0000
5	**I10%ER**	54.7360	35.6300	21.7800	0.2300	0.0000
6	**IStA**	-32.1520	-35.9730	66.3040	-11.4880	0.0000

7	**Clow**					
8	**Chigh**					
9	**AD**					
10	**CAD**					
11	**HC**					
12	**RB**	0.0000	0.0000	0.0000	0.0000	0.0000
13	**RT**	-236.1470	-332.3250	-193.9010	-3.8990	0.0000

E **Metal (M)**

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	**OD**	0.0000	0.0000	0.0000	0.0000	2.0680
2	**SL**	9.2030	2.4000	3.2470	0.9570	709.4220
3	**CL**	9.2030	2.4000	3.2470	0.9570	709.4220
4	**InoER**	70.9970	46.0720	10.1750	0.7420	0.0000
5	**I10%ER**	71.0990	46.1370	10.7960	0.7460	0.0000
6	**IStA**	41.6920	20.0530	11.2130	0.7900	0.0000
7	**Clow**					
8	**Chigh**					
9	**AD**					
10	**CAD**					
11	**HC**					
12	**RB**	0.0000	0.0000	0.0000	0.0000	0.0000
13	**RT**	-840.8310	-1473.4300	-1239.3450	-1569.4020	0.0000

F **Glass (G)**

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	**OD**	0.0000	0.0000	0.0000	0.0000	2.0680
2	**SL**	9.2030	2.4000	3.2470	0.9570	709.4220
3	**CL**	9.2030	2.4000	3.2470	0.9570	709.4220

4	InoER	70.9970	46.0720	10.9620	0.7420	0.0000
5	I10%ER	71.1010	46.1380	10.8110	0.7460	0.0000
6	IStA	41.7030	20.0610	11.2130	0.7900	0.0000
7	Clow					
8	Chigh					
9	AD					
10	CAD					
11	HC					
12	RB	0.0000	0.0000	0.0000	0.0000	0.0000
13	RT	-40.2030	-27.8620	-33.5190	-10.7430	0.0000

G **Residual (R)**

	Treatment Technology	Nutrient Enrichment	Acidification	Global Warming	Photochemical Ozone Formation. High NOx	Spoiled Groundwater Resources
1	OD	0.0000	0.0000	0.0000	0.0000	2.0680
2	SL	9.2030	2.4000	3.2470	0.9570	709.4220
3	CL	9.2030	2.4000	3.2470	0.9570	709.4220
4	InoER	70.9970	46.0720	10.1750	0.7420	0.0000
5	I10%ER	70.9970	46.0720	10.1750	0.7420	0.0000
6	IStA	41.2340	19.7050	9.6610	0.7140	0.0000
7	Clow					
8	Chigh					
9	AD					
10	CAD					
11	HC					
12	RB					
13	RT					

F5.1 Summary Result for Environmental Impacts in Case Studies I and II

CASE STUDY I (Bigger Area)					
Scenario	**Nutrient Enrichment**	**Acidification**	**Global Warming**	**Photochemical Ozone. High NOx**	**Spoiled Groundwater Resources**
S1	0	0.0042	19.3795	3.7442	260.6082
S2	1.2713	0.3357	17.2304	3.4204	97.996
S3	-4.7581	-13.5858	-7.0669	1.1515	97.996
S4	9.8072	6.3642	8.5568	0.1025	0
S5	9.266	6.0166	0.718	0.08555	0
S6	24.9381	10.3448	2.4104	-0.1915	0
S7	25.2161	10.5556	3.3514	-0.01453	0
S8	-0.358	-0.9536	-1.4131	-0.3219	0
S9	24.8199	10.0269	-0.6734	-0.1367	0
S10	-0.1161	-0.602	2.1717	-0.1825	0
S11	17.5613	1.0653	-5.8758	-1.1324	6.5265
S12	17.8393	1.2761	-4.9348	-1.0862	6.5265
S13	-7.7348	-10.2331	-9.6993	-1.2628	6.5265
S14	17.4431	0.7475	-8.9596	-1.0775	6.5265
S15	-7.4929	-9.8815	-6.1145	-1.1234	6.5265
S16	0.0847	0.0221	1.2367	0.1182	6.5265

CASE STUDY II (Smaller Area)					
Scenario	**Nutrient Enrichment**	**Acidification**	**Global Warming**	**Photochemical Ozone. High NOx**	**Spoiled Groundwater Resources**
S1	0	0.0014	6.3156	1.2095	79.0728
S2	0.4009	0.1059	5.6152	1.1034	30.901
S3	-1.5346	-4.363	-2.1856	0.3747	30.901
S4	3.0925	2.0068	2.5932	0.0323	0
S5	2.9291	1.9019	0.6083	0.0272	0
S6	8.1132	3.3816	0.7886	-0.0538	0
S7	8.2036	3.4502	1.0947	-0.0387	0
S8	-0.1161	-0.294	-0.4552	-0.0962	0
S9	8.0747	3.2782	-0.2146	-0.0359	0
S10	-0.0375	-0.1796	0.711	-0.0508	0
S11	6.0249	0.6975	-1.5112	-0.3169	2.3516
S12	6.1153	0.7661	-1.2051	-0.3019	2.3516
S13	-2.2044	-2.9781	-2.755	-0.3593	2.3516
S14	5.9864	0.5941	-2.5144	-0.2991	2.3516
S15	-2.1257	-2.8637	-1.5888	-0.314	2.3516
S16	0.0305	0.008	0.4034	0.0388	2.3516

= Group A, = Group B, and = Group C

F6. Output Unit (OU) Emissions and other products. per 1000 ton

A **Organic(O)**

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH_4)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	OD	98118.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	SL	98118.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	CL	98118.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	InoER	0.000	11.854	81.066	2.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	I10%ER	0.000	11.854	81.066	2.331	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	IStA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Clow	0.000	0.000	0.000	0.000	110.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Chigh	0.000	0.000	0.000	0.000	130.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	AD	0.000	0.000	0.000	0.000	0.000	4,000.000	68,682.600	2,490,431.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	CAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	190.000	49059.000	1,793,400.8	0.000	0.000	0.000	0.000	0.000	0.000
11	HC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	250.000	0.000	0.000	0.000	0.000	0.000
12	RB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	RT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

B **Paper (P)**

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH_4)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	OD	117394.823	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	SL	117394.823	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	CL	117394.823	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	InoER	0.000	35.050	153.720	11.634	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	I10%ER	0.000	35.050	153.720	11.634	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	IStA	0.000	7.331	88.188	11.634	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Clow	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Chigh	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	AD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	CAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	HC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	RB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	RT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	940.000	0.000	0.000	0.000

C **Plastic Bottle (PB)**

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH_4)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	**OD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	**SL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	**CL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	**InoER**	0.000	22.172	113.383	32.448	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	**I10%ER**	0.000	22.172	113.383	32.448	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	**IStA**	0.000	3.712	44.659	32.448	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	**Clow**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	**Chigh**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	**AD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	**CAD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	**HC**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	**RB**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	**RT**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	900.0	0.000	0.000

D **Plastic non Bottle (PnB)**

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH_4)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	**OD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	**SL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	**CL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	**InoER**	0.000	27.645	130.525	32.364	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	**I10%ER**	0.000	27.645	130.525	32.364	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	**IStA**	0.000	5.250	63.157	32.364	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	**Clow**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	**Chigh**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	**AD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	**CAD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	**HC**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	**RB**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	**RT**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	900.000	0.000

E Metal (M)

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH$_4$)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH$_4$)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	OD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	SL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	CL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	InoER	0.000	230.390	765.570	-0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	I10%ER	0.000	230.390	765.579	-0.207	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	IStA	0.000	62.220	748.470	-0.202	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Clow	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Chigh	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	AD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	CAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	HC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	RB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	RT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	890.000

F Glass(G)

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH$_4$)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm^3 CH$_4$)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Aluminium Product (ton)
1	OD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	SL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	CL	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	InoER	0.000	230.874	767.086	-0.202	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	I10%ER	0.000	230.874	767.086	-0.202	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	IStA	0.000	62.356	750.106	-0.202	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Clow	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Chigh	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	AD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	CAD	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	HC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	RB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	RT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1000.00	0.000	0.000	0.000	0.000

G **Residual (R)**

		Mixed Landfill	Thermal Treatment			Composting	Anaerobic Digestion			Combined Anaerobic Digestion and Composting			Home Com-posting	Recycling				
	Treatment Technology	Methane Potential (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Composted Digestate (ton)	Methane Production (Nm3 CH4)	Energy in Biogas (MJ)	Compost (ton)	New Glass bottle (ton)	New cardboard (ton)	New Plastic bottle (ton)	New product of Plastic non Bottle (ton)	New Alumunium Product (ton)
1	**OD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	**SL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	**CL**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	**InoER**	0.000	8.960	72.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	**I10%ER**	0.000	8.960	72.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	**IStA**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	**Clow**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	**Chigh**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	**AD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	**CAD**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	**HC**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	**RB**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	**RT**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

F6.1 Summary Result: Outputs

F6.1.1 Summary Result: Outputs for Case Studies I (Bigger area)

Output	Potential Methane Generation (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Energy in Biogas (MJ)	Composted Digestate (ton)	Products(ton) for (1) glass, (2) cardboard, (3) plastic non bottle, (4) plastic bottle. (5) aluminum product
Scenario 1	10246.36								
Scenario 2	10246.36								
Scenario 3	10246.36								
Scenario 4		2.8273	14.9248	1.0768					
Scenario 5		2.8273	14.2625	1.0768					
Scenario 6		0.3704	4.4560	0.8583	10.3127				
Scenario 7		0.3704	4.4560	0.8583	12.1878				
Scenario 8	6439.1465	0.3704	4.4560	0.8583		375.0089	233,483		
Scenario 9	4599.3904	0.3704	4.4560	0.8583			168,135	17.8129	
Scenario 10		0.3704	4.4560	0.8583	23.4831				
Scenario 11					10.3127				(1)2.2378. (2)8.3881. (3) 0. (4) 20.9979. (5) 0.6147
Scenario 12					12.1878				(1)2.2378. (2)8.3881. (3) 0. (4) 20.9979. (5) 0.6147
Scenario 13	6,439.1465					375.0089	233,483		(1)2.2378. (2)8.3881. (3) 0. (4) 20.9979. (5) 0.6147
Scenario 14	4,599.3904						168,135	17.8129	(1)2.2378. (2)8.3881. (3) 0. (4) 20.9979. (5) 0.6147
Scenario 15					23.4831				(1)2.2378. (2)8.3881. (3) 0. (4) 20.9979. (5) 0.6147
Scenario 16					23.4831				unknown

= Group A, = Group B, and = Group C

F6.1.1 Summary Result: Outputs for Case Studies I (Smaller Area)

Output	Potential Methane Generation (Nm^3 CH_4)	APC Residue (ton)	Bottom Ash (ton)	Lower Heating Value (GJ)	Compost (ton)	Digestate (ton)	Energy in Biogas (MJ)	Composted Digestate (ton)	Products(ton) for (1) glass, (2) cardboard, (3) plastic non bottle, (4) plastic bottle. (5) aluminum product
Scenario 1	3303.94								
Scenario 2	3303.94								
Scenario 3	3303.94								
Scenario 4		0.711	4.1407	0.3251					
Scenario 5		0.711	3.902	0.3251					
Scenario 6		0.0653	0.7856	0.254	3.3549				
Scenario 7		0.0653	0.7856	0.254	3.9649				
Scenario 8	2094.772	0.0653	0.7856	0.254		121.9972	75956.4334		
Scenario 9	1496.2657	0.0653	0.7856	0.254			54697.4899	5.7949	
Scenario 10		0.0653	0.7856	0.254	7.6248				
Scenario 11					3.3549				(1)0. (2)2.4935. (3) 1.6308. (4) 4.571. (5) 0.1783
Scenario 12					3.9649				(1)0. (2)2.4935. (3) 1.6308. (4) 4.571. (5) 0.1783
Scenario 13	2094.772					121.9972	75,956.4334		((1)0. (2)2.4935. (3) 1.6308. (4) 4.571. (5) 0.1783
Scenario 14	1,496.2657						54,697.4899	5.7949	(1)0. (2)2.4935. (3) 1.6308. (4) 4.571. (5) 0.1783
Scenario 15					7.6248				(1(1)0. (2)2.4935. (3) 1.6308. (4) 4.571. (5) 0.1783
Scenario 16					7.6248				unknown

= Group A, = Group B, and = Group C

Appendix G – Sub-Module 4-1 Bin Capacity for Drop-Off System

Appendix G Sub-Module 4-1 Bin Capacity for Drop-Off System

G1. Bins Calculation Template

Note: Y = user-defined; Z =appear accordingly

Calculation of Total Generated Waste Amount (kg)						
Waste Type		Waste Amount (kg/day)	Accumulation of Collection Day (days)		Total Waste Amount (TWA) (in kg)	
			weekday	weekend	weekday	weekend
SA	UnsortedWaste	Material Flow Group A	Y	Y	Z	Z
SB	Compostable	Material Flow Group C	Y	Y	Z	Z
	Reyclables		Y	Y	Z	Z
	Residuals		Y	Y	Z	Z

The stored waste amount per collection points				
Waste Type		Number of Temporary Collection Points (TCP)	Total Waste Amount per Collection Point TWATCP (in kg)	
			weekday	weekend
SA	UnsortedWaste	Y	Z	Z
SB	Compostable	Y	Z	Z
	Reyclables	Y	Z	Z
	Residuals	Y	Z	Z

the requirement of bins size							
Waste Type		Waste Density (WD) (in kg/m³)	Waste Volume (l)		Safety Factor (SF) (%)	Total Waste Amount per Collection Point	
			weekday	weekend		weekday	weekend
SA	UnsortedWaste	190	Z	Z	40%	Z	Z
SB	compostable	250	Z	Z	40%	Z	Z
	reyclables	55	Z	Z	40%	Z	Z
	residuals	90	Z	Z	40%	Z	Z

Number of Bins based-on the Bin Types						
Waste Type		Bin Type (n)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	Unsorted waste	Z	Z	Z	Z	Z
SB	Compostable	Z	Z	Z	Z	Z
	Reyclables	Z	Z	Z	Z	Z
	Residuals	Z	Z	Z	Z	Z

Alternative Bin Variations				
WasteType		Bin Types	Capacity	Total Bins
SB	Compostable	Y	Y	Z
	Reyclables	Y	Y	Z
	Residuals	Y	Y	Z

G2. Detail Result: waste bin calculation

G2.1 Case Study I (Bigger area)

calculation of total generated waste amount (kg)						
Waste Type		waste amount (kg/day)	Accumulation of collection day (days)		total waste amount (TWA) (in kg)	
			weekday	weekend	weekday	weekend
SA	unsorted waste	378.45	2	3	756.90	1.135.36
SB	compostable	256.85	2	3	513.70	770.55
	reyclable	96.38	2	3	192.77	289.15
	residual	25.12	2	3	50.41	75.62

The stored waste amount per collection points				
Waste Type		number of temporary collection points (TCP)	total waste amount per collection point TWATCP (in kg)	
			weekday	weekend
SA	unsorted waste	12	63.08	94.61
SB	compostable	12	42.81	64.21
	reyclable	12	16.06	24.10
	residual	12	4.20	6.38

the requirement of bins size							
Waste Type		waste density WD (in kg/m³)	waste volume (l)		safety factor (SF)	required bins size (l)	
			weekday	weekend		weekday	weekend
SA	unsorted waste	190	331.98	497.96	40%	553.29	829.94
SB	compostable	250	171.23	256.85	40%	285.39	428.08
	reyclable	55	292.07	438.11	40%	486.79	730.18
	residual	90	46.68	70.02	40%	77.79	116.69

number of bins based on the bins type						
Waste Type		Bins type (B)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	unsorted waste	0.75	1.26	2.31	3.46	6.92
SB	compostable	0.39	0.65	1.19	1.78	3.57
	reyclable	0.66	1.11	2.03	3.04	6.08
	residual	0.11	0.18	0.32	0.49	0.97

Alternative bins variation				
Waste Type		Bins type	Capacity	Total bins
SB	compostable	D	240	1.78
	reyclable	C	360	2.03
	residual	E	120	0.97

Note: Y = user-defined; Z =appear accordingly

G2.1 Case Study I (Bigger area)

calculation of total generated waste amount (kg)						
Waste Type		waste amount (kg/day)	Accumulation of collection day (days)		total waste amount (TWA) (in kg)	
			weekday	weekend	weekday	weekend
SA	unsorted waste	119.34	2	3	238.68	358.03
SB	compostable	83.56	2	3	167.12	250.68
	reyclable	26.68	2	3	53.37	80.05
	residual	9.07	2	3	18.14	27.21

The stored waste amount per collection points				
Waste Type		number of temporary collection points (TCP)	total waste amount per collection point TWATCP (in kg)	
			weekday	weekend
SA	unsorted waste	2	119.34	179.01
SB	compostable	2	83.56	125.34
	reyclable	2	26.68	40.03
	residual	2	9.07	13.60

the requirement of bins size							
Waste Type		waste density WD (in kg/m³)	waste volume (l)		safety factor (SF)	required bins size (l)	
			weekday	weekend		weekday	weekend
SA	unsorted waste	190	628.12	942.18	40%	1.046.86	1.570.30
SB	compostable	250	334.25	501.37	40%	557.08	835.62
	reyclable	55	485.18	727.77	40%	808.63	1.212.95
	residual	90	100.76	151.14	40%	167.94	251.90

number of bins based on the bins type						
Waste Type		Bins type (B)				
		A (1100 l)	B (660 l)	C (360 l)	D (240 l)	E (120 l)
SA	unsorted waste	1.43	2.38	4.36	6.54	13.09
SB	compostable	0.76	1.27	2.32	3.48	6.96
	reyclable	1.10	1.84	3.37	5.05	10.11
	residual	0.23	0.38	0.70	1.05	2.10

Alternative bins variation				
WasteType		Bins type	Capacity	total bins
	compostable	D	240	3.48
	reyclable	C	360	3.37
SB	residual	E	120	2.10

Note: Y = user-defined; Z =appear accordingly