Advanced Waste Separation-Based System for a Better Solid Waste Management in Developing Country: Case of Padang City, Indonesia

（途上国における都市固形廃棄物のより良いマネージメントに向けた先進的分別システム：インドネシア　パダンの場合）

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ABBREVIATIONS

SW	Solid Waste
SEM	Structural Equation Modeling
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
FUN	Fund Utilization Nurture
SWOT	Strength Weakness Opportunity Threat
MFA	Material Flow Analysis
LCA	Life Cycle Assessment
FFA	Financial Feasibility Analysis
E-LCA	Environmental Life Cycle Assessment
S-LCA	Social Life Cycle Assessment
O&M	Operation and Maintenance
MoCSM	Ministry of Cooperative, Small and Medium Enterprises
3R	Reduce Reuse Recycle
GPS	Global Positioning System
MSW	Municipal Solid Waste
CDM	Clean Development Mechanism
BSM	Bank Sampah Malang
BSBM	Bank Sampah Bina Mandiri
EPR	Extended Producer Responsibility
TPB	Theory of Planned Behavior
TRA	Theory of Reason
SPSS	Statistical Package of Social
AMOS	Analysis of Moment Structures
MFCA	Material Flow Cost Accounting
CFI	Comparative Fit Index
GFI	Goodness of Fix Index
AGFI	Adjusted Goodness of Fit Index
SRMR	Standardized Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
PCLOSE	p of Close Fit
CR	Composite Reliability

AVE	Average Variance Extracted
MSV	Maximum Shared Variance
ASV	Average Shared Variance
PVC	Polyvinyl Chloride
MEA	Metropolitan Electricity Authority
NPV	Net Present Value
IRR	Internal Rate of Return
AE	Annual Equivalent
B/C	Benefit-Cost Ratio
WEEE	Waste Electrical and Electronic Equipment
WTE	Waste-to-Energy
IDR	Indonesian Rupiah
WCC	Waste Credit Card
MCF	Micro Credit Finance
TDS	Temporary Dump Site

ABSTRACT

Waste separation system which has been relatively successful in developed countries is expected to be the solution for municipal solid waste's problems in Padang city, Indonesia. The changing paradigm from waste dumping into waste recycling has been already ruled by the Indonesia's Ministry of Environment regulation number 18 since 2008 for Indonesian citizens. However, the existing solid waste (SW) bank (a system for waste separation implementation in Indonesia) is claimed to be ineffective proved by the low percentage of waste that can be treated by it. This study aims to understand the social condition toward citizens' environmental behavior which brings to the conclusion of readiness of Padang citizen for plan of waste separation-based system application in the future and propose a new system that is appropriate for Padang city's social condition. The study conducted structural equation modeling (SEM) (including exploratory factor analysis (EFA) and confirmatory factor analysis (CFA)) and a scoring system of social evaluation by surveying 609 residents. This study showed that Padang citizens are not completely ready for the plan of modification of the solid waste management system and that the city needs to improve citizens' pro-environmental behavior. This study proposes the waste FUN system (improved system of existing SW bank) as a solution to improve the level of readiness of the citizens that has a high potential for application in Indonesia and other developing countries with similar social conditions.

The sustainability and feasibility of the waste FUN system then be assessed on three aspects (social, environmental, and economic) by strength, weakness, opportunity, threat (SWOT) analysis, material flow analysis (MFA), life cycle assessment (LCA), and financial feasibility analysis (FFA) methods. Those methods found that the waste FUN system is feasible to do considering by advantages given to society, environment and economy.

Furthermore, in order to see deeper about the sustainability and feasibility level of the waste FUN system, comparison study was conducted in this study which compared performance of the waste FUN system with current waste management system and other potential waste management system in Padang city. The other potential waste management system is incineration-based system called city-corporate incineration system. That is a system involving cooperation of local government and the most influential company in Padang city with the concept of a mutually beneficial between the company and the city. The framework is arranged based on prior study of Ulhasanah and Goto (2012) which utilizes the existence of the largest cement company in Padang city toward its limited availability of raw material, high operating cost, high energy consumption, and bad emission factor. Based on the results of prior study, the city-corporate incineration system has high potency to solve MSW management problems of Padang city as well as get benefits from energy and ash produced by waste incineration. Social life cycle assessment (S-LCA), environmental life cycle assessment (E-LCA), and financial feasibility analysis (FFA) were employed to evaluate the performance of those three scenarios (scenario 1 is baseline scenario (current waste management system), scenario 2 is the waste FUN system, and scenario 3 is city-corporate incineration system).

The results showed that scenario 2 has the best performance which got the most feasibility for implementation in every evaluation steps. The best scenario chosen could give innovative ideas, and diverse information to establish a better MSW management system in cities of developing countries with similar socio-enviro-economic circumstances. Because of dissimilarity condition and needs between developed countries and developing countries, the research plot or methodology of this study may give great contribution and stimulate further research for establishment of a sustainable MSW management in developing countries.

CHAPTER 1
INTRODUCTION

1.1 Background

Rapid Population growth in developing countries because of the dual effects of high birth rates and young population has accounted for 97% of the growth of world population (7.06 billion in mid-2012). On the contrary, population growth in developed countries is decreasing because the annual number of births barely exceeds deaths by the low birth rates and much older populations (Haub, 2012). This condition presents a serious challenge for the solid waste management in developing countries. The growth turns out in rising of quantity and complexity of the generated solid wastes and overburdens (Khatib, 2011). The challenge is exacerbated by poorly managed municipal solid waste (MSW) in developing countries where the waste is often disposed in un-regulated dumps or openly burned which can create serious health, safety, and environmental consequences (The World Bank, 1999). Consequently, the developing countries do not have choice but to plan for integrated sustainable waste management system earnestly with active participation of several stakeholders.

The eagerness to manage waste properly remains a challenge for many developing countries because of the expensiveness of management cost of good design of waste management system which requires integrated, efficient, sustainable, and social supported system (spends about 20-50% of municipal budgets) (The World Bank, 2017). MSW incineration commonly adopted by developed countries seems to have attractive feature of reducing the original volume of combustibles by 80 to 95 percent which lead to the reduction of landfill space usage. The system may be a beneficial when a landfill cannot be sited because of a lack of suitable sites or long haulage distances resulting in high cost. Furthermore, incineration provides the best way to eliminate methane gas emissions from waste management process for reduction of greenhouse gas emission. Nevertheless, an incineration plant demands heavy investments and high operating costs throughout its operation, suitable composition and availability of waste supply, good pollution controlled equipment, skilled staff, controlled and well-operated landfills which make this method questionable for implementation in developing countries (The World Bank, 1999).

Waste recycling as another option for waste management method is more popular in developing countries with the concept of solid waste (SW) bank system. In recent years, SW bank has been recognized among local authorities taking the cooperation of community into account organized by community-based SW institutions. The system is claimed to able to provide economic opportunities for poor families to generate supplementary income to meet their basic needs and stimulate solid waste management in the aspects of source segregation, recovery of recyclable materials, and storage waste management prior to the collection (Singhirunnusorn et al., 2012). However, in the developing countries, waste recycling methods still face some challenge because many programs have only existed as pilot programs and not been applied in large scales (Charuvichaipong and Sajor, 2006; Tadesse, 2009; Zhang, Che, Yang, Ren, and Tai, 2012). The successful application of waste recycling by separation at the source in developed countries prompted the decision-makers in developing countries to replicate the method without paying particular attention to the cost, required skills, education, and technical expertise. They repeat the same learning process that the developed countries experienced and make same mistake as the others before them made (Sheate and Partidário, 2010; Ward et al., 2009).

Previously, the focus of assessment of a waste facility was on technical aspects such as the mass flow, but the information about the application related to the performance of the project was not provided. It is generally agreed that integrated solid waste management goes beyond technical and environmental aspects (UNEP and CalRecovery, 2005). Various environmental problems are caused by human behavior and can be mitigated by changing the behavior. Behavior change can be categorized by physical and technical innovation because people need to accept, understand, and use those innovations properly (Winter and Koger, 2004; Gardner and Stern, 2002; Midden, Kaiser and McCalley, 2007; Steg and Vlek, 2009; Vlek and Steg, 2007).

Indonesia, a country located in Southeast Asia with a total population of more than 250 million people in 2016 applies the conventional method of municipal solid waste (MSW) management based on collect-transport-dispose system (Damanhuri et al., 2014). However, mismanagement of municipal solid waste leads to widespread problems in many cities in Indonesia including Padang. Since 2008, the government regulation UU No. 18/2008 stating that MSW should be managed by reduction and handling was published, but unfortunately has not been fully implemented (Ministry of Environment, 2008). The local government of Padang, which has the "open dumping" system (all waste is mixed) looks for solutions to the city`s waste problems (Dinas Perhubungan Komunikasi dan Informatika Kota Padang, 2014). Some parts of Padang have already changed the solid waste management system into a separation-based system but in reality, the citizens do not follow the rules and regulations, they do not understand how the waste separation really works. Furthermore, previous research on the solid waste management system in Padang and other cities in Indonesia examined the social aspects of waste management limited to the discussion on community participation (Aprilia et al., 2012; Zurbrugg et al., 2012; Sasaki et al., 2014; Darwin et al., 2006; Prianto R.A., 2011; Mulyadi et al., 2010; Soma S., 2005; Irman, 2005; Syahruddin H., 2016), however, there has been no discussion on direct or indirect effects of the indicators of human behavior related to the waste management system; limiting the understanding of why the projects have been failing.

1.2 Objectives

Several steps of objectives are needed to get the final goal of this study which is to achieve an integrated sustainable system for a better municipal solid waste management in Padang city, Indonesia. Those objectives of this study are:

1. To investigate the social condition of Padang citizen related to MSW management system;

   - Determine factors affecting the citizens' behavior against the MSW management system by using structural equation modeling (SEM) method,
   - Assess the human behavior of Padang citizens by scoring the answers of

questionnaires,

- Define the readiness of Padang citizens for the plan of modification of MSW management system from a mixed-based system into a separation-based system by combining the results of SEM and the assessment of scoring of answers of the questionnaires in order to reveal the answer of question: "Would the waste separation method which is successful implementation in developed countries be also successful in developing country such as Indonesia in the present state?"

2. To design a new system (integrated framework) as well as detail workflow of the system based on the results of the first objective which will be a proposed system of this study;

3. To evaluate potency of the proposed system by socio-enviro-economic evaluation using strengths, weaknesses, opportunities and threats (SWOT) analysis method, material flow analysis (MFA) and life cycle assessment (LCA) method, and financial feasibility assessment (FFA) method, respectively.

4. To compare the performance of proposed system with 2 other systems which are baseline system and other potential system in Padang city (incineration-based system) by socio-enviro-economic evaluation using social life cycle assessment (S-LCA) method, environmental life cycle assessment (E-LCA) method, and financial feasibility assessment (FFA) method, respectively;

5. To select the best system of three scenarios based on the results of fourth objective.

1.3 Scope

This study takes Padang city, Indonesia as a case study area for the primary data collection with the additional information and data from several developing countries. The data and information consist of social, environmental, and economic conditions` of municipal solid waste management system.

CHAPTER 2
OVERVIEW OF WASTE MANAGEMENT IN DEVELOPING COUNTRIES AND INDONESIA

2.1 Waste Management in Developing Countries

The fact of waste management in most places of developing world equals no separation and no controlled collection. The citizens are fine when the wastes are dumped next to the street outside the village ignoring the terrible odor, like ancestors always did. The method has been around for centuries and it worked very well until recently: Self-sufficient agricultural societies traditionally took all their goods from nature. Because those goods were 100% biodegradable, nothing happened when they were dumped – they simply returned to nature. However, when 20th century inventions were inputted into this system, the problems began. The inventions such as plastic packaging, oil containers, tires, batteries, electronics, and etc. impede the cycle from continuing to function the way it used to, interfere with nature absorption capacity. Because those things are formed by artificial production cycles, artificial treatments at the end of their lifespans are also required. Nevertheless, even as fast as these "new" products conquer new markets, the awareness of the need for a change in waste management is inversely slow (Buhner, 2012).

In collaboration with external support bodies, a lot of solid waste management projects have been performed in developing countries in the last 20 years. Under the auspices from external bodies, some projects were successful in the improvement of solid waste management in developing countries by producing lasting positive impacts. Nevertheless, the successful projects started to face big problems when the external bodies cease their support such as the projects could not support themselves or broaden further. Factors that contribute to the flop to sustain the projects are technical, financial, institutional, economic, and social factors, then they vary from each project (Ogawa, 1995).

The receiver countries and cities tend to accept whatever resources are given to them without any deliberation to subsequent resource requirements. The external support bodies often do not fully understand socio-economic, cultural, and political factors influencing the selection of appropriate solid waste management systems. The external support bodies have limitations in the amount of resources they can provide and the mandates and modes under which they can operate projects. Sometimes, projects are initiated with specific aims and expected outputs, but their scopes are not comprehensive enough to consider external factors influencing them. In other cases, very limited follow-up support, including human resource development activities necessary to sustain the project implementation, is provided by the external support agencies (Ogawa, 1995).

2.1.1. Developing Countries' Problems and Constraints

The problems of waste management system in developing countries are typically related to low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control, the breeding of flies and vermin, and the handling and control of informal waste picking or scavenging activities. Those problems restrain the development of effective solid waste management system which can be categorized into technical, financial, institutional, economic, and social constraints (Ogawa, 1995).

- Technical Constraints

  The first substantial constraint related to technical aspect is the lack of skilled human resources related to solid waste management planning and operation at both the national and local levels. A project initiated by external consultants could not be continued without adequately trained personnel. Therefore, in order to achieve the sustainable collaborative project, the human resources development in the recipient country of external support is crucial. Another technical constraint in developing countries is the lack of overall plans for integrated solid waste management at the local and national levels. Furthermore, a poor priority of research and development activities related to solid waste management leads to the selection of inappropriate technology in terms of climatic and physical conditions, financial and human resource capabilities, and social or cultural acceptability. Consequently, a solid waste technology is often selected without due consideration to its appropriateness in the whole solid waste management system. In addition, the technology selected can never be used, wasting the resources spent, and making the project unsustainable. Although the selection of solid waste management technology in developing countries sometimes could be made based on several guidelines or manuals that have been made in literatures, local studies are still needed to adjust the guidelines to the prevailing local conditions.

- Financial Constraints

  Funds provided to the solid waste management sector, the levels of services required for protection of public health and the environment by the governments in developing countries are not attained. These happen because solid waste management is given a very low priority compared to other sectors. This weak financial basis of local governments is solved out by the collection of user service charges. However, users' ability to pay for the services is very limited in poorer developing countries, and their willingness to pay for the services which are irregular and ineffective is not high either. Moreover, many local governments in developing countries lack good financial management and planning which cause quick depletion of the limited resources available for the sector, stagnancy of the solid waste management services for some periods, thus losing the trust of service users. An effective strategy for raising funds needs to be searched in any collaborative project to ensure its sustainability.

- Institutional Constraints

  In developing countries, the coordination of several agencies is a lack which results different agencies becoming the national counterpart to different external support agencies for different solid waste management collaborative projects without being aware of what other national agencies are doing. This leads to duplication of efforts, wasting of resources, and unsustainability of overall solid waste management programs. The second constraint in institutional term is effective legislation for solid waste management in developing countries which is usually fragmented and several laws include some clauses on rules/regulations. The effective legislation should be comprehensive to avoid duplication of responsibilities and gaps of important regulatory functions. Moreover, it should be noted that legislation enforcement is required for sustainable development of solid waste management systems. The third constraint is the weaknesses of institutional capacity of local government agencies because of a low priority given to the solid waste management sector particularly in small cities and towns. These weak local government institutions are not provided with clear mandates and sufficient resources to fulfill the mandates. In large metropolitan areas where there are more than one local government, coordination among the local governments is critical to achieve the most cost-effective alternatives for solid waste management in the area. Therefore, the lack of a coordinating body among the local governments often leads to disintegrated and unsustainable programs for solid waste management.

- Economic Condition Constraints

Developing countries, by definition, have weak economic bases and hence, insufficient funds for sustainable development of solid waste management systems, and local industries will produce relatively inexpensive solid waste equipment and vehicles. Also in small developing countries, waste recycling activities are affected by the availability of industry to receive and process recycled materials. For instance, the recycling of waste paper is possible only when there is a paper mill within a distance for which the transportation of waste paper is economical. Therefore, the economic conditions of developing countries and the industries which play key roles in solid waste management cannot provide a more sustainable financial basis.

- Social Constraints

The first constraint of solid waste management in social term is related to the lowness of social status of workers who work in solid waste management sector because of negative perception of people regarding the work which involves the handling of waste or unwanted material. The lowness of social status happens in both developed and developing countries but more so in developing countries. The perception heads to the disrespect for the work and in turn produces low working ethics of laborers and poor quality of their work. The second constraint is insufficient resources availability in the government sector which bring to attempt of collaboration projects to mobilize community resources and develop community self-help activities and resulting in a mixture of success and failures. The lack of public awareness and school education about the importance of proper solid waste management for health and well-being of people severely restricts the use of community-based approaches in developing countries. The third constraint is the existence of unwell organized waste pickers/scavengers at dump sites, transfer stations, and street refuse bins which creates often an obstacle to the operation of solid waste collection and disposal services. The existence of scavengers is affected by limited employment opportunity available in the formal sector where they have not received school education and vocational training to obtain knowledge and skills required for other jobs. However, if organized properly, their activities can be effectively incorporated into a waste recycling system.

2.1.2. External Support's Constraints

The constraints of external support term related to solid waste management in developing countries can be divided into technical, financial, institutional, economic, and social constraints like below (Ogawa, 1995):

- Constraint in Technical Sector

  Developed/industrialized countries which become external supporter to developing countries usually have technical expertise and human resources suitable for solid waste management in these countries through their schools and university education and subsequent on-the-job training. However, Opportunities to learn solid waste management problems and practices in developing countries through regular training programs and seminars are rarely provided in industrialized countries. Therefore, the lack of knowledge and experience in solid waste management situations in developing countries leads to a tendency to support and provide the technologies available in the donor country regardless of their applicability to the developing country situation. The second constraint is communication difficulties between consultants provided by external supporter and the local counterparts in developing countries which usually occurs in term of spoken language barrier and technical understanding/skills. While the third constraint is related to the lack of an overall plan for solid waste management by external supporter which heads to leads to a not cost-effective solid waste management system. A piece-meal approaches by external support agencies often result in unsustainable solid waste management projects.

- Constraint in Financial Sector

  The own upper limit of financial support and the lowness of priority on solid waste management sector from external agencies result in a restricted amount of funds that can be allocated to the sector. Furthermore, the condition of solid waste management that cannot easily generate revenues and be aggravated by the poorness of willingness and ability to pay for solid waste management services make external lending agencies being apprehensive on providing a loan to such a project because of the high risk potency. But even so, the high risk of loan projects can be lessened by building into the projects revenue raising systems (e.g., user charges, sales of recycled materials).

- Constraint in Institutional Sector

  The limitation of external support agencies toward their activities to certain operations such technical cooperation, loan/lending of capital funds, training, and so on is caused by their own organizational mandates circumstances. The extent of their geographical coverage is also limited to certain countries for their support. These organizational mandates and operational coverage of external support agencies determine the levels and types of resources provided to solid waste management projects in developing countries. Thereunto, the piece-meal support for solid waste management is exacerbated by the poor coordination among various external support agencies to complement each other’s efforts. Therefore, better communication and coordination among them must be improved in order to establish the sustainability of solid waste management projects in recipient countries.

- Constraint in Economic Sector

  Although the economic situation of one donor country is not so critical for the sustainability of solid waste management projects, but it is still a determinant to the amount of funds that can be allocated for foreign aid to developing countries that influences the levels of resources provided to solid waste collaborative projects. In another hand, External support agencies in industrialized countries tend to promote solid waste management technologies developed in their countries and use consultants from their countries. However, Often, the appropriateness of a technology to be used in a developing country is not fully assessed, and the technology is adopted based on the norm and experience of the donor country.

- Constraint in Social Sector

  There are social or cultural norms accepted only by the society in both developed and developing countries which effect the designs of solid waste management systems where the society allows only a certain social class or group to deal with solid waste, the availability of work force for solid waste collection and disposal becomes constrained by this rule. Handling human waste is a traditional taboo in some countries, which then prohibits the application of co-composting of refuse and human waste. The lack of understanding of local cultures and ways of life by the external support agency is often a cause of failure of a collaborative project. Furthermore, the language-related communication problem, the lack of decent attitude and experience of external consultants in working with officials of developing countries results in unnecessary tension between the consultants and local counterpart.

2.1.3. Strategies for Great Collaboration

Removing or loosening any of those constraints is not easy or simple move, even some constraints are harder to remove than others. A mix of some of the following measures or approaches may lead to a successful outcome (Ogawa, 1995).

- Combining Support from Several External Supporter

  The condition of external supporters' approaches that solve the solid waste management problems in peace-meal and not well coordinated, provide the support mostly on a short-term basis cannot be easily changed because These characteristics of external supports are inherent in the organizational mandates and operational modes of the external support agency. Nevertheless, we can make a problem solving strategy by combining support from different international aid agencies to make a collaborative project more comprehensive and long-term/continuous. This requires better coordination and communication among the external support agencies and development of partnership among them, removing the organizational egos and sharing and contributing their resources to the benefits of the recipient country. The collaborative project should be designed to improve the solid waste management situation gradually over a long period, instead of attempting a quick fix.

- Defining Clear Roles of Relevant Agencies in Developing Countries

  In order to ensure effective institutional support for a collaborative project for solid waste management, the roles and responsibilities of the various agencies involved should be defined clearly and a coordination mechanism be established. This can be done without drafting new legislation or amending the existing one, which is normally a time-consuming exercise in any country. A working group involving officials from the various agencies can be set up to discuss initially the roles and responsibilities of their respective agencies, and the working group can be later upgraded to an administrative committee or task force.

- Developing the Human Resources

  Human resource development must always be part of the external support package to achieve sustainable solid waste management in developing countries. To develop human resources with technical expertise in solid waste management in developing countries, there are three strategically important groups for external support, namely (i) key personnel in the national coordinating unit of the central government; (ii) operational managers of selected local governments; and (iii) universities and other higher educational institutions. Among these target groups, the strengthening of human resources in the national coordinating unit and one or two selected local governments is the first priority and should be done in short term while support to higher educational institutions is a long-term program. In addition, the donor countries should also improve their human resources in terms of their communication ability and knowledge of solid waste situation in developing countries.

- Supporting Strategic Planning and Follow-up Implementation

  The operation of such technical assistance is often separated from that of the provision of loans and grants for facilities and equipment. As a result, the follow-up action to the planning assistance (i.e., provision of grants and loans for facilities and equipment) is delayed or not given at all. Consequently, there are many plans produced, but they have not been implemented. For the sustainability of a solid waste collaborative project, it is crucial to provide external support to follow up on the implementation of the plan prepared. Here again, the approach of packaging external support can play a key role.

- Developing Self-financing Schemes

  Limited fund that developing countries have for solid waste management make the governments need to turn their solid waste management system into a more self-financing systems. External support can be effectively used to develop different alternative cost-cutting, cost-recovering, and revenue-raising schemes (e.g., waste minimization, deposit-refund system for recyclable materials, import or sales tax on certain packaged products, collection of user service charges, etc.) and implement pilot studies on these economic incentive measures. Moreover, private sector participation in solid waste management collection and disposal services is also a way to reduce the financial burden of the government which can draw not only investment finance from private companies for solid waste management equipment and facilities, but also managerial expertise and technical skills. Based on the experiences, privately operated services are generally more cost-effective than public sector services. Therefore, the use of private sector resources through a contractual arrangement provides a potential alternative towards self-financing solid waste management. Effective application of economic incentive measures and private sector resources in solid waste management requires human resources to design and manage such schemes. Aside from human resources development in technical aspects of solid waste management, human resource development in financial planning and management is necessary and often a key to the development of more self-financing schemes.

- Raising Awareness of the Public and Decision Makers

  Enhanced awareness of decision makers may lead to changing national socio-economic and industrial development policies and associated government programs in favor of improving solid waste management systems in developing countries. For instance, more financial aid and tax incentives may be introduced to encourage the development of recycling industry and business, or labors protection programs may be provided to improve wages and working conditions of laborers, including solid waste management workers. Changing national policies in donor countries could also improve ways in which their technologies are transferred to recipient countries.

2.2 Waste Management in Indonesia

The world`s second biggest contributor to plastic waste in ocean after China is carried by Indonesia which is in a state of emergency waste problems. The trash disposal sites are struggling to cope with tens of millions of tons of waste every year. As of 2015, an average person in Indonesia produces 0.7 kilogram of waste per day. With 250 million people, a staggering 175,000 tons of waste is produced each day, amounting to 64 million tons per year, according to data from the ministry. This waste is mostly dumped into landfill. Indonesia has more than 200 landfills but most of them are not good (only 10% of total number of sites conduct with sanitary landfill technologies). These landfills are struggling to cope with the ever-increasing waste as the population grows and people consume more and more (Jong, 2015).

Landfills in Indonesia were almost originally designed as controlled landfills, even some of them were sanitary landfills. However, in the realization, they were operated as “controlled-dumps” or even only “open dumps”. That is because there is no operation and maintenance (O&M) practice such as: no treatment carried out o incoming waste; irregular soil cover applications; many scavengers pick the waste on site, inadequate leachate treatment; and insufficient gas emission treatment. Furtehrmore, most of the landfills were located in coastal area which was potentially pollute the water course. Regarding the soil cover implementation, the purchase of soil cover materials takes a long time after the dickering process which cause the irregularly cover application to the landfills. Moreover, the worst case (soil cover application) was conducted after the landfill was finished. In connection with scavengers, all areas of lanfills were occupied by them eventhough the waste picking is not officially permissible at landfills. There are about 1.2 million scavengers nationally in 2008, where in Jakarta alone, the Ministry of Cooperative, Small and Medium Enterprises (MoCSM) estimates five to six thousand of them are living and working on the area of Bantar Gebang landfill (Munawar and Fellner, 2013)

If we take sample case in city of South Tangerang, a 147 km^2 city with 1.4 million populations, is lacking an adequate number of temporary dump sites. Many of the existing temporary dump sites are not functioning properly, forcing a large number of residents to burn their trash and suffer the negative effects of air pollution. The municipality's final trash disposal site, the 2.5 hectare Cipeucang site, runs out of space at the end of 2016 which can process only 30 percent of its total daily waste production at the moment. Another site is the country's largest dumpsite, Bantar Gebang landfill (in Jakarta city), where Jakarta residents dump 6,700 tons of solid waste per day. When the landfill started operating in 1989, it was designed to use sanitary landfill technologies, however in practice, it is merely an open dumping site that has generated environmental problems such as air pollution, odor and groundwater pollution in surrounding areas (Jong, 2015).

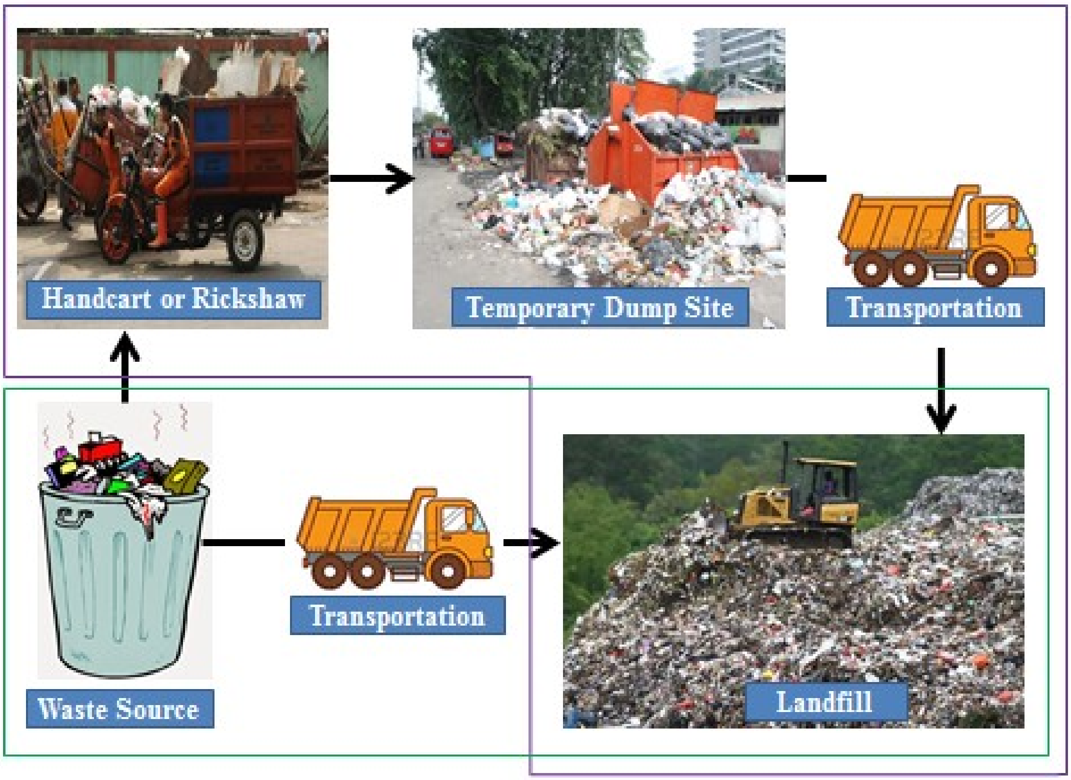
Realizing that relying on landfills would only exacerbate waste problems, the government has tried to introduce the public to the concept of “3R” (reduce, reuse and recycle) through the country’s first solid waste management law in 2008 (the government regulation “UU No. 18/2008”). However, implementation of the regulation has failed to catch on in the country. The recycling percentage in metropolitan cities makes up into 7.5% but the figure dips to 1.9 percent all across Indonesia (Jong, 2015).

In order to promote the concept of recycling, the government plans to improve the current bank sampah (waste bank) system, first introduced in 2011, to reduce the volume of waste at the household level. Under the system, residents would save their non-organic waste and deposit it. They weigh and record their trash deposits, which are later sold to trash collectors every month. The proceeds are then transferred to the customers' accounts. The system which is accessible through android-based smart phone, would help people deposit their garbage and assist bank staff tasked with taking the garbage from them, as the application would be equipped with GPS technology (Jong, 2015).

2.2.1. Waste Collection Scheme in Indonesia

Collection process of waste in Indonesia starts at the source of waste where the waste is stored in mix-waste condition, in various types of containers, and collected three times a week until every day. Compactor vehicles, dump trucks, open trucks, arm roll trucks, and handcarts/waste rickshaws are several varieties of vehicles used for the waste transportation from waste source to temporary dump site or final landfill. Handcarts and rickshaws are employed in indirect waste transportation of the first stage where the waste is not directly taken from each source to the final landfill, but it is first brought to temporary dump site. Then the second stage, the waste is transported by open trucks, open trucks, or compactor trucks to final landfill. Meanwhile, other system of waste transportation in Indonesia is direct transportation system where the waste is picked up by open truck, dump truck, or compactor vehicles to final landfill directly (Kardono, 2007).

The selection of direct or indirect system of waste transportation is determined by the waste source location. When the waste source is located beside main road, the waste transportation system would be direct system because of the easy accessibility of truck to collect garbage. But when the waste source is located in the far place from main road, indirect system is adopted because usually the road will be narrow and difficult to be passed by big trucks, so that handcarts or other similar vehicles are needed to transport the waste from door to temporary dump site beside main road. Description of typical MSW collection scheme is given in **Figure 2.1.**



Source: Wicaksono, 2016; Antara, 2015; Ichsan, 2014

Note:
Direct Transportation System =
Indirect Transportation System =

Figure 2.1. MSW collection scheme in Indonesia.

Even though waste recycling and composting program in Indonesia was officially started in 1989, until now direct haul system of solid waste management from waste source to final disposal site without any intermediate treatment is the general practice done in Indonesia. However lately, some local governments are facing some problems related to getting suitable land for waste disposal as land is getting scarcity with its prohibitively expensive price (Kardono, 2007).

2.2.2. Waste Problems in Indonesia

In general, there are five constraints that create difficult circumstances for Indonesia to establish good waste management system, they are:

- High Waste Generation

  The increasing of waste generation of Indonesia which is estimated around 2-4 percent per year could be a threat for environmental health which effect tourism, economy, and social life if Indonesia cannot improve the waste management system.

- Low Quality Waste Management

  Standard of solid waste management and services in Indonesia are still in low level such as low waste service area, lack of collection and transportation, illegal dumping, waste burning, etc.

- Limited Final Disposal sites

  Due to the full capacity of most existing final disposal sites in Indonesia, especially in big cities, governments need to close the landfills and find other space to be new disposal sites. Unfortunately, it is difficult to find a new site for landfill replacement because of public restriction, land availability, and land price.

- Absence of Special Waste Management Institution

  A lot of problems occurred in solid waste management cause the government needs to make particular institution to handle the problems associated with implementation of waste reduction and control more seriously.

- Low Financial Allocation

  Waste management budget allocation in Indonesia is not the priority and very low amount that leads to improper suitable waste management.

2.2.3. New Law to Abolish Waste Dumping System

The Ministry of Environment of Indonesia does not know exact number of operated landfill in Indonesia. However, the ministry estimates that all districts and cities have at least one landfill. By the coordination with the local governments, the Ministry of Public Work has identified the number of operated landfill in Indonesia which is 378 with 1900 ha total area. The numbers found is hardly believed because of smaller number than the number of districts and municipalities (524 districts and municipalities). Furthermore, the study also discovered that there are 81% landfilss operated by open dump sites, 16% as controlled landfill, and 3% as sanitary landfills (Munawar and Fellner, 2013).

Before May 2008, Indonesia does not have specific regulation related to waste management at the national level. The waste management was operated just by ratifying the international frameworks on related wastes (i.e. Basel convention in 1993, Kyoto protocol in 2004) and local regulations. The regulation carried out by local governments could be different between regions depends on the needs. Therefore, national level's regulation is needed to achieve the optimum effectiveness of MSW management. The slow growth of waste management in Indonesia might be caused of the lack of a legal basis which effects budgeting greatly (Munawar and Fellner, 2013).

In 2008, a new law related to waste management has been established to close all non-biddable landfills within five years. The act number 18, year 2008 entirely involves all issues regarding waste management such as (Munawar and Fellner, 2013):

- principle of waste management and rights,
- the obligations of society related waste management,
- divided the responsibility between central and local governments, both in term of established policy and strategy, as well as the financial aspects,
- the central government has responsibility to establish the waste policy and strategy at national level, and develop cooperation between local governments,

- the local government can determine the waste policies at the local level with consideration to national waste policy,
- the local government also have responsibility to run waste management, to foster and manage the waste management implementation, and to control and evaluate it,
- the local government has to make plan for the closure of landfills which operate as open dumps immediately, and not later than five years after the Act was enacted,
- the local government has responsibility to monitor and evaluate closed open dumpsites every six months for 20 years closure,
- new landfills must be equipped with integrated processing facilities, where sorting, recycling and final waste processing takes place,
- the final waste disposal site must operate as a sanitary landfill and avoid methane emissions.

As mandated by the act, it is indicated that there are 305 new landfills areas which have to be replaced the open dumps within five years. In the middle 2012, the Minister of Public Work informed that there are only 94 new landfills completed, with 13 of them were built by foreign governments under the Clean Development Mechanism (CDM) framework. By the huge numbers of landfills that are still operated by open dumps state and the transition period of the Act No. 18 is soon to end, would the law enforcement of the Act No. 18 considered as failure? And for how long the remained open dumps landfills will change to be sanitary system? (Munawar and Fellner, 2013).

2.3 Solid Waste Bank Program in Indonesia

The SW bank program in Indonesia is a social engineering tool created by the Ministry of Environment in indonesia to spread the “reduce, reuse, and recycle” (3R) concept. The main activity is exchange of separated waste from citizens (members) for money, which can either be given as cash or recorded in a book, similar to conventional bank (Rahardjo et al., 2015). Current SW banks in Indonesia are organized by communities with support from local government (technical assistance, training, monitoring and evaluation).

The SW bank is one of many programs and campaigns on the reduction of waste transported to landfill through 3R activities since the introduction of the Act No. 18, year 2008. Generally, there are several recycling activities' types in Indonesia such as recycling by informal sectors (scavengers, recycle dealers, and recycle industries), composting activity at small SW treatment facilities, and SW bank by community-based organization. Among them, the SW bank program would stimulate direct participation of the citizens (Rahardjo et al., 2015). In addition to initiating this program, the Ministry of Environment also issued regulation *PermenLH No. 13/2012*, which rules the guidelines on reduce, reuse and recycle through SW bank. This regulation considers that current MSW management is yet to implement 3R concept and that the SW management needs a comprehensive and integrated implementation. Therefore, it would give economic benefits, increase public health, save the environment and change the community behavior (Ministry of Environment, 2012). The development of this program would give a real implementation of the Act No. 18/2008 to separate and to give economic value of waste and to improve the quality of life of communities. Therefore, the communities must be encouraged to participate in this program.

Statistic for February 2012 of the SW bank in Indonesia revealed that there were 471 SW banks with 47,125 depositors and 755,600 kg/month solid waste handled which generate a turnover of $147,000/month. Three months later, the number of SW bank increased to 886 with 84,623 depositors and 2,001,788 kg/month solid waste handled and generated a turnover of $283,000/month (Assistant Deputy of Waste Management Section, 2012). The leading cities in implementing the SW bank program are Malang and Surabaya, East Java (Assistant Deputy of Waste Management Section, 2012):

- Malang has Bank Sampah Malang (BSM) which services almost the entire city and handles almost 2,000 kg of waste per day;
- Surabaya has Bank Sampah Bina Mandiri (BSBM) with a turnover of around $10,000/month and 91 SW banks under its guidance

These numbers show that there is a serious concern of some stakeholders in Indonesia to maintain the present of SW banks among the community.

Furthermore, SW banks have also been emerging in Padang City since 2011, but the achievement is still relatively low (Rahardjo et al., 2015).

SW bank program is different from other informal sectors such as waste pickers, scavengers and itinerant buyers. SW bank program aims to disseminate 3R concept and train its citizens at the level of application. SW bank program is created for various level of society, waste separation at source as a habit and a sustainable society preparation. Whereas, the other informal sectors are only done by unemployed people, emerged just to get money, forced to sort SW at transfer station or landfill site. Therefore, both have different concept and purpose.

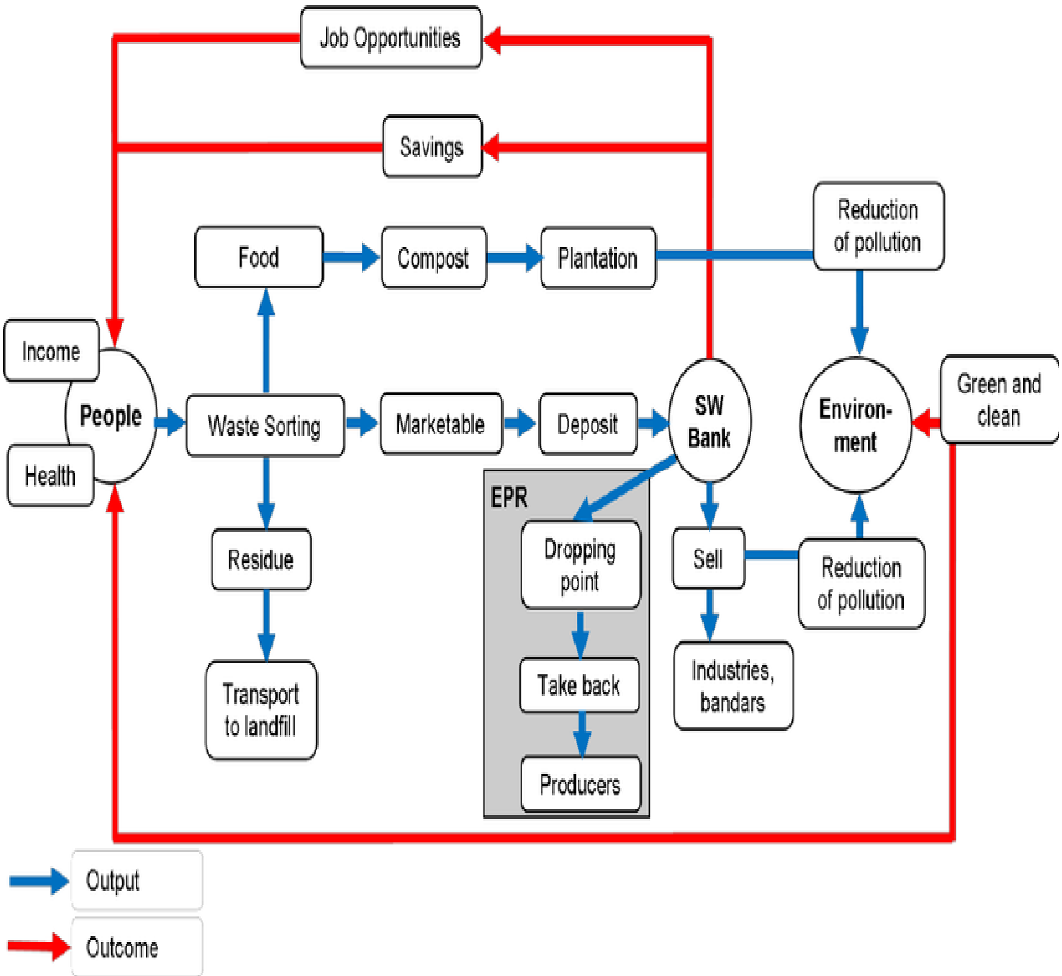


Figure 2.2. The Framework of Solid Waste Bank (Rahardjo et al., 2015).

However, the most developed activity in SW bank program is likely waste separation, collection and recycling which is possible to support local MSW management. SW bank is still being improved and is expected to develop a collective awareness among people (Rahardjo et al., 2015).

The framework of SW bank as displayed in **Figure 2.2** tells that people should sort their wastes at least in two main categories: compostable wastes (food, yard, etc.) and marketable wastes (paper, plastic, metal etc.) (Ministry of Public Work Indonesia, 2013). Types of marketable wastes that currently can be deposited to SW bank is displayed in **Figure 2.3.** SW bank can serve as a unit to help people deposit their marketable wastes by establishing cooperation with informal sectors such as recycle dealers or recycle industries. Working mechanism of SW bank as explained in the regulation includes waste separation, waste deposit, waste weighing, bookkeeping, bankbook recording of waste deposit sale and revenue sharing between depositor and SW bank. Revenue sharing is 85 % for depositor and 15 % for SW bank. Revenue sharing between depositor and SW bank means that a person who deposits SW into SW bank, would receive money as written in his/her bankbook. Extended Producer Responsibility (EPR) is another idea that SW bank could also serve as a dropping point for the producers to take back their post consumer products. Therefore, the government could share the MSW management responsibilities with the private sector. SW bank activity would give income and health to people and green and clean to the environment (Rahardjo et al., 2015).

Figure 2.3. Types of Marketable Waste in SW Bank of Padang City
(Rahardjo et al., 2015).

For Padang city, the first SW bank was established in 2010. Currently, there are 29 SW banks composed of 8 community SW banks and 21 educational institution SW banks. There is no difference in working mechanism between community SW bank and educational institution SW bank. The only difference is their depositors. They can process around 319 kg of waste per day. 12 SW banks were chosen for this study, are described below (Rahardjo et al., 2015):

1. Community SW bank

   There are 8 community SW banks, 3 of them were chosen for sampling which represented the urban, suburban and marginal area of the city.

2. University SW bank

   There are only 2 SW banks operated in University, 1 was selected.

3. Senior High School SW Bank

   There are only 3 senior high school SW banks, 2 of them were selected for this study. They represented urban and suburban area.

4. Junior High and Elementary School SW bank

   There are 8 SW banks of each junior high and elementary school. 3 of each category were selected for sampling. They represented urban, suburban and marginal area of the city.

CHAPTER 3
METHODOLOGY

One of the theories widely acknowledged by researchers in term of behavior-based research is theory of planned behavior (TPB) by Ajzen (1991) which is a revised and extended version of theory of reason action (TRA) by Ajzen and Fishbein (1980). They pointed out that individual`s behavior is not merely based on their will but also by factors such as attitudes toward behavior (personal attitude and individual conduct), subjective norms (influence of significant others; perceived social pressure), and perceived behavioral control.

In term of environmental behavior, several researchers found that people are more likely to recycle if they have concern in environment (Domina and Koch, 2002) but the individual behavior will undertake consistency if he or she has positive attitude toward environmental issues where family, friends, neighbors or colleagues may influence the positive environmental behaviors (Tucker, 1999); environmental concerns are outweighed by laziness or lack of interest in protecting the environment (Blake, 1999); the actions of neighbors can strongly influence recycling behavior among householders (Shaw, 2008); actions, attitudes and motivation of recycling are biased toward individuals rather than communities (Lyas et al., 2005); social, cultural and structural influence household waste recycling (Martin et al., 2006). Furthermore, in particular field of waste separation behavior, Zang et al (2015) have conducted research in case study of China which suggest that attitudes, subjective norms, perceived behavioral control, intentions, and situational factors significantly predicted household waste separation behaviors, Oztekin et al (2017) have distinguish the recycling behavior based on gender perspective, Stoeva and Alriksson (2017) revealed that attitude, subjective norm, perceived behavioral control, and satisfaction with local facilities influence the intention and behavior of inhabitants` participation in separation of household waste in Sweden and Bulgaria, and Plepiene et al. (2016) compared the recycling behavior of citizens between an early stage of development (Lithuania) and a more mature recycling scheme (Sweden). Based on those studies and typical condition in case study area, this study constructed two main hypotheses where the relationship between the factors is illustrated in the predictive model path diagram in **Figure 3.1**:

H1: There is a causal relationship between intention and behavior

H2: The intention score is determined by several factors, i.e., social norms, environmental awareness, environmental knowledge, government role, habit, and law enforcement

A survey was conducted with a select group of Padang citizens on the solid waste management system in Padang. The survey results were analyzed by SEM consisting of the exploratory factor analysis (EFA) using the statistical package for social sciences (SPSS 17.0) and confirmatory factor analysis (CFA) using the analysis of moment structure (AMOS 22). The responses to the questionnaires were also analyzed by a social evaluation method based on a predictive model to support the SEM model results and determine the readiness of Padang citizens for the plan of modification of the solid waste management system.

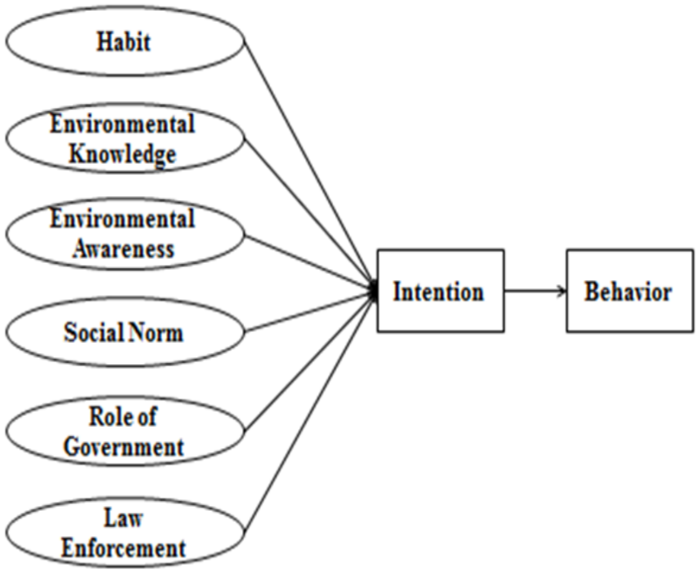


Figure 3.1. Predictive model path diagram.

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The results of SEM and social evaluation will reveal the level of citizens` readiness which can be a basic concept to create a better MSW management system. The new system is then evaluated by connected qualitative and quantitative method. The qualitative method was conducted to study the environmental behavior and social condition towards the new system application through investigation (questionnaires and interviews of the stakeholders) and observation (close observation on the new system). The quantitative method was carried out to calculate SW generation of Padang city to see the waste flow in the new system, analyze the environmental impacts potency of new system compare to current system, and evaluate the economic profitability potency of the new system application. Literature reviews, previous studies, primary and secondary data collections, data processing, and analysis have been done. Primary data includes the responses of interviews and questionnaires from stakeholders, meanwhile secondary data consists of results SEM and social evaluation of scoring system, SW generation, composition and recycling potency, environmental impacts potency, and economic profit potency. Strengths, weaknesses, opportunities and threats (SWOT) analysis, material flow analysis (MFA), life cycle assessment (LCA), and financial feasibility analysis (FFA) were employed to assess the sustainability performance of the new system for better waste management in Padang city.

In addition, in order to determine the best system among other systems which is also potential for Padang city, comparative study will be done by comparing the performances of three scenarios which are the baseline scenario (current system), the new system created (proposed system), and the other potential system (incineration-based system). The performances are assessed by socio-enviro-economic evaluation using social life cycle assessment (S-LCA), life cycle assessment or environmental life cycle assessment (LCA/E-LCA), and financial feasibility assessment (FFA), respectively. The best scenario is selected based on the most potential positive social impacts, the least potential environmental impacts, and the most feasible business financially.

3.1.Data Collection

Data for this study are obtained from questionnaire spreading to citizens of Padang city (primary data), direct investigation to cement company in Padang city (primary data), and other supported data from websites and previous studies.

3.1.1. Questionnaire toward Padang Citizens

For the data collection by questionnaire, prior to the survey, three pilot tests were conducted to test the reaction of the respondents against the questions in the lists by using SPSS software. The questionnaire in the pilot tests were adapted from the previous studies with as many as 45, 24, and 81 questions for test 1, 2, and 3 respectively (Bao R., 2011; Jatau A.A., 2013; Longe et al., 2009). Sample size for pilot studies has no specific recommendation number (Burns and Grove, 2005) (Polit and Beck, 2004), but other researchers recommend obtaining approximately 10 respondents (Nieswiadomy, 2002).

Due to the right moment for collecting data by visiting Padang city directly, a lot bigger sample size compared to the number recommended for pilot test could be collected which were 127 respondents including 38 people from general public, 48 students in the Environmental Engineering Department of Andalas University, and 41 students from the other departments at the university. Six factors were assumed to represent the characteristics of Padang citizens; attitude (3 variables), knowledge (13 variables), time (2 variables), environmental awareness (22 variables), convenience (3 variables), and social norms (2 variables). After the dimension reduction analysis in SPSS, some unexpected results have been obtained, not all variables could be calculated, not all the factors could be extracted from the data, and loading factor were very low (less than 0.5). Therefore, the second pilot test was conducted.

The second pilot test involved 15 respondents because of the reason of time and cost limitation but still within the recommendation of sample size which is 10 respondents. The variables and factors in questionnaire of pilot test 2 were taken from revised version of questionnaire in pilot test 1 added with other variables that are perceived to represent. There were nine factors including environmental awareness (4 variables), environmental knowledge (3 variables), inconvenience (4 variables), social norms (3 variables), individual initiatives (3 variables), the availability of disposal facilities (3 variables), intention (1 variable), behavior (1 variable), and law enforcement (2 variables). After the assessment by SPSS, the results of pilot test 2 were not significantly different from the results of test 1. Consequently, establishment of pilot test 3 were still needed.

The third pilot test was conducted at a larger scale of variables because we wanted to avoid the next failure of pilot test with the hope that the more number of variables the more likely data can be extracted. The variables were selected considering the real conditions of the local environment by interviewing the citizens about the waste management system of Padang city. The interview results and previous pilot test results were combined into 81 questions for eight factors including habits (10 questions), environmental knowledge (10 questions), environmental awareness (11 questions), social norms (10 questions), role of the government (10 questions), law enforcement (10 questions), intention (10 questions), and behavior (10 questions). The survey was conducted with 30 citizens of Padang city which is more than minimum recommendation sample size for pilot test. The results were satisfactory to proceed to the actual test. The questions list for pilot test 1, 2 and 3 are shown in **Table 3.1-3.3** respectively.

Table 3.1 The question list of pilot test 1

RESEARCH ON SOCIETY READINESS TOWARD MODIFICATION OF MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM INTO SEPARATION-BASE SYSTEM

Separation-base system is a system in which people have to separate and dispose their waste into different bins according to types of the waste (organic, non-organic).

Gender :	Occupation :
Age :	Number of People per Household :
Kids :	Residential Area :
Married :	Household Income :

Please give tick √ to the right answer according to your opinion. The data of respondents will be anonymous and confidential.

No.	Questions	Strongly Agree	Agree	Disagree	Strongly Disagree

1	I know how to separate my garbage based on the types (organic, non-organic).				
2	Separating waste is a major way to reduce pollution.				
3	Separating waste is a major way to conserve natural resources.				
4	Other personal issues (like cost of living, unemployment, crime, etc.) are more important to me than waste problem.				
5	Separating waste is bothersome.				
6	Separating waste is difficult to do.				
7	Improper waste management attracts the multiplication of microorganism, fungi, bacteria, viruses which affects human health.				
8	Improper waste management pollutes the source of water and precipitates the occurrence of air and land pollution which affects human health.				
9	I have no time to separate my garbage.				
10	I believe that my waste separation activity will help to improve environmental quality.				
11	Throwing away garbage to drainages and rivers will block the water flow which cause flooding.				
12	Curriculum on environment should be developed at school, college, university and technical institutions				
13	If the waste management in this city is changed to be separation-base system, I will separate my garbage according to the rules.				
14	If the waste management in this city is changed to be separation-base system, I will throw away my garbage to the right place and time according to the rules.				
15	If the waste management in this city is changed to be separation-base system, I will do it continuously.				
16	I do not want to separate my garbage because only me doing it, others do not.				
17	I do not want to separate my garbage because I do not believe local government will do the plan well and sustainably.				
18	The solid waste management in this city is bad.				
19	Environmental knowledge and conception should be given to the people.				
20	Radio, TV, and other media should telecast more programs about environment.				
21	Fair/ exhibition on environment should be organized.				
22	Initiative should be taken to make people understand that 'vulnerable situation of environment means vulnerable situation				

	of mankind'.				
23	Personal initiative should be taken to conserve the environment.				
24	Environmental organization should be established at local level.				
25	Different local bodies like committee, society, organization should be encouraged to take environmental programs.				
26	Enforce the Implementation of the environment friendly law.				
27	I purchase products usable for a long time rather than a disposable product.				
28	When I go shopping, I go with the shopping bag.				
29	I agree "a charged plastic shopping bag".				
30	I would like to buy recycled products more.				
31	I would like to know more how to use things effectively.				
32	I think that I should cooperate more with the community for the recovery of recyclable waste.				
33	I am interested in the news about environmental issues.				
34	I have participated in an environmental event.				
35	I often take part in seminars and lectures related to the environment.				
36	I often burn my garbage.				
37	I throw away my garbage into river.				
38	I throw away my garbage into drainage.				
39	I do not throw away my garbage into trash bin.				
40	I am careful to use effectively without waste.				
41	I try to reduce the amount of waste.				
42	I compost garbage at home.				
43	I actively involved in the recovery of recyclable waste.				
44	It will waste my time to learn and understand about new method (separation base system).				
45	I am lazy to separate my garbage.				

Table 3.2 The question list of pilot test 2

RESEARCH ON SOCIETY READINESS TOWARD MODIFICATION OF MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM INTO SEPARATION-BASE SYSTEM

Separation-base system is a system in which people have to separate and dispose their waste into different bins according to types of the waste (organic, non-organic, etc).

Gender :	Occupation :
Age :	Number of People per Household :
Number of Children :	Address :
Married : yes/no	Household Income :

Please give tick √ to the right answer according to your opinion. The data of respondents will be anonymous and confidential.

No.	Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	Personal initiative should be taken to conserve the environment.				
2	Radio, TV, and other media should telecast more programs about environment.				
3	I am interested in the news about environmental issues.				
4	I am careful to use effectively without waste and try to reduce amount of waste.				
5	I understand the way of waste separation.				
6	I understand the effect of good waste management system for environment.				
7	I understand the importance of good environmental management system to the survival of living beings.				
8	Waste separation is bothersome and difficult.				
9	I have no time to separate my garbage.				
10	I do not want to separate my garbage because only me doing it, others do not.				
11	I do not want to separate my garbage because I do not believe local government will do the plan well and sustainably.				
12	People around me tend to care about the environmental issues				
13	People around me tend to care about waste separation.				
14	People around me suggest me to separate my waste.				
15	I compost my garbage at home.				
16	I actively involved in the recovery of recyclable waste activity in my community.				
17	I actively involved in the local environmental organization				
18	I throw away my garbage into rivers.				
19	I throw away my garbage into drainages.				
20	I throw away my garbage on the streets.				
21	From here on I would like to separate my garbage according to the rules and continuously in my day-to-day life.				
22	I want to do waste separation.				
23	I have to obey the applicable laws on waste separation.				
24	Enforce the Implementation of the environmental laws.				

Table 3.3 The question list of pilot test 3

RESEARCH ON SOCIETY READINESS TOWARD MODIFICATION OF MUNICIPAL SOLID WASTE MANAGEMENT SYSTEM INTO SEPARATION-BASE SYSTEM

Separation-base system is a system in which people have to separate and dispose their waste into different bins according to types of the waste (organic, non-organic, etc).

Gender :
Age :
Number of Children :
Married : yes/no
Occupation :
Number of People per Household :
Address :
Household Income :

Please give tick √ to the right answer according to your opinion. The data of respondents will be anonymous and confidential.

No.	Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1	I throw away my garbage just anywhere				
2	I throw away my garbage into rivers				
3	I throw away my garbage into sea				
4	Littering is usual/normal because everyone is doing it				
5	Garbage littered and unpleasant smell is common for my communities				
6	The environment where I live, garbage piled everywhere				
7	I often burn my garbage by myself				
8	I do not feel ashamed when littering				
9	I am lazy to separate my garbage because it is bothersome and difficult				
10	I have no time to separate my garbage				
11	If the population increased, the amount of garbage is also increasing				
12	If people do not care to environment, danger will occur in living beings				
13	If people do waste separation, it will help much in environmental conservation				
14	If people do waste separation, it will improve environmental quality				
15	If people do waste separation, it will reduce pollution				
16	If people do waste separation, it will reduce wasteful use of landfills				
17	If improper management of waste happens, it will cause many diseases				
18	If improper management of waste happens, it will cause water, land and air pollution				
19	If improper management of waste happens, it will precipitate the breed of flies, microorganism, fungi, bacteria, viruses as source of many diseases				
20	If people do waste separation, it will give benefit to community in the form of healthy life and maybe green energy produced by waste treatment.				

21	Schools should give environmental education to the student				
22	People should increase the awareness of the importance of cleanliness				
23	People should increase sensitivity to the environment				
24	People should increase discipline to the environment				
25	Radio, TV and other media should telecast more the program about environment				
26	I should be careful to use things effectively without waste				
27	I should try to reduce amount of waste				
28	Personal initiative should be taken to conserve the environment				
29	I am interested in the news about environmental issues				
30	I should learn how to separate my waste well				
31	I feel I should not waste anything if it could be used again				
32	People around me tend to not remind/reprimand if they see someone littering				
33	People around me tend to not care about waste separation				
34	People around me tend to not care about environmental issues				
35	People around me tend to not know interested about waste problem				
36	People around me tend to not persuade me to separate my waste				
37	People around me tend to not feel responsible for waste problem in our community				
38	People around me tend to not have concern about waste problem in our community				
39	People around me tend to not feel guilty when they littering				
40	People around me tend to not worry about the danger if they do not care about environment				
41	People around me tend to not participate when there are environmental activities				
42	Government does not provide adequate bins				
43	Government is not doing enough to fix the garbage problems				
44	Government is not giving enough socialization about environmental education				
45	Government is not giving enough seminar about waste management				
46	Government might be already give enough environmental education to				

	people but it does not reach me				
47	Government does not provide enough advertisement, pamphlet or slogan about disposing garbage properly and well				
48	Government does not spread evenly the placement of bins				
49	Government does not provide enough janitors who transport garbage to landfill so that garbage piled up for days				
50	Government takes very long time to fix the garbage problems				
51	Government does not provide enough information about waste separation way				
52	I obey the rule if viewed by security personnel				
53	I obey the rule if it gives benefit to me				
54	Socialization of waste management rule is not clear for me				
55	I persuade my family to obey the rules related to waste management				
56	I obey the rule because I fear of penalty				
57	I obey the rule because my awareness				
58	I do not know about the rules related to waste management				
59	I obey the rules because there are CCTV which monitor my waste management activities				
60	I obey the rules because I feel guilty of myself if I do not obey				
61	I obey the rules because I am ashame of myself if I do not obey				
62	From here on I would like to separate my garbage according to the rules in my day-to-day life				
63	From here on I would like to separate my garbage continuously in my day-to-day life				
64	From here on I would like to reduce amount of my garbage by reuse the things I have used				
65	From here on I would like to learn how to separate my garbage well				
66	From here on I would like to increase my environmental awareness				
67	From here on I would like to increase my discipline to the environment				
68	From here on I would like to increase sensitivity to the environment				
69	From here on I would like to use things effectively without waste				
70	From here on I would like to participate when there are environmental activities in my community				
71	From here on I would like to obey the rules related to waste management				
72	I will do waste separation				
73	I will reduce the amount of my waste				

74	I will reuse again the things I have used before throw it to be waste				
75	I will obey the rules related to waste management because of my awareness				
76	I will learn how to separate my garbage well				
77	I will participate on environmental activities in my community				
78	I will be more responsible for my waste				
79	I will watch or read more about environmental issues news to increase my environmental awareness				
80	I will be more care about environmental problems				
81	I will watch or read more about environmental issues news to increase my discipline and sensitivity to environmental				

In the actual test, the questions were same as the ones in pilot test 3 because of the satisfactory result obtained by pilot test 3. The questions were presented on a four-point Likert scale: 4= strongly agree, 3= agree, 2= disagree, 1= strongly disagree. In the pilot tests, respondents who were too lazy to think of an answer, did not want to answer, or did not answer seriously and tended to choose the option “neutral”. Therefore, the “neutral” option was not used in this survey to obtain more valid and reliable data. The questions of the survey as well as the factor group of each questions are provided in **Table 3.4**.

3.1.2. Data from Cement Company in Padang City

The data are adopted from author`s previous research titled “Proposal of Preliminary Design of Eco-city by Using Industrial Symbiosis Based on the MFA, LCA, and MFCA of Cement Industry in Indonesia” (Ulhasanah and Goto, 2012). Due to limited supply of raw materials and high energy needed to produce cement, the research proposed new system which utilizes the MSW of Padang city as fuel replacing the role of coal in klinker. The klinker uses high heat to burn and blend the raw materials which usually apply coal as a heat producer. However, coal leads a lot of bad impacts for environment, so that alternative source of fuel is needed.

Table 3.4. The questions list and the group factors in the questionnaire

Factor	Questions	Factor	Questions
Habit	Q1. I throw away my garbage just anywhere Q2. I throw away my garbage into rivers Q3. I throw away my garbage into sea Q4. Littering is usual/normal because everyone do Q5. Garbage is littered and unpleasant smell is common for my communities Q6. Where I live, garbage is piled everywhere Q7. I often burn my garbage by myself Q8. I do not feel ashamed when littering Q9. I am lazy to separate my garbage because it is bothersome and difficult Q10. I have no time to separate my garbage	**Role of Government**	Q42. Government does not provide adequate bins Q43. Government is not doing enough to fix the garbage problems Q44. Government is not putting sufficient emphasis on environmental education Q45. Government is not giving seminars about waste management Q46. Government might be already giving environmental education to people but it does not reach me Q47. Government does not provide enough advertisement, pamphlets or slogan about disposing garbage properly. Q48. Government does not place the bins evenly Q49. Government does not provide sufficient number of workers to transport garbage to landfills so garbage piled up for days Q50. Government takes very long time to fix the garbage problems Q51. Government does not provide enough information about waste separation.
Environmental Knowledge	Q11. If the population increases, the amount of garbage will also increase Q12. If people do not care about the environment, it will harm living beings Q13. If people do waste separation, it will help much environmental conservation Q14. If people do waste separation, it will improve environmental quality Q15. If people do waste separation, it will reduce pollution Q16. If people do waste separation, it will reduce wasteful use of landfills Q17. If improper management of waste happens, it will cause many diseases Q18. If improper management of waste happens, it will cause water, land, and air pollution Q19. If improper management of waste happens, it will precipitate the breed of flies, microorganism, fungi, bacteria, viruses as the source of many diseases Q20. If people do waste separation, it will benefit the community in the form of a healthy life also maybe green energy will be produced by waste treatment.	**Law Enforcement**	Q52. I obey the rule about garbage if viewed by security personnel Q53. I obey the rule if it benefits me Q54. Socialization of waste management rule is not clear for me Q55. I persuade my family to obey the rules related to waste management Q56. I obey the rules because I fear of the penalty Q57. I obey the rules because of my awareness Q58. I do not know about the rules related to waste management Q59. I obey the rules because there are CCTV which monitor my waste management activities Q60. I obey the rules because I feel guilty of myself if I do not obey Q61. I obey the rules because I am ashamed of myself if I do not obey.
Environmental Awareness	Q21. Schools should give environmental education to the students Q22. People should increase the awareness of the importance of cleanliness Q23. People should increase sensitivity to the environment Q24. People should increase environment discipline Q25. Radio, TV, and other media should telecast more programs about environment Q26. I should be careful to use things effectively without wasting Q27. I should try to reduce amount of waste Q28. Personal initiative should be taken to conserve the environment Q29. I am interested in the news about environmental issues Q30. I should learn how to separate my waste well Q31. I feel I should not waste anything if it could be used again.	**Intention**	Q62. From here on I would like to separate my garbage according to the rules in my day-to-day life Q63. From here on I would like to separate my garbage continuously in my day-to-day life Q64. From here on I would like to reduce amount of my garbage by reusing the things I have used Q65. From here on I would like to learn how to separate my garbage well Q66. From here on I would like to increase my environmental awareness Q67. From here on I would like to increase my discipline for environment Q68. From here on I would like to increase sensitivity to the environment Q69. From here on I would like to use things effectively without wasting Q70. From here on I would like to participate when there are environmental activities

			in my community Q71. From here on I would like to obey the rules related to waste management.
Social Norm	Q32. People around me tend not to remind/reprimand if they see someone littering Q33. People around me tend to care about waste separation Q34. People around me tend not to care about environmental issues Q35. People around me tend not to interested about waste problem Q36. People around me tend not to persuade me to separate my waste Q37. People around me tend not to feel responsible for the waste problem in our community Q38. People around me tend not to have a concern about the waste problem in our community Q39. People around me tend not to feel guilty when they litter Q40. People around me tend not to worry about the danger if they do not care about the environment Q41. People around me tend not to participate in environmental activities.	**Behavior**	Q72. I will do waste separation Q73. I will reduce the amount of my waste Q74. I will reuse the things I have used before throwing them away Q75. I will obey the rules related to waste management because of my awareness Q76. I will learn how to separate my garbage well Q77. I will participate in environmental activities in my community Q78. I will be more responsible for my waste Q79. I will watch or read more news about environmental issues to increase my environmental awareness Q80. I will be more careful about environmental problems Q81. I will watch or read more news about environmental issues to increase my discipline and sensitivity to environment.

The proposed system called city-corporate incineration is a system involving cooperation of local government and the most influential company in Padang city with the concept of a mutually beneficial between the company and the city. The framework is arranged based on prior study of Ulhasanah and Goto (2012) which utilizes the existence of the largest cement company in Padang city toward its limited availability of raw material, high operating cost, high energy consumption, and bad emission factor. Based on the results of prior study, this system has high potency to solve MSW management problems of Padang city as well as get benefits from energy and ash produced by waste incineration (Ulhasanah and Goto, 2012).

3.2.Structural Equation Modeling

SEM is a robust technique that has been used extensively in behavioral science research to conceive and define the relationship among the elements in a system (Lu et al., 2006). It can be considered an integration of factor analysis and path analysis (Hox and Bechger, 1998). The elements or variables in the SEM usually include observed variables that are directly measured and latent variables that cannot be measured (its presence is inferred from what is observed) (Zang et al., 2015). In waste management study, to observe each household and conjecture, the latent variables are improbable. On the contrary, the degree of the latent variables can be measured indirectly by questionnaire deployed to individuals. SEM had been used in many research related to environmental behaviors such as environmental concern and recycling behavior in Selangor, Malaysia (Jekria and Daud, 2016), pro-environmental behavior of consumers in Canada (Ertz et al., 2016), quantification of attitudes and perceptions on enhanced solid waste management practices in Sri Lanka (Mudalige et al, 2012), housewives' recycling behavior in Turkey (Ari and Yilmaz, 2016), structural relationship between environmental attitudes, recreation motivations, and environmentally responsible behaviors (Kil et al., 2014), contractor`s construction and demolition waste management behavior in mainland China (Wu et al., 2017), and waste separation behaviors at the source (Zang et al., 2015).

Because hypothetical model of this study implicates multiple-path linkages that suggest complex associations among the variables, and also many researchers had verified that SEM technique could be employed in environmental behavior related studies successfully, the SEM is selected as an appropriate tool for this analysis. In order to conduct SEM, factor analysis steps were adopted due to the limited tools reason. The procedure includes instrument development, an exploratory factor analysis (EFA), a confirmatory factor analysis (CFA), and a test of a structural model (Koufteros, 1999; Koufteros et al., 2001; Lu et al., 2006). EFA specifies many latent variables underlying the complete set of items. The reliability of the data-set can be determined by Cronbanch's Alpha, which is one of the most widely used metrics for reliability evaluation (Koufteros et al., 2001).

Exploratory techniques assist the researchers to develop hypothesized measurement models which can subsequently be examined using CFA (Koufteros, 1999). The use of CFA was proposed by many researchers to assess uni-dimensionality (Anderson, 1987; Segar, 1997). The limitations of exploratory factor models can be overcome by the CFA approach in scale estimation and construct reliability; CFA is used to determine (1) which pairs of the common factors are correlated; (2) which observed variables are influenced by the common factors; (3) which observed variables are influenced by an error-term factor; and (4) which pairs of error terms are correlated (Long,1983; Garver and Mentzer, 1999). The goodness-of-fit of the model can be detected by the indices of Chi-square, p-value, comparative fit index (CFI), goodness of fix index (GFI), adjusted goodness of fit index (AGFI), standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), and p of close fit (PCLOSE) (Kline, 1998; Shevlin and Miles, 1998; Bentler, 1990; Hu and Bentler, 1999). The discriminant and convergent validity can be detected by the indices of Composite Reliability (CR), Average Variance Extracted (AVE), Maximum Shared Variance (MSV), and Average Shared Variance (ASV). The shared variance between a construct and any other construct, which is less than the variance that the constructs shares with its indicators, determines the discriminant validity (Fornell and Bookstein, 1982).

The validity is evaluated by comparing the square root of AVE of a construct with the correlations that relate that construct to other constructs. When the square root of AVE for the off-diagonal elements that correspond to the columns and rows is larger than the correlations that relate a construct to other constructs, the correlations between a construct and its indicators are stronger than the correlations between the other constructs. If the convergent validity exists, then the variables do not correlate well with each other within their parent factor; i.e., the latent factor is not well-explained by its observed variables. If the discriminant validity exists, then the variables correlate more strongly with the variables outside their parent factor than with the variables within their parent factor; i.e., the latent factor is better explained by other variables (of a different factor), than by its own observed variables (Hair et.al., 2010). When the model passes the requirement processes of EFA and CFA, the structural model can be established by considering the goodness-of-fit. The result of the structural model can then be compared with that of the predictive model formulated to determine whether the results support the hypotheses or not.

3.3.Social Evaluation by Scoring System

In this study, social evaluation methods were used to support the SEM results. SEM (EFA and CFA) analyzes all the data by not distinguishing the data source while the social evaluation analyzed the data by the source (students and the general public) to compare their behavior. SEM used a predictive model only as a starting point to test the hypotheses and the social evaluation used the predictive model to determine the behavior of citizens by analyzing the survey responses. Each answer is measured on a four-point Likert scale point as described in section 2.1. Afterwards, the total number of respondents who chose each option were counted and rated with assumption of the following scale; 85-100% (A, very good), 75-84% (B, good), 60-74% (C, fair), 50-59% (D, bad), and 0-49% (E, very bad). For example, if >85% or more of total respondents gave a positive answer to the questions in the "behavior" factor, "behavior" factor of the respondents was considered very good. It is assumed that the level of the citizens' pro-environmental behavior is comparable to the number of respondents who responded positively. Using this scale, the level of pro-environmental behavior can be measured to define the readiness of the citizens for the modification of the solid waste management system.

3.4.Proposed Model

An improved framework is designed as a solution for the better waste management system in Padang city starting from SEM and social evaluation results. The idea of creation is developed based on the citizens' behavior condition so that the citizens as a technology's users can accept, understand, and apply the system in their day-to-day life. Preliminary concept of the proposed model is separation-based system through solid waste bank (SW bank) system. The SW bank system has established in Padang city since 2010 which was managed by community-based and private institutions. Currently, there are 29 waste banks consist of eight community waste banks and 21 educational institution waste banks which have difference only by the source of depositors. However, the effectiveness of current waste bank was still very low seen by percentage of treated waste that is only 0.05% of total Padang city's waste in 2015. The small amounts of waste that can be handled by waste bank suggest that the direct participation of people in Padang city's MSW is relatively poor (Raharjo et al., 2015). The lack of participation, planning procedure, and time contribution and resource to educate participants also happen in waste bank project in Mahasarakham municipality, Thailand (Singhirunnusorn et al., 2012), meanwhile the high participation is obtained from low income family of waste bank in Quran education park, Sleman, Yogyakarta, Indonesia (Indriati, 2016), and waste bank in Surabaya, Indonesia (Wijayanti and Suryani, 2015). Therefore, establishment of advanced level of waste management system in Padang city is needed, not only reaching the low-income families' participation, but also high income families'.

3.5.Strengths, Weaknesses, Opportunities, Threads Analysis

SWOT analysis is a tool to make decision for the preliminary stages on the one hand and as forerunner to strategic management planning on the other hand (Johnson et al., 1989). The SWOT analysis needs to be updated frequently because of the condition changing in time so that the analysis has to be supple (Schmoldt et al., 1994). In this research, the SWOT analysis is used to evaluate and develop the new system proposed by observing the strengths, weaknesses, opportunities and threats faced as well as building strategies on how to solve the problems in each part.

In the waste management field, Srivastava et al (2005) has used SWOT analysis to improve solid waste management in Lucknow, India, Aich and Ghosh (2016) utilized the method to select the right technology for the sustainable processing and disposal of MSW, Zheng et al (2017) applied the method to clearly present the condition of door-to-door recycling scheme of household solid waste in Nagoya, Japan, Beloborodko et al (2015) took the method to propose advancement of waste-to-energy cluster in Latvia, Yuan (2013) adopted the method to promote and develop future construction waste management at the strategic level in Shenzhen city, China, and Raharjo et al (2015) employed the method to see the potency of SW bank for local MSW management improvement in Padang city, Indonesia. Those previous studies showed that the SWOT analysis is a suitable tool for investigating problems from a strategic perspective of social term. Therefore, the SWOT analysis is adopted in this study to strategically analyze the feasibility of the proposed system for implementation in developing countries generally, Padang city, Indonesia particularly.

3.6. Material Flow Analysis and Life Cycle Assessment/Environmental Life Cycle Assessment

MFA is a systematic and descriptive assessment of the metabolism of material's flows and stocks within defined system in space and time connecting the sources, the pathway, and the intermediate and final sinks of a material based on the principle of mass conservation (Brunner and Rechberger, 2004). The data and results of MFA can be used in LCA to assess the environmental effect of both materials and processes from cradle to grave in order to describe or improve understanding of the environmental hazards caused by the materials life stage. LCA can produce results at the level of the interventions (emissions, extraction of natural resources), at the level of impact categories (global warming, toxicity), at the level of damage to endpoints (human health, material welfare), or at the level of one single indicator (Curran, 1996).

MFA and LCA are basically different tools for environmental decision support which highlight that MFA and LCA can complete each other and therewith improve the quality of studies in both domains (Laner and Rechberger, 2016). In the waste management area, MFA and LCA have been successfully used to design eco-city by using waste co-processing in Padang city, Indonesia (Ulhasanah and Goto, 2012), to assess holistically the performance of the construction and demolition waste management system in Europe (Dahlbo et al., 2015), to support solid waste management decision making in Wales, United Kingdom (Turner et al., 2016), to investigate the flow of PVC waste in Thailand (Nakem et al., 2016), to determine the supporting decision-making of waste paper recycling management in Spain (Savigne et al., 2015), and to decide the suitable waste management strategy for wastes of metropolitan electricity authority (MEA), Bangkok (Yahom et al., 2016). The previous studies above show the greatness of combination of MFA and LCA to be employed in this study to evaluate impact of the new system's existence compare to the current system's (open dumping system) in term of waste cycles. In this research, MFA and LCA will evaluate impact of the new system's existence compare to the current system's (open dumping system) in term of waste cycles. This evaluation may give quantitative determination for the governments about advantages and disadvantages of the new system application.

3.7.Social Life Cycle Assessment

Evaluation of the S-LCA as a tool to measure social impacts has been a focus subject of many researchers recently where most of the studies were deal with the evaluation of methodological and implementation issues because it was a new research area (Weidema, 2006; Grießhammer et al., 2006; Klöpffer, 2008; Jorgensen et al., 2008; Reitinger et al., 2011; Parent et al., 2010). Compared to other assessment method such as LCA, there are only a few S-LCA case studies on waste management in the literatures such as Teeriojaet al. (2012), Ferrao et al. (2013), Foolmaun and Ramjeeawon (2013), Vinyes et al. (2013), Aparcana and Salhofer (2013), Umair et al. (2013), Umair et al. (2015), and Yildiz-Geyhan et al. (2017). Meanwhile other previous studies employed S-LCA in various fields such as Chang et al. (2015) in welding technologies, Prasara-A and Gheewala (2017) in Thai sugar industry, Peruzzini et al. (2017) in new generation of kitchen sinks project, Europe, Mattioda et al. (2017) in hydrogen energy technologies, Tsalis et al. (2017) in the corporate social profile of companies. These literatures insufficiency about case studies on waste management research makes us believe that this study will give endowment to the education world.

Assessment of S-LCA describes the system's potential positive and negative impacts along the life cycle consisting of extraction and processing raw materials, manufacturing, distribution, re-use, maintenance, recycling, and final disposal. The final goal for conducting an S-LCA technique is to promote improvement of social conditions and socio-economic performance of a product or service throughout its life cycle for all of its stakeholders (UNEP/SETAC, 2009). When initiating S-LCA study, determination of main impacts and stakeholder groups should be categorized. The main impacts categories identified by UNEP/SETAC (2009) in the most used guideline are health and safety, human rights, working conditions, socio-economic repercussions, cultural heritage, and governance whereas the stakeholder groups are workers, consumers, local community, society, and value chain actor. In this study, all main impacts and stakeholders are adopted depend on activity type of each scenario. The assessment of social life cycle in this study will give potential impact for each process of scenarios but not interpret the impacts in detail scoring system because it is not possible to value the social condition of system that has not been run yet (still in the form of design plan). It is expected that by performing an S-LCA from general data, hotspots can still be identified in a rough analysis and early action or changes can be made.

3.8.Financial Feasibility Assessment (FFA)

FFA is a necessary preliminary analysis before a determination of investment decision which has to be considered with respect to several different aspects in order to determine whether the investment should be realized or not. There are two types of measurements in the financial feasibility study which are measurement on the basis of accounting profits (income statement) and the cash flow method (Bjornsdottir A.R., 2010). Usually, the income statements are recorded based on actual financial activities, but for the business plan, projection of statements can be used to gain a better understanding of a project's finances. However, the cash flow method is claimed to be more appropriate for evaluating the financial feasibility of investment projects which is indicated by several criterions such as net present value (NPV), internal rate of return (IRR), annual equivalent worth (AE), and benefit-cost ratio (B/C). The payback period is another method to determine the "break even" time of a project in order to measure the time it takes to recover the initial investment (Bjornsdottir A.R., 2010; Jamaluddin A, 2014). In this study, three criterions of cash flow method will be counted to assess the financial feasibility of those three scenarios as well as considering about payback period of each scenario to see how much risk is faced by those.

The FFA method with the concept of cost analysis was a broadly used method by sundry studies. Moreover, on waste management research, these studies have successfully utilized FFA concept to see the recyclable separation effect on cost reduction of MSW in Japan (Chifari et al., 2017), to make a market diagnosis of the recovery and recycling of waste tires in Poland (Godlewska, 2017), to investigate the organic solid waste potency to be biodisesel (Gaeta-Bernardi and Parente, 2016), to evaluate the performance of treating swine concentrated animal feeding operations (CAFOs) waste (Amini et al., 2017), to assess the economic advantages of adopting waste electrical and electronic equipment (WEEE) reverse logistic for recycling and reuse (Neto et al., 2017), to analyze the performance of some waste-to-energy (WTE) plants in China (Xin-gang et al., 2016), to compare the cost-effective performance between plastic recycling and energy recovery from plastic incineration in Netherlands (Gradus et al., 2016).

CHAPTER 4
RESULTS AND DISCUSSIONS

By formula suggested by Krejcie and Morgan (1970) about sample size determination, we decided to take 609 samples with 95% confidence level and 3.97% margin of error due to the reason of time and cost limitation. The surveys were conducted for approximately two months with 300 students of Andalas University located in Padang city and 309 people from the general public. Determining the number of sample was decided based on statistic of whole Padang population percentage based on age range (Badan Pusat Statistik Kota Padang, 2016) which are age 0-4 years old = 25.9%, age 15-24 years old = 23.5%, age 25-34 years old = 15.7%, age 35-44 years old = 13.5%, age 45-54 years old = 10.7%, age 55-64 years old = 6.9%, and age more than 65 years old = 3.8%. Meanwhile, the percentage of data are age 0-4 years old = not considered, age 15-24 years old == 49.3%, age 25-34 years old = 15.6%, age 35-44 years old = 13.8%, age 45-54 years old = 10.8%, age 55-64 years old = 6.9%, and age more than 65 years old = 3.6%. The percentage of age 15-24 years old between data and statistic is different, but percentage of other age ranges are almost same, so that this sample can represent the whole Padang city`s condition.

Data collection lasted two weeks for university students beginning of July 2015. The university student respondents consisted of 50 agricultural engineering students, 45 civil engineering students, 92 industrial engineering students, 41 environmental engineering students and, 72 students from other departments. The public participants were interviewed in each of the eleven 11 districts in Padang; those are East Padang district (28 respondents), West Padang district (28 respondents), North Padang district (29 respondents), South Padang district (28 respondents), Bungus district (28 respondents), Nanggalo district (28 respondents), Lubuk Kilangan district (28 respondents), Koto Tangah district (28 respondents), Kuranji district (28 respondents), Lubuk Begalung district (28 respondents), and Pauh district (28 respondents). Data collection lasted 1.5

months for the public sample (from the middle of July to the end of August 2015). The respondent category for the general public was a random group, not limited by demographics.

4.1.Structural Equation Modeling

4.1.1. Exploratory Factor Analysis

A total of 11 factors screened by EFA were extracted from 48 questions (variables). The number of factors was determined based on eigenvalues above 1, and the fitting method procedures was maximum likelihood. Those factors are labeled as, behavior, social norm, intention related to waste separation (separation intention), environmental awareness, environmental knowledge related to environmental quality (Quality Knowledge), 6th Factor; Intention Related to Willingness to Increase Positive Environmental feeling (feeling intention), government role related to provision (government provision), environmental knowledge related to pollution and diseases (pollution knowledge), habit, government role related to information socialization (government information), law enforcement. The results of EFA as well as the Cronbach's Alpha value are shown in **Table 4.1** where the result had been rotated by the rotation method of Promax with Kaiser Normalization. The value of Cronbach's Alpha for the satisfactory reliability of each construct is 0.75 (Nunnally, 1978; Churchill, 1991; Litwin, 1995). Furthermore, the answers of respondents regarding the questionnaire were then inputed to the SPSS to see the corelation between the questions and grouped the questions into a factor. The screened questions of its factor is displayed in **Table 4.2**.

Table 4.1. Factor analysis result (of all data)

Predictors	Pattern Matrix										
	Behavior	**Social Norm**	**Sep. Intention**	**Environ. Awareness**	**Quality Knowledge**	**Feeling Intention**	**Government Provision**	**Pollution Knowledge**	**Habit**	**Government Information**	**Law Enforcement**
Q79	0.811										
Q75	0.797										
Q77	0.769										
Q81	0.764										
Q78	0.727										
Q80	0.726										
Q74	0.715										
Q73	0.667										
Q38		0.911									
Q37		0.876									
Q39		0.860									
Q40		0.797									
Q41		0.707									
Q34		0.648									
Q36		0.536									
Q62			0.985								
Q63			0.940								
Q65			0.819								
Q72			0.585								
Q30			0.567								
Q23				0.917							
Q22				0.854							
Q24				0.848							
Q21				0.705							
Q14					0.970						
Q15					0.811						
Q13					0.763						
Q16					0.616						

Q67						0.951					
Q68						0.876					
Q66						0.866					
Q64						0.515					
Q49							0.808				
Q50							0.747				
Q48							0.716				
Q51							0.687				
Q18								0.944			
Q19								0.886			
Q17								0.745			
Q2									0.926		
Q3									0.882		
Q1									0.744		
Q43										0.833	
Q42										0.775	
Q44										0.727	
Q52											0.857
Q53											0.728
Q59											0.591
Reliability (Cronbach`s Aplha)	**0.910**	**0.908**	**0.898**	**0.901**	**0.882**	**0.907**	**0.845**	**0.914**	**0.883**	**0.855**	**0.772**

Table 4.2. The screened questions list and its factor

Factor	Questions	Factor	Questions
Factor 1st (Behavior)	Q73. I will reduce the amount of my waste Q74. I will reuse again the things I have used before throw it to be waste Q75. I will obey the rules related to waste management because of my awareness Q77. I will participate on environmental activities in my community Q78. I will be more responsible for my waste Q79. I will watch or read more about environmental issues news to increase my environmental awareness Q80. I will be more care about environmental problems Q81. I will watch or read more about environmental issues news to increase my discipline and sensitivity to environment.	**Factor 7th (Government Provision)**	Q48. Government does not spread evenly the placement of bins Q49. Government does not provide enough janitors who transport garbage to landfill so that garbage piled up for days Q50. Government takes very long time to fix the garbage problems Q51. Government does not provide enough information about waste separation way.
Factor 2nd (Social Norm)	Q34. People around me tend to not care about environmental issues Q36. People around me tend to not persuade me to separate my waste Q37. People around me tend to not feel responsible for waste problem in our community Q38. People around me tend to not have concern about waste problem in our community Q39. People around me tend to not feel guilty when they littering Q40. People around me tend to not worry about the danger if they do not care about environment Q41. People around me tend to not participate where there are environmental activities.	**Factor 8th (Pollution Knowledge)**	Q17. If improper management of waste happens, it will cause many diseases Q18. If improper management of waste happens, it will cause water, land, and air pollution Q19. If improper management of waste happens, it will precipitate the breed of flies, microorganism, fungi, bacteria, viruses as source of many diseases
Factor 3rd (Separation Intention)	Q30. I should learn how to separate my waste well Q62. From here on I would like to separate my garbage according to the rules in my day-to-day life Q63. From here on I would like to separate my garbage continuously in my day-to-day life Q65. From here on I would like to learn how to separate my garbage well Q72. I will do waste separation	**Factor 9th (Habit)**	Q1. I throw away my garbage just anywhere Q2. I throw away my garbage into rivers Q3. I throw away my garbage into sea
Factor 4th (Environmental Awareness)	Q21. Schools should give environmental education to the student Q22. People should increase the awareness of the importance of cleanliness Q23. People should increase sensitivity to the environment Q24. People should increase discipline to the environment	**Factor 10th (Government Information)**	Q42. Government does not provide adequate bins Q43. Government is not doing enough effort to fix the garbage problems Q44. Government is not giving enough socialization about environmental education
Factor 5th (Quality Knowledge)	Q13. If people do waste separation, it will help much in environmental conservation Q14. If people do waste separation, it will improve environmental quality Q15. If people do waste separation, it will reduce pollution Q16. If people do waste separation, it will reduce wasteful use of landfills	**Factor 11th (Law Enforcement)**	Q52. I obey the rule about garbage if viewed by security personnel Q53. I obey the rule if it gives benefit to me Q59. I obey the rules because there are CCTV which monitor my waste management activities
Factor 6th (Feeling Intention)	Q64. From here on I would like to reduce amount of my garbage by reuse the things I have used Q66. From here on I would like to increase my environmental awareness Q67. From here on I would like to increase my discipline to the environment Q68. From here on I would like to increase sensitivity to the environment		.

The screening process by SPSS produced some outputs that determined the reliability and validity of data. The outputs are shown in Tables 4.3-4.10.

Table 4.3 The output of SPSS regarding the KMO and Bartlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.859
Bartlett's Test of Sphericity	Approx. Chi-Square	20385.484
	df	1128
	Sig.	0.000

Table 4.4 The output of SPSS regarding the communalities

Communalities

	Initial	Extraction
Q1	0.533	0.550
Q2	0.747	0.864
Q3	0.725	0.798
Q13	0.598	0.606
Q14	0.750	0.883
Q15	0.689	0.713
Q16	0.530	0.506
Q17	0.672	0.668
Q18	0.812	0.924
Q19	0.767	0.795
Q21	0.542	0.534
Q22	0.710	0.738
Q23	0.729	0.812
Q24	0.710	0.743
Q30	0.438	0.393
Q34	0.520	0.452
Q36	0.482	0.396
Q37	0.731	0.724
Q38	0.777	0.818
Q39	0.733	0.762
Q40	0.719	0.671
Q41	0.652	0.572
Q42	0.606	0.667
Q43	0.650	0.756
Q44	0.564	0.592
Q48	0.591	0.588

Q49	0.626	0.661
Q50	0.612	0.613
Q51	0.585	0.572
Q52	0.545	0.700
Q53	0.552	0.622
Q59	0.389	0.398
Q62	0.833	0.888
Q63	0.837	0.877
Q64	0.558	0.504
Q65	0.751	0.764
Q66	0.794	0.802
Q67	0.835	0.895
Q68	0.758	0.769
Q72	0.586	0.585
Q73	0.645	0.532
Q74	0.654	0.541
Q75	0.617	0.600
Q77	0.549	0.552
Q78	0.582	0.552
Q79	0.637	0.608
Q80	0.635	0.586
Q81	0.692	0.631

Extraction Method: Maximum Likelihood.

Table 4.5 The output of SPSS regarding the total variance explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.886	18.512	18.512	8.140	16.959	16.959	6.429
2	5.816	12.116	30.628	4.388	9.142	26.100	4.762
3	3.909	8.144	38.772	4.315	8.989	35.090	5.193
4	3.184	6.633	45.405	2.667	5.557	40.646	3.965
5	2.822	5.879	51.284	2.488	5.184	45.830	4.573
6	2.568	5.350	56.634	2.154	4.487	50.317	5.387
7	2.205	4.594	61.228	2.147	4.474	54.791	3.699
8	1.873	3.902	65.130	1.977	4.118	58.910	3.838
9	1.704	3.550	68.680	1.333	2.778	61.687	2.711
10	1.242	2.587	71.268	1.419	2.956	64.643	3.226
11	1.020	2.125	73.393	0.749	1.560	66.204	2.338
12	0.869	1.810	75.202				
13	0.794	1.654	76.856				
14	0.678	1.412	78.269				
15	0.626	1.305	79.573				
16	0.587	1.224	80.797				

17	0.547	1.139	81.936				
18	0.526	1.097	83.033				
19	0.502	1.045	84.078				
20	0.467	0.972	85.050				
21	0.457	0.952	86.001				
22	0.450	0.937	86.939				
23	0.406	0.846	87.785				
24	0.392	0.816	88.601				
25	0.374	0.778	89.379				
26	0.350	0.729	90.108				
27	0.344	0.716	90.824				
28	0.336	0.699	91.524				
29	0.311	0.648	92.172				
30	0.297	0.618	92.790				
31	0.285	0.593	93.383				
32	0.281	0.586	93.970				
33	0.271	0.565	94.534				
34	0.258	0.537	95.071				
35	0.236	0.491	95.562				
36	0.235	0.489	96.051				
37	0.222	0.463	96.514				

38	0.212	0.441	96.955				
39	0.200	0.417	97.372				
40	0.183	0.380	97.752				
41	0.176	0.367	98.119				
42	0.168	0.351	98.469				
43	0.151	0.314	98.784				
44	0.137	0.286	99.070				
45	0.133	0.278	99.348				
46	0.122	0.254	99.601				
47	0.103	0.215	99.817				
48	0.088	0.183	100.000				

Extraction Method: Maximum Likelihood.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 4.6 The output of SPSS regarding the factor matrix[a]

Factor Matrix[a]

	Factor										
	1	2	3	4	5	6	7	8	9	10	11
Q67	0.701										
Q63	0.683	-0.434									
Q62	0.672				-0.442						
Q66	0.665										
Q68	0.653										
Q65	0.652										
Q64	0.593										
Q14	0.583								-0.446		
Q72	0.567										
Q15	0.556										
Q13	0.515										
Q80	0.500										
Q81	0.494										
Q73	0.481										
Q78	0.455										
Q30	0.447										
Q75	0.443										
Q74	0.439										
Q77	0.434										
Q16	0.425										
Q79	0.402										
Q18	0.506	0.679									
Q19	0.469	0.615									
Q17	0.467	0.592									
Q50											
Q51											
Q38		0.440	0.642								
Q37			0.624								
Q39		0.412	0.624								
Q40			0.592								
Q41			0.578								
Q43			0.478								
Q34			0.472								
Q44			0.429								
Q36			0.424								
Q42											

Q2				0.607		0.478					
Q3				0.576		0.440					
Q23					0.439	0.581					
Q24	0.426					0.508					
Q22	0.414					0.503					
Q1				0.406		0.434					
Q21						0.403					
Q48											
Q49											
Q52										0.625	
Q53										0.580	
Q59										0.403	

Extraction Method: Maximum Likelihood.

a. 11 factors extracted. 5 iterations required.

Table 4.7 The output of SPSS regarding the Goodness-of-fit Test

Goodness-of-fit Test

Chi-Square	df	Sig.
1817.839	655	0.000

Table 4.8 The output of SPSS regarding the pattern matrix[a]

Pattern Matrix[a]

	Factor										
	1	2	3	4	5	6	7	8	9	10	11
Q79	0.811										
Q75	0.797										
Q77	0.769										
Q81	0.764										
Q78	0.727										
Q80	0.726										
Q74	0.715										
Q73	0.667										
Q38		0.911									
Q37		0.876									
Q39		0.860									
Q40		0.797									
Q41		0.707									
Q34		0.648									
Q36		0.536									
Q62			0.985								

Q63			0.940								
Q65			0.819								
Q72			0.585								
Q30			0.567								
Q23				0.917							
Q22				0.854							
Q24				0.848							
Q21				0.705							
Q14					0.970						
Q15					0.811						
Q13					0.763						
Q16					0.616						
Q67						0.951					
Q68						0.876					
Q66						0.866					
Q64						0.515					
Q49							0.808				
Q50							0.747				
Q48							0.716				
Q51							0.687				
Q18								0.944			
Q19								0.886			
Q17								0.745			
Q2									0.926		
Q3									0.882		
Q1									0.744		
Q43										0.833	
Q42										0.775	
Q44										0.727	
Q52											0.857
Q53											0.728
Q59											0.591

Extraction Method: Maximum Likelihood.

Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Table 4.9 The output of SPSS regarding the structure matrix

Structure Matrix

	Factor										
	1	2	3	4	5	6	7	8	9	10	11
Q81	0.788					0.439					
Q79	0.768										
Q75	0.766										
Q80	0.761					0.429					
Q78	0.737										
Q77	0.732										
Q74	0.722										
Q73	0.717					0.425					
Q38		0.902									
Q39		0.863									
Q37		0.843									
Q40		0.809									
Q41		0.743									
Q34		0.648									
Q36		0.557									
Q62			0.937								
Q63			0.927			0.458					
Q65			0.860			0.464					
Q72	0.497		0.686								
Q30			0.594								
Q23				0.896							
Q24				0.860							
Q22				0.857							
Q21				0.726							
Q14					0.935			0.434			
Q15					0.840			0.467			
Q13					0.776			0.422			
Q16					0.689			0.490			
Q67	0.451		0.421			0.944					
Q66	0.470		0.423			0.892					
Q68	0.439					0.873					
Q64	0.477		0.419			0.675					
Q49							0.796			0.454	
Q50							0.778				
Q48							0.738			0.485	
Q51							0.729				
Q18					0.522			0.960			

Q19					0.483			0.890			
Q17					0.495			0.809			
Q2									0.926		
Q3									0.891		
Q1									0.736		
Q43							0.449			0.865	
Q42							0.426			0.812	
Q44							0.430			0.756	
Q52											0.831
Q53											0.768
Q59											0.601

Extraction Method: Maximum Likelihood.

Rotation Method: Promax with Kaiser Normalization.

Table 4.10 The output of SPSS regarding the Factor Correlation Matrix

Factor Correlation Matrix

Factor	1	2	3	4	5	6	7	8	9	10	11
1	1.000	-0.082	0.332	0.234	0.260	0.501	0.140	0.130	-0.089	0.044	-0.047
2	-0.082	1.000	-0.148	0.059	-0.032	-0.060	0.236	0.042	0.072	0.303	0.158
3	0.332	-0.148	1.000	0.210	0.284	0.426	-0.159	0.088	-0.155	0.107	-0.169
4	0.234	0.059	0.210	1.000	0.272	0.217	0.085	0.251	-0.176	0.015	-0.217
5	0.260	-0.032	0.284	0.272	1.000	0.238	0.078	0.524	-0.213	0.045	-0.072
6	0.501	-0.060	0.426	0.217	0.238	1.000	0.173	0.169	-0.086	0.096	-0.177
7	0.140	0.236	-0.159	0.085	0.078	0.173	1.000	0.232	0.033	0.464	0.191
8	0.130	0.042	0.088	0.251	0.524	0.169	0.232	1.000	-0.124	0.148	0.032
9	-0.089	0.072	-0.155	-0.176	-0.213	-0.086	0.033	-0.124	1.000	0.026	0.188
10	0.044	0.303	0.107	0.015	0.045	0.096	0.464	0.148	0.026	1.000	-0.041
11	-0.047	0.158	-0.169	-0.217	-0.072	-0.177	0.191	0.032	0.188	-0.041	1.000

Extraction Method: Maximum Likelihood.

Rotation Method: Promax with Kaiser Normalization.

4.1.2. Confirmatory Factor Analysis (CFA)

CFA is the next step after the exploratory factor analysis to determine the factor structure of the dataset. In this calculation, the measurement model was developed and satisfactory goodness-of-fit was obtained. In this regard, Kline (1998) suggested that there should be a minimum of four tests that are acceptable and compatible with the model fit. **Table 4.11** shows that six out of eight values passed the threshold value; chi-square/df (cmin/df), CFI, AGFI, SRMR, RMSEA, and PCLOSE value. The results suggest that this structure fits the data well.

Furthermore, the validity and reliability tests for the CFA model in this study showed that the model had no validity concerns (**Table 4.12 and 4.13**). **Table 4.12** shows that the threshold value of CR should be greater than 0.7, AVE should be greater than 0.5, MSW should be less than AVE, and ASV should be less than AVE, where all the factors passed the threshold values. **Table 4.13** shows that in order to reach the state of "no validity concern" of the model, the value of the square root of AVE of each factor should be greater than the value of the inter-construct correlations (all values passed the threshold values). Based on the results of the validity and reliability tests, the measurement model was established as shown in **Figure 4.1.**

Table 4.11. Model fitting test (of all data)

Fit Index	Value of the model	Threshold Value	Acceptability
Chi-square/df (cmin/df)	2.317	<3 good; <5 sometimes permissible	+ (good)
p-value for the model	0.000	>0.05	-
CFI (Comparative fit index)	0.933	>0.95 great; >0.90 traditional; >0.80	+ (traditional)
GFI (Goodness of fit index)	0.863	sometimes permissible	-
AGFI	0.842	>0.95	+
SRMR	0.047	>0.80	+
RMSEA (Root means square	0.047	<0.09	+ (good)
error of approximation)	0.990	<0.05 good; 0.05-1.0 moderate; >1.0 bad	+
PCLOSE		>0.05	

Table 4.12. Reliability, convergent validity, and discriminant validity check of the model (of all data)

Factors	Reliability		Convergent Validity		Discriminant Validity			
	CR Value	CR > 0.7	AVE Value	AVE > 0.5	MSV	MSV < AVE	ASV	ASV < AVE
Behavior	0.90	OK	0.54	OK	0.26	OK	0.06	OK
Social Norm	0.91	OK	0.58	OK	0.10	OK	0.02	OK
Separation Intention	0.90	OK	0.66	OK	0.25	OK	0.06	OK
Environmental Awareness	0.90	OK	0.70	OK	0.07	OK	0.04	OK
Quality Knowledge	0.89	OK	0.66	OK	0.30	OK	0.06	OK

Feeling Intention	0.91	OK	0.73	OK	0.26	OK	0.07	OK
Government Provision	0.81	OK	0.52	OK	0.36	OK	0.06	OK
Pollution Knowledge	0.92	OK	0.79	OK	0.30	OK	0.05	OK
Habit	0.89	OK	0.73	OK	0.05	OK	0.02	OK
Government Information	0.86	OK	0.67	OK	0.36	OK	0.05	OK
Law Enforcement	0.78	OK	0.54	OK	0.05	OK	0.03	OK

The measurement model in **Figure 4.1** implies that there are 11 latent variables (represented by ellipses) and each latent variable has a correlation (more than 0.5 deg) with their own observed variables (represented by squares) (Jenatabadi and Ismail, 2014; Lu et al., 2006; Ardasheva, 2016). The information of connection in the measurement model includes the estimation of standardized regression weights, the estimation of squared multiple correlations and the estimation of correlations. The estimate of the standardized regression weights is distinguishable between each latent variable and its measurement. For example, when the value of question 79 refer to willingness of citizens to watch or read more news about environmental issues to increase their environmental awareness increases by one standard deviation, the value of behavior will increase by 0.74 of the standard deviation.

The estimate of the squared multiple correlations refer to the correlation that exists between the latent variables and their measurements. For instance, the predictors of Q75 ("I will obey the rules related to waste management because of my awareness") are estimated to explain 78% of its variance. Conversely, the market share error variance is approximately 22% of the market share variance itself. The estimates of correlations are detectable between latent variables. For example, the correlation between behavior and social norms is 0.08. Furthermore, the output of AMOS toward the data are shown by Tables 4.14-4.16. The Tables values determined the shape and type of measurement model.

Table 4.13. Discriminant validity by square root of AVE (square root of AVE > inter-construct correlation) (of all data)

Factors	**Discriminant Validity by Square Root of AVE (Square Root of AVE > Inter-construct Correlation)**										
	Behavior	**Social Norm**	**Sep. Intention**	**Environ. Awareness**	**Quality Knowledge**	**Feeling Intention**	**Govern. Provision**	**Pollution Knowledge**	**Habit**	**Govern. Information**	**Law Enforce.**
Behavior	**0.738**										
Social Norm	-0.082	**0.764**									
Sep. Intention	0.357	-0.118	**0.810**								
Environ. Awareness	0.242	0.065	0.203	**0.837**							
Qual. Knowledge	0.252	-0.018	0.291	0.268	**0.815**						
Feeling Intention	0.507	-0.075	0.495	0.236	0.250	**0.852**					
Govern. Provision	0.135	0.227	-0.087	0.104	0.096	0.146	**0.723**				
Pol. Knowledge	0.140	0.032	0.095	0.255	0.549	0.178	0.252	**0.889**			
Habit	-0.077	0.052	-0.150	-0.170	-0.212	-0.075	0.029	-0.119	**0.853**		
Govern. Information	0.080	0.312	0.084	-0.002	0.038	0.130	0.604	0.146	0.059	**0.817**	
Law Enforcement	-0.077	0.177	-0.176	-0.215	-0.096	-0.206	0.219	0.041	0.220	0.015	**0.736**

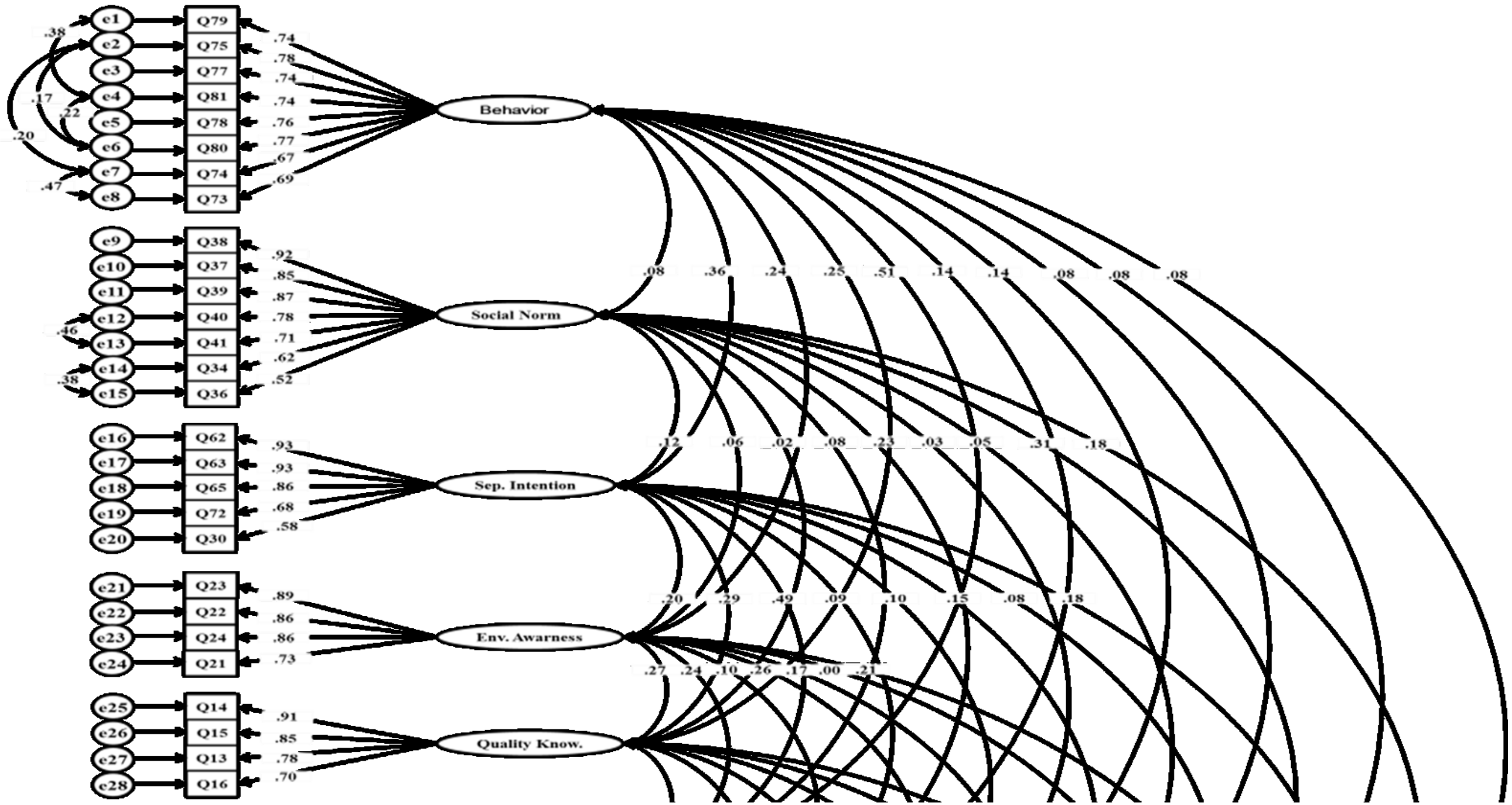


Figure 4.1. Measurement model of all data part.

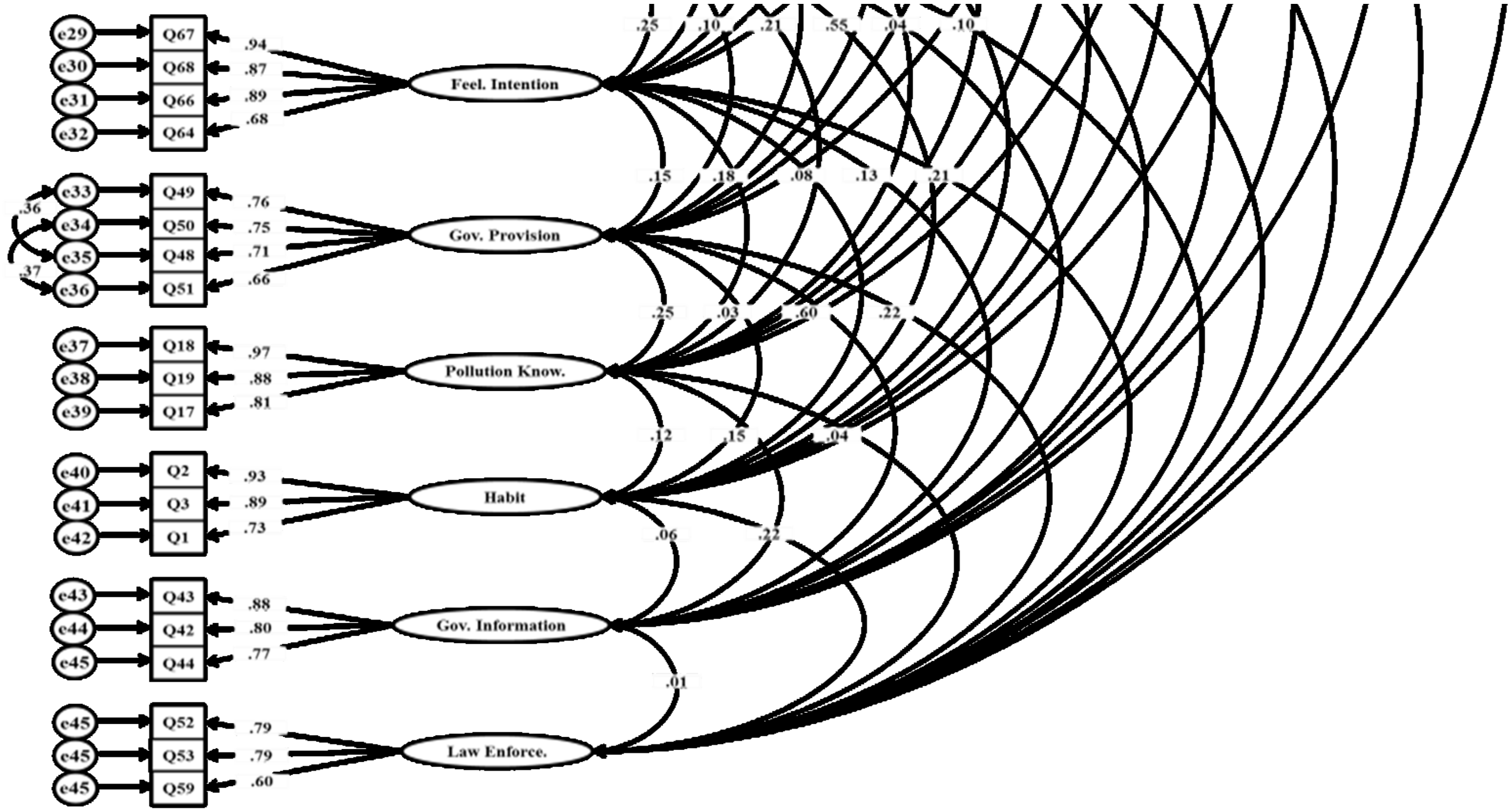


Figure 4.1. Measurement model of all data part 2.

Table 4.14 The output of AMOS regarding the correlation between factor-factor and error-error

			Estimate
Behavior	<-->	SocNor	-0.082
Behavior	<-->	IntentionA	0.357
Behavior	<-->	Envi.Awar	0.242
Behavior	<-->	Envi.KnowA	0.252
Behavior	<-->	IntentionB	0.507
Behavior	<-->	Gov.RoleA	0.135
Behavior	<-->	Envi.KnowB	0.14
Behavior	<-->	Habit	-0.077
Behavior	<-->	Gov.RoleB	0.08
Behavior	<-->	LawEnforcement	-0.077
SocNor	<-->	IntentionA	-0.118
SocNor	<-->	Envi.Awar	0.065
SocNor	<-->	Envi.KnowA	-0.018
SocNor	<-->	IntentionB	-0.075
SocNor	<-->	Gov.RoleA	0.227
SocNor	<-->	Envi.KnowB	0.032
SocNor	<-->	Habit	0.052
SocNor	<-->	Gov.RoleB	0.312
SocNor	<-->	LawEnforcement	0.177
IntentionA	<-->	Envi.Awar	0.203
IntentionA	<-->	Envi.KnowA	0.291
IntentionA	<-->	IntentionB	0.495
IntentionA	<-->	Gov.RoleA	-0.087
IntentionA	<-->	Envi.KnowB	0.095
IntentionA	<-->	Habit	-0.15
IntentionA	<-->	Gov.RoleB	0.084
IntentionA	<-->	LawEnforcement	-0.176
Envi.Awar	<-->	Envi.KnowA	0.268

Envi.Awar	<-->	IntentionB	0.236
Envi.Awar	<-->	Gov.RoleA	0.104
Envi.Awar	<-->	Envi.KnowB	0.255
Envi.Awar	<-->	Habit	-0.17
Envi.Awar	<-->	Gov.RoleB	-0.002
Envi.Awar	<-->	LawEnforcement	-0.215
Envi.KnowA	<-->	IntentionB	0.25
Envi.KnowA	<-->	Gov.RoleA	0.096
Envi.KnowA	<-->	Envi.KnowB	0.549
Envi.KnowA	<-->	Habit	-0.212
Envi.KnowA	<-->	Gov.RoleB	0.038
Envi.KnowA	<-->	LawEnforcement	-0.096
IntentionB	<-->	Gov.RoleA	0.146
IntentionB	<-->	Envi.KnowB	0.178
IntentionB	<-->	Habit	-0.075
IntentionB	<-->	Gov.RoleB	0.13
IntentionB	<-->	LawEnforcement	-0.206
Gov.RoleA	<-->	Envi.KnowB	0.252
Gov.RoleA	<-->	Habit	0.029
Gov.RoleA	<-->	Gov.RoleB	0.604
Gov.RoleA	<-->	LawEnforcement	0.219
Envi.KnowB	<-->	Habit	-0.119
Envi.KnowB	<-->	Gov.RoleB	0.146
Envi.KnowB	<-->	LawEnforcement	0.041
Habit	<-->	Gov.RoleB	0.059
Habit	<-->	LawEnforcement	0.22
Gov.RoleB	<-->	LawEnforcement	0.015
e7	<-->	e8	0.474
e12	<-->	e13	0.454
e34	<-->	e36	0.369

e1	<-->	e4	0.376
e14	<-->	e15	0.376
e33	<-->	e35	0.355
e2	<-->	e7	0.204
e4	<-->	e6	0.216
e2	<-->	e6	-0.172

Table 4.15 The output of AMOS regarding the standardized regression weights between factors and the questions

			Estimate
Q79	<---	Behavior	0.736
Q75	<---	Behavior	0.779
Q77	<---	Behavior	0.738
Q81	<---	Behavior	0.745
Q78	<---	Behavior	0.76
Q80	<---	Behavior	0.771
Q74	<---	Behavior	0.673
Q73	<---	Behavior	0.692
Q38	<---	SocNor	0.918
Q37	<---	SocNor	0.846
Q39	<---	SocNor	0.867
Q40	<---	SocNor	0.784
Q41	<---	SocNor	0.708
Q34	<---	SocNor	0.623
Q36	<---	SocNor	0.523
Q62	<---	IntentionA	0.931
Q63	<---	IntentionA	0.935
Q65	<---	IntentionA	0.864
Q72	<---	IntentionA	0.677
Q30	<---	IntentionA	0.58
Q23	<---	Envi.Awar	0.889
Q22	<---	Envi.Awar	0.86

Q24	<---	Envi.Awar	0.862
Q21	<---	Envi.Awar	0.729
Q14	<---	Envi.KnowA	0.914
Q15	<---	Envi.KnowA	0.849
Q13	<---	Envi.KnowA	0.78
Q16	<---	Envi.KnowA	0.7
Q67	<---	IntentionB	0.944
Q68	<---	IntentionB	0.866
Q66	<---	IntentionB	0.894
Q64	<---	IntentionB	0.682
Q49	<---	Gov.RoleA	0.76
Q50	<---	Gov.RoleA	0.752
Q48	<---	Gov.RoleA	0.714
Q51	<---	Gov.RoleA	0.663
Q18	<---	Envi.KnowB	0.966
Q19	<---	Envi.KnowB	0.884
Q17	<---	Envi.KnowB	0.809
Q2	<---	Habit	0.929
Q3	<---	Habit	0.889
Q1	<---	Habit	0.729
Q43	<---	Gov.RoleB	0.879
Q42	<---	Gov.RoleB	0.801
Q44	<---	Gov.RoleB	0.768
Q52	<---	LawEnforcement	0.794
Q53	<---	LawEnforcement	0.795
Q59	<---	LawEnforcement	0.603

Table 4.16 The output of AMOS regarding the variances of factors and errors

	Estimate	S.E.	C.R.	P
Behavior	0.145	0.014	10.159	***
SocNor	0.439	0.03	14.537	***
IntentionA	0.409	0.027	15.002	***
Envi.Awar	0.206	0.015	13.619	***
Envi.KnowA	0.285	0.02	14.197	***
IntentionB	0.205	0.013	15.321	***
Gov.RoleA	0.347	0.038	9.219	***
Envi.KnowB	0.355	0.022	15.775	***
Habit	0.292	0.021	14.203	***
Gov.RoleB	0.365	0.029	12.799	***
LawEnforcement	0.394	0.04	9.956	***
e1	0.123	0.008	15	***
e2	0.104	0.008	13.611	***
e3	0.132	0.009	15.029	***
e4	0.111	0.008	14.681	***
e5	0.106	0.007	14.661	***
e6	0.105	0.008	13.596	***
e7	0.144	0.009	15.799	***
e8	0.146	0.009	15.591	***
e9	0.082	0.008	10.25	***
e10	0.148	0.011	14.047	***
e11	0.148	0.011	13.336	***
e12	0.203	0.013	15.298	***
e13	0.244	0.015	16.036	***
e14	0.336	0.02	16.607	***
e15	0.432	0.026	16.937	***
e16	0.063	0.006	10.525	***
e17	0.06	0.006	10.128	***
e18	0.123	0.009	14.458	***
e19	0.257	0.015	16.613	***
e20	0.293	0.017	16.944	***
e21	0.055	0.005	11.005	***
e22	0.064	0.005	12.579	***
e23	0.066	0.005	12.499	***
e24	0.116	0.007	15.565	***
e25	0.056	0.006	8.685	***
e26	0.1	0.008	12.737	***
e27	0.137	0.009	14.76	***
e28	0.183	0.012	15.818	***
e29	0.025	0.003	8.268	***

e30	0.061	0.004	13.98	***
e31	0.047	0.004	12.635	***
e32	0.134	0.008	16.502	***
e33	0.254	0.026	9.912	***
e34	0.204	0.02	10.403	***
e35	0.264	0.024	11.2	***
e36	0.275	0.022	12.65	***
e37	0.025	0.006	4.302	***
e38	0.08	0.007	12.196	***
e39	0.135	0.009	15.175	***
e40	0.046	0.008	5.913	***
e41	0.063	0.007	9.032	***
e42	0.16	0.01	15.523	***
e43	0.107	0.012	8.601	***
e44	0.202	0.016	12.522	***
e45	0.209	0.015	13.605	***
e46	0.232	0.025	9.216	***
e47	0.245	0.027	9.171	***
e48	0.311	0.021	14.957	***

4.1.3. Structural Model

The structural model was constructed after the measurement model was developed. The goodness of fit indices of the model were cmin/df= 2.369, CFI= 0.983, GFI= 0.985, AGFI= 0.955, SRMR= 0.032, RMSEA= 0.047, and PCLOSE= 0.573 indicating that the model fits the data considerably well and the measures of fit are acceptable. The structural model is shown in **Figure 4.2**. **Figure 4.2** shows that seven factors influence the "separation intention" factor ("law enforcement" factor has no effect) and five factors influence the "feeling intention" ("pollution knowledge", "government provision", and "habits" have no effect). The **Figure 4.2** can be interpreted as:

- The behavior of Padang citizens related to the eagerness of learning how to consistenly separate the garbage well according to the rules is affected by social norms, environmental awareness, quality knowledge, pollution knowledge, government provisions, government information, and habits of citizens. Furthermore, the most influential factors on citizen behavior related to the separation intention were the "government information" factor which had highest standardized regression weight (0.37), the "government provision" factor (0.33), and the "quality knowledge" factor (0.32), followed by "environmental awareness" factor (0.19), the "social norms" factor (0.16), the "pollution knowledge" factor (0.10), and the "habit" factor (0.09).

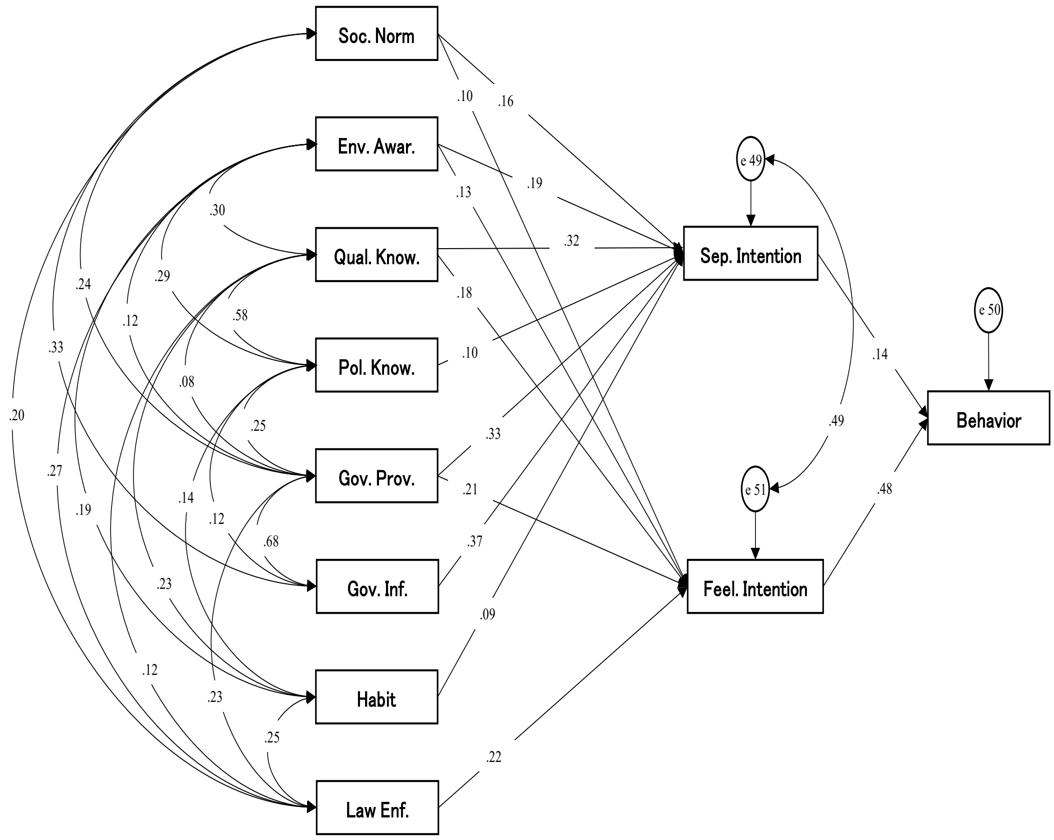


Figure 4.2. Structural model of all data.

- The behavior of Padang citizens related to the eagerness to increase environmental awareness, discipline, and sensitivity is affected by social norms, environmental awareness, quality knowledge, government provision, and law enforcement. In this case, the most influential factors on citizen behavior related to the intention were the "law enforcement" factor which with the highest standardized regression weight (0.22), the "government provision" factor (0.21), and the "quality knowledge" factor (0.18), followed by the "environmental awareness" factor (0.13) and the "social norms" factor (0.10).

Furthermore, Tables 4.17-4.21 are displayed below to show the output of AMOS toward the establishment of structural model.

Table 4.17 The output of AMOS toward the structural model establishment regarding coefficient

			Estimate	Standard Error	Statistic Test	Probability	Lable
Intention1	<---	Soc.Nor	-.158	.037	-4.308	***	
Intention2	<---	Soc.Nor	-.066	.026	-2.505	.012	
Intention1	<---	Env.Awar	.269	.054	4.946	***	
Intention2	<---	Env.Awar	.129	.040	3.188	.001	
Intention1	<---	Env.Know1	.384	.053	7.270	***	
Intention2	<---	Env.Know1	.156	.033	4.705	***	
Intention1	<---	Env.Know2	-.112	.043	-2.612	.009	
Intention1	<---	Gov.Role1	-.391	.057	-6.890	***	
Intention2	<---	Gov.Role1	.175	.033	5.328	***	
Intention1	<---	Gov.Role2	.406	.049	8.291	***	
Intention1	<---	Habit	-.106	.039	-2.739	.006	
Intention2	<---	LawEnforcement	-.173	.028	-6.244	***	
Behavior	<---	Intention1	.080	.023	3.483	***	
Behavior	<---	Intention2	.390	.032	12.128	***	

Table 4.18 The output of AMOS toward the structural model establishment regarding standardization factor

			Estimate
Intention1	<---	Soc.Nor	-.162
Intention2	<---	Soc.Nor	-.096
Intention1	<---	Env.Awar	.189
Intention2	<---	Env.Awar	.127
Intention1	<---	Env.Know1	.317
Intention2	<---	Env.Know1	.182
Intention1	<---	Env.Know2	-.104
Intention1	<---	Gov.Role1	-.330
Intention2	<---	Gov.Role1	.208
Intention1	<---	Gov.Role2	.370
Intention1	<---	Habit	-.089
Intention2	<---	LawEnforcement	-.222
Behavior	<---	Intention1	.137
Behavior	<---	Intention2	.477

Table 4.19 The output of AMOS toward the structural model establishment regarding covariance

			Estimate	Standard Error	Statistic Test	Probability	Lable
Env.Awar	<-->	Env.Know1	.066	.009	7.170	***	
Env.Know1	<-->	Env.Know2	.173	.014	12.584	***	
Env.Know2	<-->	Gov.Role1	.077	.011	7.033	***	
Gov.Role1	<-->	Gov.Role2	.203	.014	14.435	***	
Habit	<-->	LawEnforcement	.074	.011	6.549	***	
Gov.Role1	<-->	LawEnforcement	.069	.009	7.892	***	
Env.Know1	<-->	LawEnforcement	-.036	.009	-3.826	***	
Env.Awar	<-->	LawEnforcement	-.066	.010	-6.826	***	
LawEnforcement	<-->	Soc.Nor	.071	.013	5.396	***	
Env.Know2	<-->	Habit	-.042	.011	-3.687	***	
Env.Know1	<-->	Habit	-.062	.011	-5.736	***	
Env.Awar	<-->	Habit	-.042	.009	-4.588	***	
Env.Know2	<-->	Gov.Role2	.041	.010	4.019	***	
Gov.Role2	<-->	Soc.Nor	.121	.015	8.044	***	
Env.Know1	<-->	Gov.Role1	.021	.008	2.688	.007	
Env.Awar	<-->	Gov.Role1	.026	.007	3.917	***	
Gov.Role1	<-->	Soc.Nor	.082	.013	6.240	***	
Env.Awar	<-->	Env.Know2	.072	.010	7.081	***	
e49	<-->	e51	.108	.010	10.913	***	

Table 4.20 The output of AMOS toward the structural model establishment regarding correlation coefficient

			Estimate
Env.Awar	<-->	Env.Know1	.297
Env.Know1	<-->	Env.Know2	.583
Env.Know2	<-->	Gov.Role1	.253
Gov.Role1	<-->	Gov.Role2	.684
Habit	<-->	LawEnforcement	.252
Gov.Role1	<-->	LawEnforcement	.232
Env.Know1	<-->	LawEnforcement	-.124
Env.Awar	<-->	LawEnforcement	-.270
LawEnforcement	<-->	Soc.Nor	.197
Env.Know2	<-->	Habit	-.141
Env.Know1	<-->	Habit	-.234
Env.Awar	<-->	Habit	-.186
Env.Know2	<-->	Gov.Role2	.124
Gov.Role2	<-->	Soc.Nor	.334

			Estimate
Env.Know1	<-->	Gov.Role1	.077
Env.Awar	<-->	Gov.Role1	.115
Gov.Role1	<-->	Soc.Nor	.245
Env.Awar	<-->	Env.Know2	.285
e49	<-->	e51	.494

Table 4.21 The output of AMOS toward the structural model establishment regarding variance

		Estimate	Standard Error	Statistic Test	Probability	Lable
Env.Awar		.189	.011	17.560	***	
Env.Know1		.262	.015	17.543	***	
Env.Know2		.335	.019	17.566	***	
Gov.Role1		.275	.015	18.300	***	
Gov.Role2		.319	.018	17.484	***	
Habit		.269	.015	17.459	***	
LawEnforcement		.320	.018	17.646	***	
Soc.Nor		.409	.023	17.523	***	
e49		.298	.017	17.436	***	
e51		.160	.009	17.436	***	
e50		.089	.005	17.436	***	

4.2.Social Evaluation by Scoring System

4.2.1. University Students

For the survey of the university students, the authors collected data from the environmental engineering students (41 respondents) who get an intense environmental education and expected to have an improved understanding of the environmental problems, and form students of other departments (259 respondents). These two data sets were used to determine the difference between the mindsets of the students who get an environmental education and those who are not as knowledgeable about environmental issues. Logically, environmental engineering students are expected to have most positive view on environmental conservation because of their educational background. However, among the numbers of students who responded positively the responses to 81 questions in the questionnaire counter-proved that assumption. The scores of the environmental engineering students were not different from the scores of non-environmental engineering students. Even in the factor “habits”, the value of the responses of environmental engineering students were the worst compared to the students from the other departments. This finding can be explained by the structural model that suggests that the theoretical knowledge of environmental engineering students does not necessarily transition to practical actions, need many factors to become an established behavior. The most influential factors to encourage the actions to become behavior based on the structural model were found to be “role of government” (“government provisions” and “government information” factor) and the “law enforcement” factors. The “knowledge” factor is only the third influential factor suggesting that “environmental knowledge” itself is not sufficient unless it is supported by the “role of government” and “law enforcement”. The detailed explanation of the comparisons between the behaviors of environmental engineering students and others is presented in **Table 4.22**.

Table 4.22. Survey conditions and the comparisons between the environmental engineering students from other departments

No.	Factor	Response		Comparison between environmental engineering students and students from other departments	
		Condition	Meaning	Condition	Meaning
1	Habit	1. For questions number 1-6 and 8, 83-98% of students gave positive answer	1. "Habit" of students related to waste disposal is very good	Level of positive answers of environmental engineering students is the lowest	"Habit" of environmental engineering students is the worst compare to students from other departments
		2. For questions number 7, 9, and 10 65-71% of students gave positive answer	2. "Habit" of students related to waste separation is fair		
2	Environmental Knowledge	93%-100% of students gave positive answer	"Environmental Knowledge" of students is very good	"Environmental Knowledge" of environmental engineering students is just in the average level (not the highest, not the lowest)	"Environmental Knowledge" of environmental engineering students is not so different with students from other departments.
3	Environmental Awareness	93%-100% of students gave positive answer	"Environmental Awareness" of students is very good	"Environmental Awareness" of environmental engineering students is just in the average level	"Environmental Knowledge" of environmental engineering students is not so different with students from other departments.
4	Social Norm	43%-58% of student gave positive answer	Influence of other people`s behavior to oneself is bad (low)	"Social Norm" effect on students of environmental engineering students is just in the average level	"Social Norm" effect on environmental engineering students is not so different with students from other departments.

5	Role of Government	13-42% of students gave positive answer	"Role of Government" is very bad	Impression about "Role of Government" of environmental engineering students is in the average level	Impression about "Role of Government" of environmental engineering students is not so different with students from other departments.
6	Law Enforcement	1. For questions number 52-53, 55, 57, and 59-61, 77-90% of students gave positive answer	students have good awareness to obey the law	The awareness of environmental engineering students to obey the law is in the average level	The awareness of environmental engineering students to obey the law is not so different with students from other departments
		2. For question number 54, 56, and 58, 51-65% of students do not know about waste management law	Student did not recognize and get socialization of the waste management law		
7	Intention	94%-98% of students gave positive answer	"Intention" of students for pro-environmental behavior is very good	"Intention" level of environmental engineering students is just in the average level	"Intention" of environmental engineering students to do pro-environmental behavior is not so different with students from other departments.
8	Behavior	91%-98% of students gave positive answer	"Behavior" of students related to environmental behavior is very good	"Behavior" level of environmental engineering students is just in the average level	"Behavior" level of environmental engineering students related to environmental behavior is not so different with students from other departments.

4.2.2. General Public (Non-Students)

The general public data consist of respondents with many backgrounds but do not include students; thus that dataset is different from the students' dataset. The general public (non-students) sample includes 153 males and 156 females (total 309 respondents). The age range of the respondents who participated in the survey is between19-70. The sample includes civil servants (44 people), entrepreneurs (99 people), housewives (87 people), traders (46 people), private company officers (12 people), retired of civil servants (9 people), teachers (4 people), fishermen (2 people), a consultant (1 person), a nurse (1 person), a state enterprise officer (1 person), a lecturer (1 person), and 2 people who did not want to disclose their occupation. Income per household is in the range of 1-12 million Indonesian Rupiah (IDR) per month. About 90% of the respondents are married (278 people) and 10% are not (31 people). About 32% of the respondents have two children, 24% of the respondents have three children, 12% of the respondents have one child and no child, 11% of the respondents have four children, 6% of the respondents have five children, 3% of the respondents have six children, and 1% of the respondents have seven children.

Table 4.23. Survey conditions and the comparisons between the public and student survey responses

No	Factor	Response		Comparison between public and students	
		Condition	Meaning	Condition	Meaning
1	Habit	1. For questions number 1-4 and 8, 89-97% of respondents gave positive answer	"Habit" of public related to waste disposal is very good	Value of public response is lower than students	"Habit" of public is worse than students
		2. For question number 5 and 6, 67-74% of respondents gave fair answer	"Habit" of public related to littering is fair		
		3. For question number 7, 9, and 10, 0nly 28-49% of respondents gave positive answer	"Habit" of public related to waste separation is very bad		
2	Environmental Knowledge	95-98% of respondents gave positive answer	"Environmental knowledge" of respondent is very good	Value of public response is relatively same with student	"Environmental Knowledge" of public is relatively same with student
3	Environmental Awareness	1. For questions number 1-9 and 11, 87-100% of respondents gave positive answer	"Environmental awareness" of respondent related to discipline and sensitivity increasing to the environment is very good	Value of public response is lower than students	"Environmental Awareness" of public is worse than students
		2. For questions number 10, only 69% of respondents gave positive answer	"Environmental awareness" of respondent related to awareness to learn the waste separation is fair		
4	Social Norm	24-59% of respondents gave positive answer	Influence of other people`s behavior to oneself is bad	Value of public response is lower than students	"Social Norm" effect is more influential for students than public
5	Role of Government	9-31% respondent gave positive answer	"Role of government" to society is very bad	Value of public response is lower than students	Impression of the "role of government" of public to the government is worse than students

6	Law Enforcement	1. For questions number 52, 53, 55, 57, and 59-61, 80% of respondents gave positive answer	Public has high awareness to obey the law	Value of public response is higher than students	The awareness of public to obey the laws is better than students
		2. For question number 54, 56, and 58, 24% of respondents do not know and did not get socialization about waste management law	Public or students did not recognize and get socialization of the waste management law		
7	Intention	1. For question number 64, 66-71, 93-99% of public gave positive answer	"Intention" of public related to waste treatment is very good	Value of answer of Public Society is lower than students	"Intention" level of public is worse than students
		2. For question number 62, 63, and 65, 61-63% of Public Society gave positive answer	"Intention" of public related to waste separation is fair		
8	Behavior	1. For question number 73-75,77-81, 89-97% of public gave positive answer	"Behavior" of public related to waste treatment is very good	Value of public response is lower than students	"Behavior" level of public is worse than students
		2. For question number 62, 63, and 65, 61-63% of public gave positive answer	"Behavior" of public related to waste separation is fair		

The results show that the general has worse environmental behavior compared to the students. Only in the “law enforcement” factor, the public gets a better score than the students. Many people are not very knowledgeable about environmental problems or their non-conducive environments may form their negative environment view, different from the student’s conducive and positive environment (university environment). The details of the conditions and the comparison of the results between for the students and the general public are provided in **Table 4.23**.

4.3.Findings from SEM, Scoring System, and Proposed Model

4.3.1. Findings

The hypotheses of the predictive model were supported by the result presented in section 3; H1: There is a causal relationship between intention and behavior; H2: The intention degree is determined by several factors, i.e., social norms, environmental awareness, environmental knowledge, role of government, habits, and law enforcement. However, there are some differences between the results of the structural model (**Fig. 4.2**) and the predictive model (**Fig. 3.1**). The "intention" factor was divided into two factors named "separation intention" and "feeling intention", the "environmental knowledge" factor was divided into two factors called "quality knowledge" and "pollution knowledge", the "role of government" factor was divided into two factors named "government provision" and "government information".

Fig. 4.2 shows that the causal relationship between intention and behavior is significant. Therefore, the behavior towards the current and possible modification (separation-based system) of the municipal solid waste system" is considerably improved by the increased value of "intention". However, unique result found that the correlation coefficient between the "feeling intention" (related to the willingness to increase positive environmental feelings), and behavior (degree = 0.48) is higher than the correlation coefficient between the "separation intention" (related to waste separation) and behavior (degree = 0.14). It can be said that the positive environmental behavior of the citizens can be enhanced by increasing the positive environmental feelings rather than increasing the willingness to separate wastes. Padang citizens have not been familiar with waste separation until recently; thus the willingness to separate wastes is relatively low compared to the willingness to increase positive environmental feelings.

Table 4.24. Findings of social evaluation by scoring system

No.	Factor	Social Evaluation	
		Students	**Public Society**
1	Environmental Knowledge	Very Good (A)	Very Good (A)
2	Environmental Awareness	Very Good (A)	Very Good (A) related to discipline and sensitivity increasing to the environment, Fair (C) related to awareness to learn the waste separation
3	Intention	Very Good (A)	Very Good (A) related to waste treatment, Fair (C) related to waste separation
4	Behavior	Very Good (A)	Very Good (A) related to waste treatment, Fair (C) related to waste separation
5	Habit	Very Good (A) related to waste disposal, Fair (C) related to waste separation	Very Good (A) related to waste disposal, Fair (C) related to littering, Very Bad (E) related to waste

			separation
6	Social Norm	Bad (D)	Bad (D)
7	Role of Government	Very Bad (E)	Very Bad (E)
8	Law Enforcement	Good (B)	Good (B)
AVERAGE		C	

Assumed that:
1. (A: very good) is when 85-100% of respondents gave positive answer to the questions in a factor,
2. (B, good) is when 75-84% of respondents gave positive answer to the questions in a factor,
3. (C, fair) is when 60-74% of respondents gave positive answer to the questions in a factor,
4. (D, bad) is when 50-59% of respondents gave positive answer to the questions in a factor, and
5. (E, very good) is when 0-49% of respondents gave positive answer to the questions in a factor,

The social evaluation results are summarized in **Table 4.24**. The average value of the pro-environmental behavior of citizens is C (fair) meaning that current social conditions are not suitable for the modification of the waste management system successfully. The "waste separation willingness" behavior was also at the C level suggesting that the modification of solid waste management system into a separation-based system has not been well accepted by citizens. If the authorities still proceed with the system modification despite citizens' dis-approval, the implementation of the system is likely to be abortive. Consequently, the government should prioritize designing a program to educate the citizens and improve their understanding and behavior before modifying the waste management system for the successful implementation of future systems.

4.3.2. Proposed Model

This study proposes a method to increase citizen's intention and willingness related to pro-environmental behavior by establishing an institution run by the local government. The proposed model designing needs to start from the three-most influential factors as a core idea. In accordance with the structural model, three-most influential factors on the modification of behavior were the "role of government" ("government provision" and "government information" factor), "law enforcement", and "knowledge". The power and influence of local government makes them an ideal candidate to manage the proposed model and facilitate the control and the enforcement of regulations. A strong government would be effective in changing citizens' behavior. The government as an executive body of a country that has a duty to regulate the course of the law may force the citizens to obey the law (environmental related law) in a good way. The government needs to create new policy about application of waste-recycling system in Padang city's waste management through the proposed model. Forcing the citizens in a good way can be done by creating a new waste management system which gives direct mutual benefits to citizens and government so that citizens will practice the policy with pleasure without feeling compelled.

"Knowledge" is the third most influential factor after the "role of government". Improved "environmental knowledge" would increase environmental awareness and positively change the social norms and habits of citizens. Therefore, the environmental "knowledge", especially the knowledge about waste separation is the key to behavior modification. However, citizens who are newbie to the waste separation idea need encouragement and incentives such as micro credit finance, waste credit card, waste bank, environmental events and games, recycled waste craft, and fertilizer sales to be willing to get the necessary education.

Proposal of the new system is including SW bank method but adding some other activities to attract citizens` participation. However, not like previous SW bank which is run by community, the proposed model in this study is designed to be run by government to make the system more organized and integrated. The proposed model is called "waste FUN" system. This model has three basic elements which are "fund", "utilization", and "nurture" (FUN) and have to be built in good collaboration to empower and encourage citizens to change the previous behavior to be pro-environmental behavior. The programs in the system have to be carried out continuously to form new behavior (pro-environmental behavior) in society. It might take long time to change, but Phillippa et al. said that it takes an average 66 days (ranged from 18-254 days) to form a new habit. Therefore, the proposed model is expected to change citizen`s habits within at least one year. The basic concept workflow of the system is illustrated in **Figure 4.3**. Detail proposal about waste FUN system as follows:

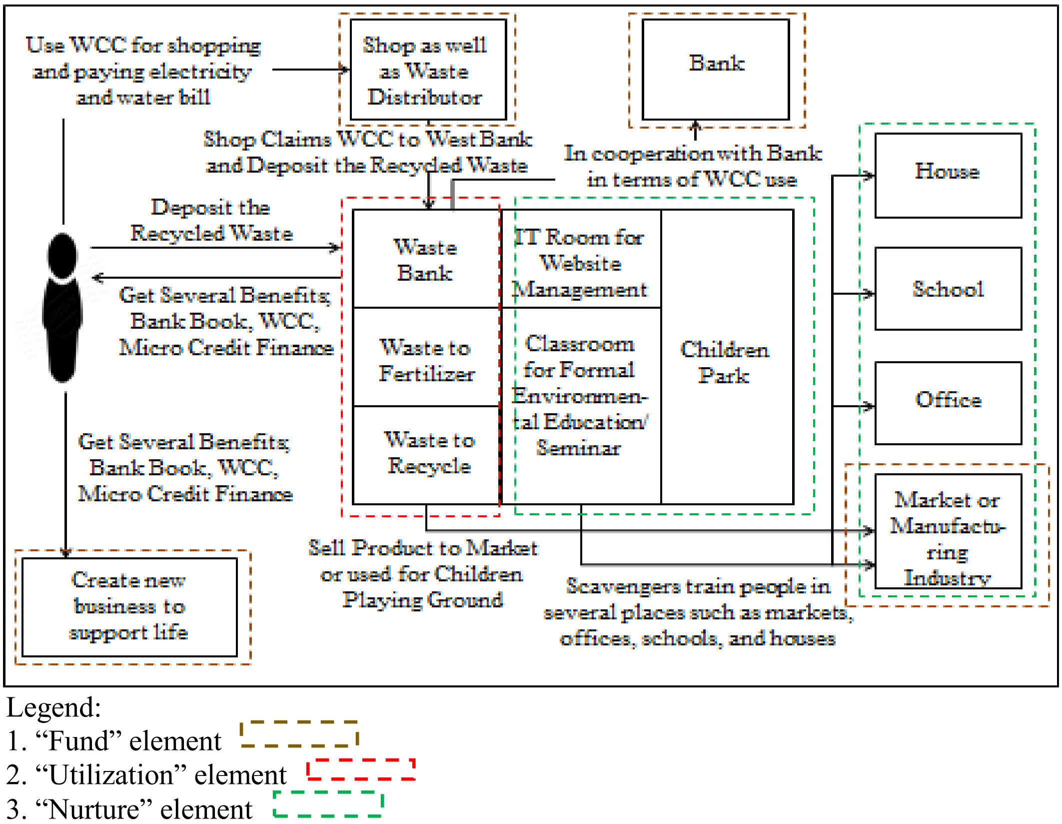


Figure 4.3. Basic concept and workflow of the waste FUN.

a. Nurture ("N" element)

The "N" element is the most important component to run other elements for success implementation of waste FUN system because "knowledge" factor is the third-most influential factor in behavior modification after "role of government" and "law enforcement" factor. Nurture in waste FUN system has meaning of the process of caring for encouraging the growth and development of citizens` education toward waste separation in the new system in fun ways. There are five activities that might be done such as:

- Waste management website contains waste separation related information (information of how to separate waste well, information of many kinds of waste classification, etc.) as well as interactive media that can connect members to the institution directly to report or ask anything.
- Children park is a playing site for children made by recycled product as tool to acquaint environmental education since early stage to children who

are expected to have high environmental awareness in their future.

- Environmental event & game is a fun activity to attract citizens to give attention to waste separation and environment by making contests such as coloring or drawing of environment related competition, contest of recycle product creation, etc.
- Environmental seminar is an activity of giving formal environmental education to many institutions such as offices, schools while "scavenger to trainer" is one to one seminar to every household. These two kind activities have same content but different method to reach the citizens. The trainer of "environmental seminar" might be from lecturers or other experts because it is formal sector but the trainer of "scavenger to trainer" is scavenger because it is informal sector that prefers direct application from housewives. The scavenger trainer is a way to restore their jobs in a better way because of the establishment of the new system. The scavengers will be trained first by lecturers or related experts before being an informal trainer in the new system.

b. Utilization ("U" element)

Utilization in waste FUN system has meaning of the process to utilize waste into valuable thing for citizens, government, and environment. There are three expected activities in this element:

- Waste bank is an activity of citizens depositing their separated waste to the new system and get money as a reward written in the bank book similar to conventional bank does. Name of the costumer will be written as a member and the reward can be cashed directly or be written in bank book as a saving.
- Waste to fertilizer is an effort to treat green/wet waste to be fertilizer by aerobic or anaerobic decomposing which can be sold to market as income for the institution.
- Waste to recycle is an effort to treat the recyclable waste (plastic, glass, paper, metal, etc.) into plastic pellets, and various product and craft which

can be sold to market or manufacturing industries for institution`s income and also used for children park.

c. Fund ("F" element)

Fund in waste FUN system has meaning of the process to attract citizens to separate waste in monetary term. There are two prospective items in this element:

- Waste credit card (WCC) is one of many ways to attract citizen to be a member of waste bank by giving easiness in shopping and water or electricity bills payment. The institution of waste FUN system will establish cooperation with many shopping centers and department which handle water and electricity bills to make WCC be able to be used effectively and comfortably. For the beginning enactment of WCC, the institution can build cooperation with conventional banks. The WCC is a way to attract rich citizens in waste FUN system`s activities.
- Micro credit finance (MCF) gives venture capital loan for jobless who want to establish new business with 0% interest and depositing separated waste periodically is procedure to pay the debts. Within a certain period, if the new business gets surplus, there will be profit sharing as remuneration to the institution based on agreement of both parties just like Islamic bank concept. Furthermore, the implementation of micro credit finance needs mutual trust and strict monitoring because instead of profit for the institution, the main purpose is to help jobless citizens to create new job to improve their living standards. The MCF is a way to attract poor citizens in waste FUN system`s activities.

4.4. SWOT Analysis of Waste FUN System

In order to describe situation being faced by the waste FUN system which can assist the preparation of proper system plan to achieve the goals, whether short term goals and long term goals, the SWOT analysis of the waste FUN system is needed. The analysis as well as strategy to solve each part is shown in **Table 4.25**. **Table 4.25** shows six points of "strengths" and "opportunities" of the system while two points of "weaknesses" and three points of "threats". Those "plus" points can be developed to be better and "minus" points can be reduced and eliminated by various collaborated strategies of each part such as at point number one of “weaknesses” and “opportunities”, the solution or strategy to solve high investment and operational cost is to increase involvement of private sectors for the funding deficiency and sustainability. The Strengths and opportunities faced by the waste FUN system are stronger than the weaknesses and threats points which means that various possible problems happened are expected to be solved by the collaborated strategies of each part. Therefore, it can be said that the waste FUN system is feasible to be implemented in Padang society in accordance with SWOT analysis.

4.5.MFA and LCA evaluation of waste FUN system

Analysis of waste flow of waste FUN system is proposed to be developed in Padang city. The city generates about 700 tones waste per day consisting of 58% wet waste and 42% dry waste (Raharjo et al., 2015). In this research, it is assumed that all citizens participate on the waste FUN system’s recycling activities. Furthermore, the system is assumed to be able to convert all of wet waste into fertilizer (with 50% mass depreciation) and 92% of dry waste into recycling product and marketable product. Eventually, there is only 3.36% of total waste generated per day sent to landfill. It means that the waste FUN system can reduce until 96.64% of the use of landfill. The significant reduction number of landfill used gives a great potential problem solving for a limited capacity of city’s landfill. Accordingly, the waste FUN system implementation might be an effective way to establish city’s sustainable waste management. Detailed diagram of waste flow of waste FUN system can be seen in **Figure 4.4**.

Moreover, LCA was also conducted in this study to see environmental effect that may be caused by the existence of the waste FUN system compared to current waste management system in Padang city which is shown in **Figure 4.5**. From LCA of the waste FUN system, there is more impact of air pollution by transportation and machine usage than LCA of current waste management which does not have waste treatment in the loop (dumping on site only). However, there are three impacts that can be eliminated by the presence of waste FUN system which are land pollution, water pollution, and massive land use where those three impacts

Table 4.25. SWOT matrix analysis on proposed model (the waste FUN system)

		INTERNAL FACTORS	
		STRENGTH (S)	**WEAKNESSES (W)**
		1. Integrated institution (various programs contained within one institution) 2. Many fun programs attracting citizen 3. New job opportunities 4. Many benefits can be earned by members related to money and comfort of daily activities 5. Relatively easier control by local government because it is a governmental institution 6. improved livelihood of members by providing capital to open a new business	1. Relatively high investment and operational cost 2. Need trained and skilled personnel
EXTERNAL FACTORS	**OPPORTUNITIES (O)**	**Strategy: S↔O**	**Strategy: W↔O**
	1. Global awareness of waste separation based system concept in the world 2. Support from home industries related to recycled waste craft 3. A large number of citizens as potential human resources 4. Support from non-governmental organization (NGO) 5. Support from conventional bank 6. Support from shopping centers	1. Build a mutually beneficial cooperation with a pilot area for waste separation (e.g. Kawasaki city in Japan) 2. Establish recycled waste based playing ground for children (educational games and facilities) 3. Open recruitment for waste FUN personnel for citizens, especially for scavengers that lose their jobs because of this waste FUN system 4. Provide good communication and collaboration with NGO in various fields such as research, funding, and operational matters. 5. Produce a waste credit card (WCC) which functions similarly to a conventional credit card 6. Promote WCC as a payment tool in several shopping centers and governmental departments handling water and electricity bills	1. Increase the involvement of private sectors for the funding deficiencies and sustainability 2. Organize intensive training programs for personnel
	THREATS (T)	**Strategy: S↔T**	**Strategy: W↔T**
	1. Low awareness of waste separation by citizens 2. Long distances between citizen residences and waste treatment 3. Lack of information provided to citizen related to waste FUN system	1. Design fun pro-environmental events or activities involving citizens 2. Provide waste pick-up services to member homes in accordance with applicable regulations 3. Provide several methods for citizen to gain the information, e.g., waste management website and environmental seminars	1. Send the scavengers as trainers to persuasively change the behavior and mindset of those that work at home 2. Create several collection branches for waste banks in remote locations 3. Communication with a city program in a foreign country, such as Japan, which has successfully implemented a waste separation-based system

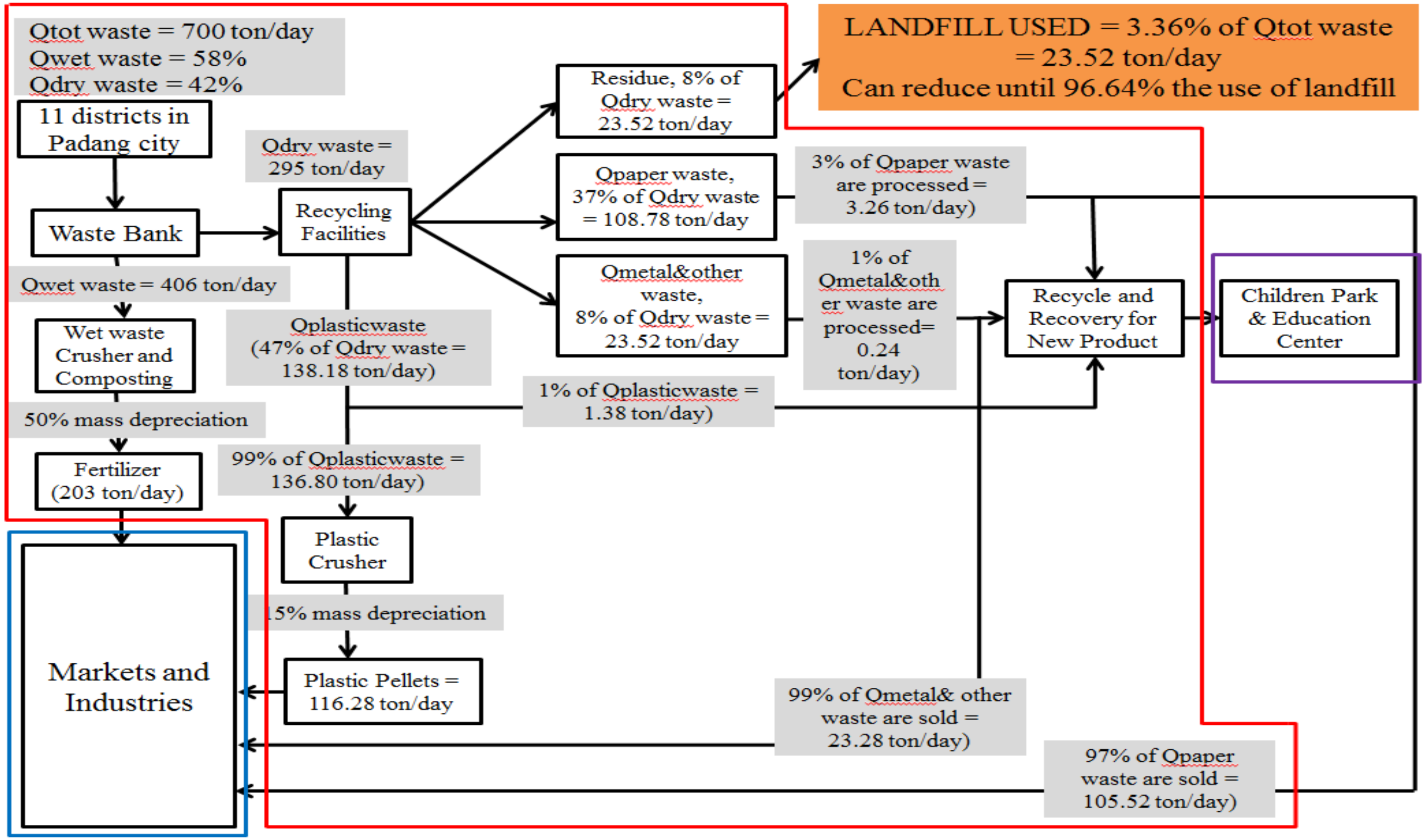
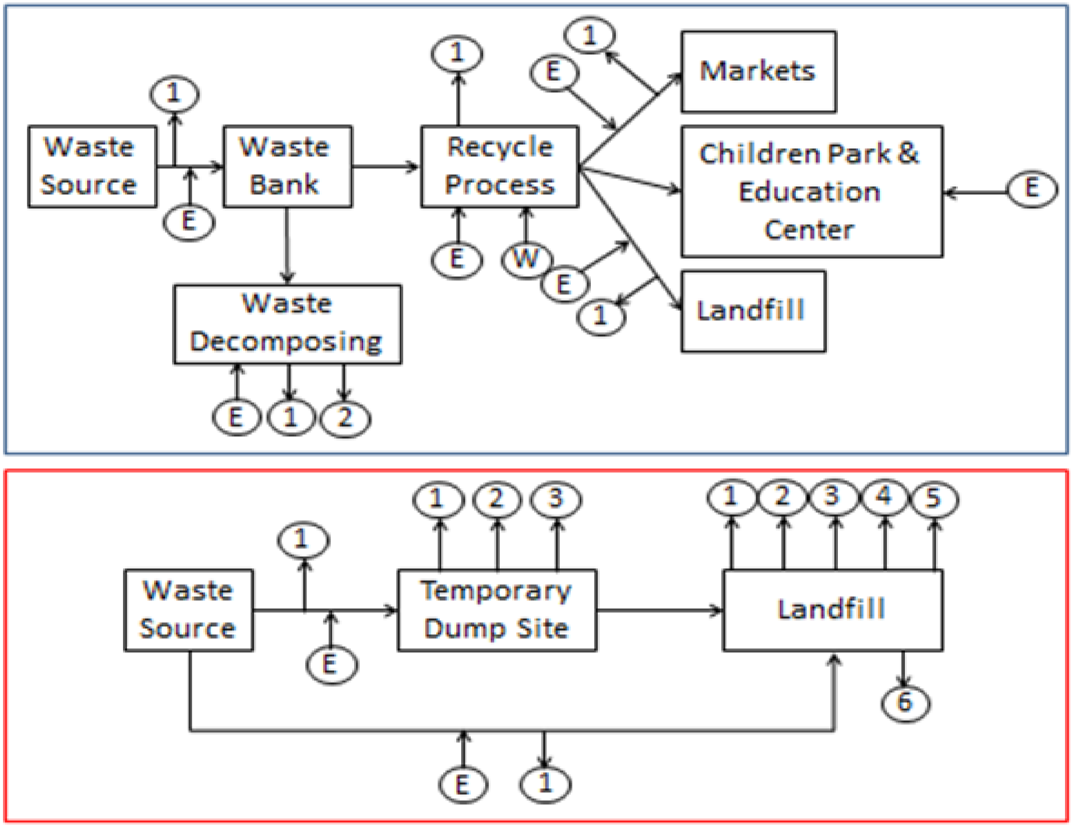


Figure 4.4. Analysis of waste flow of the waste FUN system.

occurs in the landfill of the current waste management system. Therefore, the waste FUN system is more worth to do than the current system in environmental impacts terms by LCA approach.



Legend:
E: Energy
1: Air pollution
2: Odor and bad Aesthetic
3: Source of disease
4: Land pollution
5: Water pollution
6: Massive land use

Potential impacts of the waste FUN system

Potential impacts of the current system

Figure 4.5. Potential impact of each process between waste FUN and current system.

For the detailed calculation, following explanation and calculation will show the process to evaluate the MFA and LCA of waste FUN system.

Waste Generation

Total waste generation of padang city was 700 tons/day in 2016, while the projected popultion of padang city in 2017 is 927,000 people. If we assume that the waste generation in 2016 is same with 2017, so we can get the waste production per person per day, which is 0.76 kg/person/day. Therefore, we can calculate the waste generation per distric in Padang city. Population of each district in padang city as well as its waste generation can be seen in Table 4.26.

Table 4.26 Population and waste generation of districts in Padang city

No	District	Population (person)	Waste Generation (ton/day)	Dry Waste Percentage (42%) (ton/day)	Wet Waste Percentage (58%) (ton/day)
1	Bungus Teluk Kabung	26883	20.300	8.526	11.774
2	Lubuk Kilangan	46813.5	35.349	14.846	20.502
3	Lubuk Begalung	112908.6	85.260	35.809	49.451
4	Padang Selatan	69432.3	52.429	22.020	30.409
5	Padang Timur	96129.9	72.590	30.487	42.102
6	Padang Barat	68968.8	52.080	21.873	30.206
7	Padang Utara	84171.6	63.560	26.695	36.865
8	Nanggalo	64426.5	48.649	20.432	28.216
9	Kuranji	127647.9	96.390	40.483	55.906
10	Pauh	58122.9	43.890	18.433	25.456
11	Koto Tangah	171495	129.500	54.390	75.110
TOTAL		**927000**	**700.000**	**294.000**	**406.000**

Waste Generation

= Population x coefficient of waste per person per day

= 26883 people x 0.76 kg/person/day = 20,300 kg/day = 20.3 ton/day

Furthermore, the percentage of generation of dry waste and wet waste were obtained from previous research (Rahardjo et al., 2015).

Carbondioxide Emission

The CO_2 emission of the waste FUN system operation is obtained from the waste transportation from source to treatment place, operated machines and electricity. The treatment place of waste FUN system is assumed to be in Air Pacah sub-district because the official office of Mayor of padang city is located in Air Pacah. It is expected that the waste FUN system implementation can get high attention and monitor from local government. Table D.2-D.6 shows the required time, required truck, and CO_2 emission of waste transportation, also the CO_2 of all machines of waste treatment.

Table 4.27 Time required, for waste transportation from source to waste treatment area

Place	Distance (km)		Time Required (hour)			Total Time
	Average	Round	Round-trip (hour)	Waste Loading Unloading (hour) (21 minutes x 2)	Total Time	
Bungus Teluk Kabung - Air Pacah	33.8	67.6	2.7	0.7	3.40	3 hours 24minutes
Lubuk Kilangan - Air Pacah	25.05	50.1	1.8	0.7	2.50	2 hours 30 minutes
Lubuk Begalung - Air Pacah	16.5	33	1.6	0.7	2.30	2 hour 18 minutes
South Padang - Air Pacah	21.25	42.5	1.8	0.7	2.50	2 hours 30 minutes
East Padang - Air Pacah	12.7	25.4	1.13	0.7	1.83	1 hour 50 minutes
West Padang - Air Pacah	14.55	29.1	1.13	0.7	1.83	1 hour 50 minutes
North Padang - Air Pacah	10.9	21.8	0.967	0.7	1.67	1 hour 40 minutes
Nanggalo - Air Pacah	7.5	15	0.67	0.7	1.37	1 hour 22 minutes
Kuranji - Air Pacah	7.85	15.7	0.43	0.7	1.13	1 hour 8 minutes
Pauh - Air Pacah	15.45	30.9	1.17	0.7	1.87	1 hour 52 minutes
Koto Tangah - Air Pacah	10.3	20.6	0.83	0.7	1.53	1 hour 32 minutes
	175.85	351.7			21.93	

Table 4.28 Amount of truck required for waste transportation from Source to Waste Treatment Area

Place	Ritation of 1 Truck (Truck Capacity = 2 ton)	Transport Time of total waste (hour)	Working Time (hours/day)	Amount of Truck Required per day
Bungus Teluk Kabung - Air Pacah	10.15	34.510	8	4.31
Lubuk Kilangan - Air Pacah	17.67	44.187	8	5.52
Lubuk Begalung - Air Pacah	42.63	98.049	8	12.26
South Padang - Air Pacah	26.21	65.537	8	8.19
East Padang - Air Pacah	36.30	66.420	8	8.30
West Padang - Air Pacah	26.04	47.653	8	5.96
North Padang - Air Pacah	31.78	52.978	8	6.62
Nanggalo - Air Pacah	24.32	33.325	8	4.17
Kuranji - Air Pacah	48.20	54.460	8	6.81
Pauh - Air Pacah	21.95	41.037	8	5.13
Koto Tangah - Air Pacah	64.75	99.068	8	12.38
		637.224		**79.65**

Table 4.29 Carbondioxide emission because of the waste transportation

Place	Diesel Consumption of Dump Truck 8 m^3 (liter/day) (2 - 3.8 km/liter = average 2.9 km/liter)	CO_2 Emission Factor of transportation (ton/day)
Bungus Teluk Kabung - Air Pacah	236.60	0.625
Lubuk Kilangan - Air Pacah	305.35	0.806
Lubuk Begalung - Air Pacah	485.10	1.281
South Padang - Air Pacah	384.18	1.014
East Padang - Air Pacah	317.89	0.839
West Padang - Air Pacah	261.30	0.690
North Padang - Air Pacah	238.90	0.631
Nanggalo - Air Pacah	125.82	0.332
Kuranji - Air Pacah	260.92	0.689
Pauh - Air Pacah	233.83	0.617
Koto Tangah - Air Pacah	459.95	1.214
	3309.84	**8.74**

Table 4.30 Carbondioxide emission because of the machines for waste treatment

No	Needs	Unit	Energy Source	Kilo Watt	Diesel Consumption (liter/day) (8 hours)	CO_2 emission of 1 machine (ton/day)
1	Plastic Crusher	1	Diesel 8.5 Horse Power (HP)	11.39	19.1352	0.051
2	Organic Waste Crusher	1	Diesel 8.5 Horse Power (HP)	11.39	19.1352	0.051
3	Organic Waste Siever	1	Diesel 3 Horse Power (HP)	4.02	6.7536	0.018

Table 4.31 Carbondioxide emission of all machines for waste treatment

No	Needs	Machine Capacity	Q_{waste} (ton/day)	Machine Required	Unit Machine	CO_2 Emission of All Machines (ton/day)
1	Plastic Crusher	1000 kg/8 hours	136.7982	136.7982	137	6.9
2	Organic Waste Crusher	1500 kg/hour	406	33.8333	34	1.7
3	Organic Waste Siever	2000 kg/hour	203	12.6875	13	0.2

For the electricity, there is data of electricity consumption of existing waste recycling plant (SW bank) in indonesia which is 121 kwh/month (4.033 Kwh/day) for 1.6 ton/month (54.752 Kg/day) waste (Jamaluddin., 2014). Therefore, if we assumed that the electricity consumption will be same per kg waste, so the electricity consumption of the waste FUN system can be calculated. The calculation is explained below.

For the required electricity to manage 1 kg/waste, we can calculate:

= (4.033 Kwh/day) / (54.752 Kg/day)
= 0.0737 Kwh/Kg

Source of electricity are from = Waste treatment + Water Pump

Waste treatment electricity consumption =
= (0.0737 Kwh/Kg) (700,000 Kg/day) = 51565.84843 Kwh/day

Water consumption of the waste FUN system? Water Pump required?

a. Water consumption = for employee + waste treatment

The factor of water consumption for employee in industry sector = 50 liter/employee/day

How many employee that the waste FUN system needs?

The prediction is:

Machine operator =	184	employee
IT Technician =	1	employee
Director =	1	employee
Truck operator =	160	employee
Secretary of the Director =	1	employee
Teller/Cashier =	1	employee
	348	employee

Therefore, the employees need water about = (50 liter/employee/day) x 348 employees

= 17,400 liter/day

Water consumption for waste treatment?

Based on data of the previous research (Jamaluddin, 2014), water is needed for recycling of anorganic waste, need 1.358 m^3 water/day to process 19.152 kg anorganic waste/day.

So, the water consumption for 1 kg anorganic waste/day =

= (1.358 m3/day)/(19.152 kg/day)

= 0.070906433 m3 water/Kg/day

If the waste that have to be treated by the waste Fun system is 136,798 kg/day, so the water consumption = (0.070906433 m3/kg/day) x (136,798 kg/day)

= 9717.272 m3 water/day

b. Water pump required?

We assumed that we use pump Shimizu PC 375 BIT with specification 85 liter/minutes (0.085 m3/minute) and 375 watt (0.375 Kw). If one day work is 8 hours, so the pump needs to be operated about 480 minutes/day.

So, water that can be pumped = (0.085 m3/minute) x (480 minutes) = 40.8 m3/day

Pump required = water consumption/ pumped water

= (9717.272 m3 water/day) / (40.8 m3/day)

= 238.16 pump/day

= 238 pumps

Electricity consumption of water pump = (0.375 Kw x 8 hours) x 238 pumps

= 714 Kwh (8 hours for 1 day)

Total Electricity consumption = 51655.84843 Kwh/day + 714 Kwh/day

= 52,279.84843 Kwh/day

Therefore, CO_2 emission from electricity consumption is:

= CO_2 emission factor of electricity consumption x Total electricity consumption

= (0.000697 ton/Kwh) x (52,279.84843 Kwh/day)

= 36.44 ton CO_2/day

Feasibility Analysis

The plan of waste FUN system implementation should consider about its economic aspect to sustain the activity in the future. Therefore, this study calculated the cost plan of the system. The price of materials and salaries for employees were adapted from the real condition of indonesian price and data of previous research (Jamaluddin, 2014). Table 4.32-4.45 shows the calculation of economic feasibility of the waste FUN system.

Table 4.32 The investment cost of the waste FUN system

No.	Investment	Cost Component	Unit	Price (IDR)	Economic Age(year)	Salvage value (IDR)
1	**Land and Building**		1	600,000,000	10	
2	**Machines and Equipments**	1. Plastic Crusher Machine	137	6,850,000,000	10	1,370,000,000
		2. Organic Waste Crusher Machine	34	510,000,000	10	102,000,000
		3. Organic Waste Siever Machine	13	195,000,000	10	39,000,000
		4. Water Pump	238	440,300,000	5	88,060,000
		5. Hanging scale	104	26,000,000	5	5,200,000
		6. Table	4	900,000	2	180,000
		7. Chair	8	1,600,000	2	320,000
		8. Laptop	3	15,000,000	5	3,000,000
		9. Printer	2	2,000,000	5	400,000
		10. Carpet for Employee rest room	50 x 2 meter	2,750,000	2	550,000
		11. Waste Bank Book	231750	463,500,000	2	
		12. Bucket for sorting waste	685	20,550,000	3	4,110,000
		13. Boots	184	7,360,000	3	1,472,000
		14. Water Hose	20 meters x 137 machine	30,140,000	5	6,028,000
		15. Shovel	47	1,762,500	5	352,500
		16. Composter Bin (Rotary Klin Bioposko RKM-1000L	406	7,914,970,000	10	1,582,994,000
		17. Packing machine (Sealer)	1	1,100,000	5	220,000
		18. Miscellaneous equipments (mat, scissor, Chopping Knife, etc)	various	1,500,000	2	300,000
		19. Truck	80	16,000,000,000	10	3,200,000,000
		20. Telephone	3	1,075,000	5	180,000
3	**Pre-operational**			93,835,361,917		
TOTAL INVESTMENT COST/ TOTAL PROJECT COST				**126,920,869,416**		

Table 4.33 The expenses of the waste FUN system

No	Type	Cost Component	Unit		Price/unit	Monthly (IDR)	Yearly (IDR)
1	**Employee`s Salary**						
		Machine Operator	184	people	2,000,000	368,000,000	4,416,000,000
		IT Technician	1	people	2,000,000	2,000,000	24,000,000
		Truck Operator	160	people	2,000,000	320,000,000	3,840,000,000
		Director	1	people	3,000,000	3,000,000	36,000,000
		Secretary	1	people	2,000,000	2,000,000	24,000,000
		Cashier	1	people	2,000,000	2,000,000	24,000,000
2	**Operational**						
		Electricity	52280	kwh/day	1,100	1,725,240,000	20,702,880,000
		Telephone	1	unit	100,000	100,000	1,200,000
		Transportation (Diesel Fuel Consumption)	3310	liter/day	5,150	511,395,000	6,136,740,000
		Tax of Trucks	80	unit	1,500,000	10,000,000	120,000,000
		Machines and Equipment Maintenance	various		822,000,000	68,500,000	822,000,000
		Office`s Stationary	various		100,000	100,000	1,200,000
4	**Material**						
		Plastic from citizens	138180	kg/day	500	2,072,700,000	24,872,400,000
		Paper from citizens	108780	kg/day	500	1,631,700,000	19,580,400,000
		Metal and others from citizens	23520	kg/day	2,000	1,411,200,000	16,934,400,000
		Residue from citizens	23520	kg/day	500	352,800,000	4,233,600,000
		Wet Waste from citizens	406000	kg/day	0	0	0
		EM-4	30450	liter	647,062,500	19,411,875,000	232,942,500,000
		Plastic Packing (10 kg)	108230	sheet	1,000	3,246,900,000	38,962,800,000
5	**Depreciation**					217,543,972.2	2,610,527,667

Table 4.34 The depreciation of the waste FUN system

No	Equipment	Acquisition Cost (IDR)/Beginning Price	Economic Age	Salvage Value (IDR)	Depreciation/year
1	Plastic Crusher Machine	6,850,000,000	10	1,370,000,000	548,000,000
2	Organic Waste Crusher Machine	510,000,000	10	102,000,000	40,800,000
3	Organic Waste Siever Machine	195,000,000	10	39,000,000	15,600,000
4	Water Pump	440,300,000	5	88,060,000	70,448,000
5	Hanging scale	26,000,000	5	5,200,000	4,160,000

6	Table	900,000	2	180,000	360,000
7	Chair	1,600,000	2	320,000	640,000
8	Laptop	15,000,000	5	3,000,000	2,400,000
9	Printer	2,000,000	5	400,000	320,000
10	Carpet for Employee rest room	2,750,000	2	550,000	1,100,000
11	Bucket for sorting waste	20,550,000	3	4,110,000	5,480,000
12	Boots	7,360,000	3	1,472,000	1,962,666.667
13	Water Hose	30,140,000	5	6,028,000	4,822,400
14	Shovel	1,762,500	5	352,500	282,000
15	Miscellaneous equipments (mat, scissor, Chopping Knife, etc)	1,500,000	2	300,000	600,000
16	Composter Bin (Rotary Klin Bioposko RKM-1000L	7,914,970,000	10	1,582,994,000	633,197,600
17	Packing machine (Sealer)	1,100,000	5	220,000	176,000
18	Truck	16,000,000,000	10	3,200,000,000	1,280,000,000
19	Telephone	1,075,000	5	180,000	179,000
TOTAL DEPRECIATION					**2,610,527,667**

Table 4.35 The pre-operational cost of the waste FUN system

	Month 1st	Month 2nd	Month 3rd	Month 4th	Month 5th	Month 6th
Income (I)	0	46,340,546,700	46,340,546,700	46,340,546,700	46,340,546,700	46,340,546,700
Expenses (E)	31,278,453,972	31,278,453,972	31,278,453,972	31,278,453,972	31,278,453,972	31,278,453,972
I - E	-31,278,453,972	15,062,092,728	15,062,092,728	15,062,092,728	15,062,092,728	15,062,092,728
Cumulative Balance	-31,278,453,972	-16,216,361,244	-1,154,268,517	13,907,824,211	28,969,916,939	44,032,009,667

How much the pre-operational cost?

Expenses multiple how many month that you have negative value in table

= 93,835,361,917 IDR

Table 4.36 The projected sales of all product of the waste FUN system

No.	Product	Amount	Unit	Selling Price			
				Per kg	Daily (IDR)	Monthly (IDR)	Yearly (IDR)
1	Plastic Pellet	116278.47	kg	9,000	1,046,506,230	31,395,186,900	376,742,242,800
2	Compost	203000	kg	1,250	253,750,000	7,612,500,000	91,350,000,000
3	Paper	105516.6	kg	1,500	158,274,900	4,748,247,000	56,978,964,000
4	Metal and others	23284.8	kg	3,700	86,153,760	2,584,612,800	31,015,353,600
TOTAL					1,544,684,890	46,340,546,700	556,086,560,400

Table 4.37 The cost of goods sold of the waste FUN system

	Year 1 (IDR)	Year 2 (IDR)	Year 3 (IDR)	Year 4 (IDR)	Year 5 (IDR)	Year 6 (IDR)	Year 7 (IDR)	Year 8 (IDR)	Year 9 (IDR)	Year 10 (IDR)
Material										
Purchase	3.37526E+11	3.71279E+11	4.08407E+11	4.49247E+11	4.94172E+11	5.43589E+11	5.97948E+11	6.57743E+11	7.23517E+11	7.95869E+11
Available for use	3.33293E+11	3.66622E+11	4.03284E+11	4.43612E+11	4.87974E+11	5.36771E+11	5.90448E+11	6.49493E+11	7.14442E+11	7.85886E+11
Less: Material Inventory	4233600000	4656960000	5122656000	5634921600	6198413760	6818255136	7500080650	8250088715	9075097586	9982607345
Direct Material Used	3.33293E+11	3.66622E+11	4.03284E+11	4.43612E+11	4.87974E+11	5.36771E+11	5.90448E+11	6.49493E+11	7.14442E+11	7.85886E+11
Direct Labor	8280000000	9108000000	10018800000	11020680000	12122748000	13335022800	14668525080	16135377588	17748915347	19523806881
Factory Overhead	27781620000	30559782000	33615760200	36977336220	40675069842	44742576826	49216834509	54138517960	59552369756	65507606731
Factory Depreciation	2605528667	2866081533	3152689687	3467958655	3814754521	4196229973	4615852970	5077438267	5585182094	6143700303
Total Manufacturing Cost	3.7196E+11	4.09156E+11	4.50071E+11	4.95078E+11	5.44586E+11	5.99045E+11	6.58949E+11	7.24844E+11	7.97329E+11	8.77061E+11
Add: Work in Process, January	4233600000	4656960000	5122656000	5634921600	6198413760	6818255136	7500080650	8250088715	9075097586	9982607345
Cost of Goods Put Into Process	3.76193E+11	4.13813E+11	4.55194E+11	5.00713E+11	5.50785E+11	6.05863E+11	6.66449E+11	7.33094E+11	8.06404E+11	8.87044E+11
Less: Work In Process, December	4233600000	4656960000	5122656000	5634921600	6198413760	6818255136	7500080650	8250088715	9075097586	9982607345
Cost of Goods Manufactured	3.7196E+11	4.09156E+11	4.50071E+11	4.95078E+11	5.44586E+11	5.99045E+11	6.58949E+11	7.24844E+11	7.97329E+11	8.77061E+11
Add: Finish Goods, January	0	0	0	0	0	0	0	0	0	0
Total Goods Available For Sale	3.7196E+11	4.09156E+11	4.50071E+11	4.95078E+11	5.44586E+11	5.99045E+11	6.58949E+11	7.24844E+11	7.97329E+11	8.77061E+11
Less: Finish Goods, December	0	0	0	0	0	0	0	0	0	0
Cost of Goods Sold	**3.7196E+11**	**4.09156E+11**	**4.50071E+11**	**4.95078E+11**	**5.44586E+11**	**5.99045E+11**	**6.58949E+11**	**7.24844E+11**	**7.97329E+11**	**8.77061E+11**

Net Profit = Projected sales - Cost of Goods Sold - Operating Expenses - Tax

Cost of Goods Sold : Cost that you spend to make a product

Table 4.38 The income statement of the waste FUN system

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Projected sales	556086560400	6.11695E+11	6.72865E+11	7.40151E+11	8.14166E+11	8.95583E+11	9.85141E+11	1.08366E+12	1.19202E+12	1.31122E+12
Less: Cost of Goods Sold	3.7196E+11	4.09156E+11	4.50071E+11	4.95078E+11	5.44586E+11	5.99045E+11	6.58949E+11	7.24844E+11	7.97329E+11	8.77061E+11
Gross Profit	184126911733	202539602907	222793563197	245072919517	269580211469	296538232616	326192055877	358811261465	394692387611	434161626373
Operating Expenses (Indirect)	86400000	95040000	104544000	114998400	126498240	139148064	153062870.4	168369157.4	185206073.2	203726680.5
Depreciation (indirect)	4999000	5498900	6048790	6653669	7319035.9	8050939.49	8856033.439	9741636.783	10715800.46	11787380.51
Total Operating Expenses (Indirect)	91399000	100538900	110592790	121652069	133817275.9	147199003.5	161918903.8	178110794.2	195921873.6	215514061
Net Profit Before Tax	184035512733	202439064007	222682970407	244951267448	269446394193	296391033612	326030136973	358633150671	394496465738	433946112312
Corporate Income Tax (25%)	46008878183	50609766002	55670742602	61237816862	67361598548	74097758403	81507534243	89658287668	98624116434	1.08487E+11
Net Profit	138026634550	151829298005	167012227806	183713450586	202084795645	222293275209	244522602730	268974863003	295872349303	325459584234
Return On Sales	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**	**25**
Return On Investment	**109**	**120**	**132**	**145**	**159**	**175**	**193**	**212**	**233**	**256**
Gross Profit Margin	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**

Return on sales = (net profit/projected sales)x100%

Return on Investment = (net profit/total project cost) x 100%

Gross Profit = (gross profit/prejcted sales)x100%

Table 4.39 The cash flow of the waste FUN system

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
In Flow											
Capital	1.26921E+11										
Net Profit + Depreciation		140637162217	154439825672	169622755472	186323978253	204695323311	224903802876	247133130397	271585390670	298482876970	328070111900
Out Flow											
Land and Building	600000000										
Machines and Equipment	32485507500										
Pre-Operational Cost	93835361917										
Total Out Flow	1.26921E+11	0	0	0	0	0	0	0	0	0	0
Net Cash In Flow - Out Flow	0	140637162217	154439825672	169622755472	186323978253	204695323311	224903802876	247133130397	271585390670	298482876970	328070111900
Cash Balance Beginning		0	140637162217	295076987888	464699743361	651023721613	855719044925	1080622847800	1327755978197	1599341368867	1897824245837
Cash Balance End		**140637162217**	**295076987888**	**464699743361**	**651023721613**	**855719044925**	**1080622847800**	**1327755978197**	**1599341368867**	**1897824245837**	**2225894357737**
Annual Cash Flow		140637162217	154439825672	169622755472	186323978253	204695323311	224903802876	247133130397	271585390670	298482876970	328070111900
Average Cash Flow		2.22589E+11									

Cash Flow: Want to describe In Flow and Out Flow of Cash

Break Even Point (BEP) = Fix Cost/Contribution Margin Ratio

The point that the capital given to the company can be back

How long you can get the capital back before you get profit?

In Flow = Out Flow

Table 4.40 The break even point of the waste FUN system

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Sales	556086560400	611695216440	672864738084	740151211892	814166333082	895582966390	985141263029	1083655389332	1192020928265	1311223021091
Fixed Cost	91399000	100538900	110592790	121652069	133817275.9	147199003.5	161918903.8	178110794.2	195921873.6	215514061
Variable Cost	3.7196E+11	4.09156E+11	4.50071E+11	4.95078E+11	5.44586E+11	5.99045E+11	6.58949E+11	7.24844E+11	7.97329E+11	8.77061E+11
Contribution Margin Ratio	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
BEP-Sales	276036539.4	303640193.4	334004212.7	367404634	404145097.4	444559607.1	489015567.9	537917124.6	591708837.1	650879720.8
BEP-Unit	17866.44268	19653.08695	21618.39565	23780.23521	26158.25873	28774.0846	31651.49307	34816.64237	38298.30661	42128.13727

Table 4.41 The percentage of product for sale

Product	**Amount (Kg)**	**Percentage**	
Plastic Pellet	116278.47	26	%
Compost	203000	45	%
Paper	105516.6	24	%
Metal and othersE	23284.8	5	%
	448079.87	100	%

Table 4.42 The break even point of product sales of waste FUN system

Product	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Plastic Pellet	4636	5100	5610	6171	6788	7467	8214	9035	9939	10932
Compost	8094	8904	9794	10773	11851	13036	14340	15773	17351	19086
Paper	4207	4628	5091	5600	6160	6776	7453	8199	9019	9921
Metal and others	928	1021	1123	1236	1359	1495	1645	1809	1990	2189
TOTAL	17866	19653	21618	23780	26158	28774	31651	34817	38298	42128

Note: if I want to get the capital back in year 1, you have to sell 17,574 kg products

Table 4.43 The present value of the waste FUN system

Year	Net Cash Flow	1+I'n	PV Factor	PV
Year 1	140637162217	1.06250000	0.941	1.32364E+11
Year 2	154439825672	1.12890625	0.886	1.36805E+11
Year 3	169622755472	1.19946289	0.834	1.41416E+11
Year 4	186323978253	1.27442932	0.785	1.46202E+11
Year 5	204695323311	1.35408115	0.739	1.51169E+11
Year 6	224903802876	1.43871123	0.695	1.56323E+11
Year 7	247133130397	1.52863068	0.654	1.6167E+11
Year 8	271585390670	1.62417009	0.616	1.67215E+11
Year 9	298482876970	1.72568073	0.579	1.72965E+11
Year 10	328070111900	1.83353577	0.545	1.78928E+11
			Total PV	**1.54506E+12**

I = 6.25%
PV Factor = 1/(1+i'n)

Total Project Cost = 1.26921E+11
Total PV = 1.5705E+12
NPV = 1.44358E+12
>0 = The business is feasible

Net Benefit Cost Ratio (BCR) =
Total PV/Total Project Cost = 12.37385169
>1 = The business is feasible

Table 4.44 The IRR of the waste FUN system

Year	(1+i%)'n	1/(1+50%)'n	PV
Year 1	2.20531958900600	0.453449017	63771782973
Year 2	4.86343448965359	0.205616011	31755300909
Year 3	10.72542734988050	0.093236378	15815011369
Year 4	23.65299503515210	0.042277944	7877394722
Year 5	52.16241328968260	0.019170892	3924191969
Year 6	115.03479183756400	0.008693022	1955093753
Year 7	253.68847985660700	0.003941842	974159845.7
Year 8	559.46417413293000	0.001787425	485438394.9
Year 9	1233.79730256241000	0.000810506	241922134.5
Year 10	2720.91736020365000	0.000367523	120573346.6
		TOTAL PV	1.26921E+11
		Investment cost	1.26921E+11
		NPV	0.037109375

IRR = 120.53195890060 % = >6.25% = Feasible

IRR is the discount rate that cause the net present value or NPV to equal zero

A NPV of zero essentially means that the present value of all cash flows equals the value of our investment. Put another way, the money that we expect to receive in the future, discounted into todays value, equals how much money we are investing in this project. By obtaining the IRR for several projects, we can determine which project is more likely provide a better return. Project that yield a higher IRR are considered to be more attractive compared to there lower yielding counterparts

Method = trial and error

Table 4.45 The pay back period of the waste FUN system

Year	Cash Out	Cash in	Net Cash Flow	Cumulative NCF
0	1.26921E+11	0	-1.26921E+11	
1	0	140637162217	140637162217	13716292800
2	0	154439825672	1.5444E+11	168156118472
3	0	169622755472	1.69623E+11	337778873944
4	0	186323978253	1.86324E+11	524102852197
5	0	204695323311	2.04695E+11	728798175508
6	0	224903802876	2.24904E+11	953701978384
7	0	247133130397	2.47133E+11	1200835108780
8	0	271585390670	2.71585E+11	1472420499450
9	0	298482876970	2.98483E+11	1770903376420
10	0	328070111900	3.2807E+11	2098973488320

The Pay back period = 1 year

How many year the cummulative NCF can be positive value

4.6. Study Comparison Between the waste FUN System and other Potential Systems

4.6.1. Scenarios

In order to assess feasibility of the waste FUN system, performance of the waste FUN system need to be compared to other systems that also has high potency to be implemented in Padang city. Because of data limitation, the comparison is considered into three scenarios which consist of baseline scenario, integrated waste recycling scenario, and city-corporate incineration scenario. Baseline scenario is the current system that is run by local government based on landfilling system. This baseline scenario has been running for 28 years which is expected to operate by sanitary landfill method on plan, but open dumping in reality. Furthermore, the integrated waste recycling scenario is a system called waste FUN system. City-corporate incineration is a system involving cooperation of local government and the most influential company in Padang city with the concept of a mutually beneficial between the company and the city. The framework is arranged based on prior study of Ulhasanah and Goto (2012) which utilizes the existence of the largest cement company in Padang city toward its limited availability of raw material, high operating cost, high energy consumption, and bad emission factor. Based on the results of prior study, this scenario has high potency to solve MSW management problems of Padang city as well as get benefits from energy and ash produced by waste incineration. The scenarios compared in this study are shown in **Figure 4.6**.

Scenario 1 has simple process which only involves waste displacement process from waste source into landfill. In the scenario 1, there is no waste treatment process, no waste separation, and no significant role of citizens in waste management activities (government takes 100% over the management). Scenario 2 has more complicated steps than scenario 1 to separate the waste based on the types and to treat the waste by composting and recycling activities. In scenario 2, citizens play important role to separate and collect the waste to waste distributor sites in order to proceed to next process which is recycling and composting. Scenario 3 also has waste treatment activities but there is no waste separation in source by citizens which will be done in the company. It means that level of citizens` role is same with the concept of scenario 1, but there are incineration activities in the process. The Socio-enviro-economic analysis of this study was performed against the impact caused by the systems on the welfare of people, planet, and profit for sustainable development establishment with S-LCA, E-LCA, and FFA, respectively.

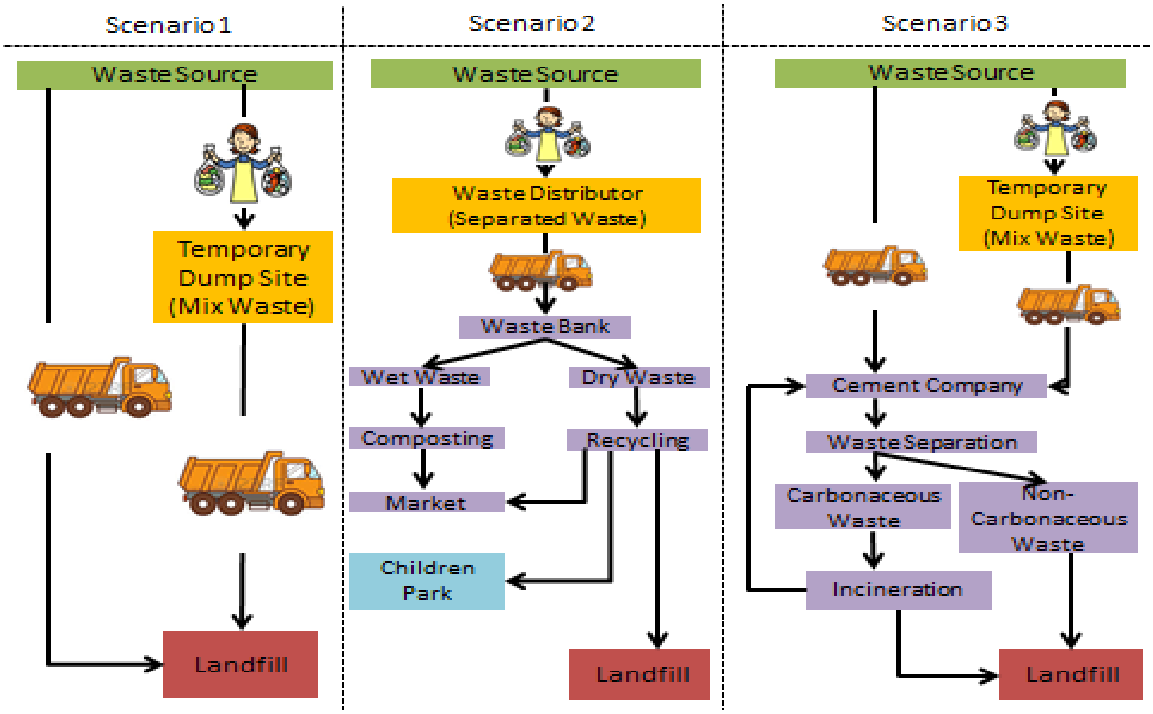


Figure 4.6. The three scenarios compared.

4.6.2. Scenarios' Evaluation by S-LCA

In this study, S-LCA inventory data was mainly based on site observation and literatures. Because of the assessment was rough analysis for design plans (except the baseline scenario) which means that the scenarios have not established yet, the qualitative data form was conducted. Stakeholders, impact categories and subcategories considered in this study are adapted from guideline of SLCA of products UNEP/SETAC (2009) according to social condition of each scenario. Assessment comparison of those three scenarios shows that scenario 1 has more potencies of negative impact in social term than scenario 2 and 3 whereas assessment of scenario 2 and 3 results relatively same value which is interpreted as positive social impacts` potency. Assessment detail of social evaluation of each scenario can be seen in **Table 4.46**.

4.6.3. Scenarios' Evaluation by E-LCA

Generation of 700 tones waste per day by Padang city is assumed to be treated all in this study. Fraction of waste treated based on mass balance calculation in scenario 1 is 100% mixed waste sent to landfill, scenario 2 is 96.64% separated waste sent to waste bank and 3.36% residue sent to landfill, scenario 3 is 87.68% mixed waste sent to incineration plant and 12.32% residue sent to landfill. For CO_2 emission term, scenario 1 brings about 9.53 tons CO_2/day from waste transportation to landfill, scenario 2 brings about 8.74 tons/day from waste transportation and 36.44 tons CO_2/day from waste treatment process, scenario 3 brings about 10.91 tons/day and 642.656 tons CO_2/day from incineration process. Furthermore, environmental assessment of three scenarios determined 7 potential environmental impacts of each chain, which are energy consumption (E), air pollution (1), odor and bad aesthetic (2), source of disease (3), land pollution (4), water pollution (5), and massive land use (6). Those potential impacts of each chain are shown in **Figure 4.7**.

Table 4.46. Potential social impacts assessment of each scenario by S-LCA

No	Stakeholders	Impact Subcategories	Relation to Impact Categories						Scenario 1		Scenario 2		Scenario 3	
			1	2	3	4	5	6	Status	Assessment	Status	Assessment	Status	Assessment
1	Workers	Freedom of Association and Collective Bargaining	√	√	√	-	√	√	There is freedom of association but need long time for collective bargaining		There is freedom of association but need long time for collective bargaining		There is freedom of association but need long time for collective bargaining	
		Child Labour	√	√	√	-	√	√	Many Scavengers involving Children		No child labour		No child labour	
		Fair Salary	√	√	√	-	√	√	The salary is under the city`s minimum wage standard		The salary will be increased above the city`s minimum wage standard		The salary will be increased above the city`s minimum wage standard	
		Working Hours	√	√	√	-	√	√	There is overload and overtime work for the employees		No overload and overtime work		No overload and overtime work	
		Equal Opportunities/Discrimination	√	√	-	-	√	√	No discrimination		No discrimination		No discrimination	
		Health and Safety	√	√	√	-	√	√	waste pollutions affect health and safety of workers		No effect because the waste is treated quickly to prevent pollutions		No effect because the waste is treated quickly to prevent pollutions	
		Social Benefits/Social Security	√	√	√	-	√	√	Government provide national health insurance security		Government provide national health insurance security		Government provide national health insurance security	
2	Consumers	Health and Safety	√	√	√	-	√	√	No consumers		Has safety products from recycled waste		Has safety ash and energy from waste incineration	
		Feedback Mechanism	√	√	√	-	-	√	There is enough chance to give feedback		There is enough chance to give feedback		There is enough chance to give feedback	
		Transparency	√	√	√	-	√	√	No transparency		Enough transparency through seminars and counselling.		Enough transparency through seminars and counselling.	
3	Local Community	Access to material resources	√	√	-	-	√	√	There is enough chance to access		There is enough chance to access		There is enough chance to access	
		Access to immaterial resources	√	√	-	-	√	√	There is enough chance to access		There is enough chance to access		There is enough chance to access	
		Safe & Healthy Living Conditions	√	√	√	√	√	√	Not good condition because of waste piles		Good condition		Good condition	
		Respect of Indigenous Rights	√	√	-	√	√	√	There is		There is		There is	
		Community Engagement	√	√	-	-	√	√	No engagement		There is		No engagement	
		Local Employment	√	√	√	√	√	√	There is		There is		There is	
4	Society	Public Commitments to sustainability issues	-	√	√	-	√	√	No commitment		There is		There is	

		Contribution to economic development	-	√	-	-	-	-	No contribution		There is big contribution		There is big contribution	
		Technology Development	-	√	√	-	√	√	No		Yes		Yes	
		Corruption	√	√	-	-	√	√	There is chance for corruption		There is chance for corruption		There is chance for corruption	
5	Value Chain Actors	Fair Competition	√	√	√	-	√	√	No competition		Fair		Fair	
		Promoting Social Responsibility	√	√	√	-	√	√	Not promoted		Promoted		promoted	

Note: Relation to Impact Categories: 1. Human Rights; 2. Working Condition; 3. Health and Safety; 4. Cultural Heritage; 5. Governance; 6. Socio-Economic Repercussion

√ There is influence

\- No influence

Indifferent positive effect

Negative effect

More or less negative effect

Positive effect

No effect

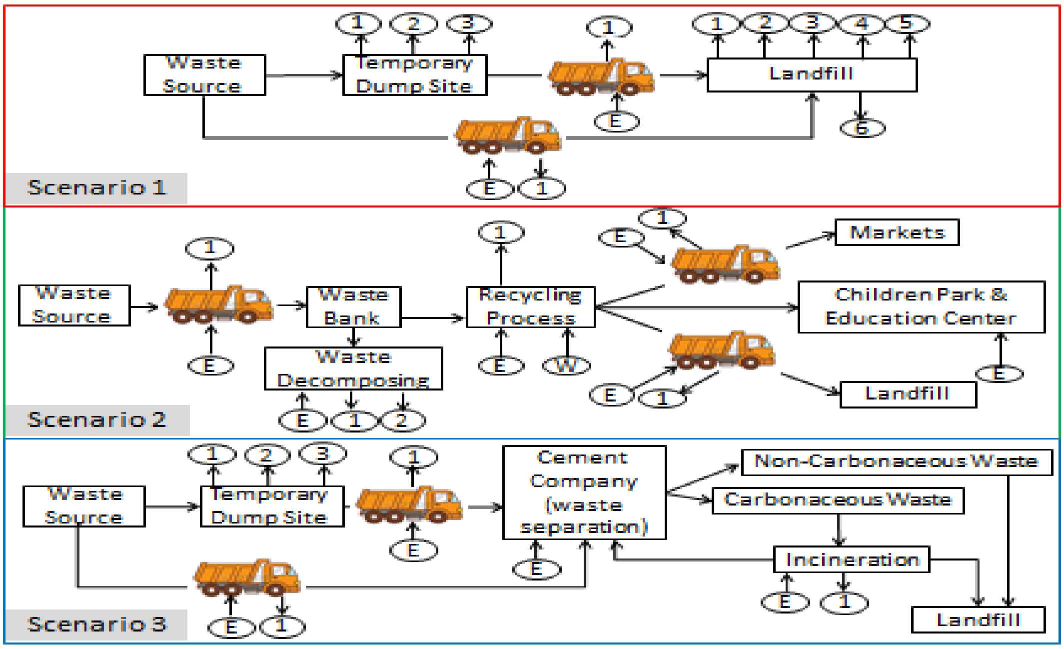


Figure 4.7. Potential environmental impacts of each chain of scenario 1, 2, and 3.

Fig. 4.7 shows that there are more potential environmental impacts' type occurred in scenario 1 compare to other two scenarios which are land pollution, water pollution, and massive land use. Potential environmental impacts occurred in scenario 3 has different with scenario 2 in releasing CO_2 emissions where scenario 3 released much more CO_2 emission from incineration process. According to above assessment in term of landfill area usage, CO_2 emissions, and potential environmental impacts of each scenario`s chain, scenario 2 has less impacts to environment. Therefore, scenario 2 is more worth to do that other scenarios in environmental term.

4.6.4. Scenarios' Evaluation by FFA

Financial feasibility analysis in this study was conducted only for scenario 2 and 3 because scenario 1 does not have revenue from waste managed (the mixed waste is directly dumped into landfill without any treatment). Therefore, the scenario 1 can be interpreted as infeasible business in term of economic aspect because of the absence of profit from product sales.

Total investment cost of scenario 2 is about 126.921 billion Indonesian Rupiah (IDR) or equal to 9.528 million USD which consists of land and building, machines and equipment, and pre-operational cost with the plan of 10 years economic age. Expenses cost comprises employees' salary, operational, material and equipment's depreciation cost that spend about 375.341 billion IDR (28.177 million USD) per year. Gross revenues obtained are from product sales of plastic pellet, compost, paper waste, and metal & other waste which gain 556.087 billion IDR per year (41.745 million USD). Those prices are adapted by possible existing price of products applicable in Indonesia. The detail cash flow and income statement in 10 years of scenario 2 are described in **Table 4.47** and **4.48** with increasing 10% every year according to inflation rate condition of Indonesia.

Scenario 3 spends about 953.550 billion IDR (73.35 million USD), 177.996 million IDR per year (13.362 thousand USD), 41.47 billion IDR per year (3.19 million USD) for investment, operating and depreciation cost respectively which are adopted and adjusted Gang et. al. (2016). Products sold in this scenario are ash from residue of waste incineration which will be used as raw material of cement production and heat energy of waste incineration. The ash can replace the company`s needs against silica, clay, copper slag, iron sand, gypsum, and pozzolan which may save material cost about 58.856 billion IDR per year (4.418 million USD) while heat energy of waste incineration can contribute about 6.5% of all energy need for company`s cement production equal to 9.946 billion IDR per year (746.681 thousand USD). The detail cost of scenario 3 can be seen in cash flow and income statement of **Table 4.49** and **4.50.**

Based on cash flow and income statement tables, four parameters (NPV, B/C, IRR, payback period) can be calculated to assess the financial feasibility of scenario 2 and 3 in this study. From the **Table 4.51**, all parameters indicate that scenario 2 is feasible financially, while scenario 3 is infeasible financially. Therefore, according to economic evaluation, scenario 2 is more worth to do and should be chosen when there are options between scenario 1, 2, and 3.

Table 4.47. Cash flow of scenario 2

(000,000 IDR)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
In Flow											
Capital	126,920										
Net Profit + Depreciation		140,637	154,439	169,622	186,323	204,695	224,903	247,133	271,585	298,482	328,070
Out Flow											
Land and Building	600										
Machines and Equipment	32,485										
Pre-Operational Cost	93,835										
Total Out Flow	**126,920**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Net Cash In Flow - Out Flow	0	140,637	154,439	169,622	186,323	204,695	224,903	247,133	271,585	298,482	328,070
Cash Balance Beginning		0	140,637	295,076	464,699	651,023	855,719	1,080,622	1,327,755	1,599,341	1,897,824
Cash Balance End		**140,637**	**295,076**	**464,699**	**651,023**	**855,719**	**1,080,622**	**1,327,755**	**1,599,341**	**1,897,824**	**2,225,894**
Annual Cash Flow		**140,637**	**154,439**	**169,622**	**186,323**	**204,695**	**224,903**	**247,133**	**271,585**	**298,482**	**328,070**
Average Cash Flow		**222,589**									

Table 4.48. Income statement of scenario 2

(000,000 IDR)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Projected sales	556,086	611,695	672,864	740,151	814,166	895,582	985,141	1,083,655	1,192,020	1,311,223
Less: Cost of Goods Sold	371,959	409,155	450,071	495,078	544,586	599,044	658,949	724,844	797,328	877,061
Gross Profit	184,126	202,539	222,793	245,072	269,580	296,538	326,192	358,811	394,692	434,161
Operating Expenses (Indirect)	86	95	104	114	126	139	153	168	185	203
Depreciation (indirect)	4	5	6	6	7	8	8	9	10	1
Total Operating Expenses (Indirect)	91	100	110	121	133	147	161	178	195	215
Net Profit Before Tax	184,035	202,439	222,682	244,951	269,446	296,391	326,030	358,633	394,496	433,946
Corporate Income Tax (25%)	46,008	50,609	55,670	61,237	67,361	74,097	81,507	89,658	98,624	108,486
Net Profit	138,026	151,829	167,012	183,713	202,084	222,293	244,522	268,974	295,872	325,459
Return On Sales	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**	**25%**
Return On Investment	**109%**	**120%**	**132%**	**145%**	**159%**	**175%**	**193%**	**212%**	**233%**	**256%**
Gross Profit Margin	**33%**	**33%**	**33%**	**33%**	**33%**	**33%**	**33%**	**33%**	**33%**	**33%**

Table 4.49. Cash flow of scenario 3

(000,000 IDR)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
In Flow											
Capital	953,550										
Net Profit + Depreciation		61,836	68,020	74,822	82,304	90,534	99,588	109,546	120,501	132,551	145,806
Out Flow											
Investment Plant	953,550	0	0	0	0	0	0	0	0	0	0
Net Cash In Flow - Out Flow	0	61,836	68,020	74,822	82,304	90,534	99,588	109,546	120,501	132,551	145,806
Cash Balance Beginning		0	61,836	129,856	204,678	286,982	377,517	477,105	586,652	707,154	839,705
Cash Balance End		**61,836**	**129,856**	**204,678**	**286,982**	**377,517**	**477,105**	**586,652**	**707,154**	**839,705**	**985,512**
Annual Cash Flow		**61,836**	**68,020**	**74,822**	**82,304**	**90,534**	**99,588**	**109,546**	**120,501**	**132,551**	**145,806**
Average Cash Flow		**98,551**									

Table 4.50. Income statement of scenario 3

(000,000 IDR)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Projected sales	68,803	75,683	83,251	91,577	100,734	110,808	121,889	134,077	147,485	162,234
Less: Cost of Goods Sold (Operating Cost)	177	195	215	236	260	286	315	346	381	419
Gross Profit	68,625	75,487	83,036	91,340	100,474	110,521	121,573	133,731	147,104	161,814
Depreciation (indirect)	41,470	45,617	50,178	55,196	60,716	66,787	73,466	80,813	88,894	97,784
Net Profit Before Tax	27,155	29,870	32,857	36,143	39,757	43,733	48,107	52,917	58,209	64,030
Corporate Income Tax (25%)	6,788	7,467	8,214	9,035	9,939	10,933	12,026	13,229	14,552	16,007
Net Profit	20,66	22,403	24,643	27,107	29,818	32,800	36,080	39,688	43,657	48,022
Return On Sales	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**	**30%**
Return On Investment	**2%**	**2%**	**3%**	**3%**	**3%**	**3%**	**4%**	**4%**	**5%**	**5%**
Gross Profit Margin	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4.51. Assessment of financial feasibility of scenario 2 and scenario 3

No	Parameters	Feasibility Criterion		Assessment for Scenario 2		Assessment for Scenario 3	
		Feasible	Not Feasible	Value	Conclusion	Value	Conclusion
1	Net Present Value (NPV)	>0	<0	1,443.579 billion IDR	**Feasible**	-269.866 billion IDR	**Infeasible**
2	Internal Rate of Return (IRR)	> Discount Rate (6.25%)	< Discount Rate	120.532%	**Feasible**	0.529%	**Infeasible**
3	Net Benefit Cost Ratio (B/C Ratio)	>1	<1	12.173	**Feasible**	0.717	**Infeasible**
4	Payback Period	< Business Age	> Business Age	1 year	**Feasible**	10 year	**Infeasible**

4.6.5. Detailed Calculation of Evaluation of Incineration System Plan in Cement Company and Waste Dumping System (Current System)

1. Evaluation of Incineration System Plan in Cement Company

Waste Generation, Time for Waste Transportation from Source to the Treatment Area, CO_2 Emission of the Combustion Process, and Energy Produced by Waste Combution of the Incineration System Plan in Cement Company are shown in **Table 4.52-4.61**. There are 103 sub-districts in Padang city and 304 Temporary Dump Site (TDS), so it is assumed that in 1 subdistrict there are 2 or 3 TDS.

Table 4.52 The TDS distribution of each distric in Padang city

Waste Generation (ton/day)	Source to Treatment Area	Amount of Sub-distric	Waste Percentage (%)	TDS
20.30	Bungus Teluk Kabung - Cement Company	6	2.9	9
35.35	Lubuk Kilangan - Cement Company	7	5.0	15
85.26	Lubuk Begalung - Cement Company	15	12.2	37
52.43	South Padang - Cement Company	12	7.5	23
72.59	East Padang - Cement Company	10	10.4	32
52.08	West Padang - Cement Company	10	7.4	23
63.56	North Padang - Cement Company	7	9.1	28
48.65	Nanggalo - Cement Company	6	6.9	21
96.39	Kuranji - Cement Company	9	13.8	42
43.89	Pauh - Cement Company	9	6.3	19
129.50	Koto Tangah - Cement Company	12	18.5	56
700		**103**	**100**	**304**
			100%	**304**

Table 4.53 Total time of waste transportation from source to treatment area of incineration system

Source to Treatment Area	Distance		Time of round trip	Total of Loading and Unloading (Hour)	Total Time
	(Km)	Round	(Hour)		(Hour)
Bungus Teluk Kabung - Cement Company	26.8	53.6	1.833	0.7	2.533
Lubuk Kilangan - Cement Company	3.7	7.4	0.200	0.7	0.900
Lubuk Begalung - Cement Company	10.7	21.4	0.700	0.7	1.400
South Padang - Cement	18.1	36.2	1.100	0.7	1.800

Company					
East Padang - Cement Company	13	26	0.733	0.7	1.433
West Padang - Cement Company	13.9	27.8	0.967	0.7	1.667
North Padang - Cement Company	17.8	35.6	1.167	0.7	1.867
Nanggalo - Cement Company	18.1	36.2	1.167	0.7	1.867
Kuranji - Cement Company	15	30	1.067	0.7	1.767
Pauh - Cement Company	10	20	0.667	0.7	1.367
Koto Tangah - Cement Company	30	60	2	0.7	2.700
	177.1	**354.2**			

Table 4.54 Required truck and CO_2 emission of waste transportation of incineration system

Source to Treatment Area	Ritation of 1 Truck (Truck Capacity = 2 ton)	Transport Time of total waste (hour)	Working Time (hours/day)	Amount of Truck Required per day	Diesel Consumption of dumptruck 8 m3 (liter/day) (2 - 3.8km/liter = average 2.9km/liter))	CO_2 Emission Factor of transportation (ton/day)
Bungus Teluk Kabung - Cement Company	10.150	25.713	8	3.214	188	0.495
Lubuk Kilangan - Cement Company	17.675	15.907	8	1.988	45	0.119
Lubuk Begalung - Cement Company	42.630	59.682	8	7.460	315	0.830
South Padang - Cement Company	26.215	47.187	8	5.898	327	0.864
East Padang - Cement Company	36.295	52.023	8	6.503	325	0.859
West Padang - Cement Company	26.040	43.400	8	5.425	250	0.659
North Padang - Cement Company	31.780	59.323	8	7.415	390	1.030
Nanggalo - Cement Company	24.325	45.406	8	5.676	304	0.802
Kuranji - Cement Company	48.195	85.145	8	10.643	499	1.316
Pauh - Cement Company	21.945	29.992	8	3.749	151	0.400
Koto Tangah - Cement Company	64.750	174.825	8	21.853	1340	3.537
		638.603		**79.825**	**4133**	**10.911**
				80		

CO_2 emission factor 1 mg MSW release 0.7-1.2 mg CO_2 = (0.7+1.2)/2 = 0.95 mg

676480 kg MSW release CO_2?

676480000000 mg MSW

CO_2 emission of waste combustion = 0.95 x 676480000000 = 642656 ton CO_2

Table 4.55 The energy produced from waste combution by incineratio process

Waste	Amount	Unit	Energy produced (BTU/ton)	Total Energy Produced (BTU/day)
Wet waste (Food Waste)	406	ton/day	5200000	2111200000
Paper waste	108.78	ton/day	6397767.094	695949104.5
Various Waste	23.52	ton/day	5200000	122304000
Plastic	138.18	ton/day	8199378.308	1132990095
TOTAL ENERGY PRODUCED				**4062443199**

Cost Calculation for Profitability Analysis

Investment Cost = 73350000 USD = 9.5355E+11 IDR = 953,550,000,000 IDR

Unit Operating Cost = 19.56 USD/ton waste

254280 IDR/ton

Qtotwaste Padang = 177996000 IDR

Depreciation = 3190000 USD = 1470000000 IDR

Based on data of previous research Gang et. Al., 2016.

Table 4.56 The projected sales of the incineration system

No.	Product	Amount	Unit	Selling Price			
				Per unit	Daily (IDR)	Monthly (IDR)	Yearly (IDR)
1	Waste Ash	4953	ton/day	32556.24323	161251072.7	4837532182	58856641546
2	Energy (Coal+Diesel)	4062443199	BTU/day	0.006707981	27250792	817523753.8	9946539004
TOTAL					188501865	5655055936	68803180550

Table 4.57 The cash flow of the incineration system

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
In Flow											
Capital	9.5355E+11										
Net Profit + Depreciation		61836388413	68020027254	74822029979	82304232977	90534656275	99588121903	109546934093	120501627502	132551790252	145806969277
Out Flow											
Investment Plant	9.5355E+11	0	0	0	0	0	0	0	0	0	0
Net Cash In Flow - Out Flow	0	61836388413	68020027254	74822029979	82304232977	90534656275	99588121903	109546934093	120501627502	132551790252	145806969277
Cash Balance Beginning		0	61836388413	129856415667	204678445646	286982678623	377517334898	477105456801	586652390894	707154018396	839705808648
Cash Balance End		**61836388413**	**129856415667**	**204678445646**	**286982678623**	**377517334898**	**477105456801**	**586652390894**	**707154018396**	**839705808648**	**985512777925**
Annual Cash Flow		61836388413	68020027254	74822029979	82304232977	90534656275	99588121903	109546934093	120501627502	132551790252	145806969277
Average Cash Flow		98551277793									

Table 4.58 The income statement of the incineration system

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Projected sales	68803180550	75683498605	83251848466	91577033312	1.00735E+11	1.10808E+11	1.21889E+11	1.34078E+11	1.47486E+11	1.62234E+11
Less: Cost of Goods Sold (Operating Cost)	177996000	195795600	215375160	236912676	260603943.6	286664338	315330771.8	346863848.9	381550233.8	419705257.2
Gross Profit	68625184550	75487703005	83036473306	91340120636	100474132700	110521545970	121573700567	133731070624	147104177686	161814595455
Depreciation (indirect)	41470000000	45617000000	50178700000	55196570000	60716227000	66787849700	73466634670	80813298137	88894627951	97784090746
Net Profit Before Tax	27155184550	29870703005	32857773306	36143550636	39757905700	43733696270	48107065897	52917772487	58209549735	64030504709
Corporate Income Tax (25%)	6788796138	7467675751	8214443326	9035887659	9939476425	10933424068	12026766474	13229443122	14552387434	16007626177
Net Profit	20366388413	22403027254	24643329979	27107662977	29818429275	32800272203	36080299423	39688329365	43657162302	48022878532
Return On Sales	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
Return On Investment	**2**	**2**	**3**	**3**	**3**	**3**	**4**	**4**	**5**	**5**
Gross Profit Margin	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 4.59 The net present value of the incineration system

Year	Net Cash Flow	1+I'n	PV Factor	PV
Year 1	61836388413	1.0625	0.941176471	58198953800
Year 2	68020027254	1.12890625	0.885813149	60253034523
Year 3	74822029979	1.199462891	0.833706493	62379612212
Year 4	82304232977	1.274429321	0.784664935	64581245584
Year 5	90534656275	1.354081154	0.738508174	66860583663
Year 6	99588121903	1.438711226	0.695066516	69220368969
Year 7	109546934093	1.528630678	0.654180251	71663440815
Year 8	120501627502	1.624170095	0.61569906	74192738726
Year 9	132551790252	1.725680726	0.579481468	76811305975
Year 10	145806969277	1.833535771	0.545394323	79522293245
			Total PV	**6.83684E+11**
				6.83684E+11

I = 6.25%
PV Factor = 1/(1+i'n)

Total Project Cost = 9.5355E+11 IDR
Total PV = 6.83684E+11 IDR
NPV = -2.69866E+11
NPV **<0 The business is NOT feasible**

Net Benefit Cost Ratio (BCR) =
Total PV/Total Project Cost = 0.716987654
>1 The business is NOT feasible

Table 4.60 The IRR of the incineration system

Trial and error			
Year	(1+i%)'n	1/(1+50%)'n	PV
1	1.00528602	0.994741775	61511238774
2	1.010599982	0.989511199	67306578729
3	1.015942034	0.984308127	73647932159
4	1.021312324	0.979132413	80586742243
5	1.026711001	0.973983915	88179298929
6	1.032138216	0.968862488	96487195576
7	1.037594119	0.963767991	1.05578E+11
8	1.043078862	0.958700282	1.15525E+11
9	1.048592598	0.953659221	1.26409E+11
10	1.05413548	0.948644666	1.38319E+11
			9.5355E+11
		Investment cost	9.5355E+11
		NPV	0.248535156

IRR = 0.528602001 % = <6.25% = NOT feasible

IRR is the discount rate that cause the net present value or NPV to equal zero. A NPV of zero essentially means that the present value of all cash flows equals the value of our investment. Is we put another way, the money that we expect to receive in the future, discounted into todays value, equals how much money we are investing in this project. By obtaining the IRR for several projects, we can determine which project is more likely provide a better return. Project that yield a higher IRR are considered to be more attractive compared to there lower yielding counterparts.

Method = trial and error

Table 4.61 The pay back period of the incineration system

Year	Cash Out	Cash in	Net Cash Flow	Cumulative NCF
0	9.5355E+11	0	-9.5355E+11	
1	0	61836388413	61836388413	-891713611587
2	0	68020027254	68020027254	-823693584333
3	0	74822029979	74822029979	-748871554354
4	0	82304232977	82304232977	-666567321377
5	0	90534656275	90534656275	-576032665102
6	0	99588121903	99588121903	-4.76445E+11
7	0	109546934093	1.09547E+11	-3.66898E+11
8	0	120501627502	1.20502E+11	-2.46396E+11
9	0	132551790252	1.32552E+11	-1.13844E+11
10	0	145806969277	1.45807E+11	31962777925

The Pay back period = 10 year

How many year the cummulative NCF can be positive value

2. Evaluation of Waste Dumping System (Current System)

The calculation of time for waste transportation, required trucks for the transportation, and CO_2 emission of waste dumping system wich is current system in Padang city are shown in **Table 4.62-4.64**.

Table 4.62 Total time of waste transportation of waste dumping system

Waste Generation (ton/day)	Place	Distance (km)		Time Required (hour)			Total Time
		Average	Round	Round-trip (hour)	Waste Loading Unloading (hour) (21 minutes x 2)	Total Time	
20.3	Bungus Teluk Kabung - Air Dingin	34.4	68.8	2.67	0.7	3.37	3 hours 18 minutes
35.3	Lubuk Kilangan - Air Dingin	26.5	53	1.63	0.7	2.33	2 hours 18 minutes
85.3	Lubuk Begalung - Air Dingin	18.3	36.6	1.6	0.7	2.3	1 hour 52 minutes
52.4	South Padang - Air Dingin	21.8	43.6	1.83	0.7	2.53	2 hours 8 minutes
72.6	East Padang - Air Dingin	15.4	30.8	1.27	0.7	1.97	1 hour 36 minutes
52.1	West Padang - Air Dingin	18.6	37.2	1.2	0.7	1.9	1 hour 52 minutes
63.6	North Padang - Air Dingin	12.2	24.4	0.97	0.7	1.67	1 hour 38 minutes
48.6	Nanggalo - Air Dingin	9.5	19	0.76	0.7	1.46	1 hour 22 minutes
96.4	Kuranji - Air Dingin	11.1	22.2	1	0.7	1.7	1 hour 26 minutes
43.9	Pauh - Air Dingin	19.4	38.8	1.23	0.7	1.93	1 hour 52 minutes
129.5	Koto Tangah - Air Dingin	6.8	13.6	0.5	0.7	1.2	1 hour 12 minutes
700			388			22.36	

Table 4.63 Required truck for waste transportation of waste dumping system

Waste Generation (ton/day)	Place	Ritation of 1 Truck (Truck Capacity = 2 ton)	Transport Time of total waste (hour)	Working Time (hours/day)	Amount of Truck Required per day
20.3	Bungus Teluk Kabung - Air Dingin	10.15	34.21	8	4.28
35.3	Lubuk Kilangan - Air Dingin	17.67	41.18	8	5.15

85.3	Lubuk Begalung - Air Dingin	42.63	98.05	8	12.26
52.4	South Padang - Air Dingin	26.21	66.32	8	8.29
72.6	East Padang - Air Dingin	36.30	71.50	8	8.94
52.1	West Padang - Air Dingin	26.04	49.48	8	6.18
63.6	North Padang - Air Dingin	31.78	53.07	8	6.63
48.6	Nanggalo - Air Dingin	24.32	35.51	8	4.44
96.4	Kuranji - Air Dingin	48.20	81.93	8	10.24
43.9	Pauh - Air Dingin	21.95	42.35	8	5.29
129.5	Koto Tangah - Air Dingin	64.75	77.70	8	9.71
			651.31		**81.41**
					82

Table 4.64 CO_2 emission of waste trasnportation process of waste dumping system

Waste Generation (ton/day)	Place	Diesel Consumption of Dump truck 8 m^3 (liter/day) (2 - 3.8km/liter = average 2.9km/liter))	CO_2 Emission Factor of transportation (ton/day)
20.3	Bungus Teluk Kabung - Air Dingin	240.80	0.64
35.3	Lubuk Kilangan - Air Dingin	323.02	0.85
85.3	Lubuk Begalung - Air Dingin	538.02	1.42
52.4	South Padang - Air Dingin	394.13	1.04
72.6	East Padang - Air Dingin	385.48	1.02
52.1	West Padang - Air Dingin	334.03	0.88
63.6	North Padang - Air Dingin	267.39	0.71
48.6	Nanggalo - Air Dingin	159.37	0.42
96.4	Kuranji - Air Dingin	368.94	0.97
43.9	Pauh - Air Dingin	293.61	0.78
129.5	Koto Tangah - Air Dingin	303.66	0.80
		3608.45	**9.53**
		3609	

4.7. The Best Scenario Selected

The best scenario in this study is chosen based on the results of socio-enviro-economic evaluation above. In the social evaluation by S-LCA, scenario 2 and 3 have same feasibility rate of the most potential positive impacts compare to scenario 1 whereas E-LCA specify that scenario 2 has the least environmental impacts by the percentage reduction of landfill area usage, the amount of CO_2 emissions, and the condition of potential environmental impacts of each scenario`s chain. Furthermore, Economic evaluation by FFA mark that scenario 2 as a feasible business financially by the values of NPV, B/C, IRR, and payback period. Therefore, it can be stated that scenario 2 is the best scenario in case study of Padang city. Detail illustration of the feasibility status of each scenario is shown in **Table 4.65**.

Table 4.65. Comparison of feasibility rate of each scenario

Scenario	**Feasibility Rank**		
	Social Evaluation	**Environmental Evaluation**	**Economic Evaluation**
1	3rd	3rd	3rd
2	1st	1st	1st
3	1st	2nd	2nd

The choice of scenario 2 as the best scenario is specific for Padang city and other cities with similar social, environmental, and economic condition. Build upon interviews to several students originated from various developing countries, the socio-enviro-economic conditions of their countries are similar to Padang city`s. Therefore, the design ideas, numbers, and methodology of this study are expected to be applied to cities in many developing countries.

Among those three scenarios, scenario 3 which is incineration-based system has grown rapidly in many developed countries because of its efficient way to reduce the waste volume and demand for landfill space by 80 to 95%, and its speed in processing waste in clean way without causing bad odor and aesthetic. However, capital-intensive, high operating and maintenance cost requirement, suitable waste composition’s condition, skilled staff requirement, controlled and well-operated landfills requirement, of incineration plant may make MSW incineration beyond the reach of many developing countries (The World Bank, 1999). The statement above is proved by assessment results of this study that shows infeasibility of implementation of scenario 3 by the heavy cost requirements. Immature and unwell-functioning waste management system as well as skilled staff requirement unavailability may make the incineration-based system questionable for implementation in developing countries. Accordingly, as long as there are other MSW management system alternatives, the incineration-based system will be the last choice for developing countries.

4.8.New Methodology Proposed

The waste FUN system could be implemented to other cities with similar social, environmental, and economic conditions. Therefore, the local government should evaluate the specific conditions of the city first before application starting from social evaluation. The selection of the waste FUN system should be tested by comparison study with other specific potential systems in the city on socio-enviro-economic evaluation. The methodology of the best system selection can be seen in **Figure 4.8**.

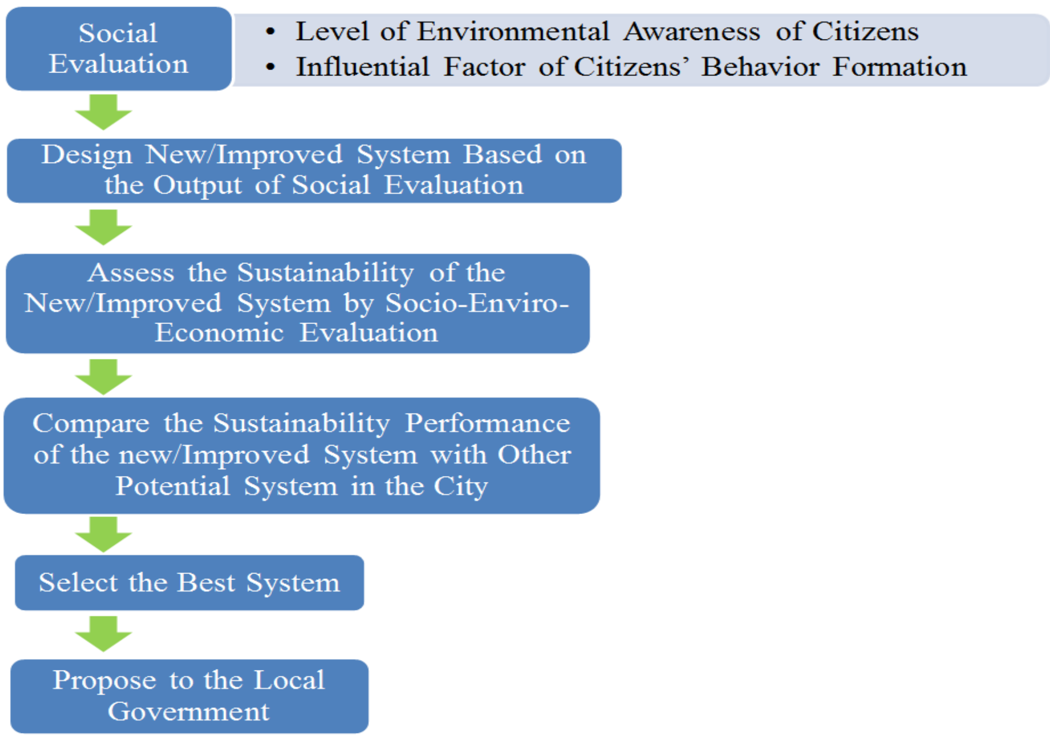


Figure 4.8. Methodology proposed to determine the best system for other cities.

CHAPTER 5
CONCLUSIONS

5.1. Summary

This study investigates the root cause of the problems with the waste management system in Padang city, Indonesia. Modifying the current waste management system of the city is not technically difficult, but the readiness of citizens to accept and comply with the new system should be considered prior to making any changes to the system. Separation-based waste management systems that are successfully applied in developed countries such as Japan, Germany, and the U.S. do not guarantee success in developing countries. The demographics, culture, and many other social factors differ from one society to another. This study takes the unique approach of examining the environmental behavior of Padang citizens to determine their level of readiness for modified waste management methods for a successful implementation of the system.

SEM was used to determine the relationship of one set of unobserved constructs to another set of construct. A survey was conducted with Padang citizens and the survey responses were analyzed using EFA and CFA to establish the structural model. The results of SEM were supported by the results of the social evaluation (scoring system) of the citizens' environmental behavior and view of the current and future waste management system. SEM and social evaluation together determined the readiness of Padang citizens for the modification of the solid waste management system which requires separating the waste at the source. Padang citizens are not yet completely ready to accept and apply the modified system in their day-to-day life. The waste separation method is a fairly new concept for the citizen, therefore the environmental education and specifically the education on waste separation and management should start at the basic level. The local government should encourage the citizens toward adopting positive environmental behavior by increasing the effects of "law enforcement" and "environmental knowledge" before modifying the system for successful implementation.

This study proposes the “Waste FUN” system as an idea to improve citizens’ understanding of the system and problems associated with it in fun ways. The new system consists of three main components; “Fund” for economic benefits, “Utilization” for waste management, and “Nurture” for environmental education and encouragement. This model is expected to change the negative environmental behavior of citizens to pro-environmental behavior and make citizens accustomed to the idea of waste separation. In accordance with evaluation by SWOT analysis, MFA, and LCA, those show that the waste FUN system is feasible to do with many good impacts for environment and society.

Furthermore, this study also examines the performance of the waste FUN system if it compares to other potential waste management system which can be implemented in Padang city to see the feasibility level. Two different systems which are incineration-based system and the waste FUN system as well as current MSW management system are assessed in this study and compared their performance in term of social, environmental, and economic aspects with the case study of Padang city using social life cycle assessment, environmental life cycle assessment, and financial feasibility assessment, respectively. The results showed that the waste FUN system has the best performance which got the most feasibility for implementation in every evaluation steps. The best scenario chosen could give innovative ideas, and diverse information to establish a better MSW management system in cities of developing countries with similar socio-enviro-economic circumstances. Because of dissimilarity condition and needs between developed countries and developing countries, the research plot or methodology of this study may give great contribution and stimulate further research for establishment of a sustainable MSW management in developing countries.

5.2. Concept and Strategy for the System Implementation

The basic concept of this study is centered on social aspect of a system. The authors found that the main aspect which can determine the success towards the implementation of a system is social aspect. The starting point should be social aspect evaluation in order to achieve sustainable design. The users, in this case citizens have to be first recognized about their level of understanding and acceptance toward the design plan. Even the best designs will not be applied properly if the citizens do not understand or do not want to run the system.

The waste FUN system in this study is required a new regulation creation by Padang local government which then can be adopted by other cities in developing countries if the system going well. Padang city can be a Pilot area for the waste FUN system project to test the system in real conditions. For Indonesia case, if the waste FUN system going well in many cities, the central government can create a national level regulation related to waste separation-based system through parliamentary approval. The application of the waste FUN system to Padang government could be started by doing discussion and presentation to Padang Mayor and people working in governmental position. If they doubt the successfulness of the system, we can start the system from small scale (district) and make larger area gradually.

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