EVALUATION AND DEVELOPMENT OF WASTE MINIMIZATION SYSTEM IN BANGKOK

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ABSTRACT

Title of Dissertation	EVALUATION AND DEVELOPMENT OF WASTE MINIMIZATION SYSTEM IN BANGKOK
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This research aimed to evaluate the effectiveness of the waste minimization of the Bangkok Metropolitan Administration (BMA), study relevant factors, and propose an appropriate system of BMA's waste minimization (BMAWM). The data were collected through document research, participatory observation, and interviews with the BMA administrators and officers, and community leaders. Data analysis employed the CIPP-I framework for BMAWM evaluation, SWOT analysis for factor analysis, and Input-Process-Output (I-P-O) model for developing an appropriate system of BMAWM.

The results of the BMAWM evaluation by the CIPP-I framework revealed that: (1) Context: positive issues regarding government and BMA policy and plan, industry and private sectors collaboration, communication technology, Bangkok environment, solid waste's law, and inadequate issues on the people's waste littering behavior, and local politicians; (2) Inputs: inadequate issues in terms of number of personnel, personnel development, budget, communication tools, waste utilization capacity, and organization management; (3) Processes: positive issues regarding monitoring and evaluation, BMAWM guidelines, and inadequate issues on the BMA district action plan, personnel acceptance, law enforcement, public participation promotion, open communication activity, and waste separation collection operation; (4) Products: positive issues in terms of the agencies participation, incresed amount of waste utilization, and accomplishment issues in terms of communities participation in community-based solid waste management, waste separation types and waste composition remaining unchanged, and amount of waste disposal increasing; and (5) Impacts: on environment was high level of carbon dioxide emissions; impact on the economy in terms of collection and disposal cost, renewable resources loss, low collection fee; and positive impacts on society were people's participation, earnings of low-income people, waste collection workers, and recycling businesses.

Internal factors affecting BMAWM consist of concrete plans and strategies, the appropriate administrative structure has the power to set policies, budgets, materials, equipment, personnel, and can issue BMA ordinances, stipulated as an essential policy by the Bangkok governor, clear assignment of responsible personnel, integration all sectors' collaboration, and shared value-creating for BMA officers. External factors consist of concrete government policy, responsibility for waste management of manufacturers, the strength of recycling business, knowledge, and awareness of the population on waste separation and value of waste, public and private participation, communication technology, and waste separation law development.

The appropriate system of BMAWM by the I-P-O model consisting of; Input dimension: create BMA zero-waste committee and BMA district zero-waste committee, support personnel, personnel development, increase communication tools, support budget for the BMA district’s waste minimization management, broadcasting for public awareness, research and develop waste minimization process, and improve vehicles and plants for waste separation collection system. Process Dimension: announce Bangkok's zero-waste agenda, establish a solid waste minimization action plan, promote all sectors' cooperation, promote the community-based solid waste management into the communities and the 14 target groups, complete waste collection services, promote home composting, enforce waste management law conscientiously, monitor and improve enact the guidelines. Output dimension: create KPIs action plan implementation including communities and the 14 target groups solid waste management participation, increase amount of waste utilization, the ratio of waste separation types changed, the waste composition changed, the amount of waste disposal decreased, BMA district waste decreased, and people have the behavior of solid waste reduction and separation.

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ABBREVIATIONS

Abbreviations	Equivalence
BDP	Bangkok Development Plan
BMA	Bangkok Metropolitan Administration
BMADC	BMA Disposal Center
BMADO	BMA District Office
BMAED	Bangkok Metropolitan Administration, Environment Department
BMAPPD	Bangkok Metropolitan Administration, Policy and Planning Department
BMASED	Bangkok Metropolitan Administration, Strategy and Evaluation Department
BMAWM	Bangkok's Waste Minimization
CBM	Community-Based Solid Waste Management
CPPS	Cleansing and Public Park Section, BMADO
EM	Environmental Management
ISWM	Integrated Solid Waste Management
MEJ	Ministry of the Environment of Japan
MSW	Municipal Solid Waste
NESDP	National Economic and Social Development Plan
ONESDC	Office of the National Economic and Social Development Council
PCD	Pollution Control Department
PPD	Policy and Planning Division, BMAED
SWM	Solid Waste Management
WDD	Waste Disposal Division, BMAED
WHNMD	Waste, Hazardous Waste and Nightsoil Management Division, BMAED
WMPI	Waste Minimization Policy Implementation
WMS	Waste Minimization System
WRS	Waste Reduction and Separation
20-year DPBM	20-year Development Plan for Bangkok Metropolis

CHAPTER 1

INTRODUCTION

1.1 Statement and Significance of the Study

Solid waste management (SWM) in Thailand has been an increasingly major problem. The total amount of municipal solid waste generated nationwide increased from 23.93 million tons in 2008 to 27.93 million tons in 2018 (Pollution Control Department [PCD], 2019). This was an average generation of 1.14 kg per person per day, an increase from 2008 of approximately 0.11 kg per person per day. A total of 2,881 local administrative organizations throughout the country were unable to provide satisfactory waste collection and disposal services. Municipal solid waste was disposed of in an inappropriate manner such as open burning and open dumping into abandoned pits or vacant land at an annual rate of 7.37 million tons. Moreover, hazardous wastes combine with general wastes, electronic waste is disassembled for sale, and the residue is discarded onto vacant land, as well as unsanitary littering. Infectious waste is estimated to account for 11% of waste and has not been included in government data, particularly infectious waste from private clinics, health care centers, and animal hospitals (PCD, 2019).

Bangkok Metropolitan Administration (BMA) has been managing waste consistent with the national laws and the BMA collects waste throughout Bangkok areas. The amount of municipal solid waste (MSW) increased from 3,260 tons per day (1.19 million tons) in 1985; to 8,695 tons per day (3.17 million tons) in 1997; 8,719 tons per day (2.18 million tons) in 2007; to 10,526 (3.8 million tons) in 2017. This represents an increase of 223% since 1985. BMA, Environment Department [BMAED] (2019) reported that the BMA faces solid waste problems such as disposal of waste at the inappropriate time, illegal dumping, unseparated and uncovered collection of hazardous wastes in small health care centers, inefficient separation at the source, and weak enforcement. The details are shown in Table 1.1.

Table 1.1 Amount of Municipal Solid Waste in Bangkok (1985-2017)

Year	Amount of solid waste (tons/day)	Amount of solid waste (million tons/year)	Amount of MSW increase (tons/day)	Percentage of amount of MSW increase (%)
1985	3,260	1.19	Base year	Base year
1992	5,372	1.96	2,112	65
1997	8,695	3.17	5,435	167
2002	9,460	3.45	6,200	190
2007	8,719	3.18	5,459	167
2012	9,748	3.56	6,488	199
2017	10,526	3.84	7,266	223

Source: BMAED, 2019.

BMA's cost of SWM increased from 1,386 million baht in 2003 to 4,189 million baht in 2017. The costs of MSW disposal management increased from 1,124 million baht in 2003 to 2,953 million baht in 2017. The total cost of waste collection and disposal increased from 2,510 million baht in 2003 to 7,143 million baht in 2017. Meanwhile, the waste collection fee increased from 138 million baht in 2003 to 509 million baht in 2017 (BMAED, 2019). The details are shown in Table 1.2.

Table 1.2 Cost of Municipal Solid Waste Management of BMA (2003-2017)

Year	Amount of MSW (tons per day)	Cost of MSW collection (MB)	Cost of MSW disposal (MB)	Cost of MSW collection and disposal (MB)	Cost per ton (baht)	MSW collection fee (MB)
2003	9,350	1,386	1,124	2,510	735	138
2005	8,496	2,080	1,131	3,211	1,035	409
2007	8,719	2,856	1,455	4,311	1,354	399
2009	8,788	2,974	1,496	4,470	1,393	419
2011	8,943	3,408	2,319	5,727	1,754	438
2013	9,963	3,667	2,451	6,118	1,682	455
2015	10,167	3,926	2,641	6,568	1,769	476
2017	10,526	4,189	2,953	7,143	1,859	509

Source: BMAED, 2019.

BMA established waste reduction and separation (WRS) as part of the waste minimization system (WMS) policy of the Bangkok Development Plans (BDP) since 1987. The BMA, Policy and Planning Department [BMAPPD] added the WRS in the 3rd BDP (1987-1991) and the 4th BDP (1992-1996) aimed to control the amount of waste by establishing public participation for waste reduction, separation at source, and plastic and Styrofoam reduction (BMAPPD, 1987, 1992). The main purpose of the 5th BDP (1997-2001) was the reduction of waste generation per capita to 1 kg per person per day. The 6th BDP (2002-2006) focused on waste reduction in 2006 which should be increased by 15% from 8.57% (BMAPPD, 2002). BMA, Strategy and Evaluation Department [BMASED] had the Bangkok Administration Plan (2005-2008) intended to reduce the amount of waste by 6.16% to 10.47% from the target 10% per year (BMASED, 2005). In 2009-2012, the Bangkok Administration Plan (2009-2012) targeted to decrease the waste generation rate per capita by 0.98 kg per person per day from the target at least 0.75 kg per person per day in 2012 (BMASED, 2009).

While during the period 2013-2019, BMA has launched the 20-year Development Plan for Bangkok Metropolis (20-year DPBM) during the year 2013-2032 that established the reduction target to at least 20% in 2032 (BMASED, 2013a). The waste management plan Bangkok 2015-2019 defined targeted waste reduction at 3% by 2015 and 7% by 2019 (BMAED, 2015). Nevertheless, the result of waste reduction has not been successful, but the amount of waste disposal has increased continually.

However, the 20-year DPBM (2013-2032) is determined to eliminate the amount of waste disposal at least 20% by 2032 by based on the year 2013. The plan defined the BMA's waste management vision as "the BMA has household waste and hazardous waste under the zero-waste approach by being active in recycling, minimizing, and disposal through suitable methods and technologies." It is reasonable that the BMA must improve the methods of waste minimization process to meet the target solid waste reduction of at least 20% by 2032.

Hence, BMA is still facing critical issues to solve and develop solutions to drive the policy toward BMA's waste minimization (BMAWM). Notably, the reduction and separation of solid waste at the source are the most vital keys to achieve the goal.

Therefore, this research intended to assess the effectiveness of BMA's waste minimization by evaluating policy theory, investigating the influence of factors on BMAWM in Bangkok, and developing an appropriate system for achieving the BMA's sustainable waste management goal which is the BMA has household waste and hazardous waste under the zero-waste approach by being active in recycling, minimizing, and disposal through suitable methods and technologies that bring forward the sustainability of waste management in Bangkok other municipals in Thailand.

1.2 Research Questions

1) Has the BMAWM implementation been successful?
2) What are the factors influencing BMAWM implementation?
3) What is an appropriate system for BMAWM?

1.3 Objectives of the Study

This research has three objectives as follows:

1) To evaluate the effectiveness of the BMAWM implementation.
2) To analyze the factors influencing the BMAWM implementation.
3) To develop an appropriate system of BMAWM for new guidelines to improve the BMAWM policy implementation.

1.4 Expected Benefits of the Study

1) To gain insights into the effectiveness of the BMAWM implementation, and factors influencing the BMAWM system.

2) To propose an appropriate system of BMAWM which can adopt BMA's policies and the policies of the other municipals in Thailand.

3) The results from the study can be applied in the form of a suitable BMAWM system and suggestions from this research could lead to the achievement of the sustainable waste management goals and welfare of the society.

1.5 Terms and Definitions

1) Waste is the municipal solid waste in Bangkok generated from households, commercial and service spaces, and office buildings. Also, the solid wastes from factory offices are counted but it does not include wastes from the production process or industrial waste and does not include wastewater.

2) Waste minimization is the process of the SWM of BMA to reduce the amount of waste disposal to landfills and incinerators. The wastes from reduction and separation processes at the source are collected to be utilized by the BMA District Offices (BMADOs) or BMA disposal centers (BMADCs).

3) Waste reduction is the process of the solid waste management system that aims to eliminate the amount of waste disposal by reducing non-recycling material such as single-use plastic, Styrofoam, packaging products, and reducing transportation, retail, wholesale trade, and consumption.

4) Waste Separation is the process of the solid waste management system that aims to reduce the amount of waste disposal by separating waste at sources. Waste separation could occur at the household, collection station, and utilization plant at the disposal center.

5) General waste is the mixed waste that is mostly non-recyclable and disposed of into waste bins or at the collection point. General waste is collected by BMA collection trucks and taken to the BMA's disposal stations.

1.6 Scope of the Study

1) Content Scope:

This research focused on evaluating the effectiveness of BMAWM implementation of the 20-year DPBM during the year 2013-2019. Also, the study will analyze the influencing factors and formulation of strategies to develop an appropriate system for the BMAWM.

2) Area Scope:

This research is conducted in the Bangkok Area, Thailand.

3) Timing Scope: 2016-2020.

4) Population Scope:

The key informants include:

(1) The Deputy Governor of Bangkok.

(2) The Secretary to Governor of Bangkok.

(3) The BMASED administrator.

(4) The BMAED administrators and staff.

(5) The BMADOs staff.

(6) The community leaders who participated in the Community Based Solid Waste Management (CBM) Project and or Green Community Project.

CHAPTER 2

LITERATURE REVIEW

This study reviewed the theories and research related to the solid waste minimization (SWM) process. The SWM literature involved policies such as planning, implementation, public policy and participation, laws, evaluation theories, environmental management (EM), and sustainable development (SD). Also, case studies and other research were studied to be applied as a guideline for developing an appropriate BMAWM system. The literature review consists of the following sections:

2.1 Public policy
2.2 Public participation
2.3 Environmental management
2.4 Sustainable development
2.5 Waste Management
2.6 General information of the Bangkok Metropolitan Administration
2.7 Evaluation, factor analysis, and strategy formulation theories

2.1 Public Policy

2.1.1 The Definition of Public Policy

Public policy is a process of organizational politics of government and non-government organizations (NGOs) that respond to public issues. In particular, the government is expected by the people to seek solutions to effectively solve problems. Thus, public policy has become part of the political theory according to the relationship between citizens, political parties, parliament, judiciary, bureaucracy, administrative system, and local government (Thamrongtunwong, 2005). Also, the public policy covers government activities such as education, welfare, provisions, and regulations to control people, corporations, and government activities. The activity

processes are based on the peaceable principle, usefulness monitoring, and control. Yavaprabhas (2014) stated that public policy is the guideline for determining government activities for preventing and solving problems that occur. However, these depend on the decision-makers and the complexity level of the problems. Generally, national policies are often established mostly very broadly and non-specifically. The lower-level policies must be consistent and clear to support higher-level policies. Ourairat (1983) identified policy as to how the national government chooses to pursue its intended appropriate and feasible purposes for the public and environment. Several scholars believe that government policies are the government's decision-making process for allocating resources or values in society, as well as the activities or actions of the government. Similarly, Ngernklay (2008) argued that public policies are guidelines or activities of government or government agencies to determine the authority and responsibility according to society and community benefits.

Hence, public policy is the process of government decision making including domestic and international activities based on appropriate political, economic, and social analysis for the public majority benefit. It is not an individual decision, but a systematic decision. These are measured the actual outputs and results of government operations. Public policies could be developed by government agencies, civil servants, political parties, politicians, and NGOs that influence and drive government policies.

2.1.2 Public Policy Implementation

In the study of Chantasorn (2008), there are policy implementation successes and failures, which could be evaluated in three dimensions by using the level of performance on effective-ineffective policy implementation as the measurement. The first dimension focused on the results and the measurements of policy assessment. The process measures the objectives and successes by considering three aspects as output, outcome, and outcome. Outputs are measured in terms of quantity, time, expense, quality, and satisfaction. Outcomes are productivity effects that evaluate the policy implementation in target groups. Last, ultimate outcomes include output and outcome effects on the development of the nation.

The second dimension is the evaluation of policy implementation accomplishment in four circumstances. Firstly, the policy does not cause other policy problems. Secondly, the policy has high reliability according to the fundamentals of Thai bureaucracy. Thirdly, the achieved policy should not have problems in terms of implications such as overuse of natural resources or not following regulatory guidelines. The main measurements take into consideration such factors as time, resources, and the excessive expense above the value of the return of the policy and effort expended. Lastly, the successful implementation of the policy should not contravene humanitarian or moral issues.

The third dimension is that the totals of all policy implementations must produce desirable results for the nation's development. The state policies aim to succeed and not cause problems or conflicts with other policies or projects. The achieved policy implementation has indirectly been measured by other factors. Thus, the level of achievement of the policy might be measured by the completion of another service factor that supports successful policies.

2.1.3 Factors Determining Success of Public Policy Implementation

According to Yavaprabhas (2014), 10 factors affected the success or failure of policy implementation presented below.

1) The nature of the policy, which results in change and is in line with the organization's objectives, will show the successful results of policy implementation.

2) Policy objectives have a clear purpose, could be easily recognized and understood for implementation by policymakers. The practitioners have an assured purpose of the policy (Thamrongtunwong, 2005).

3) The political possibility must be supported by the business sector.

4) Technical feasibility and theoretical reliability are important.

5) Human behavior will be changed from effective theoretical and policy implementation.

6) Sufficient finances are needed for resources, manpower, and quality of personnel.

7) The necessity is one of the factors to consider such an adequate role, specific knowledge, the services as to materials, offices, tools, land, and other facilities.

8) Hierarchical structures and superiors are involved in the success of policy implementation. The structures of institutions play an important role in implementation. Small organizations have fewer experiences of administrative problems in comparison to larger organizations that have more complex structures. Nevertheless, small organizations have more opportunities to succeed with policy implementation because of less hierarchical levels.

9) The attitude and understanding of leaders are a necessity in practice. Leaders have the authority to enact policy. Therefore, leaders have a great effect as an example of behavioral change for other organizational members and the public.

10) Relationships between the various agencies must concern success or failure. For example, if an organization has several units and different tasks, this could result in a delay in operation or ineffective implementation.

These dimensions serve as a metric for policy assessment of goals and objectives of policy development. Thamrongtunwong (2005) stated that policy assessment is the most important procedure for policy implementation as it evaluates the level of success or failure. Also, it can measure the effectiveness of meeting goals and objectives of policies in terms of inputs, processes, organization, outputs, outcomes, impacts, and environment. These factors are important tools for policy decision-makers to pursue policies.

2.1.4 Public Policy Assessment

Ngernklay (2008) stated that the five criteria for a successful assessment of policy success or failure as follows:

1) Policy Goal Attainment: Attempts to evaluate the effect of policy implementation by measuring the goals achieved.

2) Efficiency: The main key is the costs that are evaluated based on quality performances.

3) Constituency Satisfaction: This reflects the attitudes and perceptions of people that could be measured as a rank or level of the accomplishment or failure of policy implementation.

4) Clientele Responsiveness: This is the perception criteria of people involved in the policy.

5) System Maintenance: The criteria for effectiveness are evaluated at the macro-level and micro-levels. For example, the micro-level includes political stability at the local level as a part of policy implementation by the various units.

Therefore, policy implementation and policy assessment are the processes with several factors that affect the success or failure of public policy. The BMAWM is a BMA waste reduction policy implementation procedure. The evaluation result led to determine the important factors that affect the success or failure of the policy such as the nature of the policy, policy objective, technical feasibility, human behavior, the sufficiency of financial or manpower, quality of personal, specific knowledge, materials and other facilities, attitude, and understanding of policy leaders.

2.2 Public Participation

Office of the National Economic and Social Development Council (ONESDC) (2018), the public participation refers to the process by which people in general and relevant people can participate in raising awareness, understanding, and make suggestions related to the issues. Also, they could contribute and share ideas in the decision-making process for solving problems. They could join in the development process as a development partner. Principles of public participation began with lessons of failing to develop rural communities because the development did not focus on people's participation and sustainable development. The local and international academic philosophies have since described that public participation in progress and involvement of local communities is essential for driving successful development. Public participation is a key issue in the community for development. In the 6th National Economic and Social Development Plan (NESDP), public participation has been clearly defined, with development being a process related to the public and other sectors. Additionally, the involvement of the public sector including businesses,

individuals, people, communities, and organizations in the decision-making process is an opportunity, contributing to a sustainable democratic society. The involvement of all sectors in decision making increases the effectiveness of implementation. Moreover, such development benefits from public participation as it is sustainable. The public participation conceptual framework consists of five procedures leading to sustainable community development:

1) Participation in awareness can provide feedback and suggestions.
2) Participation in the selection and decision-making process.
3) Participation in decision-making.
4) Participation in the monitoring.
5) Beneficial participation and ownership of the public policy.

Public participation is an important key to the SWM process. Because BMAWM is generated by households, schools, universities, hotels, supermarkets, department stores, hospitals, convenience stores, office buildings, housing estates, markets, and the entire city population behavioral change is the most difficult practical aspect of policy implementation.

2.3 Environmental Management

Environmental management is exceptionally broad in scope. It incorporates many specialist aspects such as finance, and numerous environmental perspectives. The environmental adjustment and biological system are properly maintained by nature itself. But since the arrival of the modern industrial age, there has been large-scale environmental destruction caused by overwhelming industrialization, innovative transformation, the rapid development of transportation, major misuse of assets, rapid urbanization, and so on. Environmental management is related to facilitating humanity existing within nature. This includes the reasonable utilization of natural resources without the destruction of the biological system. However, at present, the natural resources are overexploited and this will influence national socio-economic advancement (Orun, 2018).

Environmental management is regularly sought after as a responsive, piecemeal approach, working on ventures that have natural destinations or components planned to moderate, instead of dodge, natural impacts (World Bank, 1989). Environmental management should take a long-term perspective that meets the outcomes proposed by the organizers and lawmakers. Longer-term measurements increase the chances of maintaining a strategic distance from issues. Environmental management was created in the western government for majority rules and there was relative flexibility for collecting the data (Haefele, 1973). Currently, environmental management must advance and spread adjustment for a distinctive suit for all social and political conditions. It will proceed in strides. The methodologies for environmental management are required to closely coordinate with other disciplines involved in the progress of natural stewardship. The modern environmental manager is a multi-disciplinary administrator who encompasses and understands the expertise in many aspects as technology, business, finance, federal, state, and local statutes and regulations (Erickson & King, 1999).

For the ideological level, environmental management allows companies to be “green” and legitimizes the power of corporate management's part in natural issues. Environmental management is hence seen to focus more on legislative issues than natural supportability (Levy, 1997). This coincides with Orun (2018) stated that the concept of natural determinism, probabilism, and possibilism are noteworthy within the concept of natural asset administration. The perspectives of natural asset administration incorporate (1) Natural Recognition and Open Mindfulness; (2) Natural Instruction and Preparing; (3) Asset Administration; (4) Control of Natural Corruption and Contamination; and (5) Natural Affect Evaluation.

Poboon (2014) stated that there are two main approaches to solving environmental problems. Firstly, prevention is an approach to protect the environment and manage humans by raising awareness through participation and integration. Secondly, environmental problems should be solved with rejuvenation therapy and management by using command and control, national laws, and international laws, and economic instruments under the Polluter Pay Principle (PPP). For example, the market-based incentives are charges, subsidies, deposit-refund systems, taxation, market creation, and so on. The management instrument could be managing by a principle consisting

of management establishing control measures, director empowered for implementation, and social measures by creating environmental awareness and raising environmental awareness. The concept is shown in Figure 2.1.

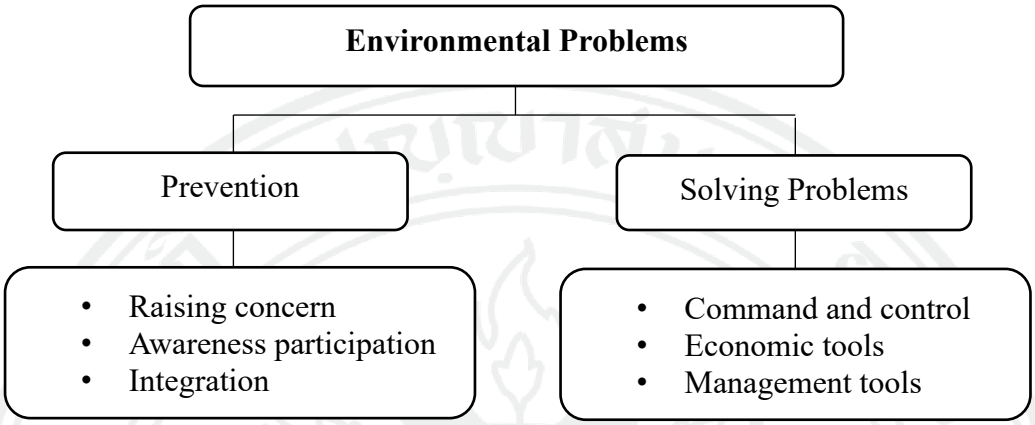

Figure 2.1 Concept of Approaches to Environmental Problems Solving
Source: Poboon, 2014.

For the BMA's SWM, solutions and prevention have integrated into policy implementation for environmental management. The prevention activities are included raising awareness of residents, enhancing participation, and integration. For solving problems, BMA has been using command and control, economic tools, and management tools.

2.4 Sustainable Development

Thailand Sustainable Development Foundation [TSDF] (2016) explained that sustainable development is the transformative process of resource consumption, investment guidelines, technologies, and human society developments to meet present and future needs. Also, intra-generational equity and inter-generational equity must be considered. Representatives from other countries also have focused on achieving the Millennium Development Goals (MDGs) goals. In 2012, the Earth Summit was held in Rio de Janeiro, Brazil. The conference tag lined as was "The Future We Want" with leaders from 192 countries, including Thailand. It politically endorsed sustainable

development and promoted sustainable development principles by setting sustainable development goals (SDGs). The SDGs guidelines measure and evaluate the sustainable development of member countries. The MDGs have driven sustainable development in Thailand and supported the SDGs. Thailand has made great efforts to integrate the SDGs into National Strategy for 20 years (2017-2036) by implementing the Sufficiency Economy Philosophy. The vision is "Thailand is secure, prosperous, sustainable, a developed country with a development based on the Sufficiency Economy Philosophy." The NESDP has developed under the national strategic plan for 20 years with cooperation across sectors (TSDF, 2016). However, the United Nations (n.d.) explained that the Brundtland Report of 1987 also defined sustainable development as a development that reaches the needs of the present without compromising the needs of future generations. It describes the development in five aspects. First, development must be restricted to the biosphere to absorb the effects of human activities. Second, basic human needs are important for development especially the quality of life of poor people should be improved. Third, citizens should participate in national and international decision-making activities effectively and equally. Fourth, the harmony of the affluent lifestyle and boundaries of the ecology must be with acceptable limits. Lastly, population size and population growth must be balanced with the ecosystem's potential to meet their needs.

TSDF (2016) explained that the sustainable development framework stresses that the factors of economy, society, and environment must connect effectively. There are three main characteristics taken into consideration. Firstly, the development must meet the needs of society under the constraints of the environment and not impact the capacity to meet the needs of the next generation. Secondly, the economy, society, and environment are linked. Finally, the goal is to achieve a global society's sustainability, including sustainable consumption and sustainable resources. To safeguard natural resources and eradicate poverty, there are three sustainable development paths which are as follows. Firstly, appropriate demographic policies such as population control by family planning and addressing population problems by solving educational problems, which also addresses other problems. Secondly, natural resources conservation and environmental protection are a necessity. The ecosystem, restoration of degraded environments, and resource consumption in several areas such

as the declared areas or forest reservations, national parks, and wildlife sanctuaries, must be free from chemicals and pollutants resulting from human activities. Lastly, ethics are important for harmonious existence between humans and the environment for a prosperous future through such means as wastewater technology, modification to sustainable lifestyles, and energy saving.

Unsuccessful sustainable development could result due to three factors: (1) passion, (2) endurance, and (3) intolerance. Therefore, the economy and human resources must be developed in parallel with the development of ethics. This depends on four factors as listed below.

1) The human factor is the development of productivity includes value, health, responsibility, skills, and advanced knowledge to be a vital force in the socio-economic system. This has allocated support and leads to sustainable development by providing and supporting a proper educational system.

2) Social factors are aspects such as organizations, economy, political system, and business sectors related to development. These need to be based on the knowledge and difference of each aspect to create a climate of non-persecution, a conducive atmosphere, and mutual support.

3) Natural factors are the natural consumptions and creations that humans must live within harmony with nature.

4) Technological factors are technology uses that do not harm nature.

The society must develop technology alongside self-development. Sustainable SWM has defined targets in Goal 12 of the SDGs to ensure sustainable consumption and production patterns (United Nations, n.d.) and consists of eight details as follows.

1) All countries must take action to implement the 10-year framework. The developed countries are the leaders who need to share their capabilities with developing countries.

2) By 2030, the world must achieve sustainable management goals and natural resources must remain sufficient.

3) By 2030, global food waste at the retail and consumer levels be halved per capita. Also, the food losses must decrease along with production, supply chains, and post-harvest losses.

4) By 2020, the chemicals and all wastes must be safely managed and controlled through lifecycle management following the international framework agreement. Volumes of wastes and pollutions in air, water, and soil have a significant reduction to minimize adverse impacts on human health and the environment.

5) By 2030, waste generation must be substantially reduced through prevention, reduction, recycling, and reuse principles.

6) Private companies especially large and transnational companies must be encouraged to adopt sustainable development in practices and integrate sustainability information into their reporting systems.

7) The national policies must set the SDGs as a high priority policy and promote them regularly to the public.

8) By 2030, all people around the world must have received relevant information and had their awareness of the SDGs raised. Also, their lifestyles are to be in harmony with nature.

Thailand has a sustainable development publication from His Excellency the Buddhist philosopher (Payutto, 1995). He researched and compiled a text on sustainable development that introduced concepts drawn from the Buddhist religion. These concepts can be divided into two: (1) sustainable development is based on the concept of CSD to focus on developing with the emphasis on the environment. Because the environment has been facing many problems from humans such as increasing population, resulting in scarce resources, and more pollution; and (2) UNESCO's concept of human values and culture was the critical factor in development. For Buddhists, sustainable development creates a sustainable society which means taking responsibility for meeting their own needs. However, in so doing they should not harm the world, animals, and subsequent generations. In summary, human activities must conform to the rules of nature by integrating both the economy and the natural environment (Payutto, 1995).

Poboon (2014) stated that two basic concepts of sustainable development. First, development has flexible limits. Second, the technology that people use. The social organization has an enormous impact on environmental resources and the world has a limited ability to handle the effects of human activities. Therefore, humans can manage and improve not only the technology but also social organizations for suitable

economic growth. The objectives of the Sustainable Development Policy are: (1) maintain economic growth; (2) improve the quality of economic growth; (3) basic needs consideration such as work, food, energy, water, and sanitation; (4) proper population proportion; (5) conservation and increasing amounts of resources; (6) suitable technology usage and manage the risks; (7) for policy-making decisions procedure, the environment and economy are both required to be taken into consideration. Moreover, social systems can solve the conflicts resulting from development. Lastly, the management system is flexible and has the potential for improvement.

2.5 Waste Management

Waste means food waste products, useless paper, rags, plastic bags, food containers, ash, dung or carrion, and other objects that are swept from the streets, markets, or other places (Public Cleansing and Orderliness Act, 1992). Additionally, The Enhancement and Conservation of National Environmental Quality Act (1992) defined the definition of “waste” as solid waste, sewage, wastewater, air pollution, including carcasses of other objects. Also, the definition in the Public Health Act (1992) defined the definition of “waste” as solid waste, sewage, wastewater, air pollution, or wastes including carcasses of other objects defined “solid waste” as something swept from the streets, markets, or other places. It also covers infectious waste and toxic or hazardous waste from households or communities. Moreover, PCD (2014b) defines the meaning of MSW as the objects from activities in the community such as businesses, shops, residential housing, and markets.

2.5.1 Waste Management Concepts

Municipal solid waste is increased from production and consumption that have impacts on the environment and life and well-being. There is also an impact on the SWM system, which is the solution to the problem. To solve the MSW problem, various sciences, technology, and resources must be used extensively in the SWM system. Tchobanoglous, Theisen, and Vigil (1993) insisted that solid SWM was an associated process of waste controlled, collected, transported, and disposed of along

with other processes. The wastes that are well-organized and well-managed would have positive impacts in terms of public health, the economy, engineering, the environment, and resource conservation. Moreover, policy planning on comprehensive solid waste management would be developed and integrated for a better solution. Therefore, solid SWM is a combination of various fields of sciences and other academic fields. In the 20th Century, the concept of SWM was "how to get rid of waste effectively with the lowest impact on health and the environment. In the 21st Century, the concept became "how to manage disposed resources and bring back the value of such resources, even partially, for the next generation" (Connett, 2007). While Schall (1992) mentioned the development of solid SWM as "from emphasizing the Disposal Based SWM to Integrated Management, retrospect in 1960, people were using only waste disposal, which was occurring more severe as it showed the ineffective solid SWM. Therefore, the new concept has been established by considering the diverse components of solid wastes that could be managed with the proper method and could also be reused without disposing them to landfill or incineration only" (Schall, 1992). Gertsakis and Lewis (2019) mentioned that "this new concept was the prevention principle of the public health system which solving by preventing the problem to occur and it was more effective than the investment of building system after problems occurred." According to the new concept, the operation needs to integrate the multidisciplinary fields from production, consumption, and SWM procedures. However, there has been a consistent concept noted by Tchobanoglous et al. (1993) who stated that "solid waste occurred in all stages of production and consumption. The best solution was to reduce wastes or solid waste in all stages, for example, reduced the use of materials by reusing them, reused waste or leftover materials in the production process or so-called recycle."

2.5.2 Sustainability Solid Waste Management

United States Environmental Protection Agency [USEPA] (2011) presented the SWM concept for sustainability known as the SWM Hierarchy. This has important four steps for SWM: (1) source reduction and reuse; (2) recycling and composting; (3) energy recovery; and (4) treatment and disposal. The SWM Hierarchy promotes strategies and integrated SWM systems. However, it must be added to the SWM

context, which focuses on critical activities such as waste reduction, recycling, composting, turning into energy, and eliminating waste. The details are shown in Figure 2.2.

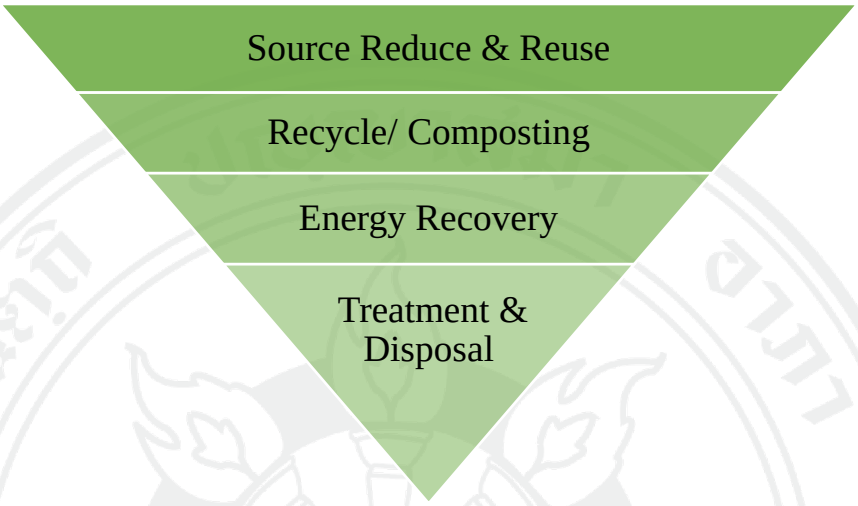

Figure 2.2 USEPA Integrated Solid Waste Management Hierarchy
Source: USEPA, 2011.

Waste is generated from production and human consumption and the economy needs as increasing populations to drive growth. The research shows that economic models must balance with SWM. The purpose of SWM is to reduce the impact of production and consumption including the effects of management processes, especially in the disposal process. Thus, reuse and recycling processes are the first of the hierarchy priorities as they prevent waste generation. The economy begins by consuming natural resources and energy for production and the economy. The number of solid wastes generated from equals both production and consumption by consuming resources or raw materials for entering the economy in the long run (USEPA, 2011).

Field and Field (2012) suggested three solutions to reduce the solid waste impact on the ecosystem. First, the reduction of the number of goods is a social process by encouraging society to reduce the demand for goods consumption that directly affects the volume of waste by decreasing goods production and reducing resource consumption. This solution is better for the ecosystem recovery in the long-term; however, from an economic perspective, it might be detrimental. Second, the

reduction of the number of waste products is needed by improving the efficient production and quality of raw materials usage. There is a guideline for the government and industrial sectors to improve technology to be eco-friendly and reduce waste. This represents a deliberate reconstruction of the concept of the relationships between the ecosystem, economy, and industry. Finally, reuse capacity must be increased as much as possible. It is a priority that should be immediately implemented for natural resources benefits as it reduces waste generated. Also, the amount of consumption would be reduced. The details are shown in Figure 2.3.

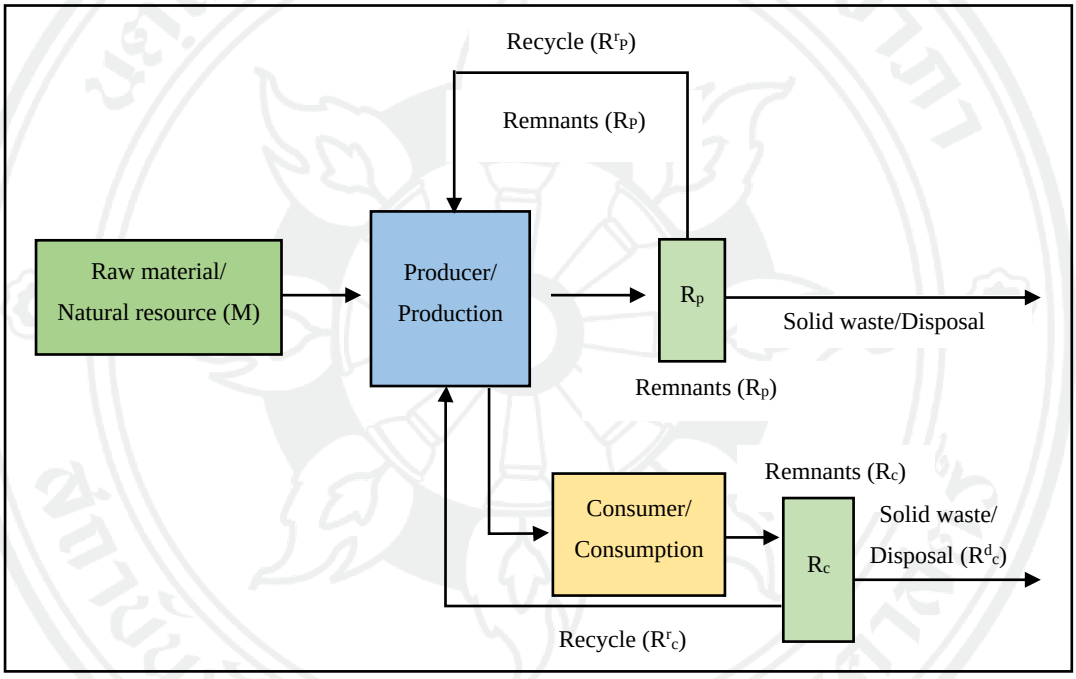

Figure 2.3 Reduction of Solid Waste Solutions on Economic Model
Source: Field and Field, 2012.

Japan has been achieving on SWM by tackling it at the source via a separation method following the 3Rs principle (Reduce, Reuse, and Recycle) for solid waste utilization and elimination. They have implemented and integrated the 3Rs principles into the production and consumption processes. Regarding reuse, materials remain in the production and consumption process. The recycling method includes reusing waste as raw materials for the production of products in the factory (Material

Recycling) and energy recovery (Ministry of the Environment of Japan [MEJ], 2005). The 3Rs process is shown in Figure 2.4.

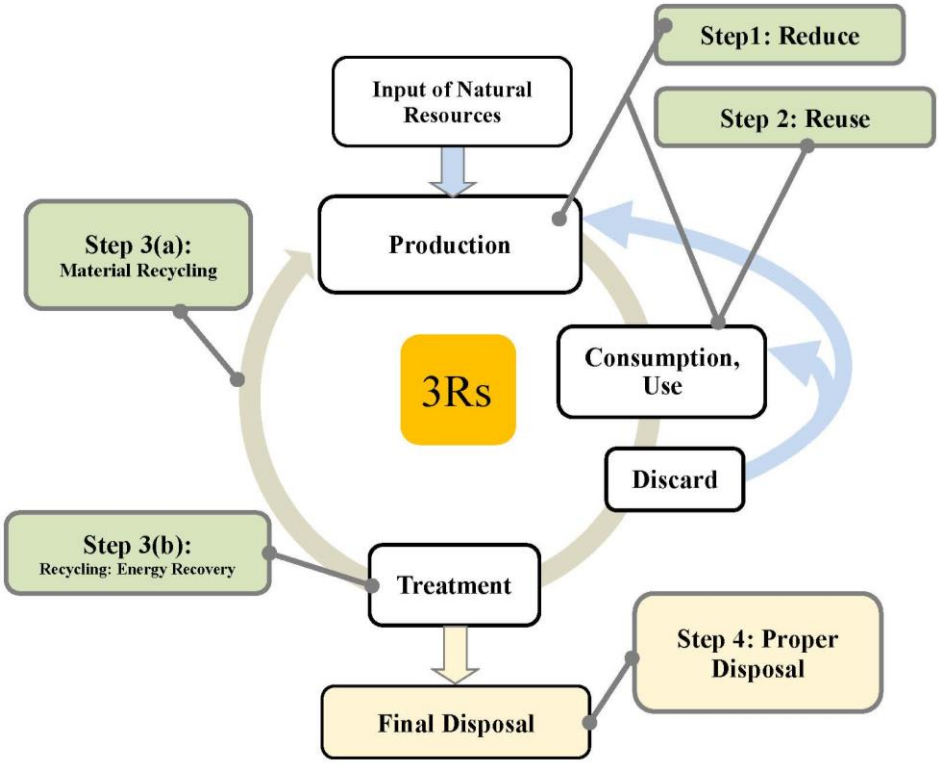

Figure 2.4 The 3Rs in Waste Management Processes of Japan
Source: MEJ, 2005.

The Japanese government had set a goal for making the country a renewable resource society (Material-Cycle Society). They started from the central government by issuing legislation, formulating national action plans, and establishing a community revolving society promotion committee. Next, the local governments formulated action plans by building networks from several sectors such as communities, private sectors, central government, and NGOs to work on 3Rs. There are five main factors involved: raising awareness in the society, information dissemination, partnership creation in all sectors, incentives and technology development, and serious law enforcement. The projects have been created to reduce waste such as setting waste collection points, dates, and time of trash disposal.

Additionally, the European Commission [EC] (2015) has been using the circular economy concept for making SWM policy by promoting durable products and effective energy. Manufacturers must avoid unnecessary and harmful materials, as well as non-recyclable objects. Moreover, secondary raw material markets have been built for receiving the eco-design products and to recall wastes, repair, or develop recycling products. These have been supporting eco-consumers and more efficient BMAWM. Also, the circular economy promotes waste separation and collection systems to reduce, reuse, and recycle effectively (Bonciu, 2014). The circular economy concept is shown in Figure 2.5.

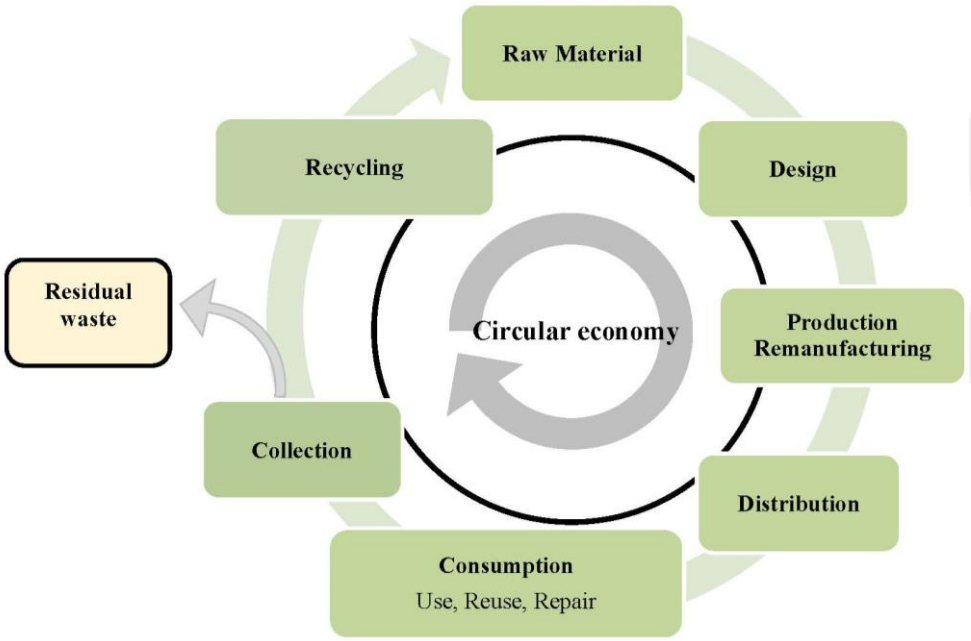

Figure 2.5 Circular Economy Process
Source: EC, 2015.

Sustainable SWM, therefore, does not mean allowing the waste to decompose naturally but is the value management of resources with the concept of ISWM, circular economy, and 3Rs principles. These ideologies aim to manage waste from production and consumption for maximizing benefits. Thus, sufficient natural resources will be preserved for future generations, which are basic needs of living

according to the development principles. The indicators have been established for integrated sustainable SWM in cities. This includes vital quantitative indicators as well as qualitative composite indicators (Wilson et al., 2015). For the physical components of a solid SWM system, there are three quantitative indicators include:

1) Public health: Indicates the cleanliness and effectiveness of SWM that will affect health. The indicators include street cleaning, waste collection points, collection in low-income areas, supervision and management control, and health and safety of collection workers.

2) Environmental control: The indicators are set to control the impact on the environment. These include treatment or disposal control, pollution emission control especially greenhouse gases, energy efficiency, management system control, and occupational health and safety regulations.

3) Resource management: The indicators measure the quality of 3Rs provision according to levels of the waste hierarchy, including source separation that reduces the amount of waste generated and is recycled, including both materials and organics recycling. Also, it measures SWM system integration of the community, informal recycling sector, and concern of workers in terms of occupational health and safety by use of proper personal protection equipment and supporting procedures.

2.5.3 The Case Study of Sustainable Solid Waste Management

In the case study of solid waste management in developing countries, there are different policies and management processes. The Republic of Germany has a government policy that requires manufacturers, importers, and resellers to restore packaging, be responsible for packaging services, and are charged a fee based on weight and type of packaging and set a stamp on the goods to show that the packaging is recycled. There are six groups: glass, cans, metal, plastic, paper, and aluminum. Also, Canada emphasizes reducing unnecessary packaging waste and encourages people to participate by providing information and activities for consumers as follows: (1) use family pack; (2) use refilled products; (3) reuse products; and (4) use recycled products. In the United States, a policy has been established to reduce the amount of solid waste generated at the place of production, such as by planning production and changing raw materials, and consumers have also changed their

behavior by buying products that cause less pollution and can be recycled. Moreover, the law is to reduce waste at the source by reducing the amount and creating less toxic solid waste, for example, measures to use product markers that prohibit the use of certain materials that cannot be recycled included as part of the product (Malikamal & Kanjanawat, 2000).

Furthermore, Malikamal and Kanjanawat (2000) state that the success of the Japanese government on SWM demonstrates that they have been using and enforcing laws and regulations strictly such as promoting reuse or recycling laws, laws on purchase of non-destructive products, containers and packaging law, and specific laws for container manufacturers. Japan has laws on returning used household appliances, laws on recycling remaining food waste, laws on the reuse of building materials, efficient use of resources law, promotion, and initiation of a reusable waste society law. These pieces of legislation set out the guidelines for the recycling of waste. To be successful, cooperation from four sectors has been integral including:

1) The municipality has a role in designing and organizing the waste collection and packaging programs at the source.

2) Manufacturers, retailers, and importers play a role in choosing containers that are easily recyclable and use materials economically.

3) Consumers have a role in separating packaging according to the specified criteria of the municipality. They should consider supporting and buying recyclable products, avoiding extravagant packaging, and using refillable packaging.

4) Recycle centers play a role in accepting recycling materials collected from the municipality.

BMAED (2019) stated that Japan established the concept of waste categorization and collection into the national policy that serves as an instruction for the action of the local administrative organizations' implementation. The details are shown below.

1) Determine the date, time of disposal, and disposal points.

2) Wastes for incineration are collected only on Tuesday and Friday before 09.00 a.m. This is used to generate electrical power.

3) Non-combustible waste such as glass, metal, and cans are collected only on the second Wednesday and fourth Wednesday of the month and transported to a waste separation plant.

4) Recyclable materials such as newspapers and cardboard boxes are collected only on the third Monday of the month and transported to a paper factory.

5) Bulky wastes are collected only on the second Thursday and the fourth Thursday of the month. It is transported to the separation plant to classify materials and deliver to different disposal plants, which includes combustible wastes, unburn wastes, hazardous waste, and others.

6) Special wastes must be notified to the government, agencies, or municipalities for special waste collection.

7) Hazardous wastes must be disposed of at a collection point such as bin in supermarket, shop, store for recycling, and disposal.

The summary of the new concept of solid waste management is associated with the global trend driving the concept of "Green Economy" to adjust the current production and consumption patterns toward more environmentally friendly processes. Green Economy is one of the mechanisms for preventing instead of solving the problem by using natural resources in effective ways. Appropriate waste management includes control of waste generation, storage, collection, transferring and transportation, transformation processing, and disposal. The method for this management must be based on sanitation, economics, engineering, environmental conservation, landscape, and environmental impact. Also, the formats and methods should be effective and appropriate for SWM according to local conditions and types of solid waste.

2.5.4 Research on Solid Waste Management in Thailand

The study of waste reduction and waste separation in Thailand has been conducted by several researchers. For example, Pradejphong (1998) studied the policy implementation and waste separation before disposal of the Lat-Phrao district. The study found that the project of WRS in that district was unsuccessful because of several factors including the project had less continual communication and public participation processes, and fewer action plans in specific areas. Moreover, resources for project management were lacking such as fewer than required waste trucks and bulk carriers. The officials at the field level were aware of the problem and keen to train; however, most waste collectors were working on waste separation for sale and thought the sustainable project was a waste of time. Sustainable SWM requires

cooperation from all sectors, especially the local people in terms of behavioral change to separate waste and utilize waste at the source. Furthermore, Ratanawiboon (2000) indicated that behavior, institutional factors, age, occupation, time spent in the community, and income were correlated with different behaviors while gender factors, number of family members, and media did not correlate with the SWM behavior. Also, Chanhthamixay (2016) presented the overall assessment for the appropriate management of waste treatment and disposal in Bangkok. The study found positive results. However, effective regulation and enforcement were lacking, especially related to MSW management. The study also showed that waste collection services were insufficient, the promotion of resource management was low, there was insufficient available space, subjective norms, mistrust in the MSW service, and people lacked knowledge regarding waste separation and management.

2.5.5 Laws, Policies, and Plans of Waste Management in Thailand

Roadmap of Master Plan for Solid Waste and Hazardous waste of the country had four SWM guidelines for the country are defined: (1) eliminate old waste, close or improve the disposal place following a theoretical term; (2) create appropriate waste and hazardous waste models, focusing on reduction and waste separation at the source, technology disposal integrated, and emphasis on energy transformation; (3) establish regulations and measures to manage solid waste and hazardous waste, prepare a national waste management master plan and define an alternative technology model for waste disposal, and consider relevant laws; and (4) create national discipline for sustainable management by checking and enforcing illegal hazardous waste dumpers. Particularly, awareness should be raised in government and related organizations for being a good example for the public for BMAWM (PCD, 2014a). That is a new guideline for SWM in Thailand that brings to developing the SWM master plan and action plan as follows.

2.5.5.1 Action Plan “Thailand Zero Waste” 2016-2017

Department of Local Administration and Pollution Control Department (2016) mentioned that the purpose of the Action plan “Thailand Zero Waste” 2016-2017 was to guide and provide direction for management implementation of solid waste, hazardous waste, and hazardous industrial waste across the country. All sectors

had to participate, divided into three stages. First, the early stage had the purpose to reduce the amount of waste and increase sorting at sources such as households, government places, public areas, and enterprises. Second, the middle stage considered efficient collection and transportation. The third stage sought the proper and effective principles and academic approach to SWM. Due to the short-term plans, Thailand has been focusing on the early and middle stages. For the early stage, the 3Rs principle has been implemented for the reduction and promotion of waste separation waste at the source and separate hazardous waste. In the middle stage, concentration has been to establish efficient and adequate storage and transportation systems by the vision "Together, manage the waste properly, strengthen the quality of life, environmentally friendly, well clean, people in the country are happy" with the following goals: (1) decreasing the amount of waste entering the disposal system, (2) increasingly isolate hazardous waste, and (3) hazardous wastes and industrial hazardous waste is properly managed and disposal.

The plan is established based on the ideals of (1) encouraging the reduction of MSW by 3Rs, (2) promoting separation at source by recycling and reusing wastes, (3) optimizing waste collection and transferring to the disposal system, (4) supporting all sectors to participate in SWM, and (5) promoting the systematic and accurate disposal of hazardous and industrial hazardous wastes.

1) 3Rs principle is a simple requirement to implement for waste separation at household, enterprise, and public areas. Everyone must integrate waste for waste separation and increasing the value of waste.

2) The state line principle addresses the responsibility, awareness, and participation of people to manage solid and hazardous wastes for sustainable development. It encourages the role of all sectors in the society that consist of five sectors: government (central, regional, and local), private sector, public sector, civil society, educational sectors, and religious sector. All relevant sectors will be involved in every activity and procedure including policy formulation, providing information and opinions, designing waste separation, transportation, setting measures, participating in the area, and so forth.

3) The measures aim to ensure efficient and effective waste operation management. There is a guideline for each measure as follows:

(1) Reduction of waste and separation at source to reduce the amount of waste. People must be encouraged to realize and understand about SWM and support environmentally friendly products and services.

(2) The potential for solid waste collection and transportation should be increasing. Department of Local Administration and provinces have the responsibility to organize the collection and transportation of solid waste and hazardous waste to the disposal plants. Also, they are responsible for managing the disposal center to reach the standard requirements. Instead, the private sectors have been investing or jointly investing in solids waste and hazardous waste systems in some areas.

(3) Raising awareness is important for all people from youth by enhancing education and knowledge on waste reduction, waste separation, and disposal. Moreover, the development of efficient SWM management from other perspectives is required such as linking database systems and improving laws and regulations with thorough enforcement.

2.5.5.2 The Nation Master Plan for Solid SWM 2016-2021

PCD (2016) integrated all local government and relevant parties to made the Nation Master Plan for Solid SWM 2016-2021 that has three critical concepts for SWM in Thailand as follows:

1) 3Rs principle (Reduce, Reuse, and Recycle) aims to reduce the consumption rate, increase the reusing and recycling rate, modify behavior toward SWM, and create and support friendly environmental consumers and products.

2) The disposal of solid wastes and hazardous wastes has been utilized for power generation. Also, adoption of appropriate systems to accommodate the collection, transportation, and waste separation.

3) All sectors must become involved in SWM by raising the level of public awareness and the level of discipline of waste and hazardous waste from the source until the end of the disposal process.

2.5.5.3 Policies of Bangkok's Governor and 20-year DPBM

BMAED (2019) stated that a green city was one of the six central policies by M.R. Sukhumbhand Paribatra, Governor of Bangkok during 2015-2016. Green city in this context means a mobilization for city management under the environmentally friendly concept. Also, the concept means a city that is designing with concern for environmental effects, public awareness of ecology, and sustainable living. The policy framework is broad and includes the increasing of green areas, Dog Park, encouragement of green roofing for high rise buildings, the increase in environmentally friendly SWM systems, conversion of waste to energy, wastewater treatment plants, moving the electricity/telephone/cable wires underground, clean public toilets as well as transit points and tourism areas. The Strategy and Evaluation Department of BMA has implemented these policies into actions by conducting a 20-year DPBM (2013-2032) (BMASED, 2013a).

2013 was a preliminary year to implement the 20-year DPBM (2013-2032) by transforming the public's vision over the next 20 years for participating in and developing Bangkok that is to create a growing Asian megacity in the next 20 years by implementing several changes concerning environmental issues as part of the Asian regional and world community as well as part of the move toward increased participation in the ASEAN community. The plan is divided into four five-year phases that include: in 2017, Bangkok would be a safe city; in 2022, Bangkok will be a convenient city, the center of economy, and green city for everyone; in 2027, Bangkok will be a physical urban structure transformed from having a single city center to having dispersed city centers, both in old town areas and in the suburbs connected by infrastructural systems such as economic and efficient mass public transportation systems. Meanwhile, urban development in central Bangkok will be controlled. Additionally, from a political perspective, Bangkok will be a leading democratic city of Asia with a clean political system, without corruption, and "A Megacity for Democracy." In the next 20 years, Bangkok will be a central city of the economy, academia, investment, logistics, trade, and culture of Asia. In terms of SWM, BMA will be a zero-waste city that applies solid and hazardous waste for utilization. Also, the residues will be disposed of with effective technology (BMASED, 2013a).

2.5.5.4 Solid Waste Management Plan of Bangkok 2015-2019

BMAED (2015) stated that the Roadmap of the Master Plan for Solid Waste and Hazardous waste of the country has been defined as a guiding and framework for SWM according to the roadmap of the master plan, waste has defined as a resource. The plan focuses on waste reduction and separation at source, controlling the amount of solid waste, efficiently collecting and disposing of waste by classification and corporation with related organizations, reduction of the amount of waste for landfill but increasing the amount of waste for energy and fertilizer. It has set a five-year operational plan 2015-2019. The goals of the year 2019 compared with 2013 were proposed as follows: (1) the amount of solid waste should be reduced by at least 7%; (2) the amount of hazardous waste collected can be increased by at least 20%; (3) the amount of waste that has been disposed of by waste disposal technology will be increased by no less than 30%.

BMAED (2015) explained the plan is intended to succeed according to the following strategy:

1) Improving the efficiency of general waste and hazardous waste is needed to reduce the problem of inappropriate disposal systems by the separation of SWM which includes waste reuse for the maximum benefit. This strategy focuses on increasing the efficiency of SWM since it promotes the reduction and utilization from the source by introducing the 3Rs principle. This promotes the separation of hazardous waste and electronic waste (e-waste) from general waste. Also, efficient, and appropriate SWM development systems that focused on the waste collection process for waste disposal technologies, encourage the adoption of environmentally friendly technologies for collection, transportation, disposal, and making valuable waste. The four sub-strategies for increasing efficiency are:

(1) Encouraging 3Rs principle: Reduce, Reuse, and Recycle.

(2) Encouraging waste separation: separation of hazardous and infectious waste from general waste.

(3) Developing a valid waste collection process and appropriate technology for municipal waste disposal.

(4) Utilizing environmentally friendly technology and waste utilization.

2) Discipline in participation and responsibility for SWM of relevant organizations and the public are important. This is a strategy to emphasize the participation of all sectors including government, the private sector, and the public for collaborating in WRS for behavioral change such as less consumption to reduce waste. For the private sector and communities, collaboration might include implementing the law and economic measures to resolve problems. However, encouraging knowledge among the population to learn about the basic methods for WRS is also important. The strategies for driving discipline and responsibility of the public and relevant sectors are:

(1) Using law enforcement measures.

(2) Using economic incentives controls the volume of MSW.

(3) Encouraging the public with knowledge of SWM for adjusting their consumption behaviors.

(4) Encouraging mutual participation among communities and the private sector for SWM.

3) The integration of the SWM process focuses on the setting of a comprehensive plan, policy implementation, funding, and knowledge. For BMA, when Bangkok SWM Plan is announced, the agency is supposed to set targets, allocate budgets following the measures and projects that are approved and related to the reduction of MSW. The strategies for integration of municipal SWM process are:

(1) Preparing an SWM plan with participation from all relevant sectors.

(2) Utilizing an IT system for SWM.

(3) Creating a fair, transparent, and measurable management system.

4) Greater Bangkok's empowerment in SWM means the knowledge and skill development of Bangkok officers regarding SWM. The enhancement of attitude is a necessity to modify the behavior of Bangkok officers in their operational work for SWM. The details are shown as follows:

(1) Building capability of BMA officers; knowledge and skills on how to manage municipal solid waste properly.

(2) Building attitudes toward BMA officers for municipal waste operational activities.

(3) Encouraging participation among local and governmental agencies and international institutions for SWM.

5) Research and development knowledge of technology in SWM is a necessity. The development of knowledge and innovation to increase efficiency in SWM must increase new knowledge and technologies for suitable problem-solving. The two strategies for this perspective are as follows:

(1) Encouraging and supporting research relevant to SWM.

(2) Supporting knowledge development and innovation to increase the efficiency of SWM.

2.5.5.5 Legislation and Measures of SWM in Thailand

Thailand still has no specific legislation for waste reduction and separation. The current laws focus on controlling and eliminating waste in the country, which is a waste collection and disposal procedure that summarize the current laws involve in BMA waste management. Public Health Act,1992 is the law for public health that has the purpose of the law is to establish the SWM and empower the local government for solid waste operation such as Article 18 provides for solid waste and sewage management in any local areas, the authority belongs to that local government, and Article 20 (2) provides for containers of solid waste or sewage provided in the public area. Act on the Maintenance of The Cleanliness and Orderliness of the Country,1992 is the law for public area clean that has the main purpose of establishing cleanliness and prohibiting waste disposals such as Article 31 prohibiting the disposal of sewage or solid waste in public areas, to give authority to BMA for the operation related to the cleanliness and tidiness within Bangkok Metropolitan Administration Act, 1985 Article 89 (4) and (10) BMA has authorities and duties to maintain public areas in Bangkok.

Also, Thailand has specific laws that focus on some areas to clean and healthy such as Regal Water System Act, 1942 Article 28, disposal of solid waste, animal and plant remains, ash or waste in the irrigation canals, or endanger water to agriculture or consumption are prohibited. Violators found guilty can be punished with imprisonment not exceeding 10 days or a fine, not more than 50 baht or both imprisonment and fine, Article 36. Water Supply and Canal Treatment Act, 1983 Article 15, disposal of solid waste, animal and plant remains, ash or waste in the irrigation canals, canals, or canals for water supply is prohibited. Violators found guilty can be punished with imprisonment not exceeding 1 month or a fine, not more than 2,000 baht or both imprisonment and fine, Article 19. Railway and Interstate Arrangement Act, 1921 Article 82, disposal of solid waste causing damages to the train are misdemeanors and punishable. Moreover, the Highways Act, 1992 Article 45, disposal of solid waste, sewage, wastewater, debris, sand on the road, or pavement is prohibited. Violators found guilty can be punished with imprisonment not exceeding 3 years or a fine not more than 60,000 baht or both imprisonment and fine, Article 71 and Building Control Act, 1979 is the law for building control is the key point to the advice of the building control committee, established the ministerial regulations on solid waste and sewage disposal Article 8 (6).

Nevertheless, for BMA has regulation on criteria for waste and sewage management of the building and health facilities by Bangkok Regulation on Guideline for Solid Waste and Nightsoil Management of the Building Places and Public Health Premises, 2002 that has central point under the Public Health Law, 1992 which is Bangkok regulation on criteria for waste and sewage management that provisions of BMA on the solid waste and sewage collection on time at the collection point and waste separation collection by Governor of Bangkok authorizes to the director of each district office and director of BMAED include 1) the announcement of the waste disposal schedule (done by BMA Governor who authorizes to the director of each district office for the announcement) and 2) Bangkok Regulations empower BMA's Governor to announce the announcement on waste separation, but at present, there is no empowerment and no announcement ("Bangkok Regulations empower BMA's Governor According to the Bangkok Regulation on Guideline for Solid Waste and Nightsoil Management of the Building Places and Public Health Premises, B.E. 2545,").

In conclusion, the theory and concept of SWM in the 21st century has changed following the sustainable development principle that people make the value of waste and return it as resources or materials for the next generation. The most effective SWM measure is the 3Rs concepts of Reduce, Reuse, and Recycle aimed at the prevention and reduction of waste disposals such as into landfills and for the incarnation that are end methods for waste management and is costly for the government to invest in waste collection and disposal system. The national policies, master plans, legislations, and environmental of Bangkok have direct impacts on creating policy and master plans on Bangkok's SWM. In particular, the national policies, master plans, and legislations are the fundamental guidelines for people's behavior on WRS.

2.6 General Information of the Bangkok Metropolitan Administration

BMASED (2013b) explained that Bangkok located in the lower central region of Thailand at a latitude of 13.45 degrees north, and longitude of 100.28 degrees east. Bangkok has a lowland landscape with an average height of 1.5-2.0 meters above sea level, with a slope in the ground level from the north, gradually sloping into the Gulf of Thailand to the south. The lower Chao Phraya River basin is not higher than 1.50 meters above sea level. It is located in an area that is geographically called the river delta, which is caused by sedimentation (alluvium). As part of the Lower General Plain of Thailand, Bangkok has a tropical climate, under the influence of two types of monsoons: the northeast monsoon and the southeast monsoon, which creates three distinct seasons: summer February-April, rainy season May-October, and cold season November-January.

BMASED (2016b) explained that the Bangkok was established as the capital city in 1782 and has changed from a small community on the river banks of the Chao Phraya River to a metropolis that covers an area of 1,568.737 square km. with a population of 5,686,646 people with a density of 2,816,711 houses. The average population is 3,625 people per square km. Pom Prap Sattru Phai District is the most densely populated area with 24,573 people per square km. Next, Samphanthawong District has 17,504 people per square km., and Din Daeng District has 14,839 people

per square km. The area with the least densely populated area is the Nong Chok area with 710 people per square km followed by Thawi Watthana district with 1,552 people per square km., and Khlong Sam Wa district with 1,712 people per square km. There are 2,067 registered communities within BMA. The total latent population of Bangkok is approximately 10 million. Bangkok is a “metropolis,” that is, it is a center of prosperity in all aspects. The national development policy of the government focuses on expanding development in various areas in the five adjacent provinces, namely Nonthaburi, Pathum Thani, Samut Prakan, Samut Sakorn, and Nakhon Pathom. The capital and its adjacent provinces are continuously linked and can be called the same city. The developed economy is the country's main economic base and is ranked as 15th as a center of economy, trade, and services in Southeast Asia. Also, Bangkok is a significant international financial center (Kokpol, 2011).

BMASED (2013b) Bangkok metropolitan region accounts for 51% of national production and has social facilities, utilities, and is an industrial and commercial center for goods and services. However, these have caused problems in terms of adaptation of migrant workers leading to housing density and slum communities with residents living in degraded areas. This has resulted in a poor quality of life, traffic, concentration in activities, and laborers' migration to the metropolitan area. The transportation network has been unable to support rapid urban and population growth. Bangkok has faced continual flooding problems that increase in intensity every year. Moreover, there are other environmental problems such as traffic density causing air pollution. The Bangkok population is rapidly increasing while most people lack public awareness regarding protecting the environment. There is an obstacle to urban environmental management. Bangkok has not yet adopted the principle of the Polluter Pays Principle (PPP). The detail of the Bangkok area is shown in Figure 2.6.

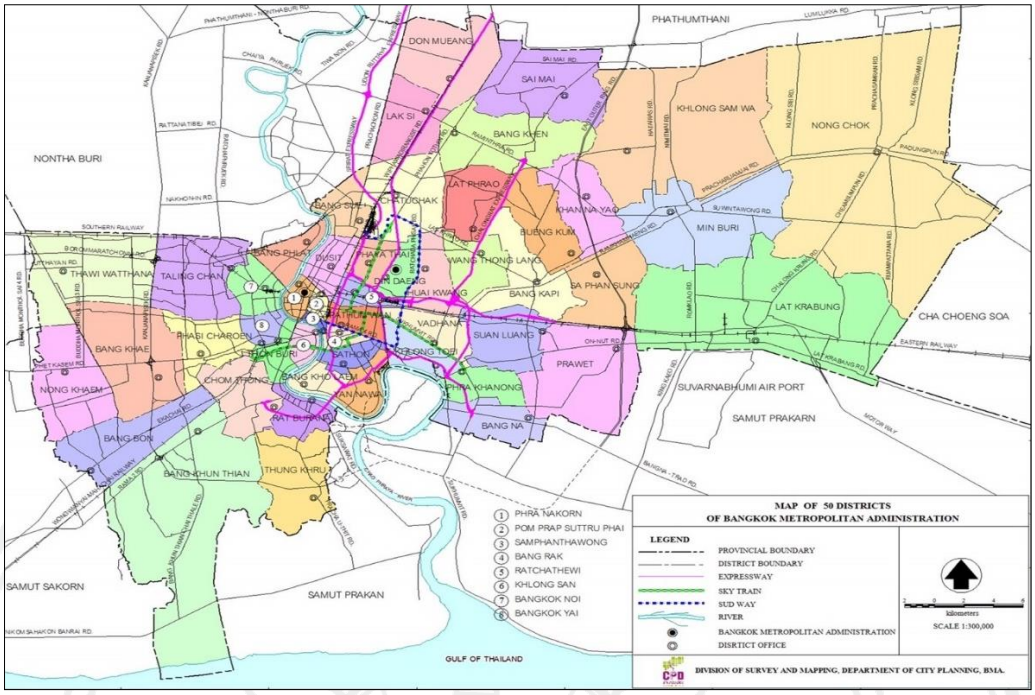

Figure 2.6 Maps of 50 Districts of Bangkok, Thailand
Source: BMA, Department of Planning and Urban Development, 2019.

2.6.1 Bangkok Metropolitan Administration

Bangkok, as the capital, has changed in administration style over time. In the past Bangkok was under the responsibility of the Department of Wiang which later changed to the Ministry of City and Ministry of Public Health, and only later was sanitation established. During the reign of King Rama V, the government changed with the Municipal Organization Act in 1933 which established the Bangkok Metropolitan Municipality, which developed as the Bangkok Metropolitan Thonburi Municipality. Finally, Bangkok was established as a unique local administrative organization that is different from other provinces of the country which have two levels of local government, namely the upper level provincial administrative organization (Kokpol, 2011).

Bangkok Metropolitan Administration is a juristic person and is a local government administration, with administrative regulations that collapsed or change the district area by the announcement of the Ministry of Interior in the Government Gazette ("Bangkok Metropolitan Administration Act B.E. 2528,"). The provisions of any law

referring to the provincial area shall mean Bangkok and the laws referred to as the district area, the locality of the sub-district, the district chief, and the district director (BMASED, 2013b).

2.6.2 Authority of Bangkok Metropolitan Administration

BMASED (2013b) explained that the BMA has the authority to administer in the Bangkok under Bangkok Metropolitan Administration Act (1985) regarding public order maintenance, registration, disaster prevention, and mitigation, maintaining cleanliness and orderliness of the city, town planning, and providing maintenance of land, water and drainage, traffic management and engineering, police station promotion and support, transportation, market provision and control, docks, crossing and parking lots, public maintenance, building control, improvements to slum communities and management of housing, establishing and maintaining recreation facilities, environmental development, and conservation. Also, Bangkok has to maintain art, customs, local knowledge, good local culture, public utilities, public health, family health and medical care, the provision, and control of cemeteries and crematoriums, animal husbandry control, the provision and control of slaughter, the control of safety, orderliness, and hygiene in theaters and other public places. The commerce of Bangkok and other duties as specified by the law as the authority of the provincial governor, sheriff, the municipality also is the responsibility of BMA that assigned by the Council of Ministers, Prime Minister or Interior Minister or as specified by the law as BMA or any powers and duties belonging to the central government or provincial government may be given to BMA to perform, which will be made into a Royal Decree, Ministerial Regulations, Regulations or Notifications, as the case may be. The outside operation of Bangkok could occur when such action is necessary and is in connection with an activity carried out under the jurisdiction of BMA or for the benefit of the people of Bangkok. In case of necessity, Bangkok might grant the private sector to carry out business, which is within the authority of Bangkok and might collect fees, service fees, or related compensation on behalf of BMA ("Bangkok Metropolitan Administration Act B.E. 2528,").

2.6.3 Bangkok Metropolitan Administration Organizational Structure

The Bangkok administration consists of the Bangkok Council, the Governor of Bangkok, which is directly elected by the population named in the civil registration of Bangkok. The BMA has 15 BMA Department offices, and 50 BMADOs as a mechanism ("Bangkok Metropolitan Administration Act B.E. 2528,"). Details are as follow:

1) The Bangkok Metropolitan Council consists of Councilors of Bangkok Metropolitan Council, each elected by citizens who have the right to vote in each district. If any district has more than 150,000 residents, the BMA Council member shall increase every 150,000 people per one BMA Council member that has a term of the Council member is four years. The Bangkok Metropolitan Council has the power to enact regulations regarding the ethics of the BMA Council member, meeting rules regarding the selection and performance of the President of the Bangkok Metropolitan Council, Vice President, and the General or Extraordinary Committee of Bangkok Council, meeting methods, proposing and considering draft provisions, proposals, consultations, discussions, votes, questions, general discussions, treatment Regulations and order and other activities which are the duty of the Bangkok Metropolitan Council to drive the policy and plan.

2) The Governor of Bangkok is elected by citizens from the 50 districts. The Governor of Bangkok shall hold office for a term of four years as from the date of selection, for no more than two consecutive terms. If the Governor of Bangkok does not complete their term of four years, it shall be considered one term. After two consecutive terms, the governor can hold the position only after the expiration of four years from the date of the vacation. The Governor of Bangkok is the supervisor of Bangkok officials and employees of BMA that are responsible for the BMA and has the powers and duties as specified by other laws to be the power. The Governor of Bangkok has the following powers and duties:

(1) Determining policies and administration of the BMA to be by the law.

(2) Ordering, granting, and approving the civil service of Bangkok.

(3) Appointing and dismissing the Deputy Governor of Bangkok, Secretary to the Governor of Bangkok, Assistant Secretary to the Governor of Bangkok, with qualifications as the advisor of the Governor of Bangkok or as a committee to perform any civil service.

(4) Delegating administrative of the government service by the cabinet of the Prime Minister or the Minister of the Interior.

(5) Establishing regulations for Bangkok duties to be completed.

(6) Acting by the BMA regulations.

(7) Other powers and duties as provided in this Act and other laws.

BMASED (2016b) explained that the Government offices of Bangkok consist of the Office of the Bangkok Metropolitan Council Secretariat, the Office of the Governor of Bangkok, the Office of the BMA Civil Service Commission, the Office of the Permanent Secretary for the BMA, the BMA Department offices, BMA district offices or a government office called otherwise. The BMA officers consist of 22,012 ordinary civil servants, 16,087 teacher civil servants, 39,300 full-time employees, and long-term employees. Current positions are 18,219 which are distributed in the 50 BMADOs. In 2013, the total workforce was 61,191 consisting of 7,471 civil servants, 15,891 teacher civil servants, 25,576 permanent employees, and 12,253 temporary employees. In 2017, BMA had a total workforce of 95,618 consisting of 22,012 ordinary civil servants, 16,087 teacher civil servants, 39,300 permanent employees, and 18,219 temporary employees.

BMASED (2013b) explained that structure, authorities, and duties of BMA officials are shown as follow:

1) The Office of the Bangkok Metropolitan Council Secretariat has the authorities and duties related to the official affairs of the Bangkok Metropolitan Council, with the Bangkok Metropolitan Council Secretariat is an ordinary Bangkok civil servant as a supervisor of BMA officials and employees under the Permanent Secretary for the BMA.

2) The Office of the Governor of Bangkok has the authorities and duties related to the governor with the Governor of Bangkok Secretary, who is a political office as a supervisor of BMA officials and employees under the Governor of Bangkok.

3) The Office of the BMA Civil Service Commission has the authority and duties related to the official service of the BMA. The Chief of the Office of the BMA Civil Service Commission is a BMA official, to supervise BMA officials and employees under the Permanent Secretary for the BMA.

4) The Office of the Permanent Secretary for the BMA has the authority and duties relating to the general affairs of BMA, and that not explicitly designated as a function of any government agency. The Permanent Secretary for the BMA is a supervisor of BMA civil servants and employees.

5) The Department is the BMA agencies under the control of the Governor of BMA and the Permanent Secretary for the BMA has the authority and duties to connect with the government service as specified filed in the BMA. The Director of the BMA department is an ordinary BMA civil servant as a supervisor of BMA officials and employees. Also, they have the authorities and duties as stipulated by law and according to the orders of the Governor of Bangkok and the Permanent Secretary for the BMA and be responsible for supervising the official functions of the BMA accountable for the compliance with Bangkok policies, including control, intensive, follow up the work performance that was assigned.

6) The District office has the Director of BMA district as the supervisor of BMA district officials and employees. They have authorities and duties to provide by law, including the powers and duties of the sheriff as provided by the law and the powers and duties assigned by the Governor of Bangkok or the Permanent Secretary for the BMA.

BMASED (2013b) reported that the highest supervisor of the Bangkok government official is the Permanent Secretary for the BMA, who has the authority and duties as specified by the law and the order of the Governor of Bangkok. The responsibility is for control the Bangkok government's operations, by the Governor of Bangkok policies, including managing, follow up on the government performance in Bangkok, including the authority to control BMA officials both the political official and regular civil servants. The BMA organization is shown in Figure 2.7.

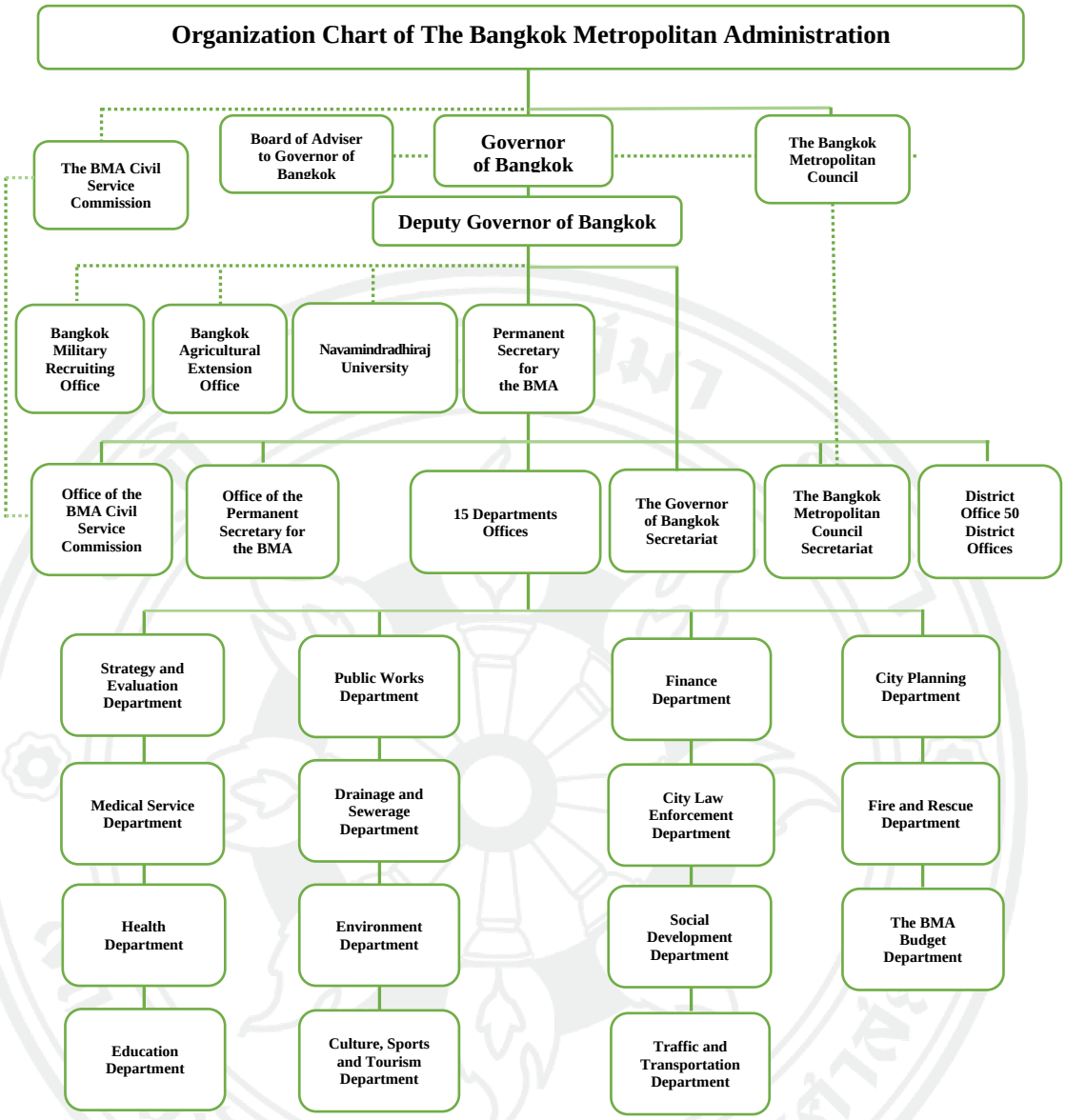

Figure 2.7 BMA's Organization Structure

Source: BMASED, 2016b.

2.6.4 Legislation and Local Law Enforcement

1) Legislation

BMASED (2013b) declared that the BMA is authorized to issue Bangkok ordinances with the approval of the Bangkok Metropolitan Council in the following cases:

(1) To perform duties by the authorities and duties of BMA.

(2) When the law provides, BMA has the authority to enact as a Bangkok Metropolis.

(3) Commercial operations of Bangkok.

(4) Responsible for finance, budget, property, employment, property procurement, and procurement.

The draft Bangkok ordinances were proposed by the Governor of Bangkok, the Bangkok Metropolitan Council members, or the citizens who have the right to vote in the Bangkok area under the law on nominations for local ordinances. In the case the Bangkok Metropolitan Council is proposing, it must be endorsed by at least one-fifth of the members of the Bangkok Metropolitan Council. Councilors of BMA may submit a draft of financial regulations only with the endorsement of the Governor of Bangkok. In case of doubt as to whether any draft bill is a financial provision draft, it must have an endorsement of the Governor of Bangkok. It shall be the authority of the President of the Bangkok Metropolitan Council to decide.

Draft of Bangkok ordinances related to financial statements in whole or one as shown below:

(1) Set up or deny or reduce or change, amend, or pay installments or impose regulations on taxation.

(2) The allocation, maintenance, or payment of BMA or transferring of the expenditure budget of BMA.

(3) Borrowing money, guarantees, or using loans.

(4) Finance, budget, property management, asset procurement, employment, and supplies.

(5) The commerce of Bangkok.

(6) Issuance of Bangkok bonds.

2) Law Enforcement

BMASED (2013b) explained that the Governor of Bangkok, Deputy Governor of Bangkok, Permanent Secretary for the BMA, Deputy Permanent Secretary for the BMA, Director of the BMA department who is an office or equivalent BMA District director, the assistant BMA District director, and the BMA officials are appointed by the Governor of Bangkok as a competent official. They shall have the status of administrative or police officials within the meaning of the Criminal Procedure Code or as an official under the Criminal Code. They have authority to enter the building or the area where the building is to be reasonably suspected of a violation or does not comply with the said laws or ordinances between sunrise and sunset or during working hours of that place and has the power to inquire about facts or order to show documents or other relevant evidence from people living or working in the place. The authorities the power to seize or attach documents, evidence, vehicles, or anything related to the offense, including the power to arrest offenders ("Bangkok Metropolitan Administration Act B.E. 2528,").

2.6.5 Finance and Budgetary of Bangkok Metropolitan Administration

1) Finance

BMASED (2013b) stated that the BMA has the authority to collect local maintenance tax, house and land tax, billboard tax, slaughtering tax, and other benefits. For slaughtering animals in Bangkok, taxes, and fees for cars or cars or rolling wheels collected by BMA follows the authorities to issue Bangkok tax. The issuance of regulations to collect taxes and fees can increase not more than 10% of any or all types of taxes and fees as follows: specific business tax under the Revenue Code Fees for selling liquor licenses under the law on liquor Gambling license fees on gambling, the value-added tax is set to be a VAT rate, which collected one-nine of the value-added tax rate under the Revenue Code, except for zero value-added tax that cannot be collected. The issuance of provisions to collect fees from people who use or have benefited from public services provided by BMA upon approval of the Minister of Interior. For collecting taxes and fees under this Act, the Deputy Governor of Bangkok, Permanent Secretary for the BMA, Deputy Permanent Secretary for the BMA, the head of a BMA department called otherwise, with the status of an official,

the head of BMA district, and the equivalent person has appointed by the Governor of Bangkok as a competent official, have the authorities and duties to perform under the law unless otherwise stipulated by the law. For enforcing the collection of arrears in taxes, the Permanent Secretary of the BMA, or the BMA District Director, with the approval of the Governor of Bangkok, has the power to order seizure and auction of the property of those responsible for paying the tax without requesting the court. Issuing a warrant of seizure or order in compliance with the Civil Procedure Code mutatis mutandis, the proceeds from the auction after deduction of the fee and the cost of seizure and sale and the unpaid tax and tax, if there is any money remaining; return it to the property owner. BMA may be giving to ministries, bureaus, or departments that are responsible for collecting taxes or fees, collecting taxes, or fees for BMA. In this case, once the expenses deducted as prescribed in the Ministerial Regulations, the ministry, bureau, or department will deliver to BMA ("Bangkok Metropolitan Administration Act B.E. 2528,").

Furthermore, BMA may have the following. Income from assets of BMA income from public utilities of Bangkok. The commercial income of Bangkok, a joint venture with other persons or from taxes or fees as provided by law to belong to the municipality or the law explicitly belonging to Bangkok. Fees, license fees, and fines as provided by law services fee income from the sale of bonds when approved by the Cabinet and enacted as a BMA ordinance. Loans from ministries, bureaus, government departments, various organizations, or juristic persons approved by the Bangkok Metropolitan Council subsidies, government agencies, or other local government and contributions from the government. Foreign aid, foreign organizations, or international organizations. Loans from foreign countries, foreign organizations, or international organizations approved by the Bangkok Metropolitan Council. Money and other assets donated, Grants or compensation, Income from the property of the State or state enterprises operating for profit in Bangkok as provided by law. Income from property tax or individual fee as required by law. Other incomes as provided by law for belonging to Bangkok Metropolitan ("Bangkok Metropolitan Administration Act B.E. 2528,").

2) Budget Usage

BMA must use the budget for expenses as follows: salary, regular wage, temporary wage, compensation, living expenses, utilities, the material cost of durable goods, land and construction costs, and subsidies. Other expenses as specified by the laws or regulations of Bangkok. Expenses under the obligation by payment of BMA as permitted by the annual budget ordinance or additional budget expenditure ordinance ("Bangkok Metropolitan Administration Act B.E. 2528,").

2.7 Evaluation, Factor Analysis, and Strategy Formulation Theories

2.7.1 CIPP-I Model

The Certified Information Privacy Professional (CIPP) Assessment is a comprehensive system for directing assessments of programs, ventures, staff, items, teaching, and assessment frameworks. CIPP was created in the late 1960s to increase responsibility for U.S. school programs, particularly the key factors to moving forward educating and learning in urban, inner-city school areas. The CIPP was created and connected to instructive programs both within and outside of the U.S. The CIPP has been adjusted and utilized in philanthropy, social programs, commerce, development, and the military. It has been utilized by schools, school areas, colleges, charitable organizations, businesses, government organizations, and other organizations by contracting outside evaluators and other experts who evaluate and develop organizations. The model's basic idea is the evaluation of the most critical factors (Gullickson, King, LaVelle, & Clinton, 2019).

Poboon (2011) stated that the CIPP Model was developed in 1966 by Daniel Stufflebeam and the Faculty of Curriculum Development Evaluation in Education Administration, by evaluating the process from the input, process, product to be continually evolving. The corporate goal was set from an analysis of context or environments, including needs assessment, and planning from the study of the inputs and strategic assessment to determine tactics or plans. It has 10 categories defined as follows:

1) Contractual agreements between evaluators and stakeholders on methodology, budget, and joint action planning.

2) Context evaluation about needs, benefits, and problems under environment factors.

3) Evaluates input activity planning and budget.

4) Evaluates the process activities, recording of the performance, and tracking.

5) Evaluates the impact of community.

6) Evaluates the effectiveness of results from activities.

7) Evaluates sustainability about future continuity.

8) Evaluates transportability spreading to other communities.

9) Meta-evaluation is summarizing the sum of the evaluation reports using different algorithms.

10) Final synthesis report about what to do, accomplishments, and lessons from experience.

Poboon (2011) suggested the improved CIPP model called the CIPP-I Model which consists of five components: (1) Context, (2) Input, (3). Process (4) Product, and (5) Impact. The details of each are as follows:

1) Context Evaluation (C) examines the external environment and the underlying factors of the project, such as policy, vision, problems, capital, social, economic, and political volatility, as well as the tendency for the formation of the issues that may hinder the implementation of the project. The CIPP-I Model uses context evaluation to characterize program objectives and target goals, set priorities, and ensure the objectives that focused on addressing significant, necessities, and issues. Also, it enables the constituents to pass judgment on the recently define goals and needs to decipher the essentials of program results. Which focused on recipients surveyed requirements and conditions in the nature program (Kellaghan & Stufflebeam, 2003).

2) Input Evaluation (I) includes resources used such as personnel, facilities, tools, equipment, supplies, and administrative capacity. Each factor can be further subdivided, for example, employees may consider about gender, age, socioeconomic status, satisfaction, expectations, attitude, capacity, potential, experience,

qualification, residence, and social group characteristics. The input assessments evaluate a program procedure, activity arranges, staffing courses of action, and budget for achievability and potential cost-effectiveness to reach the needs and accomplish the objectives (Kellaghan & Stufflebeam, 2003).

3) Process Evaluation (P) is a study of the implementation of the tactic or plans that follow the prescribed procedure. It also examines the weaknesses, defects, or strengths of the project management process by considering the effectiveness of the project procedure. The process evaluations are monitoring the document, assessment, and implementation report of plans. Also, it provides feedback during the implementation program, and reports on the extent (Stufflebeam & Zhang, 2017).

4) Product Evaluation (P) examines the effectiveness of a project, especially the consistency between the objectives set and the output. Then it compares the result with the defined criteria. The item assessment recognizes and assesses costs and outcomes intended and unintended. The primary address is the program to achieve its objectives, adequately address the focus on needs and issues. The startling results are the result of the program with the costs (Stufflebeam & Zhang, 2017).

5) Impact Evaluation (I) is an assessment to examine the effects of both positive and negative plans/projects on target groups and other groups such as communities, economy, society, and the environment. This is part of the study of the requirements and arrangement of the movement of the policy cycle. That is the portion of the assessment and administration movement of the approach cycle. Broadly, assessment points are to assess the degree and approach mediation remedies of the issue. The effect of evaluation is centering on the impacts of the mediation to cover the broader extent of problems (OECD Directorate for Science, 2014).

This study used the CIPP-I model framework for evaluation of BMAWM implementation of the 20-year DPBM (2013-2019), as this model covers important aspects of BMAWM policy implementation of BMA. Aspects include the external factors in a context such as government policy and plan, national law, the economy, society, technology, and the environment; and internal factor such as input by using 4M (man, money, material, management), and evaluating the process using the Deming circle (plan, do, check, and action).

2.7.2 SWOT Analysis

SWOT is the analysis of internal and external conditions that analyze strengths, weaknesses, opportunities, and threats of the organization and the environment surrounding it. These could help the executives to recognize the changes in the internal and external environment of an organization. The strengths and weaknesses assess the environment and organization that focus on the organization's potential and readiness, which attempts to avoid the threat or risk from the external environment and solve the weaknesses of the organization (Mind Tool, 2016). However, the organization's SWOT analysis must determine the tasks to increase opportunities and handle the threats as well (Greedisgoods, 2018).

The SWOT analysis broadly covers a range of factors by identifying strengths, weaknesses, opportunities, and threats. It will have information on the direction or goal to be created on the organization's strengths and seek opportunities from the environment. Moreover, it can also strategically overcome environmental barriers or minimize the weaknesses of the organization. Under the SWOT analysis, it is necessary to analyze both the internal and external environments by following the below procedure.

2.7.2.1 Evaluating the Internal Environment

Evaluating the internal environment an organization is analyzing and considering assets and capabilities of the full organization to distinguish the organization's strengths and weaknesses and surveying the internal environment of an organization (Mind Tool, 2016). Greedisgoods (2018) stated that the internal environment includes structure, system, rules, procedures, working atmosphere, and administrative resources. This includes the organization's past performance to understand the situation and the past strategic plan. Internal factors analyze two issues as follow:

1) Strengths (S): analyzes internal factors from the perspective of the personnel within the organization to find any factor within the organization that is an advantage. These are used for developing an organization and should be maintained to strengthen the organization.

2) Weaknesses (W): analyzes internal factors from the perspective of the personnel within the organization to find any factor within the organization that is a weakness or disadvantage that the administrator should improve or eliminate.

2.7.2.2 Evaluating the External Environment

In the external environment, organizations can find the opportunities and threats to the organization's operations affected by the economic environment, both domestic and international. This involves the organization's operations such as economic expansion, financial policy, budget, and social environments such as education level, literacy rate, settlements and movement of the population, community characteristics, traditions, values, beliefs, and culture (Greedisgoods, 2018). Mind Tool (2016) stated that the political environment includes acts, decrees, and ministerial resolutions. The technology environment also means new methods, developing tools, and equipment that increases productivity and service. Greedisgoods (2018) stated that external factors analyze two issues as follows.

1) Opportunities (O) analyze what external factors affect the organization or provide both direct and indirect benefits to the organization's operation at the macro level. The organization can take advantage of these strengths to strengthen the organization.

2) Threats (T) are an analysis of external factors, which factors impacted in a way that caused damage at the macro level, both direct and indirect. Organizations must avoid or tweak the organization and be ready to face the impact.

2.7.3 PESTEL Analysis

Bush (2019) explained that PESTEL analysis discusses the influence of political, economic, social, technological, legal, and environmental impacts on an organization. These influences are external factors. The PESTEL model is the name given to the six utilized classifications in the PESTEL investigation. Frequently, the two terms used reciprocally provided how comparative they are. The PESTEL model considers the most six significant components that influence a business or individual endeavor. The PESTEL model not only evaluates different business investigation models but also can be used to study the failure of the whole market or industry. The detail of the six PESTEL factors are as follows:

1) Political: The political elements influence a business to incorporate exchange approaches, workforce guidelines, and other government enactments. If the market wants to remain inside the limits of the law, these political variables are genuinely significant.

2) Economic: The economic elements influence a business to allude to the economy wherein it works. The single variable incorporates Gross Domestic Product (GDP) (a proportion of the estimation of merchandise and ventures traded in a nation), trade rates, and fluctuations. Monetary variables influence a wide range of organizations, yet they are generally significant for money-related ones.

3) Social: The sociocultural variables influence business (in some cases, just called social components) identity with the public and culture in each region. Two instances of sociocultural variables are customer spending and ethnic breakdown.

4) Technology: The innovative components influence a business to incorporate new technological advancement, that is, replacing old technologies with new technologies. Specific significant mechanical components include excellent cellphone quality and computerization.

5) Environment: The environmental components influence business now more than any other time as environmental concerns and consumption are considered a threat to the Earth. Numerous ecological variables have sounded the alarm worldwide, for example, environmental change, contamination, and the reduced stockpile of natural assets.

6) Legal: The legal factors affecting components influence business and are associated with political factors. These incorporate discrimination laws, antitrust laws, employment laws, consumer protection laws, copyright and patent laws, and health and safety laws.

Moreover, The PESTEL investigation makes a difference with objectives in an unexpected way. It recommends focusing on the outside variables merely for assessing the impacts that incorporate arrangements, economics, society, innovations, laws, and the environment. That is the effect on objectives to reply to these questions: Are approaches making it harder to attain? Is there missing subsidizing, or their paycheck is being reduced? Are others think around their objectives impacting their victory? (Greedisgoods, 2018).

2.7.4 The McKinney 7-S Framework

Peters and Waterman (1982) stated that the McKinsey 7-S Framework is a simple management model but is a powerful way of describing the key elements of a business organization. The McKinsey 7-S Framework is used to improve the overall performance, implement a chosen strategy, and diagnose the problems inside a firm that is struggling with change and aligns people and activities following a significant difference. McKinney 7-S Framework was developed in the 1980s by Thomas J. Peters and Robert H. Waterman, Jr. It found the factors that affect operational success, strategy, and structure. There are seven related factors linked and connected. The structure is a simple form. The McKinney 7-S Framework is a high-level orientation device. It aids an initial diagnosis of the working process and identifies critical areas where might be problems. This analysis allows drilling down into greater detail, depending on where the issues emerge. The seven elements can be defined as follows:

1) Strategy: This means the plan of action devised by the senior management of the firm, to build and maintain a competitive advantage. An ideal approach is to establish a long-term strategy that aligns with the other elements of the model and communicates the organization's objective and goals. A firm plan was developed to achieve sustained competitive advantage and successfully compete in the market. In general, a strategy is clearly articulated, long-term, and helps to gain a competitive advantage. It is reinforced by a strong vision, mission, and values.

2) Structure: This is a formal allocation of people into their respective areas of responsibility. The boxes and arrows on an organization chart provide a graphical representation of the structure. It the characteristics of an organization that is useful in terms of the methodology. Since the organization, the structure is fitting and consistent with the methods chosen, it will result in quality. Be that as it may, on the off chance that the organization structure is not fitting and is steady with the technique chosen, it will be the organization's weak point. The methodology of the organization incorporates operations inside. The organization was formulated to be reliable and reasonable for change within the outside environment. Inside the organization, the methods of the organization assist the organization in having procedure capability.

The structure of the organization is closely related to the construction of the organization.

3) Systems: The procedures and rules that guide people on how they work on a day-to-day basis. For example, budgeting, performance management, accounting systems, recruiting, and selecting employees' systems to train the network for contact and hire. It includes IT which at present plays a large part in making these systems function. The method of the organization is both formal and informal.

4) Shared values: The underlying beliefs people have about what constitutes appropriate behavior in the firm. These were called 'superordinate goals' in the original version of the 7S Framework. Often the word 'culture' is used here. Shared Values are universal concepts, values, and expectations of the organization. It is a fundamental concept of each organization. Organizations with excellence in management tend to share common values that contribute to success.

5) Style: It is closely related to shared values, but it refers mainly to leadership behavior. It is the management style of senior management, including the personality of senior management, because senior management's actions or behavior will influence the employees' feelings more than the words of the administration.

6) Staff: The people employed in the firm, including such things as their attitudes and motivations. It consists of personnel and staff at all levels within the organization and includes the pattern and various behaviors that the organization demonstrates and how it treats its employees, such as the involvement of high-level executives in motivation and development.

7) Skills: The practical capabilities employees bring to their work. The organization's qualifications are the things that an organization can do better than other organizations and are considered knowledge, capabilities of employees such as the capacity and skills of the organization to provide services to clients or customers, research and development, capabilities marketing capability, and financial ability.

The McKinney 7-S Framework is used in internal organization analysis in the SWOT analysis for the strengths and weaknesses factors of the organization. The concept is shown in Figure 2.8.

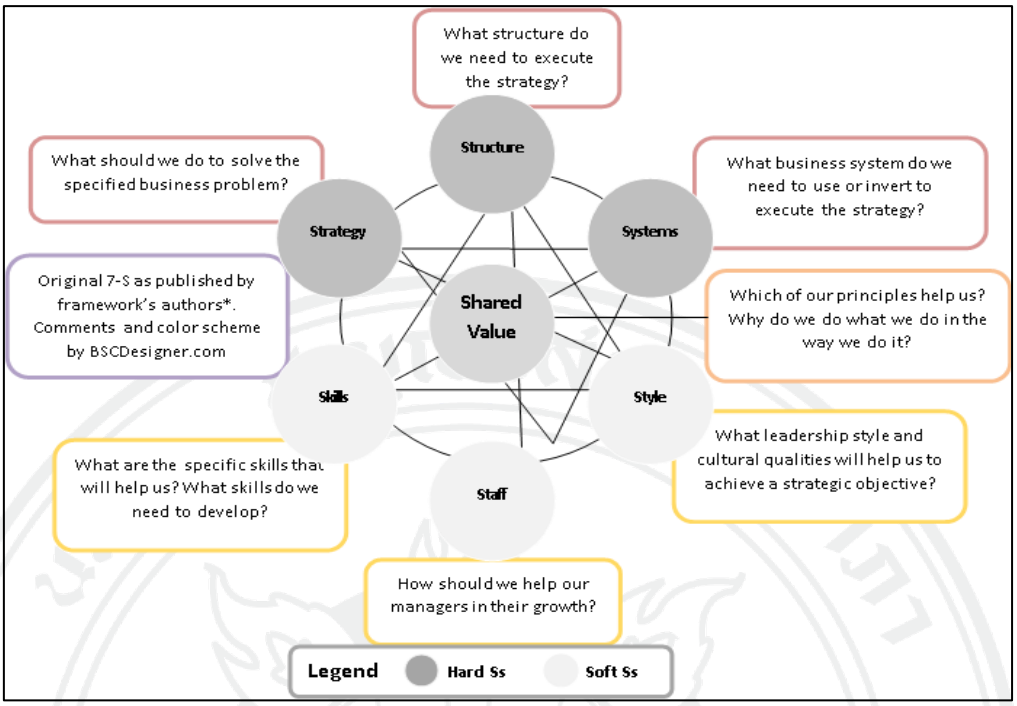

Figure 2.8 The McKinney 7-S Framework
Source: Peters and Waterman, 1982; Savkin, 2020.

Peters and Waterman (1982) explained that the McKinney 7-S Framework utilizes the distinguishing components that must realign and move forward in execution or preserve arrangement and performance amid other changes. These changes incorporate rebuilding, modern forms, organizational mergers, unused frameworks, and administration (Mind Tool, 2016). It could be utilized step by step beginning with the organization's shared values: are they reliable with an organization's structure, procedure, and frameworks? In case they are not, what must be changed? At that point, see the delicate components that need to be considered; how well does each one back the others? Identify where changes need to be made. Organizations must then find the sensitive parts of shared values, fashion, staff, and abilities: do they bolster the required hard elements or not, and do they support one another? If they do not bolster, what must be changed? Modify and adjust the components and, after that, re-analyze how that impacts other elements and their arrangement, and the result of superior execution (Peters & Waterman, 1982).

2.7.5 4M Management Resources

The resources for management are materials and appliances to be operated, including management resources that can be divided into four categories commonly referred to as 4M. The details are as follows:

1) Man: There is a management policy for each employee to undertake training for skills and abilities before entering work. Therefore, assigning tasks are appropriate to the expertise available to each person. This is to manage people efficiently according to the concept by Wiratniphawan (2005) states that human management is a factor that is important to control, and training is an element of control. Each executive contributes to the working process to achieve the objectives of the organization. Ratna (2017) explained that human resources management is a strategy in applying management functions including planning, organizing, leading, and controlling every activity/function of resource operation starting with the process of withdrawal, selection, training, and development, promotion, demotion, and transfer, job assessment, compensation, industrial relations, to termination of employment aimed at increasing the productive contribution of the organization's human resources toward the achievement of organizational goals more effectively and efficiently. The quantity of labor must be tailored to the company's needs or institution to achieve its objectives effectively and efficiently.

2) Money: The organization has set guidelines for managing money and production costs. It is more cost-effective than the set cost for financial management, which is an essential component of management (Wiratniphawan, 2005). For example, the lowest quality, which comes from the technology tools and production personnel, is directly related to the management principles of the control and development from money. Financial management could be a part of strategic management about the operation of the organization, the nature of the business in the future, the environment, resource allocation, and performance to achieve the objectives.

3) Material: There is an essential part of the products that are acceptable in quality and can be produced within a specified period. Ratna (2017) stated that in the process of implementing the activities, materials, and raw materials in the business world are utilized to achieve better results. Therefore, it is also a management tool to achieve organizational goals. Similarly, in the process of conducting activities for

material, humans cannot be separated because without this element the desired result would not be attained.

4) Management: There is a management strategy that considers the organization's internal and external environment that analyzes the weaknesses, strengths, opportunities, and obstacles that have an impact on management. These are directly related to the management principles of control of Henry Fayol who stated that ideas associated with planning and forecasting are forecast and plan to anticipate the future and draw up plans of action. This is foresight, implementing a plan of action for the future. Moreover, the planning requires a forecast of events and based on the estimates, the operating program's construction. Also, this is associated with a commanding, that means directing and supervising staff. Commanding encompasses the art of leadership putting the organization into motion (McNamara, 2009).

4M management is strategic management that covers the control principles as an essential part of management, presenting efficiency in controlling management such as workload quality control, time employees work, and control of operating expenses. These have a significant impact on the success of the organization and its development. Various activities are created to develop the organization by focusing on excellence in internal management.

2.7.6 PDCA Deming Circle

Moen (2009) documented the history of W. Edwards Deming's PDSA cycle for learning and advancement beginning with the scientific revolution of Galileo in the 1600s and moves through Deming's final form of the PDSA cycle of 1993. It incorporates the Shewhart Cycle of 1939, the Deming Wheel (circle) of 1950, the Japanese PDCA of 1951 and 1985, and the advancement of the Deming's PDSA from 1986 through 1993. It concludes with a few of Deming's responses to the PDCA. Shewhart (1939) adapted the “Shewhart Cycle” in 1939 that contrasts the thought of the cycle with the ancient see of the detail, generation, and assessment. It composed three steps that must go in a circle rather than in a straight line. It appeared it might be accommodating to think of the three levels within the mass generation prepare as steps within the logical strategy. In this sense, determination, generation, and assessment compare separately to making a theory, carrying out a test, and testing the speculation.

The three steps constitute an energetic logical handle of securing information. Edwards (1950) adjusted the Shewhart Cycle at a Japanese Union of Researchers and Engineers (JUSE) supported the eight-day course on measurable quality control for directors and engineers in 1950. His straight-line: Step 1, Plan; Step 2, Deliver; Step 3, Offer changed to a circle with a fourth step: Step 4, Overhaul.

The Japanese called this the "Deming Wheel" (or Deming Circle): (1) Plan the item (with suitable tests); (2) Make it; test it within the generation line and the research facility; (3) Put it in the advertising; (4) Test it in terms of benefit, through advertising investigate, discover what the client considers of it, and why the non-user has not bought it; and (5) Re-design the item, within the light of buyer responses to quality and cost. Ishikawa (1985) reclassified the PDCA cycle to incorporate deciding objectives and targets and strategies for reaching the goals within the step. Within the do step, he includes preparing and instruction to go with the execution. He says reasonable control implies permitting guidelines to be ceaselessly changed to reflect the voices of shoppers and their complaints as well as the necessities of the following handle. The concept behind the term control is conveyed throughout the organization, whereas Imai (1986) expressed that the Japanese officials recast the Deming wheel from 1950. The details of the PDCA cycle is shown in Figure 2.9.

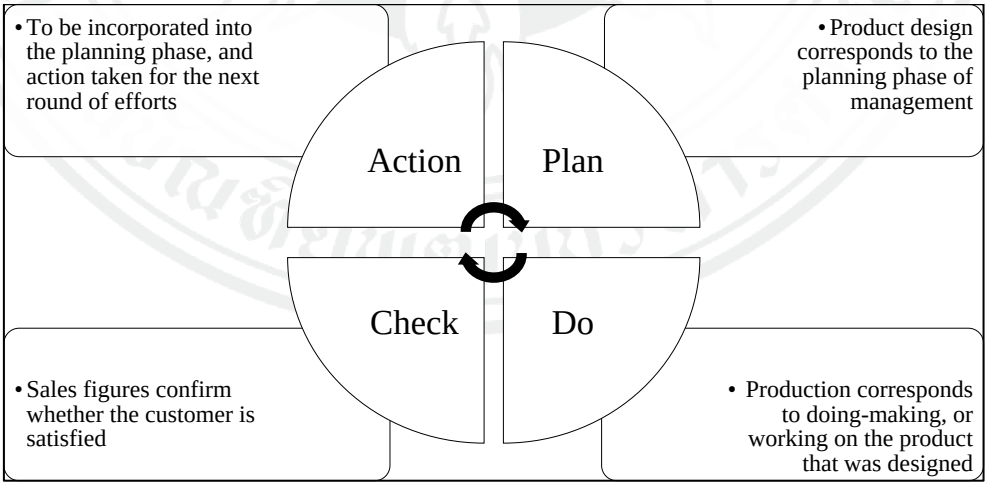

Figure 2.9 PDCA Cycle or the "Deming Wheel"

Source: Moen, 2009.

Moen (2009) The four steps of solving the problem consist of planning, which is the definition of a question and a hypothesis about possible causes and solutions, doing plan implementation, and checking that is evaluation of the results. Action is going back to the plan if the unsatisfactory results or standardization if the results are unsatisfactory. The PDCA cycle emphasized the prevention of error recurrence by establishing standards and the ongoing modification of those standards.

In summary, PDCA is an iterative, four-stage approach for persistently progressing forms, items, or administrations, and for settling issues. It includes efficiently testing conceivable arrangements, evaluating the outcomes, and actualizing the ones that appeared to work. The four stages are (1) Plan: recognize and analyze the issue or opportunity, create speculations around what the problems may be, and choose which one to test. The primary arrangement must realize and understand the organization's issue or the opportunity that needs to require an advantage; (2) Do: test the potential mechanism, in a perfect world on a little scale, and degree the results; (3) Check: think about the outcome, degree viability, and choose whether the theory upheld; and (4) Act: in case the arrangement was fruitful, execute it.

2.7.7 TOWS Matrix

Heinz (1982) stated that the TOWS Network examination shows four conceptually unmistakable elective procedures, strategies, and activities. They may be implemented concurrently and in concert. However, for the reason of dialog, the center is on four sets of factors. The essential concern here is the technique, but this investigation might moreover be connected to the improvement of strategies vital to actualizing the procedures, and to more particular activities steady of policy.

Greedisgoods (2017) pointed out that when analyzing weaknesses-strengths, opportunities-threats, take strengths-weaknesses from the internal environment and compare them with opportunities-threats from the external environment to see what the organization is confronting and under what circumstances. What ought the organization do? There are four styles to analyze by utilizing SWOT and TOWS Metrix.

1) The SO Strategy: The SO Strategy formulation matches the positive or strengths in the internal environment, and the positive or opportunities in the external environment to find advantages or excellent opportunities to formulate

aggressive strategies. This situation is the most desirable because the organization's executives should take an offensive approach to take advantage of existing strengths to leverage opportunities for maximum benefit.

2) The ST Strategy: This strategy is based on the organization's qualities that can negotiate with dangers within the environment. The lesson to be learned is that strengths must frequently be utilized with constraint and caution.

3) The WO Strategy: The technique endeavors to play down the weaknesses and to maximize the opportunities. The agency may identify openings in the external environment but have organizational gaps that prevent the firm from taking advantage of it. One conceivable procedure would be to secure innovation through participation with a firm having competency in this field. An optional tactic would be to enlist and prepare individuals with the desired specialized capabilities. Of course, the firm, too, has the choice of doing nothing, however, this leaves the opportunity open for competitors.

4) The WT Strategy: The point of the WT procedure is to play down both shortcomings and dangers. An organization confronted with outside risks and inside failures may undoubtedly be in a dubious position. The WT position is one that any firm attempts to avoid.

2.7.8 Input-Process-Output Model

The input-process-output (I-P-O) model or input-process-output pattern is a widely used approach in systems analysis which is a problem-solving technique. It is broken down a system into its component pieces to study how well they work and interact to accomplish their purpose (Bentley, 2007). For software engineering, it is the systematic application to software development in computer science for describing the structure of an information processing program or other processes (Zelle, 2010). The field of system analysis relates closely to requirements analysis or operations research. It usually has some combination of the following: identification and reidentification of objectives, constraints, and alternative courses of action; examination of the probable consequences of the alternatives in terms of costs, benefits, and risks; presentation of the results in a comparative framework. Thus, the decision-maker could make an informed choice from among the alternatives. The typical use of systems analysis is to guide decisions

on issues such as national or corporate plans and programs, resource use and protection policies, research and development in technology, regional and urban development, educational systems, and health and other social services (Heylighen, Joslyn, & Turchin, 2002).

Walley (2017) showed that the operations management role is divided into three areas:

1) Managing input resources, that is, operations managers must ensure the right support, such as man, equipment, and materials, that are available in the right quantity at the right time for the operation's needs.

2) Managing processes are defined as a series of interlinked activities or steps which consume resources to achieve a goal or output.

3) Managing outputs, which are functional operation and responsible for meeting customers' needs by delivering the required products or services.

In this study, the I-P-O model was adopted for proposing the appropriate system of MMAWM as it has widely recognized as a practical model for driving public or private organizations to achieve their goals or targets effectively and efficiently. The operation's effectiveness and efficiency dictate how much resource is needed, and this feeds straight through to unit cost and relative profitability. The concept of the system approach is shown in Figure 2.10.

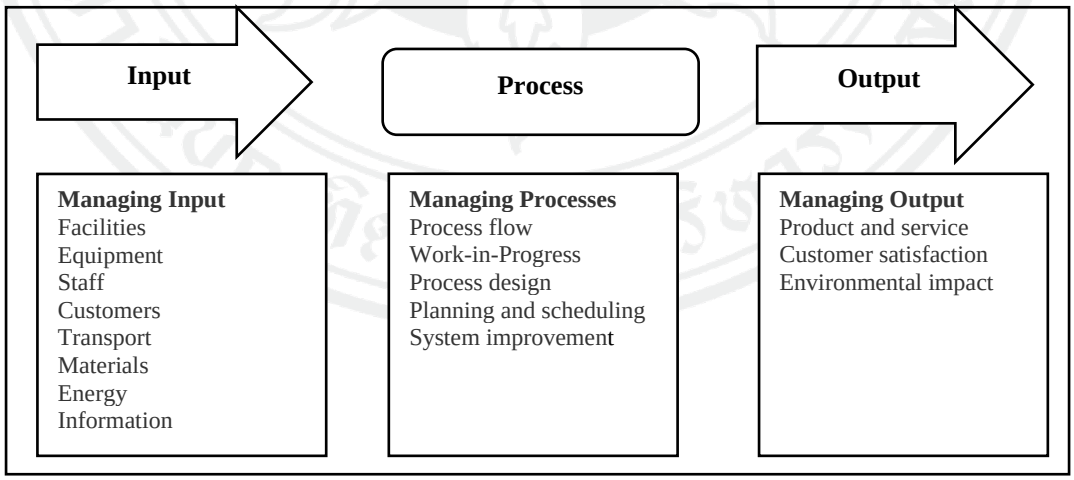

Figure 2.10 Operation Input-Process-Output Model

Source: Walley, 2017.

CHAPTER 3

RESEARCH METHODOLOGY

This research aims to study the effectiveness and influencing factors of the BMA's waste minimization (BMAWM) which used the qualitative method based on primary data collected through interviews, participatory observation recording, and secondary sources. The data were analyzed to find the effectiveness of the waste minimization policy implementation (WMPI), the factors influencing, and the appropriate system for BMAWM of the 20-year DPBM (2013-2032) during the period 2013-2019. The result of this research can serve as a guideline for BMAWM not only for BMA but also for other municipalities to apply sustainable municipal SWM and development.

3.1 Research Framework

The research objectives comprise: (1) to evaluate the effectiveness of the BMAWM implementation; (2) to analyze the influencing factors on the BMAWM implementation; and (3) to develop an appropriate system of BMAWM. The data analysis of this qualitative research was comprised of six procedures: (1) the effectiveness of WMPI analysis using CIPP-I model; (2) affecting factors analysis using SWOT analysis; (3) strategy formulation using TOWS matrix analysis; (4) Drafting an appropriate system of BMAWM using I-P-O model that is a guideline for BMAWM; (5) the BMAWM guideline has been tested in one BMA district for at least sixth months to ensure the effectiveness of the new model; and (6) the guideline improved and policy proposed for BMA, with overall research results applied in the policymaking of BMA and other municipalities toward SWM sustainability. The conceptual framework of this research is described in Figure 3.1.

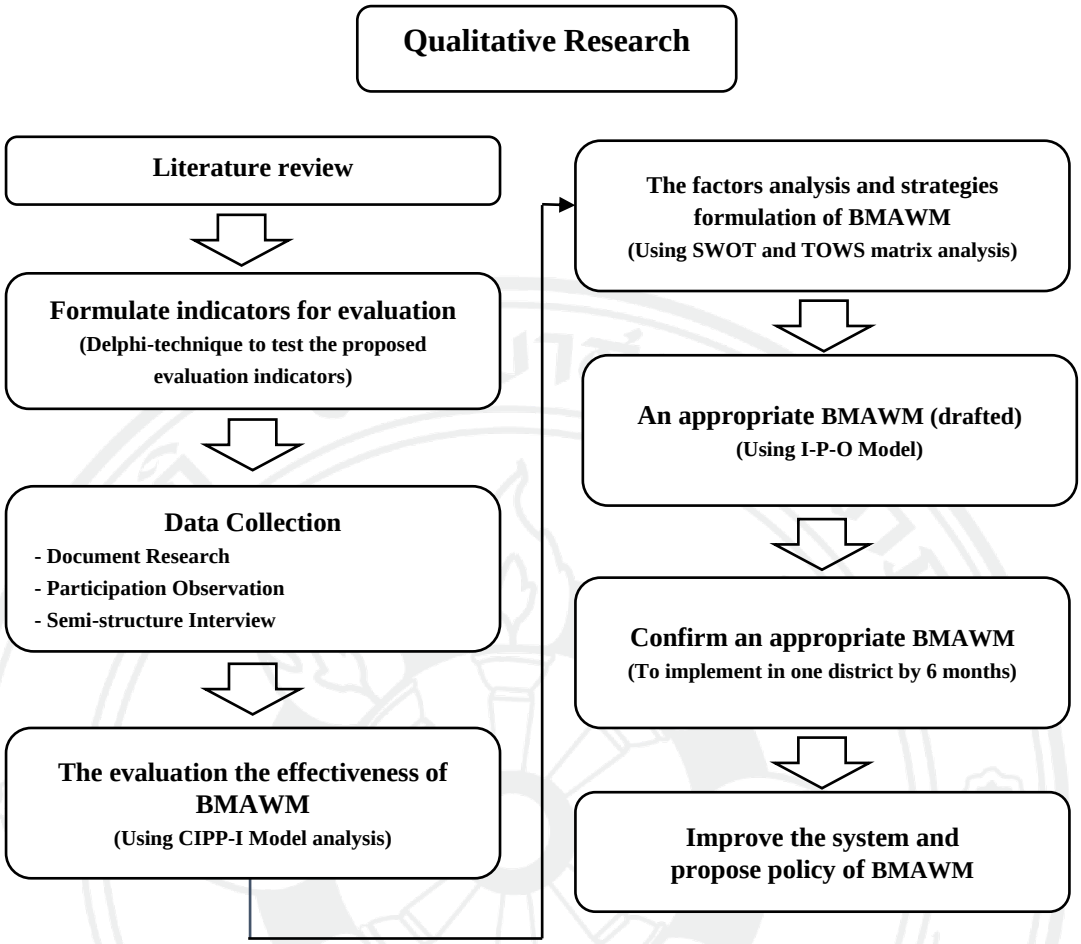

Figure 3.1 Research Conceptual Framework

3.2 Research Methodology

This qualitative research included primary and secondary data collection using three methods: document research, interviews, and participatory observation. The data analyzed via four methodologies consisting of CIPP-I framework, SWOT analysis, TOWS matrix analysis, and Input-Process-Output model that are:

3.2.1 Evaluation of the BMA's Waste Minimization

The evaluation of the BMAWM used CIPP-I model analysis for determining the effectiveness of BMAWM under the 20-year DPBM (2013-2019). The CIPP-I model was employed as the evaluation because this model covers all factors that could affect

the effectiveness of BMAWM, including external issues, internal issues, outputs, and impact issues explained below and shown in Figure 3.2.

1) The external issues are uncontrolled factors by the BMA is C: Context evaluation its used PESTEL analysis, an acronym that stands for political, economic, social, technological, environmental, and legal. These were uniquely related to BMAWM policy implementation.

2) The internal issues include: I (Input evaluation) used 4M Management Resources include man, money, materials, and management; P (Process evaluation) used the PDCA concept, a continuous management loop, including plan, do, check, and action.

3) The output and outcome include: P (Product evaluation) was the indicator of results such as the amount of waste disposal, amount of waste separation type, the waste composition, the number of communities and agency participating in CBM, and the waste of districts decreased, I (Impact evaluation) used the Sustainable Development Indicators (environmental, economic, and society). These evaluations focused on the positive and negative impacts on the environment, economy, and society.

The evaluation indicators were tested by using the Delphi technique, which is a method for predicting results based on expert opinions. This method is to verify the appropriateness of the evaluation indicators based on past and present data. The researcher surveyed the views of experts by employing the same questionnaire twice with 24 experts from four relevant four groups include:

1) Government organizations: 3 experts
2) BMA policy management officers: 6 experts
3) NGOs and academic institutions: 3 experts
4) BMA’s policy implementation officers: 12 experts

The Delphi technique indicators verification results were used as the materials the semi-structured interview questions were based upon. The Delphi technique testing results of this study were in ranged between 108-120 from 28 indicators. This showed that the issues were logically consistent and covered all the objectives of the study comprehensively. The result of the Delphi technique was shown in Appendix A.

3.2.2 Analysis of Factors Affecting BMA's Waste Minimization

The SWOT analysis was employed to analyze the factors affecting BMAWM. It is widely used for the study of the internal and external environment of an organization. This analysis helps identify strengths and weaknesses from the internal environmental factors of the organization and identify opportunities and threats from the external environmental factors explained below and shown in Figure 3.2.

1) The internal factors were under the control of BMA that were using the McKinsey 7S Framework. It is a simple method for internal review. It is a powerful way to describe an organization's internal factors from seven key elements that comprise strategy, structure, system, shared value, staff, skill, and style. Internal factors analysis is to investigate the strengths and weaknesses of the BMAWM, which could be determined from the inputs and processes of the BMAWM.

2) The external factors are uncontrolled issues of the BMA that were using the PESTEL analysis for identifying the external factors of an organization that stands for political, economic, social, technological, environmental, and legal that investigated opportunities (the positive impact of government politicians, laws, social change demography, and the external technological changes) and threats (the impact of government policy, national law, macroeconomic change, social change demography, and external technology changes) of the BMAWM.

3.2.3 Strategy Formulation Analysis

The TOWS matrix analysis is a useful strategy formulation model that adopts the strength, weakness, opportunity, and threat factors of the policy implementation from SWOT analysis. The results generate new strategies in four dimensions for creating new projects and activities that are included.

1) The SO Strategy formulation matches the positive or strength in the internal environment, and positive or opportunity in the external environment to combine strengths, advantages, and good opportunities to formulate an aggressive strategy.

2) The WO Strategy formulation matches the negative weaknesses in the internal environment and the positive or opportunities in the external environment to take advantage of opportunities to handle the gap in the organization. This situation indicates that the organization has several competitive advantages, but also has many

weaknesses. Thus, the solution is to use a Turnaround strategy, an adaptive strategy to eliminate or correct various internal defects.

3) The ST Strategy formulation matches the positive or strengths of the internal environment and the negative or threats in the external environment. It uses the organization's strengths and advantages to overcome external obstacles.

4) The WT Strategy formulation matches the negative or weaknesses in the internal environment and the negative or threats in the external environment, which are threats to reduce defects and avoid risks. It has the main goal to prevent or avoid worsening situations. The WT Strategy: this situation is the worst because it faces external threats and many weaknesses in many aspects. The best option is the defensive strategy to reduce or avoid the risks that are expected to occur and determine the measures to reduce losses.

The TOWS Matrix analysis was used to determine BMAWM strategies. The study analyzed the matching elements from the internal environment and compared them with the external environment as strengths-opportunities, strengths-threats, weaknesses-threats, and weaknesses-threats. The objectives were to identify the organization's situation and circumstances and seek the appropriate solutions to prevent or solve problems and enhance the BMAWM as shown in Figure 3.2.

3.2.4 Development of an Appropriate BMA's Waste Minimization System

The researcher established the appropriate BMAWM system by using the I-P-O model based on the concept of the success of administration that depends on the inputs and processes of an organization (Figure 3.3) that are:

1) The input development uses 4M resource management that includes man, money or budget, materials or equipment, and the organization's management for policy implementation.

2) The process development uses the PDCA concept that includes the plan, do, check, and action for developing appropriate BMAWM.

3) The output development is the input and process results consisting of product and impact, which can be measured by key performance indicators (KPIs) based on targets for the plan. Moreover, it includes the effects on the environment, economy, and society.

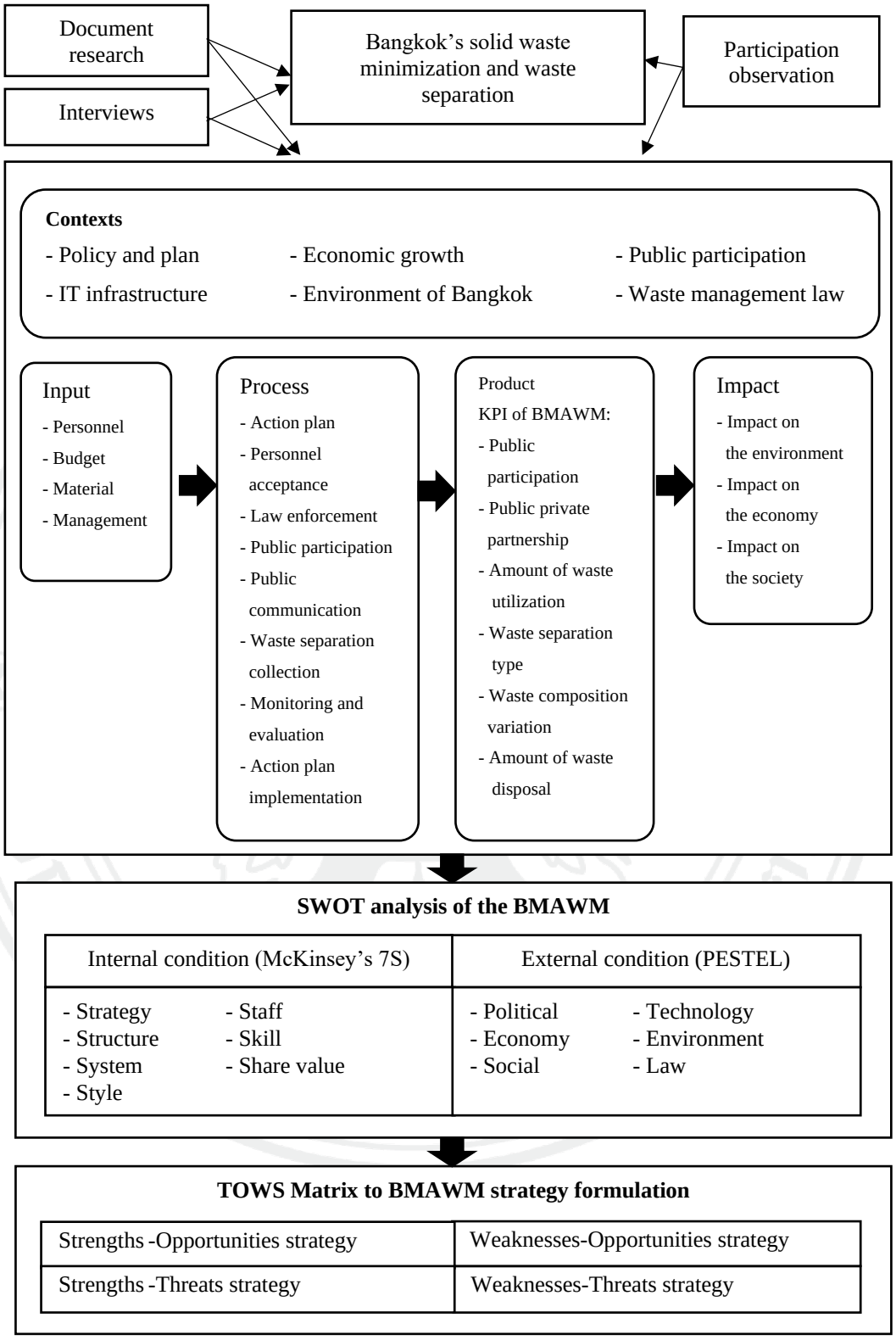

Figure 3.2 The Evaluation, Factor, and Strategy Analysis

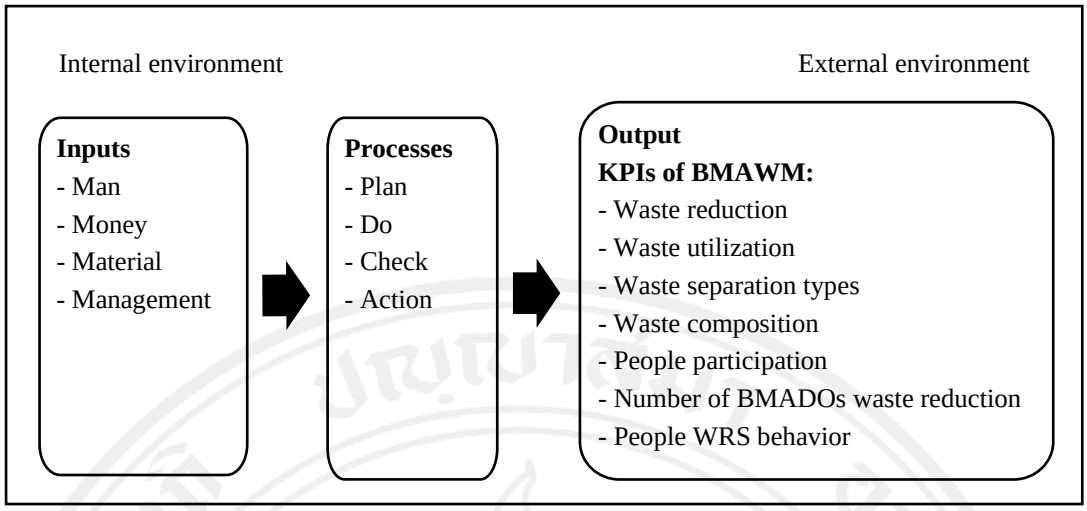

Figure 3.3 The Appropriate BMAWM System Based on the I-P-O Model

3.3 Data Collection Methods and Tool

This study used three data collection methods under the concept of triangulation of qualitative data resources comprised of:

3.3.1 Secondary Data

Secondary data are collected from journals, books, articles, theses, reports, news, websites, and any other related documentary materials. The data focused on, for example, the policies and plans of BMA, BMAWM guidelines and procedures for BMAWM, BMADOs report, BMA's SWM situations, country policies, laws, economic, social, and environmental impact, technology, structure and administrative systems of BMA, and so on. This secondary data could support the primary data, which included methods such as interviews and observation.

3.3.2 Primary Data

Primary data were collected from participatory observation and interviews by the researcher who conducted as a part of the BMAWM. The researcher has been a BMA officer since 2005, working at the Planning and Evaluation Division, Department of Environment of BMA. The Policy and Plan Division has the responsibility to manage the environment and SWM policy implementation and monitor the KPIs of

20-year DPBM (2013-2019) that covers the implementation, monitoring, and evaluation of BMAWM. The details are as follows.

3.3.2.1 Semi-Structured interviews were used to collect the data for evaluation of the indicators, which were analyzed by the CIPP-I framework and SWOT analysis, as shown in Figure 3.2. The CIPP-I structure and SWOT analysis are as follows:

1) CIPP-I Framework consists of

(1) Context indicators including policy and plan, economic, social, technology, environment, and law.

(2) Inputs indicators include man, money, material, and management.

(3) Process indicators include plan, do, check, and action.

(4) Product indicators include the output of the process for quantitative production, such as KPIs related to the policy and plan.

(5) Impact indicators include the impact on the environment, economy, and society.

2) SWOT Analysis consists of

(1) Internal factor indicators

(2) External factor indicators

3.3.2.2 Structured interviews were developed by defining details of the questions from the semi-structured interview to be more understandable.

3.3.2.3 Participatory observation was conducted by the researcher who collected data by observing the activity and environment of BMAWM under the issues applied from the semi-structured interview. The observation activity included the KPIs of the 20-year DPBM (2013-2019) that were assigned during a 50 BMADOs meeting, field observations. Also, the meeting of waste minimization guideline development under the Deputy Bangkok Governor's command was observed. This observation is critical to help the researcher understand more about the activity of BMADOs on WMPI implementation and public participation for WRS. These observations were confirmed by the findings found by a different method. The details of the observations are shown in Appendix B.

3.3.3 Questions of Semi-Structured and Structured Interviews

The questions were developed for interviews with the key informants under the CIPP-I model and SWOT analysis. The processes of item preparation are shown below.

1) Indicator formulation for BMAWM evaluation defined under the CIPP-I framework includes:

(1) Context indicators are defined under PESTEL analysis, which comprises policy, economic, social, technology, environment, and law.

(2) Input indicators defined as 4M that consist of man, money, material, and management.

(3) Process indicators were defined under PDCA Deming Circle that includes the plan, do, check, and action.

(4) Product indicators are defined as the output of the process of policy and plan implementation.

(5) Impact indicators are identified based on the sustainable development principle, including impact on the environment, economy, and society.

2) Indicator formulation for BMAWM's factor analysis defined under SWOT analysis includes:

(1) Internal factors described under the McKinsey 7S Framework. There are seven key elements of strategy, structure, systems, shared values, staff, skills, and style.

(2) External factors are defined under the PESTEL theory. There are six key elements of policy, economic, social, technology, environment, and law.

The detail of the questions for semi-structured interviews is shown in Appendix C and structured interviews shown in Appendix D.

3) The content validity process applied the Index of Item-Objective Congruence (IOC) to the questions of interviews. The quality of qualitative tools used for testing content validity with objectives or curriculum that selected an item relating to the evaluation and apart from the behavioral content. The expert's opinions were used to test the accuracy assessment and the questions used for measuring the research objective of the research (Rovinelli & Hambleton, 1977). The assessment was divided into three types as shown below:

+1 = definite feeling the Question is a measure of an objective

0 = undecided on whether the Question is a measure of an objective

-1 = exact feeling the Question is not a measure of an objective

The results of content validity assessment calculated to find the value of IOC from the following equation:

$$IOC = \frac{\Sigma R}{N}$$

ΣR = Sum of scores checked by the experts

N = Number of experts

The IOC testing results were in the range between 0.60-1.00 from 22 questions. This showed that the items were logically consistent and covered all the objectives of the study comprehensively. The details are shown in Appendix E.

3.4 Key Informants

This research used a purposive sampling method to select appropriate key informants and a judgment selection method to collect data (Phoochinda, 2015). The key informants are divided into three groups as follows:

3.4.1 BMA Administrators

1) BMA's Executive

The researcher determined the criteria for selecting the key informants of the represent the BMA governor who were assigned to control, supervise, monitor, and decide on the overall of SWM and have experience working more than at least one year. In this research, the key informants include:

(1) The Deputy Governor of Bangkok who is responsible for the BMAED.

(2) The secretary to the Governor of Bangkok commissioned to manage and supervise.

2) The BMA Policy and Plan Administrators

The criteria for selecting the key informants in this study were determined by considering the position within the organization and responsibility for BMA's SWM policy and plan with work experience of at least one year. In this research, the key informants are:

(1) The Director of BMASED.

(2) The Director of the BMAED.

(3) The Director of Policy and Planning Division (PPD), BMAED.

(4) The Director of Waste, Hazardous Waste and Nightsoil Management Division (WHNMD), BMAED.

(5) The Chief of the Planning and Evaluation Section, PPD, BMAED.

3.4.2 BMA District Officers

The criteria for selecting the key informants of BMADOs officers were determined by considering the position such as Chief of the Cleansing and Public Park (CPPS) and the heads of districts where this study was conducted with work experience of at least one year. If the leaders have less than one year of experience, the researcher took into consideration their previous position and work experience on SWM. In this research, there are 12 key informants from 12 districts and 6 district groups. The study area districts were determined according to two conditions: (1) the highest amount of waste reduction and (2) the lowest amount of waste reduction in the fiscal year 2017. The 12 critical informants of the BMADOs officers are shown in Table 3.1.

Table 3.1 Details of the BMA District Officer's Key Informants

District groups	The highest amount of waste reduction	The lowest amount of waste reduction
Central Bangkok	Pom Prap Sattru Phai District	Phaya Thai District
North Bangkok	Sai Mai District	Bang Sue District
West Bangkok	Bang Kapi District	Nong Chok District
South Bangkok	Klong-Toei District	Pathum Wan District
North Thonburi	Bangkok Yai District	Taling Chan District
South Thonburi	Nong Khaem District	Bang Khun Thian District

3.4.3 Community Leaders

The criteria for selecting the community leader key informants who have been taking a position as the head of the community for at least three years and have responsibility for the CBM or green community project of the BMAED. The communities gained the zero-waste community prize and green community prize. If community leaders have occupied the position for less than a year, the community leader was then selected from a prosperous community that practiced WMS. These include:

1) Zero-waste community prize:
   (1) Kao-Klang Village, Klong-Toei District
   (2) Sa-Ngaun-Kam Village, Nong-Kham District
   (3) Suankanka Nong-Kham Village, Nong-Kham District
   (4) Bangbau Village, Bang-Khen District
   (5) Phecharawoot Village, Lak-Si district
   (6) Smitichote Village, Lat-Phrao District
   (7) Ranee 2 Village, Lat-Phrao District
   (8) Thanyakarn Village, Lat-Phrao District
   (9) Khetpairao 3-5 Village, Pha-Kanong District
   (10) Soonthontham Village, Pha-Kanong District
   (11) Sukjai village, Pha-Kanong District

2) Green community prize:

(1) Kao-Klang Village, Klong-Toei District

(2) The Emporio Place Condominium, Klong-Toei District

The overall number of key informants from the three target groups were 45 persons. They play a vital role and have responsibility for waste minimization and separation policy and management that includes policymaking, assessment, and implementation. For the public sector, the head of the communities has had experience in WMS in the villages (The Sixth Executive Program for Senior Executives of the Metropolitan, 2013). They could provide information concerning the success factors and provide feedback for BMA to improve the policy on waste minimization and separation to increase efficiency. The details of the respondents are shown in Table 3.2.

Table 3.2 Number and Roles of Key Informants

Key Informants	Roles and Responsibility	Number of Key Informants
Deputy Governor of Bangkok	The Deputy Governor of Bangkok has the authority to order or perform official duties on behalf of the Governor of Bangkok concerning the BMA organization that has responsibility on SWM and includes the BMAED, BMA districts, and others. The BMA districts related to the cleaning and park division, which has the mission of managing waste reduction and segregation in Bangkok.	1
Secretary to the Governor of Bangkok	The secretary acts as the assistant to the Governor of Bangkok. Coordinates with Bangkok departments to perform duties following the Bangkok Governor's policy. These include making suggestions for the reduction and separation of waste from the capital city of Bangkok to the Governor of Bangkok and continuously monitoring the operations of the relevant departments.	1
Director of BMASED	The director is the head of the Strategy and Evaluation Department with the duty to coordinate the development of the development plan for Bangkok. The department transfers the BMA Development plan to another department	1

Key Informants	Roles and Responsibility	Number of Key Informants
	for implementation monitoring, and evaluation. These include waste reduction and separation management as an integral part of the department's annual performance evaluation and the coordination of the integrated indicator for waste reduction and segregation between the BMAED and BMADOs.	
Director of BMAED and Staff	The BMAED is responsible for the SWM process consisting of BMAWM, waste collection, and waste disposal. The BMAED is accountable for implementing the plan's strategy to achieve the goal. It has the power to pass on missions and objectives to district offices. Moreover, it is responsible for establishing guidelines for legal development, supporting materials, equipment, budgets for promoting waste reduction and segregation waste collection and transportation, waste treatment, and disposal for district offices.	5
Chief of CPPS, BMADOs, and Staff	The head of CPPS, BMADO, is responsible for SWM focus on BMAWM, waste collection, and transportation for disposal at the waste disposal center. The section is under the command of the BMADOs director, and the supervision of the Deputy Governor of Bangkok. Normally, the Deputy Governor would order a joint meeting between the BMAED and staff coordinate work to achieve the WRS goals.	50
Community Leaders	Community leaders have a leading role in creating participation of people in the community to change behavior from waste disposal to a new practice by participating in the guidelines for reducing waste production in the communities. They implemented the community-based solid waste management (CBM) concept in their communities to achieve zero-waste goals. They received the zero-waste community award and the green community award.	12
	Total	70

3.5 Questions and Data Collection Sources

The data were collected from three sources comprised of document review, semi-structured interviews, and structured interviews. The details are shown in Table 3.3 and Table 3.4.

Table 3.3 Questions and Data Collection Sources for CIPP-I Model

Issues	Definitions	Data collection methods	Questions	Data collection sources
1) Context: PESTEL analysis				
Political: Policy and plan	Policies and plans related to the BMAWM of government, and BMA	- Document review - Interview	Do the policy and plan to support the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Economic: Economic growth	Economic growth affects waste generation and waste increase which affects BMAWM.	- Document review - Interview	Does economic growth support the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Social: Public participation	The people and private companies in society support the activities of BMAWM.	- Document review - Interview	Does citizenry participate in the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Technological: IT infrastructure	IT is accessible to people such as the Internet, mobile phone, tablet, computer.	- Document review - Interview	Does the technology infrastructure support the BMAWM? How?	- Document review - BMA administrators and staff
Environmental: Environment of Bangkok	The situation of Bangkok's environment such as temperature, moisture, flooding problem.	- Document review - Interview	Does the environment of Bangkok support the process of BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Legal: Waste management law	The laws, regulations of the government and Bangkok governs to BMAWM	- Document review - Interview	Does SWM law support the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
2) Input: 4M				
Man: Personnel	The personnel and personnel development supplied to work in the BMAWM.	- Document review - Interview - Observation	Are personnel sufficient for the BMAWM? How? Are the BMA personnel developed for the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Money: Budget	Budget for activities and projects relevant to BMAWM, which is	- Document review - Interview	Is budget sufficient for the BMAWM? How?	- Document review - BMA administrators and staff

Issues	Definitions	Data collection methods	Questions	Data collection sources
	supported by BMA.	- Observation		- BMADOs staff
Materials: Materials	Materials used for the activities and projects relevant to BMAWM, which is support by BMA.	- Document review - Interview - Observation	Are materials sufficient for the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Management: Organization	The organization was responsible for BMAWM activities and projects, which is assigned support by BMA.	- Document review - Interview - Observation	Is the organization structure appropriate for the BMAWM? How? Does waste collection infrastructure support the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
3) Process: PDCA				
Plan: action plan	Action plan launched for BMAWM activities in the BMA district.	- Document review - Interview - Observation	Is the action plan appropriate for the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Do - Personnel acceptance	Personnel works for activities or projects under the BMAWM.	- Document review - Interview - Observation	Do personnel accept the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
- Law enforcement	Law enforcement concerning BMAWM.	- Document review - Interview - Observation	Is law enforcement on BMAWM effective? How?	- Document review - BMA administrators and staff - BMADOs staff
- Public participation	Participation of local people and private organizations in activities or projects under the BMAWM	- Document review - Interview - Observation	Does public participation support the process of BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
- Public communication	Communication by BMA to the public in the BMAWM.	- Document review - Interview - Observation	Is communication to the public on the BMAWM effective? How?	- Document review - BMA administrators and staff - BMADOs staff
- Separated waste collection	Activities or projects launched for waste separation collection in the BMAWM	- Document review - Interview - Observation	Is separated waste collection practiced for BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Check: Monitoring and evaluation (M&E)	M&E of the activities or projects under the BMAWM	- Document review - Interview - Observation	Is there M&E of the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Action: Improvement of the BMAWM	New implementation guidelines in the BMAWM	- Document review - Interview - Observation	Are there new guidelines for the BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff

Issues	Definitions	Data collection methods	Questions	Data collection sources
4) Product: Output				
Public participation	People in communities and households cooperate with BMAWM	- Document review - Interview - Observation	What percentage of the communities participated in BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff - Community leaders
Public-Private Partnership	Government agencies and private agencies cooperated to BMAWM	- Document review - Interview - Observation	What percentage of government and private organizations participated in BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff
Waste Utilization	Solid waste utilized at households, communities, government agencies, private agencies	- Document review - Interview - Observation	What was the percentage of waste utilization? How?	- Document review - BMA administrators and staff - BMADOs staff
Waste Separation type	Type of solid waste utilized from households, communities, government agencies, private agencies	- Document review - Interview - Observation	What was the percentage increase in the amount of waste separation type?	- Document review - BMA administrators and staff - BMADOs staff
Waste Composition Variation	Composition of solid waste disposal in the BMA disposal center	- Document review - Interview - Observation	What was the change in the percentage of the composition of MSW?	- Document review - BMA administrators and staff - BMADOs staff
Amount of Waste Disposal	Amount of solid waste disposed of in the BMA disposal center	- Document review - Interview - Observation	What was the percentage decrease in the amount of waste in the district? How many districts have decreased waste?	- Document review - BMA administrators and staff - BMADOs staff
5) Impact: Sustainability Outcome				
Impact on the environment	Positive impact or negative impact from BMAWM on the environment	- Document review - Interview - Observation	What is the environmental impact of BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff - Community leaders
Impact on the economy	Positive impact or negative impact of BMAWM on the economy	- Document review - Interview - Observation	What are the economic impacts of BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff - Community leaders
Impact on society	Positive impact or negative impact of BMAWM on society	- Document review - Interview - Observation	What are the social impacts of BMAWM? How?	- Document review - BMA administrators and staff - BMADOs staff - Community leaders

Table 3.4 Questions and Data Collection Sources in SWOT Analysis

Issues	Definition	Data collection methods	Questions	Data collection sources
1) Internal environment assessment (7s McKinsey)				
Strengths	Management factors within the authority of Bangkok which are strengths for BMAWM, such as strategies, structure, system, style, staff, the skill of staff, and share value relevant to BMAWM	- Document research - Interview	How did the internal environment including strategy, structure, system, shared value style, staff, and skills strengthen BMAWM plan implementation?	1. Document review 2. BMA administrators and staff 3. BMADOs staff
Weaknesses	Management factors within the authority of Bangkok which are a weakness for BMAWM, such as strategies, structure, system, style, staff, the skill of staff, and share value relevant to BMAWM	- Document research - Interview	How did the internal environment including strategy, structure, system, shared value style, staff, and skills weaken BMAWM plan implementation?	1. Document review 2. BMA administrators and staff 3. BMADOs staff
2) External environmental assessment (PESTEL)				
Opportunities	Factors outside the authority of Bangkok which are positive for BMAWM, such as policy and plan of government, economic situation, social situation, technology environment, and law relevant to BMAWM	- Document research - Interview	How did the external environment include policy, economy, social, technology, environment, and law opportunities for BMAWM plan implementation?	1. Document review 2. BMA administrators and staff 3. BMADOs staff 4. Community leaders
Threats	Factors outside the authority of Bangkok which are negative for BMAWM, such as policy and plan of government, economic situation, social situation, technology environment, and law relevant to BMAWM	- Document research - Interview	How did the external environment include policy, economy, social, technology, environment, and law threats to BMAWM plan implementation?	1. Document review 2. BMA administrators and staff 3. BMADOs staff 4. Community leaders

3.6 Data Analysis

3.6.1 Triangulation Analysis

This research initially analyzed the consistency of the qualitative data from three data collection methods under the concept of triangulation including (1) the data from the document research; (2) the data from interviewing BMA administrators and staff, district officers, and community leaders; and (3) the data from observation by the researcher of BMAWM implementation in the districts as shown in Figure 3.4.

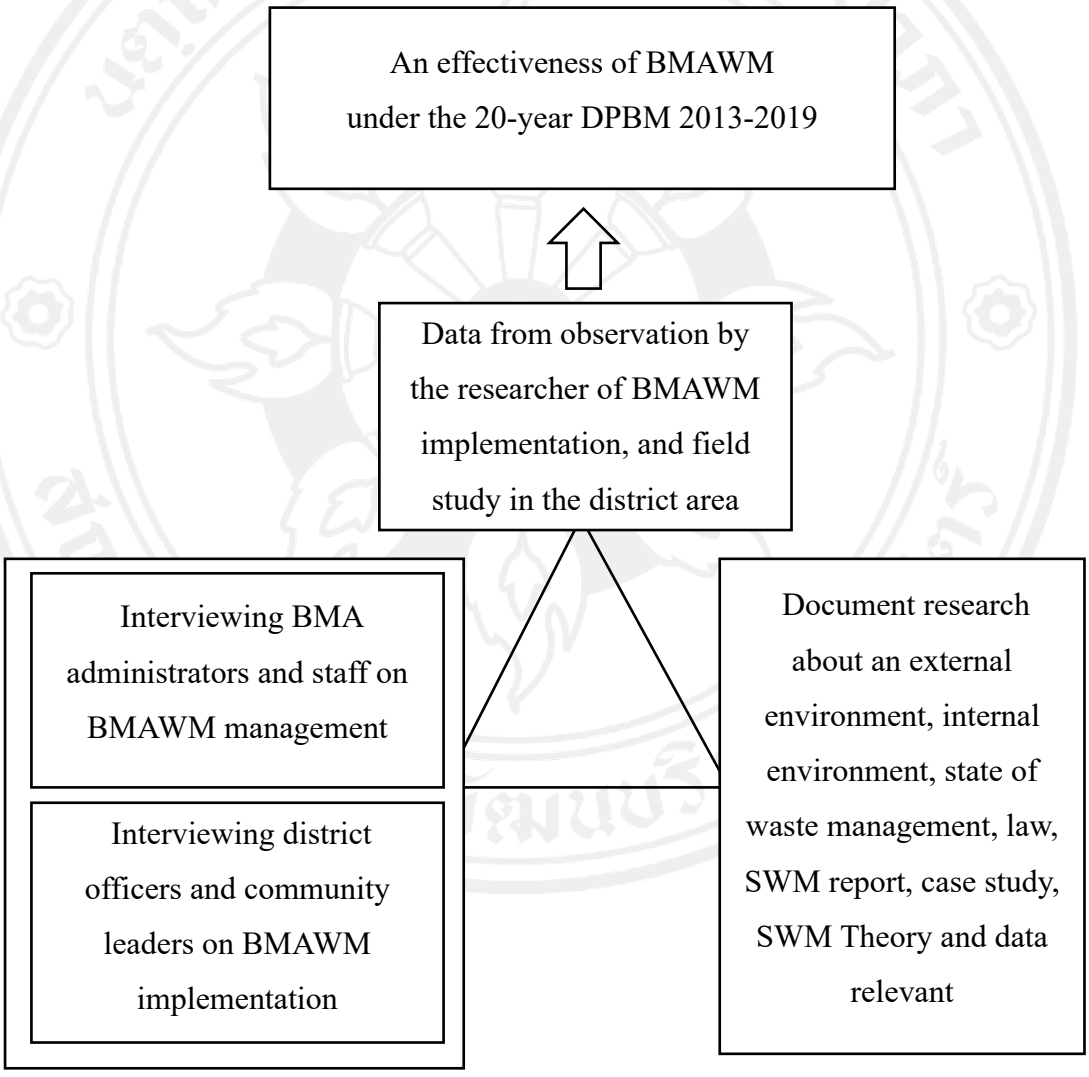

Figure 3.4 Qualitative Data Initial Analysis by Triangulation Concept

3.6.2 Content Analysis

This study analyzed the data from document research, interviews, and observation to evaluate the BMAWM and determine the factors affecting the implementation of BMAWM. The analysis process was divided into five steps, as follows.

1) The researcher transcribed the data (Beck, Keddy, & Cohen, 1994) collected by notetaking, recording via interviews, document research, and observation, prepared in various files according to the framework.

2) The researcher determined coding, category, and indexing by selecting the words and concepts for categorizing data.

3) The researcher conducted memoing data reduction and made a short conclusion for each issue to reduce the size of the data and help eliminate unwanted data. After that, the data were presented for display, analysis, and conclusions were drawn to answer the research questions.

4) The researcher verified conclusions, including searching for patterns, groupings, and factor analysis specifying the relationship of the events linking concepts, theories, and findings.

5) The researcher proceeded to support the conclusion by connecting the abstract end back to the concrete in the new function to ensure that the results were appropriate. The credibility of the data was established by examining multiple data triangles from the sources and using a variety of theoretical perspectives to explore each other. The details are shown in Table 3.5 and Table 3.6.

Table 3.5 Factors, Sub-Factors and Sources by CIPP-I Framework

Issues	Factors	Sub-factors	Sources
Context			
Policy and plan	Policy and plan	- National waste minimization policy and plan - BMA's waste minimization policy and plan - Local politicians	Bush, 2019 Greedisgoods, 2018
Economic	Economic growth	- Industry collaboration	Bush, 2019 Greedisgoods, 2018
Social	Public participation	- Public behavior - Private sectors participation	Bush, 2019 Greedisgoods, 2018
Technology	IT infrastructure	- IT communication	Bush, 2019 Greedisgoods, 2018
Environment	Environment of Bangkok	- Bangkok area environment	Bush, 2019 Greedisgoods, 2018
Law	Law	- Waste management laws	Bush, 2019 Greedisgoods, 2018
Input			
Man	Personnel	- Number of personnel - Personnel development - Personnel assignment	Wiratniphawan, 2005, Wardani, 2017, July
Money	Budget	- Waste minimization project	Wirat Wiratniphawan, 2005
Materials	Materials	- Communication tools - Waste utilization capacity	Wardani, 2017, July
Management	Management	- Organization management	
Process			
Plan	Plan	- Action plan	Moen, 2009 Shewhart, 1939 Edwards, 1950 Ishikawa, 1985 Imai, 1986 Mind Tool, 2016
Do	Do	- Personnel acceptance - Law enforcement - Public participation - Public communication - Waste collection system	Moen, 2009 Shewhart, 1939 Edwards, 1950 Ishikawa, 1985 Imai, 1986 Mind Tool, 2016
Check	Check	- Monitoring and evaluation	Moen, 2009 Shewhart, 1939 Edwards, 1950 Ishikawa, 1985 Imai, 1986 Mind Tool, 2016

Issues	Factors	Sub-factors	Sources
Action	Action	- Waste minimization guidelines	Moen, 2009 Shewhart, 1939 Edwards, 1950 Ishikawa, 1985 Imai, 1986 Mind Tool, 2016
Product			
KPIs of the action plan	Public participation	- Number of CBM participation	Gullickson et al., 2019 Poboon (2011)
	Public-private partnership	- Number of agencies cooperation	Kellaghan & Stufflebeam, 2003 Stufflebeam & Zhang, 2017 OECD Directorate for Science, 2014
	Waste utilization	- Amount of waste utilization	
	Waste separation	- The ratio of waste separation types	
	Waste composition	- The ratio of waste composition	
	Waste disposal	- Amount of waste disposal	
Impact			
Environment	Impact on the environment	- CO_2 emissions	Gullickson et al., 2019 Poboon, 2011
Economic	Impact on the economic	- Collection and disposal cost - Renewable resources - Collection and disposal fees	Kellaghan & Stufflebeam, 2003 Stufflebeam & Zhang, 2017
Social	Impact on the social	- CBM social participation - Low-income people - BMA's waste collection workers - Recycling businesses	OECD Directorate for Science, 2014

Table 3.6 The Factors, Subfactors, and Sources by SWOT Analysis

Issues	Factors	Sub-factors	Sources
The internal environment			
	Strategy	- BMA' policy and plan that supports to BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
	Structure	- BMA's structure that supports to BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
	Systems	- Systems BMA administration that supports to BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters, et al., 1982
	Shared value	- BMA officers shared value on BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
	Style	- Style on city management of BMA Governor	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
	Staff	- BMA officers who response on BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
	Skills	- Skills of BMA officers who response on BMAWM	Peters & Waterman, 1982 Mind Tool, 2016 Peters et al., 1982
The External environment			
	Political	- Policy and plan	Bush, 2019 Greedisgoods, 2018
	Economic	- Economic growth	Bush, 2019 Greedisgoods, 2018
	Social	- Public participation	Bush, 2019 Greedisgoods, 2018
	Technological	- IT infrastructure	Bush, 2019 Greedisgoods, 2018
	Environmental	- Environment of Bangkok	Bush, 2019 Greedisgoods, 2018
	Legal	- Waste management laws	Bush, 2019 Greedisgoods, 2018

CHAPTER 4

RESULTS OF STUDY

This research used the qualitative method with data collected by document research, interviews, and participant observation. The research evaluated the policy implementation on waste minimization of BMA to determine the success of BMA's waste minimization policy implementation as defined by the 20-year DPBM during the years 2013-2019. The evaluation processes used the CIPP-I model consisting of five dimensions which are context, input, process, product, and impact. After that, the SWOT analysis was used to study the external and internal environmental factors affecting the accomplishment of BMA's waste minimization. Then the study employed the TOWS matrix to determine the strategies of waste minimization and finally, to developed an appropriate system of BMA's waste minimization based on the I-P-O model and proposed the recommendation for BMA and other local governments in the formulation the waste minimization policy.

4.1 BMA Waste Management

4.1.1 Policy and Plan of BMA Municipal Solid Waste Management

Policy and plan of the BMA waste management consist of three dimensions include the Country's SWM Strategies, Law and Regulations, Bangkok Executive policy, and Bangkok solid waste management that shown as follows.

4.1.1.1 Country's SWM Strategies, Law and Regulations

BMA manages the MSW primarily according to the national laws and the BMA regulations under BMA Regulation on Waste and Property Management, the Regulation for Premises and Public Health Facilities 2002, Article 49 of the BMA Act 1982, as well as Article 7 and Article 14 of the BMA on Waste Collection and Disposal, 2001. These establish the measures regarding SWM in public health facilities that SWM of buildings or places other than public health facilities and sewage

management by managing waste of buildings or places other than public health facilities. They determine the role and duty of the owner or occupant of the building or place. The public health law specifies guidelines for SWM in the public ("Public Health Act B.E.2535,") as follows:

1) Laws specify the owner or occupant of the building or place must provide a substantial waste container. The qualifications for the substantial waste container are stable, robust material, shape easily cleaned, has a lid to prevent animals from feeding, and does not annoy nearby residents. Also, the owner or occupant must provide enough waste containers without overflowing out of the tank. This does not include containers located in buildings that are residential areas, kitchens, dining rooms, toilets, dormitory rooms, or a combined residential building.

2) The owner or occupant of a building for many people entering, exiting, and passing through such as markets, restaurants, hotels, and so on must provide solid waste containers. The owner or occupant of the building or location must provide a durable and easy to clean container with a lid to protect it from feeding animals. The number of waste containers must be sufficient so waste will not overflow the bin. If the place has many people using services or entering and exiting, the owner must provide a bucket where people who pass around those areas can easily dispose of waste storage in their building.

3) Owners or occupants of buildings or premises except for large buildings with more than one cubic meter of solid waste per day must put waste in a plastic bag and put it at the specified point. When the Bangkok governor announces the separation of waste, the owner of the building or the occupant of the building or the place must have the waste containers for waste separation according to the type of waste and put in a plastic bag. This is for the staff's work that can store according to the date and time that was set by BMA.

4) Buildings or facilities with the amount of waste of 1 cubic meter or more per day must have a shared facility of enough size and amount to support solid waste from the building in the amount of 3 days. If the facility is not available in the area, the owner or the occupant of the building or place must assist and facilitate the convenience of waste collection of Bangkok or private officers who are licensed by the local authorities; such as organizing staff to transport solid waste

to the Bangkok waste collection vehicles or private licensed vehicles. The waste collection facility must be made of durable material that can prevent water leaking or liquid seeping from inside and outside, smooth interior surface with a shape that is easy to clean. In the case of using the container, there must be a tight cover, or if it is a building, the door must close completely to prevent insects and odor from disturbing people passing by or residing. Solid waste must be put in plastic bags or bags specified by BMA or waste container which has the characteristics specified above.

5) The owner or occupant of a building that requires BMA to collect and transport solid waste from construction or other solid waste which cannot be discarded together with other solid waste due to the size or volume must be collected in their building area and notify the authorized Bangkok officer or a private company that is licensed to collect and transport.

6) Some laws and guidelines specify the roles of people in managing waste in their buildings. They must put the waste in a plastic bag and tie the bag tightly. The waste must be placed in the collection point or put into containers. When the Bangkok Governor announces waste separation regulation, the owner of the building or the occupant of the building or the place must have a waste container for waste separation according to types of waste and put in a plastic bag so that the staff can store it on the date and time. In practice, the governor of BMA has authorized the district directors to issue a notification for the date, time, and waste collection points, and designates waste collection points, which have announced the general waste collection date in all 50 districts, depending on the waste classification regulations. The governor has empowered the Director of the BMAED to announce the classification of waste before disposal (Thai PBS News, 2019a).

4.1.1.2 Governor of Bangkok Waste Management Policy

During 2013-2016, Governor Sukhumphan Boriphat's policy was to develop Bangkok to be a green city or an environmentally friendly metropolis, promoting WRS and transforming waste into energy (BMASED, 2013a). In 2016, BMA Police General Aswin Kwanmuang became governor and introduced the 5C (Clean, Convenient, Community, Care, and Common ways of living) Clean policy has been focusing on big cleaning days to control vegetation and clean the streets and

canals (BMAED, 2016). The changing of policy has changed the implementation of BMAWM by the BMA officers in 50 districts.

4.1.1.3 BMA Solid Waste Management Plan

The challenge of SWM in Bangkok is dealing with the increasing trend of the amount of solid waste in Bangkok. This tends is concomitant with changes in the way of life and excessive resource usage patterns of residents. The amount of waste is likely to continue to increase, which will result in an overflow of waste in Bangkok if it is inefficiently managed. There are numerous unsuitable areas used for landfill, and environmentally friendly waste disposal options such as an air pollution-free incinerator require advanced technology and come at a high initial and system maintenance costs. BMA also lacks comprehensive WMS planning and awareness-raising and WMS campaigns from the household to the community level.

BMASED (2013a) explained that the BMA developed the 20-year DPBM (2013-2032), in cooperation with Chulalongkorn University. The plan has established the fundamental mission and main objective of SWM, that is, for roadsides, rivers, and canals to be consistently clean. The plan has stipulated the vision of Bangkok SWM as “BMA has waste and hazardous waste with a zero-waste concept by recycling and disposal of the waste which residue from that process with efficiency technology.” The plan’s main objective is for BMA to reduce and control the amount of waste at source and increase the efficiency of BMA’s SWM by six strategies: (1) increasing the efficiency of WRS at source by 3Rs principle; (2) increasing the efficiency of participation from government agencies, private organizations, and residents on SWM; (3) increasing the efficiency of the household hazardous waste collection; (4) increasing the efficiency of e-waste; (5) increasing the efficiency of waste disposal and waste treatment; and (6) increasing the efficiency of SWM of related agencies that have eight indicators as shown in Table 4.1.

Table 4.1 Strategies and KPIs in the 20-Year BDPM (2013-2032)

Strategies (Action)	Indicators	Based on 2013	2014-2017	2018-2022	2023-2027	2028-2032
Strategy 1 Increasing efficiency of WRS at source by 3Rs principle.	1.1 Amount of solid waste utilization at the source is increased.	Based year 1,366 tons per day	Not less than 20%	Not less than 30%	Not less than 40%	Not less than 50%
	1.2 Amount of MSW is reduced.	Based year 9,963 tons per day	Not less than 5%	Not less than 10%	Not less than 15%	Not less than 20%
Strategy 2 Increasing efficiency of participation from government agencies, private organizations, and residents on solid SWM.	2.1 Number of communities that participate in solid SWM is increased.	Based year 314 Units	Not less than 5%	Not less than 20%	Not less than 30%	Not less than 40%
	2.2 Number of government agencies and private organizations increased.	Based year	Not less than 5%	Not less than 20%	Not less than 30%	Not less than 40%
Strategy 3 Increasing efficiency of household hazardous waste collection	The amount of household hazardous waste collected is increased.	Based year 666 tons per year	Not less than 20%	Not less than 30%	Not less than 40%	Not less than 50%
Strategy 4 Increasing efficiency of e-waste	The amount of e-waste to recycling is increased.	No data	Base year	Not less than 10%	Not less than 20%	Not less than 30%
Strategy 5 Increasing efficiency of waste disposal and waste treatment	The amount of MSW treatment at the BMA disposal center increased.	Based year 1,000 tons per day	Not less than 100%	Not less than 200%	Not less than 300%	Not less than 400%
Strategy 6 Increasing efficiency SWM of the related agencies	The percentage of satisfaction of residents on SWM is increased.	Based year 80%	Not less than 80%	Not less than 85%	Not less than 90%	Not less than 90%

Source: BMASED, 2013a.

BMASED (2013a) explained the 20-year DPBM (2013-2032) had set the objective of SWM in the pollution-free metropolis safety strategy to achieve the basic mission and main achievement that “Bangkok reduce and control the amount of waste at the source and increase the efficiency of SWM.” The plan implementation was launched as part of the BMA annual action plan that has targets and KPIs including waste reduction, waste utilization, community participation, government, private organization participation, household hazardous waste collection, recycling e-waste, and MSW treatment and disposal capacity. The details are shown in Table 4.2.

Table 4.2 Strategies and KPIs in the 20-Year BDPM (2013-2019)

Strategies (Action)	**Indicators**	**2013 Based year**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Strategy 1 Increasing efficiency of WRS at source by 3Rs principle.	1.1 Amount of solid waste utilization at the source is increased.	1,346 tons per day	-	Not less than 15%	Not less than 18%	Not less than 20%	Not less than 21%	Not less than 97%
	1.2 Amount of MSW is reduced.	9,963 tons per day	-	Not less than 3%	Not less than 4%	Not less than 5%	Not less than 6%	Not less than 7%
Strategy 2 Increasing efficiency of participation from government agencies, private organizations, and residents on solid SWM.	2.1 Number of communities that participate in solid SWM is increased.	262 Units	-	Not less than 5%	Not less than 6%	Not less than 5%	Not less than 29%	Not less than 37%
	2.2 Number of government agencies and private organizations increased.	52 Units	-	Not less than 5%	-	Not less than 5%	-	-

Strategies (Action)	Indicators	2013 Based year	2014	2015	2016	2017	2018	2019
Strategy 3 Increasing efficiency of household hazardous waste collection	The amount of household hazardous waste collected is increased.	666 tons per year	-	Not less than 10%	Not less than 15%	Not less than 20%	Not less than 25%	Not less than 30%
Strategy 4 Increasing the efficiency of e-waste	The amount of e-waste to recycling is increased.	-	-	-	-	Base year	-	-
Strategy 5 Increasing efficiency of waste disposal and waste treatment	The amount of MSW treatment at the BMA disposal center increased.	1,000 tons per day	-	-	-	Not less than 100%	Not less than 100%	Not less than 100%
Strategy 6 Increasing efficiency SWM of the related agencies	The percentage of satisfaction of residents on SWM is increased.	80%	Not less than 80%	Not less than 80%	Not less than 80%	Not less than 90%	Not less than 90%	Not less than 90%

Source: BMASED, 2015, 2016a, 2017; BMAED, 2019.

4.1.2 BMA's Waste Minimization

BMASED (2013a) explained the 20-year DPBM (2013-2032) targets to reduce the amount of solid waste by 20% in 2032 compared with the base year of 2013. The BMA has attempted to reduce the amount of solid waste at the source by issuing guidelines that include reduction of Styrofoam and plastic bags, reusing reusable items such as plastic or glass bottles, and recycling any recyclable waste. This could be done by separating the solid waste into two types of recyclables, which are solid waste that can be reused in some way, and organic solid waste, which will be processed and become compost. In the process of the municipal solid waste minimization, BMA will promote the process to residents in several ways including:

4.1.2.1 Process of Waste Minimization Management

BMAED (2019) explained that the process of waste minimization consists of:

1) Raise awareness of residents about the landfill problem from the increasing amount of waste and the existing guidelines.

2) Educate the public about how to minimize the amount of solid waste that passes through the disposal system by effectively dispose of it.

3) Create campaigns by promoting eco-friendly activities such as using fewer plastic bags in department stores and recycling of solid waste.

4) Create an exemplary community that can effectively dispose of solid waste in their areas such as schools and industrial areas. This is called community based solid waste management (CBM). The goal is to create a well-behaved community which can be used as an example for other communities to follow. This creates a guideline for how to effectively manage solid waste based on the exemplary community and distribute it to the representatives of other communities in Bangkok.

4.1.2.2 Project and Activity of BMA's Waste Minimization

BMAED (2019) explained the implementation measures have been carried out in the form of a project to promote public participation in reduction and separation waste at source in a specific target group. Most projects aim to develop a prototype of SWM under sustainable SWM principles with the 3R principle to reduce the amount of waste disposal. Media has been created to disseminate information about the principle of reduction and separation waste and information about the success of the prototype through the newspaper, radio, television, and social media. The important projects are as follows:

1) Bangkok green city project encourages members of various organizations to adopt environmental management under the Green City Index consisting of eight categories: (1) energy consumption and CO_2 emissions; (2) land and building use; (3) transportation and traffic; (4) solid waste management; (5) water management; (6) sanitation management; (7) air quality management; and (8) environmental governance such as green community, green school, green university,

green market, green department store, green produce, green store, green building, green hospital, and green government office.

2) The environmental protection strategy project studies the environmental impact caused by the integration of ASEAN in the year 2015. It was found that waste, wastewater, and air pollution may increase due to the number of foreign workers working, living, and traveling more. Therefore, the Bangkok Environmental Protection Strategic Plan and the Environmental Management Manual for the public must be distributed through publications and online social media.

3) Community-based solid waste management (CBM) Project developed personnel as speakers, a process to promote public participation in waste reduction and separation of communities, with communities sharing ideas, making decisions, participating in and solving problems under the concept of sufficiency economy to create a pleasant community. Live for the good quality of life concept integrates the community by developing 6-9 prototypes in each district, a total of 314 places including 265 communities, 35 schools, 12 commercials, and 2 markets. That is waste management Learning Centers of the district. BMAED has created a community SWM manual for the Office of Community Distribution District to use as a way to manage waste by the community, in which the principle of SWM by the community includes making a framework for reduction and separation of waste according to various projects up to the present. The process of CBM includes: (1) raising awareness of waste and environmental problems that occur in communities and have an impact on the residents, communities, and ecosystems; (2) thinking together about searching for solutions for the problems, making decisions, choosing methods for solving problems, and jointly implementing the specified guidelines together; and (3) creating knowledge and understanding about recycling waste, separation of waste before throwing it away, and disposing of waste at the right time.

CBM principle has five activities by the communities consisting of: (1) recyclable waste or merchandise: promote residents to separate glass, paper, metal, plastic, and other items that can be sold to Salang, car dealers, or recycling shops; (2) organic waste or compostable waste: promote separation of vegetable and fruit scraps to make bio-fermented water, compost by using leftover food scraps for animal feed or mixed with dried leaves to make organic fertilizer or

biogas fermentation; (3) manage waste bin in the household. After every household has separated waste, the amount of waste will be reduced; (4) reduce the frequency of waste collection in the communities, and (5) clean the street and plant the tree in front of the house and roadside. The waste in BMA is divided into four types: recyclable, organic waste, general waste, and hazardous waste. Therefore, there need to be two household waste bins: (1) organic waste or food waste bin for composting or animal feed and (2) general waste bins for waste collection. This should result in a reduction in the frequency of waste collection. The recyclable waste is kept in plastic bags for sale and hazardous waste is kept in plastic bags for BMADOs collection.

4) A Community-based environment management project studies and develops a model of waste and environment management by the community through participatory action and guidelines. Also, the project creates videos and manuals on waste and environment management by the community to distribute to BMADOs personnel and community leaders, with the model in five groups totaling 112 communities including (1) flats and condominiums communities, (2) housing communities, (3) urban communities, (4) suburban communities, and (5) slum communities.

5) The community waste and wastewater management project has used the concept of CBM to apply. This includes elements of society within many communities such as temples, schools, and establishments with a canal as the center and encouraging group members' participation. The common goal is to maintain the quality of the canal by returning the water to a clear and clean state and stopping the dumping of waste into the canal. The processes included installing a grease trap before disposing of wastewater, separation of waste before disposal, developing a clean and beautiful canal environment by developing a model for waste and wastewater management in canal 12 canals area, and developing a model for WMS in a specific target group consisting of government buildings such as government offices, railway stations, and transportation stations as well as markets, temples, mosques, universities, schools, condos, office buildings, housing development, a total of 16 places.

6) BMA district waste separation and utilization project has been integrated into the district as a prototype and SWM learning center. The BMAED has established guidelines for SWM for BMADOs that occur within the BMADO under the concept of SWM by communities and developed into the SWM learning center of the BMADOs by establishing a waste categorization bin consisting of recyclable waste, organic waste or food waste, general waste, and hazardous waste. A collection point is arranged for branches and leaves to be disposed of hygienically, recyclable waste to be separated for sale, food scraps to be mixed with dried leaves for composting, and composting in the office area or raising earthworms or making bio-fermented waste. Hazardous waste to be eliminated at the secure landfill. Branches waste crushed and composted with food scraps. Fruit peels are used to make bio water. Some branches that exceed the granulator capacity of the small granulator can be delivered to a branch mill at On Nut and Nong Khaem waste disposal centers for granulation and included as an ingredient for composting organic fertilizer with night soil sludge.

7) A Prototype for waste separation in BMA's school project has promoted the school to separate and utilize solid waste. There is a waste bin to separate according to type with signage, and public announcements to educate the students, visitors, and the public about how to separate waste. Also, the school composts food waste and makes biogas. A guideline has since been prepared and distributed to all schools under the BMA.

8) The integrated waste and recycling management in the Chatuchak district project was integrated development of SWM systems of the BMADOs by improving waste classification systems and encouraging the private sector to participate in waste reduction and separation. This promotes and combines SWM, such as recycling materials, covering the creation of occupational health and safety for solid waste collection workers, creating awareness of solid SWM among each target group. This project has three aspects of SWM to achieve sustainability, including environmental issues, and the amount of waste collected in the Chatuchak district office to be reduced.

9) The food waste utilization promotion project has been disseminated to the public to participate in reducing the amount of waste, food scraps, and fruit and vegetable scraps. For example, food waste could be converted into bio-fertilizer or organic fertilizer as appropriate in each area. This will reduce the amount of waste and food waste for Bangkok to store in landfills. The budget appropriations for the 50 BMADOs were 50,000 baht per year to provide training on food waste establishment projects among community leaders, schools, government agencies, state enterprises, and private organizations in their area with the benefits of BMADOs being able to apply the knowledge at both the home and business environments.

10) The Bangkok environmental protection volunteer project promotes cooperation from residents to join the environment network as volunteers working with a good attitude and spirit to protect the environment including SWM. Currently, this project has 750 participants including community leaders, academics, teachers, and the public. Volunteers are expected to introduce the knowledge of reduction and separation waste more broadly to the people around them.

11) The study and development of the waste as a resource of the BMA project was studied the SWM system of Bangkok taking into account the context of population structure change at the level of public participation, including related laws in SWM, existing Bangkok infrastructure systems, and economic measures. The project studied and developed a system of waste separation and collection in the Suan Luang district. The waste storage was experimented upon by classifying it into six types of recyclable waste collected every Sunday including hazardous waste, food scraps, large pieces of waste, branch waste, and general waste. The results found that few residents separated discarded recyclable waste, food waste, and dangerous waste in the specified amount of time. However, in the experimental area, it was found that 20% of the waste separation was branches, leaves, and large pieces of waste. The project proposed the SWM strategy as a resource to create the Solid waste management plan of Bangkok 2015-2019.

12) The project to create inventions to promote waste materials and increase the value of usable waste materials. For example, BMA organized a training course for the public to design and create products from waste materials or

improve product quality, as well as organized a competition for products from waste materials and submitted the winner to the national competition level.

13) The promotion of WMS in 14 target groups is a project implemented under the Thailand Waste Plan 2016-2017 by encouraging the people in all sectors including government, private sector, education sector, religious sector, civil society, and communities to join with BMA to reduce and sort waste at source. The BMAED surveyed 14 target groups that produce waste from offices in 50 districts. The results found that a total of 33,167 organizations consisting of 2,829 communities/villages, 825 of buildings that higher than 8 floors, 1,425 buildings, 1,301 educational institutions, 632 temples/religious sites, 285 markets, 163 department stores, 3,389 supermarkets/minimarts, 609 petrol stations, 390 hotels, 11,012 factories, 10,880 restaurants, 1,437 banks, 59 parks, and 252 hospitals for SWM Promotion Personnel in 14 public groups in 12,000 units of 50 districts.

14) Set up a hazardous waste receiving point by assigning the communities under the BMA policy. The 2,060 communities were the first target group to set up a hazardous waste receiving bin from each community. Bangkok has signed a collaboration with 106 Shell petrol stations in 46 district areas. BMA also collaborated with the PCD to set up a hazardous point and the office to collect waste every 15 days, or every Sunday, or when full.

15) Waste reduction and separation in all the BMA offices have been implementing policies to reduce, abandon, and discontinue the use of plastic and foam in offices, shops, activities in government offices, and container-free meetings. Plastics and foam waste must be separated as must the two types of waste that can be recycled or composted, while the other two types of disposal categories including hazardous waste and general waste is to be sent to BMADCs for elimination. Private and the public staff is to be involved by setting the zero-waste school policy, discontinuing the use of milk in plastic bags, managing waste among the 437 schools to reduce and separate waste from utilization. Hospitals and public health centers no longer give away plastic bags containing drugs and suggest patients carry their cloth bags to reduce and sort waste.

4.1.3 BMA Municipal Solid Waste Collection and Transportation

BMAED (2019) reported the public waste collection is a function of the 50 BMADOs, with the BMAED providing waste collection vehicles by renting and buying and delivering to BMADOs to use waste collection services from households. Total solid waste collection truck trucks are 2,018 units divided into 1,571 rental cars or 77.85% of the total amount of waste collection vehicles and 447 vehicles belong to Bangkok or 22.15%. Of the trucks, 902 are 5 tons' compact waste trucks, 356 trucks are 2 tons' compact waste trucks, 135 are 1.5 tons' container trucks, and 135 are forklift trucks. The facilities of the container include 185 units of size 8 cubic meters, 271 pickup trucks of size 6 tons, 91 trucks with 2 tons open-side, and 87 trucks with 1.5 tons open-side. For worker resources, BMA has 10,454 personnel to collect general waste, hazardous waste, tree waste, construction waste, and large waste. The details are as follows:

4.1.3.1 General Waste Collection

The BMA collects the general waste that is mixed waste from households and commercial premises in 50 district areas. The waste collection service policy is separated into two groups:

1) Along main roads, minor roads, and in the markets, waste is collected daily at the collection points between 08.00 p.m. to 03.00 a.m. The BMA district waste collection trucks complete their rounds by 05.30 a.m.

2) The sub-main roads, sub-miner roads, and in the communities, the districts collect 2-3 times per week according to a schedule. Moreover, in the unreachable areas, the BMA has volunteers to collect the waste and place it in reachable locations. Currently, there are 311 volunteers in 279 living communities.

4.1.3.2 Hazardous Waste Collection

The residents of Bangkok educated are about hazardous waste used in their daily lives, such as the batteries, light bulbs, spray cans, expired medicines, motor oil, paints, and various chemicals that can be harmful to their health and the environment. The BMA has separated this hazardous waste since 1997 by having residents separate this waste from regular solid waste and the city then collect it as per schedule. During the disposal process, hazardous wastes are separated into light bulbs, batteries, spray cans, and electronic waste. The amount of hazardous waste increased

by 2.7 tons per day in 2019 from the base year of 2013. Waste collection: BMA provides specific containers for household hazardous waste, includes a set of waste separation bins and orange hazardous waste bins distributed to all district offices to accumulate household hazardous waste at various appropriate locations. BMA provides services to collect household hazardous waste by using a general solid waste collection vehicle which has a separate compartment on the rear of the driver's seat to store household hazardous waste or use this vehicle to collect household hazardous waste on Sundays.

4.1.3.3 Infectious Waste Collection

Infectious waste requires a very careful disposal method of collection, transportation, and disposal, including limitation of waste collection at source. If this infectious waste is not managed to meet the standards or sanitary principles, this will result in various pathogens, contamination to the environment, and have health effects including the spread of infectious diseases. Regarding infectious waste management, BMA has hired Krungthep Thanakom Co., Ltd. to collect, transport, and dispose of infectious waste from infirmaries in Bangkok, such as hospitals, public health centers, and clinics. These collected infectious wastes will be disposed of by burning in infectious waste incinerators that are in the waste disposal centers of Bangkok. At present, the capacity for infectious waste disposal is 40 tons per day. In the fiscal year 2017, the average amount of disposed of infectious waste was 39 tons per day. This was collected from the 2,783 infirmaries that the company provided the services for, divided into 2,452 clinics and others (88%), 172 public and private hospitals (6%), and 159 hospitals and public health centers of BMA (6%).

Regarding containers for infectious waste collection, it must be read and opaque as well as containing black texts that can be read clearly, specified "Infectious Waste" to be dissimilar to containers of general solid waste. Infectious waste bags are usually single-use and disposed of, together with infectious waste. The cooling system is installed on the infectious waste collection vehicles to control the temperature at 10 Celsius. At present, there are 30 infectious waste collection vehicles, divided into 16 units of 6-wheel vehicles and 14 units of 4-wheel vehicles.

4.1.4 BMA Municipal Solid Waste Disposal

BMAED (2019) reported that BMA's waste disposal as follows:

4.1.4.1 General Waste Disposal

General waste accounts for the highest proportion of solid waste in Bangkok at approximately 10,564 tons in 2019. The waste composition proportions are divided into three groups: organic waste 48%, non-recycling waste 38%, and recyclables waste 14%. There are three methods for eliminating general waste:

1) Composting plants with capacities of 1,600 tons per day.

2) Incinerator plant with the capacities of 500 tons per day.

3) Landfills with an amount of waste at approximately 8,464 tons per day and 80% of BMA waste is landfilled. The landfills are managed by private companies.

4.1.4.2 Hazardous Waste Disposal

The city of Bangkok has hired a private company to eliminate hazardous waste by incineration or disposal of a secure landfill. The private company has a responsibility to transfer hazardous waste from the storage of the three BMADCs to the hazardous waste disposal plant. The collected household hazardous waste is delivered to the store at the solid waste transfer stations located within the BMADCs. It is disposed of by the secure landfill method operated by a private company licensed by the Department of Industrial Works. According to the fiscal year 2017, BMA spent 11,980 baht per ton for household hazardous waste disposal.

4.1.4.3 Infectious Waste Disposal

Infectious waste will be disposed of by an infectious waste incinerator. Currently, there are two infectious waste incinerators, namely:

1) The infectious waste incinerator, located in On Nut Solid Waste Disposal Center, has a waste disposal capacity of 10 tons per day. It has two incinerators of Two-Stage Burning Incineration. The function of the primary chamber is to burn infectious waste at a temperature of approximately 800-900 Celsius while the function of the secondary chamber is to burn the gas generated by the primary chamber at a temperature of approximately 1,000-1,200 Celsius. This causes the pollutants to be completely burned before the gas moves into the gas treatment system. The incinerator applies a wet scrubber system as a waste gas treatment

system. It altogether serves two functions, reduction of the temperature of the gas before releasing into the atmosphere and treating gas to meet the legal standards.

2) Infectious waste incinerator, located in Nong Khaem Solid Waste Disposal Center, has an infectious waste disposal capacity of 10 tons per day with two rotary incinerators. These incinerators have a function of waste flipping that is particularly designed to burn infectious waste from infirmaries. Also, air pollution treatment and pollution control systems consist of a dust filter system, dioxin-furan removal system, and a wet scrubber system.

4.2 Evaluation of the BMA's Waste Minimization Implementation

This study evaluated the effectiveness of BMAWM implementation as part of the 20-year DPBM during the years 2013-2019, using the CIPP-I Framework, which composes context, inputs, processes, products, and impacts. The details are included in the context of policy and plan, economic growth, public participation, information technology infrastructure, environment of Bangkok, and waste management law. Inputs include personnel, budget, materials, and management. Processes include plan, do, check, and action. Products are KPIs of the plan included public participation, public-private partnership, waste utilization, waste separation, waste composition, waste disposal. Impacts include the impact on the environment, economy, and society. Details of the study result are:

4.2.1 Context Evaluation of BMAWM

The evaluation of Bangkok waste reduction and separation operation during 2013-2019 found the contextual factors that affect the waste reduction and separation goals at the source of Bangkok consist of policies and plans, economic growth, public participation, IT infrastructure, environment of Bangkok, and waste management laws. The details of the context are as follows:

4.2.1.1 Policy and Plan

The government announced waste as a national agenda and announced the country's SWM roadmap in 2014 and the national SWM master plan 2016-2017, after which the Ministry of Interior announced the Thailand zero-waste action plan

according to the local state 2016-2017. The legal requirements for waste separation had been developing under the Notification of ("Announcement of the ministry of Interior Re: Solid Waste Management B.E.2560,") based on four types of waste bins: recyclable waste, organic waste, hazardous waste, and general waste. Concerning public and private agencies, government agencies are responsible for driving sustainable SWM plans, and the private sector plays a role in driving a circular economic system and recycling system. Currently, communication technology is more convenient to reach people, and most residents of Bangkok have access to the Internet through smartphones, tablets, and computers. Waste separation behavior studies have found that the population does not yet separate waste before discarding. This behavior needs to be seriously changed with waste separation at source. Also, local political factors are not related to waste collection and waste separation, with the waste reduction and separation procedure requiring cooperation from all residents. Therefore, cooperation must integrate all government departments in joint operations. The Bangkok Governor must formulate a policy with clear directions for achieving management goals to reduce and sort waste appropriately and efficiently.

BMA operates SWM under the government policy framework, the NESDP, and related laws. In Bangkok, SWM strategies are set to reduce and separate waste in the BDP. To be an effective SWM framework, the concept of waste reduction and separation has been discussed in the NESDP since 1992, which is a supporting factor for waste reduction and separation operations. This is divided into two parts: (1) Policy and Plan of SWM in Thailand and (2) Policy and Plan of SWM in Bangkok. The details are as follows:

1) National Waste Minimization Policy and Plan

The concept of WRS in Thailand has been discussed since 1992 as part of SWM that developed continuously including using technology for waste disposal and promotion of waste reduction and waste utilization at source by the 7th NESDP 1992-1996 (ONESDC, 1992). Then, the 8th NESDP 1997-2001 developed appropriate guidelines for hygienic storage, transportation, disposal, waste reduction, waste utilization, and appropriate recycling (ONESDC, 1997). After that, the 9th to 11th NESDP during the years 2002-2016 (ONESDC, 2012) determined the waste utilization goal for increasing recycling by 30% by integrating appropriate technology

under the 3R principles. Then the 12th NESDP (2017-2021) has been promoting laws and mechanisms for waste separation, supporting the transformation of waste to energy, and using economic measures to reduce waste. This measure builds discipline in the nation's citizenry for sustainable SWM to increase SWM efficiency, support the SWM integration along with the cycle by reducing the amount of waste production, encourage the waste separation to be reused as much as possible, promote processing solid waste and raw materials from production processes into energy by using innovation and technology, and raise public awareness to participate in concrete SWM (ONESDC, 2018).

The solid waste and hazardous waste roadmap aim to establish four measures: (1) elimination of cumulative old waste; (2) installation proper waste and hazardous waste systems that focus on waste reduction and separation at sources by using and integrating transforming waste to energy technology for the highest utilization; (3) regulation and declaration for SWM measures by assigning governors to manage the efficiency of provincial SWM over local administration organizations; and (4) encouraging national discipline for sustainable SWM by using legislative enforcement and strict punishment for illegal waste operation (ONESDC, 2018).

The National SWM Plan 2016-2021 focused on waste reduction and waste separation using the 3Rs. This focuses on waste reduction, reuse, and recycling at source by the behavioral change to manage waste under an environmentally friendly approach. The concept also applied to adolescents to be concerned about waste reduction and saving resources through utilization before sending for elimination. Furthermore, the concept aims to develop the recycling business and maintain society's motivation for waste reduction and separation. Moreover, the plan has applied the SWM cluster for waste and hazardous waste that is focusing on technological integration on SWM by cooperation between local administrative organizations and the private sector. The plan has applied separation systems, including fertilization, incineration, and sanitary landfill, to reduce the impact on the environment. Also, the plan is to increase public involvement from all social sectors under a zero-waste concept and to increase waste reduction and separation measures from the government sector by encouraging SWM discipline in residents (ONESDC, 2018).

2) BMA's Waste Minimization Policy and Plan

BMA has had policies to cope with the problem included in the 3rd BMA Development Plan (1987-1991) and the 4th BMA Development Plan (1992-1996) that focused on controlling the amount of waste by establishing a public relations policy, campaigns and encouraging people to separate MSW for utilizing at the source. Also, the plan was announced to avoid using plastic and Styrofoam to reduce the amount of waste disposal and reduce costs. (BMAPPD, 1992; 1997). After that, BMA prepared the 6th BMA Development Plan (2002-2006) with a target to reduce MSW by separation at a source of at least 15% for recycling in 2006 BMADPUD (2007). Then, the BMA Administration Plan (2005-2008) changed the target to reduce MSW by at least 10% per year (BMASED, 2005). In 2013, BMA stipulated the 20-year DPBM (2013-2032), which has the SWM vision of "the BMA has waste and hazardous waste using a concept of zero-waste by 3Rs and treatment and disposal of them by environmentally friendly technologies." The targets for 2030 are based on the year 2013 including waste utilization will increase by 50%, and waste disposal will reduce by 20%, the participation on SWM of government organizations, private companies, or communities will increase by 50%, the hazardous waste collection will be increased by 50%, and the amount of electronic waste to recycle will increase by at least 30% (BMASED, 2013a).

The director of the Policy and Planning Division, BMAED, explained the positive points of the policy and plan of the national government and BMA governor as follows:

> The Roadmap of waste and hazardous waste is required to build up an integrated SWM program from all provinces. That had been conducted in the SWM plan of the BMA for 2015-2019 and implemented to separate hazardous waste from general waste. The plan has been developing on waste reduction and waste separation by reduction, reuse, and recycling, the separation collection system, and elimination by the incinerator, sanitary landfills, and other technology. This supported the BMA solid SWM that focused on waste reduction, separation, collection for separation of the waste, to utilization before disposal.

3) Local Politicians

BMAED (2015) stated that the Governor of Bangkok and Councilors of the Bangkok Metropolitan Council are the politicians that have a specific policy regarding the city administration. Regarding BMA governor, M.R. Sukhumbhand Paribatra, his policies focused on WRS and environmentally friendly systems from the waste transportation process to convert the waste into clean energy. The next governor, Pol. Gen. Aswin Kwanmuang, had the policy of "Big Cleaning Day," made Bangkok a clean city with the participation of all sectors (BMAED, 2016). However, these policies did not focus on waste separation and waste minimization, which might be one cause of inefficiency in waste minimization implementation by the 50 BMA districts because their priority was on the BMA governor's policy. This could be a weakness in waste minimization in Bangkok. Moreover, the politicians often use favorable policy more than negative policy according to an interview with several BMA executives, one of whom responded as shown below:

> Politicians often do not issue negative policies because they will affect the next election votes, so there is no law to force people to separate waste before discarding. In the past, some districts were able to reduce waste, while others could not reduce waste. That depends on various factors, such as the importance of district administrators, the chief of the CPPS. This is considered a success by those who do not work in the system. Therefore, the system must be developed appropriately and with enough support measures. The Governor of Bangkok and the Council of Bangkok must understand and support the legislation to set measures and support the development of the system to manage waste by type.

Moreover, several issues related to the authority of the BMA governor, which is derived from the BMA Act 1985, have resulted in city administration problems and obstacles such as limitations on the power of the public service, lack of administration unity to address problems, and centralization of BMA administration that was not conducive to rapid problem solving or rendering effective public service (The Committees of the National Reform Steering Assembly [CNRSA], 2017).

In summary, government policy and national planning have supported the BMA's waste minimization plan focused on waste separation. That has been the priority as well as to promote public awareness on waste reduction and separation at source according to the 3R principle, improving the waste separation collection system, and sanitation treatment in compost plants and incinerators. The policy and planning were supportive of the policy and plan for BMA on waste reduction, however, the Governor has been an essential factor that drives waste reduction and separation operations of BMA.

4.2.1.2 Economic Growth

According to the interview and participation observation summaries that an Industry Collaboration: Recyclable waste collection in Thailand and Bangkok has been mainly operated by the private sector as part of an economic system in the utilization of recyclable waste to raw materials. These private operators include Salang, junk shops, and factories that produce new products. There is a marketing mechanism for collecting recyclable materials at source, including households, commercial places, office buildings, and other places, and the ragpickers or in Thai "saleng" and waste pickers on waste collection trucks. The government and local government support and encourage residents to separate recyclable objects for sale. The efficiency of the recyclable collection depends on the price of recyclable materials. If the recyclables have a low price, the waste collectors or the ragpickers do not collect them, and it will go through the BMA collection system where the BMA workers cannot separate all the recyclable waste on the main streets because it obstructs traffic, especially during the daytime. The price of recyclables in Thailand has been low resulting in less income for the ragpickers. Thus, they have been changing their occupations resulting in a decrease in their number.

4.2.1.3 Public Participation

1) Public Behavior

The behavior of householders on BMAWM is significant. The BMA announced the MSW from households should be placed at collection points. Normally, the 50 district offices have one type of collection truck for the waste collection service. This practice has resulted in the mixing of waste in the final disposal site. Refer to a study on waste composition in Bangkok during the fiscal year

2011-2018, found the mixed waste composition divided by utilization of material by three types: (1) waste to recyclable 12.54% included glass 2.50%, metal 1.40%, plastic 4.42%, foam 1.54% and paper 2.68%); (2) waste to composting 51.97% included food waste 46.04%, wood and leaves 5.91, others 0.02%); and (3) waste to landfill 35.49% included non-recycled plastic 18.68%, non-recycled paper 9.50%, leather and rubber 1.18%, cloth, and textile 4.02%, rock, and ceramic 0.53%, and bone and shell 1.57% and other 0.01% (BMAED, 2019).

According to an interview with BMAED executives stated that "the recyclable waste for sale is the practice of Thai people around the country meaning waste is sold to the ragpickers and sent to a recycling shop." This is an informal system for collecting recyclable waste to use as renewable raw materials. BMA has not focused on a formal recyclable collection waste system because of the cost.

In the interview, the BMAED staff described that:

> The BMA had studied on waste separation collection with, Kasetsart University that had experimented with collecting waste including recyclable waste, food waste, general waste, branch waste, and bulky waste with the specified date for separation and classification of waste by separation waste trucks, with a frequency of every three months. Communication with residents covered all households in the experimental area through a process of public hearings and mobile public relations vehicles knocking on doors and distributing brochures and posters. The study found that it is impossible to collect recyclable waste because when residents put recyclable waste in front of their houses, it is typically collected before the arrival of the waste collection truck. Moreover, residents often separate recyclable waste and sell it themselves. Thus, they do not put in the collection point. Also, as little as few organic waste and hazardous waste were collected as well as a large amount of yard waste, and bulky waste. For general waste reduced by 20%.

The researcher found the situation of waste separation at Shell petrol stations there are three types of waste bins with the symbol and name of the waste type namely hazardous waste, recyclable waste, and general waste. however, people still do not put the trash into the right waste bins. So, the gas stations increased their communication with the customers, including placing the trash in the right area that is not too close to the toilet. However, people are in a rush and are not interested in following signposts for proper disposal.

As a result of the waste disposal behavior of people without classifying waste, there are recyclable waste, food waste, twigs, and leaves comingled with general waste. This directly increases the amount of waste, and the value of recyclable waste leads to a decrease in the number of ragpickers, who collect recyclable waste from bins in public places and the community. This waste separation behavior during the waste collection service of the waste collector creates income for the staff collectors of Bangkok. However, it does not reduce more amount of waste and this has been the waste time on waste collection.

However, the site monitoring and evaluation of waste reduction and separation operations of communities that participated in the CBM project, found communities were successful in their waste separation by cooperating in screening to separate recyclable waste for sale by themselves. These could reduce the amount of waste by 40%. Also, if a community had a public fermentation tank, they were able to reduce waste by 60%.

Regarding the attitude of the residents toward Bangkok on WRS, the study shows that they continue to lack an understanding of Bangkok's guidelines on waste separation due to a lack of clear communication from the BMA. According to interviews, the community leaders and residents have mainly focused on waste disposal and collection process information which specifies the Bangkok waste collection policy. General waste disposal is scheduled along main and secondary roads from 8.00 p.m. to 03.00 a.m. daily or 2 to 3 times per week. In the communities, the time is determined by the BMADOs to collect recyclable waste every Sunday. Hazardous waste is collected on the 1st and 15th of the month (BMAED, 2016). Nevertheless, according to the BMAED waste separation brochure, it recommends residents separate waste into four types and suggests waste utilization methods such

as separation of recyclable waste for selling and making fertilizing at source from food scraps. BMA only collects hazardous waste and general wastes.

According to the interviews with the operating officers of the 50 BMADOs, it was concluded that:

> Most BMADOs use the same vehicles to collect waste, which is collected daily or 2-3 times a week. For hazardous waste separation, along with the separation of recyclable waste, or set up a community revolving hazardous waste collection service every Sunday there are always announcements in advance and occasional collection.

However, it was found that the BMADOs that organized a unique hazardous waste collection service covering all routes were Sai Mai District, Don Mueang District, and Lak Si District. Most BMA districts collected hazardous waste at a collection point and transported it to the hazardous waste transfer station at the BMA waste disposal center. Moreover, residents of Bangkok do not understand how to separate waste for collection.

The diversity of the population in Bangkok is enormous because it is the capital city and a major tourist city as well as being an economic center. As a result, the population has been increasing leading to increasing demand for public services to cover a total population of at least 18 million. This number consists of the permanent resident population and non-registration population, those who commute in and out to work daily or at certain times, foreign workers, and both Thai and foreign tourists, all of whom are included in the population that receives public services from BMA (CNRSA, 2017). This research shows that the population has not yet received communication to create awareness and has insufficient public cooperation on WRS. Also, they lack an understanding of waste separation bins. For behaviors to change, effective communication, and supervision of the waste bins are required as most of the population leaves the waste without any attempt to separate it by classification. The waste separation adds value to sales for extra income and subsistence income for low-income people. This is an essential factor in correcting people's behavior to separate waste by enhancing and educating them about waste problems and waste separation that has value as a renewable resource.

In conclusion, Bangkok's population is familiar with general waste bins and BMA district collection. Residents typically leave all in these bins. However, some recyclable is often sold or donate, and food waste is often made home compost by residents. That is one of the main causes of mixed waste in the general bins in Bangkok. Therefore, waste composition at disposal centers includes recycled material, 13%; food waste, kitchen waste, branches, and leaves, 54%; and general waste such as rubber, fabric, textile, small rock, ceramic, bone, plastic bag, foam, and shell, 37%. The general waste collection has resulted in residents having less participation in waste separation at the source.

2) Private Sectors Participation

According to the interviews with Bangkok executives about cooperation from the private sector on SWM, they believe that:

> Bangkok has signed an agreement for cooperation among government, business, and civil society cooperation projects to manage plastics and waste sustainably with 36 organizations at Central World Department Store, Pathum Wan District, Bangkok. This is considered a new dimension of Bangkok's SWM, which has received concrete cooperation and support from government agencies, private agencies including producers, wholesalers, retailers, NGOs, and civil society to manage plastic problems and sustainability of SWM that has resulted in increased recycling. The project has been designated as a pilot area in Khlong Toei District. Since the Khlong Toei district office has established good practices for effective waste reduction and management for many years, which can create connections following the new concept of the circular economy and become more active. Then, this will be extended to 50 BMADOs.

In this regard, government agencies have established policies and guidelines that promote waste reduction and separation. For example, industrial estates use the concept of "Industrial Ecology" to develop industrial estates under the symbiosis principle and sustainability. For sustainable development, they concern the health and safety of the community and quality of life with the goal that all industrial estates will develop into environmentally friendly industries by 2019. The Ministry of

Natural Resources and Environment and the network partners have been promoting environmentally friendly consumption, which consists of a wide range of actions, but is not comprehensive because of a lack of enforcement measures and incentives. Environment-friendly consumption is varied, for instance, green labels, energy-saving ratings, and recyclable product symbol, green leaf symbol, and green procurement in various public and private organizations. These create new forms of consumption through coordination and collaboration with businesses or using digital platforms by purchasing products and services online. This includes reusing products by renovating them and convert them to qualify as new goods.

However, after the government announced that SWM is part of the national agenda, government agencies have taken their role in waste reduction and separation more seriously, resulting in increased momentum across the country. The PCD has prepared a national roadmap to manage waste and hazardous waste that focuses on waste correction according to academic principles and consists of the separation of hazardous waste from general waste, reduction and separation of waste, utilization at the place of origin, and eliminating the remaining waste through technology. Moreover, the PCD prepared the National Waste Master Plan 2016-2021, which focuses on waste reduction and separation at the source following the 3R principle.

In summary, the government, private sector, and civil society play an important role in collecting recyclable materials for reuse in the production process. These effectively react to market mechanisms, but there are unable to collect all recyclable materials. The government has a precise policy on SWM to reduce and sort at the source using the 3R principle. Environment-friendly technology has been applied by the government for waste collection with classification and disposal, especially recycling waste. The private sector has thoughtfully and continually cooperated in sustainable SWM, which is a positive factor for BMA to reduce and separate waste more efficiently.

4.2.1.4 Information Technology Infrastructure

IT Communication has developed rapidly, such as the computer, smartphone, and other internet-connected technologies. These have changed people's lifestyles, and the Cloud facilitates a robust connection with people through mass communication or individual's communication on smartphones or computers online. This is a healthy situation for increasing the efficiency of communication on WMS of BMAWM to raise public awareness on WRS at the source. However, BMA still does not use this technology for WMS of BMAWM. The data collection of computers, mobile, and internet usage of the population in the Bangkok area. There were 3,613,846 desktop computer users, an increase from 3,302,566 computer users; 2,230,951 portable computers; and 1,808,789 tablets with total 4,080,875 users (BMASED, 2013b).

Nevertheless, BMASED found that there still were 4,005,940 non-users and 7,380,117 mobile phone users in 2012. These have citizens who use mobile phone 5,386,679 users, and non-users of mobile phones were 706,698. The number of Internet users increased from 5,592,956 in 2012, 2,848,286 users of the Internet, with non-users at 2,493,859. Social media administration has changed how people live and do business around the world. There are more than 4 billion web users around the world, driven by the development of the "smartphone." It is estimated that in 2017, that two-third of the world's population had smartphones, vastly increasing the number of social media users. At present, there are more than 3 billion individuals around the world using social media monthly. In Thailand, there are 46 million regular Internet users (National Statistical Office, 2016) from a population of 65.9 million (Department of Provincial Administration, 2016).

Facebook was the most popular social media among Thais. Then YouTube, LINE, Facebook Messenger, and Instagram, respectively. The number of Facebook users in Thailand is 51 million, with 90% access it through a mobile device. Bangkok has the most Facebook page usage in the world with 22,000,000 users; followed by Dhaka, Bangladesh, with 20,000,000 users; Bekasi, Indonesia, with 18,000,000 users; Jakarta, Indonesia, with 16,000,000 users; and Mexico City with 14,000,000 users, respectively. Facebook users in Thailand are between 18-34 years old who use technology in daily life, followed by 35-44 years old. However, according

to the results of the 2018 Digital Yearbook for Thailand by using “advertising media” to create a brand or product awareness, it was found that the most powerful five media in creating brand awareness and products services were television, online media, media, media in the store, and posters, respectively (Digital Government Development Agency (Public Organization) [DGDA], 2018).

Innovation 4.0 is “the vision of the Thai financial advancement arrangement or the government's financial improvement demonstrate based on the vision” steady, affluent, and maintainable “with important missions within the social change driving to alter, organize, alter the course and make a way to create the country to be able to manage with openings and dangers. The better approaches can alter rapidly in the 21st century” to alter to “an economy driven by development” with the most thought alter from item generation “Commodities” to “imaginative” items. Change is driving the nation with innovation, inventiveness, and development (DGDA, 2018).

According to the United Nations e-Government Readiness Survey 2012, Thailand ranked 92 among the total 193 member states. Thailand fell from number 76 in 2010 and dropped from number 64 in 2008 (DGDA, 2018). The 12th NESDP stipulates a strategy for the development of science, technology, research, and innovation to strengthen the country's science and technology. Also, the plan increases the ability to apply science, technology, and innovation to upgrade the competitiveness of the manufacturing and service sectors and the quality of life of the people consisting of: (1) accelerate investment, research, and development, and push for commercial and social benefits; (2) develop entrepreneurs to be technological entrepreneurs; and (3) develop an environment for the development of science, technology, research, and innovation in research personnel (ONESDC, 2018).

In summary, communication technology is developing rapidly in Thailand. Most of the population has mobile communication devices, with over 99% using smartphones that can access 3G and 4G Internet networks. This is the highest per day Internet access globally, and Bangkok remains the city with the largest population using Facebook applications globally, reaching 22,000,000, with Facebook users accessing it via mobile devices. Bangkok is, therefore, a city where most people have access to personal communication technology with various applications. The government must promote technology usage for government management tasks and

develop various innovations, as the country is a suitable environment for supporting communication processes.

4.2.1.5 Environment of Bangkok

Bangkok Area Environment is a tropical city that is suitable for the natural microbes' growth and the decomposition of organic matter into fertilizer. Normally, the temperature of composting is between 27-39 degrees Celsius (Rangseesuriyachai & Saricheewin, 2018). The relative humidity is high throughout the year. Bangkok is near the Gulf of Thailand which steam blows consistently (BMASED, 2013b). An obstacle, however, is flooding that creates conditions unsuitable for organic composting. Moreover, high temperatures and humid are also suitable for the growth of microbes that cause food waste to perish. There is also the problem of odor from trash and waste containers. Also, multistory buildings and slum communities alike do not have a place to compost organic fertilizer. Therefore, it must be thrown in with general waste.

4.2.1.6 Waste Management Laws

The essential laws of Thailand related to waste management include:

1) Public Health Act B.E.2535, Article 18 provides which solid waste and sewage management in any local area, the authority belonged to that local government, and Article 20 (2) provides that solid waste containers be provided in the public area. It had a central point of establishing waste management and empowering the local government in operation. In this respect, the assurance of the rate of expenses for waste transferring or local government is carried out by clean conditions. The government must stipulate rules, methods, and conditions for capacity, transportation, and transfer of waste for the licensee to perform. They indicate progress benefit rates agree to the nature that is the licensee under Article 19 ought to be chargeable. For the collection, transportation, and transferring of waste to continue. The issue of Bangkok statute to expenses for collection and transportation of sewage or waste follows the Public Health Act 1992 by BMA Ordinance on Solid Waste and Nightsoil Collection Fee According to the Public Health Law, B.E. 2548 and Article 20 (4) specifies a general waste fee of 40 baht per month for households with the amount of waste not exceeding 20 liters per day and to amend the fee to 20 baht per month under the BMA regulations.

In summary of the BMAED staff interview that the fee for collection and transportation of sewage or waste (No. 2) 2005, if the amount of waste exceeds 20 liters per day but not more than 500 liters, a charge will be collected every 20 liters or part of each 20 liters per month 40 baht. The fee is 2,000 baht per month for establishments with a volume of over 500 liters of waste per day, but not more than one cubic meter per day. The collection and transportation are charged for the next one cubic meter or a part thereof customers at the rate of 2,000 baht per cubic meter. The general waste collection and transportation fees will be charged 150 baht per time and the volume does not exceed one cubic meter; if more than one cubic meter, the fee will be 150 baht per cubic meter.

2) Act on the Maintenance of The Cleanliness and Orderliness of the Country B.E. 2535, Article 31 provides that disposal of sewage or solid waste in the public area was prohibited. Moreover, the penalty with a fine was established in case the violation, Article 15 provides that those who saw the offender can notify the authorities. In the 2017 revision, there are significant issues in waste management by the local administrative organization:

(1) The waste collection and disposal are the responsibility of the local government, which the local government may delegate to a government agency or other local government, including the provincial or private administrative organization to replace or join with local government. In this regard, the private sector granted to undertake or participate in the operation above shall not be regarded as a joint investment under the law on private participation in public affairs.

(2) The local government collected municipal solid waste by government agencies or other local governments, including the provincial or private administrative organization, and they are assigned. These shall have the power to take, use, or find benefits by the agreements made between them according to the rules, methods, and conditions set by the Ministry of Interior.

(3) The local government must collect fees for the collection, transportation, and disposal of sewage and waste from the persons at the rate specified in the local regulations, which must not exceed the rate specified in the Ministerial Regulations.

(4) Hazardous and non-hazardous waste under the law on factories shall be by the law on factories. However, in the case of hazardous waste or non-hazardous waste mixed with sewage and waste collected by the local government are excepted, the local government or government agencies or other local governments, including the provincial or private administrative organizations, were assigned to store.

(5) Any person would like to operate the business of receiving, collecting, transporting, disposing of waste, and SWM as a business or receiving compensation in return for service. That person must obtain a license from the local official—the license prescribed by the local regulations.

(6) The local government might have an obligation to issue neighborhood directions, comprising of endorsing rules for waste arrangement. Also, the government has to decide strategies of division on the collection, transportation, and transfer of solid waste, indicate the rate of benefit expenses of the neighborhood government benefit or other government organizations or local government organizations with the standard or authoritative private organization. It is dependent on the local government to act on the sake of the collection and expulsion of solid waste up to the rate. The permit charge rate must not surpass the rate indicated within the Government Directions.

(7) The local government has duties to perform in the separation, collection, transportation, and disposal of solid waste. The local government must undertake the duty to provide sufficient and hygienic waste disposal facilities. It is within the power of the Bangkok Governor to announce a limit of time for the owner of the building or the occupant of the building to place waste from their buildings or places at the place or container.

According to the interview, the BMAED staff said that:

The Bangkok Governor, Mr. Samak Sundaravej, ordered Bangkok No. 3305/2545 authorizing Bangkok government officials to perform their duties on behalf of the BMA by authorizing the Director of the Department of Cleanliness to issue a notification specifying the separation of waste before the officers of Bangkok or the private sector that permitted to be stored with waste classified. The district director authorizes to issue a notification for the collection point, time, and date for waste collection. The building owner or occupier must place waste from the building or place in the place or container that the owner is set or provided. In the past, the district director determined the date and time for general waste collection, but the BMAED has not yet announced the classification of waste to require the owner or occupant of the building and location to separate solid waste before littering ("Bangkok Regulations empower BMA's Governor According to the Bangkok Regulation on Guideline for Solid Waste and Nightsoil Management of the Building Places and Public Health Premises, B.E. 2545,").

3) Announcement of the Ministry of Interior on Solid waste management 2017 consists of three main parts: (1) the local government creates understanding and awareness among people to participate in the reduction and separation of waste; (2) the local government shall announce the date, time, place, and route of solid waste collection and transportation to the person who generates solid waste in advance. This is to prevent waste, water, or other things from being dropped or leaked from such equipment or vehicles and carried out quickly to prevent any impact on traffic, public health, or the quality of life of the people; and (3) Compostable waste is biodegradable and should be separated from non-biodegradable before disposal. The disposal shall be made as appropriate according to the physical characteristics and properties of the solid waste. Also, they must be careful about the impact on people, communities, and the environment ("Announcement of the ministry of Interior Re: Solid Waste Management B.E.2560,").

Moreover, BMAED (2019) stated that the law of waste controlling for various agency responsibility included 1) BMA Administration Act gives authority to BMA for the operation related to the cleanliness and tidiness within BMA and maintains public areas by Article 89 (4) and (10) ("Bangkok Metropolitan Administration Act B.E. 2528,"); 2) Legal Water System Act specify is relates to the transfer of solid waste, creature, and plant remain, fiery remains, or waste within the water system canals or imperil water to farming or utilization are precluded. The violator can be imprisoned for not more than ten days or fined not more than 50 baht or both imprisoned and fined (Article 36) ("Regal Water System Act, B.E. 2485,"); 3) Water Supply and Canal Treatment Act is related to the transfer of stable waste, creatures, and plant remains, ash or trash within the canals, or canals for water supply were precluded. The violator can be imprisoned for not more than one month or fined not more than 2,000 baht or both imprisoned and fined (Segment 19) ("Water Supply and Canal Treatment Act, B.E.2526,"); 4) Railway and Interstate Arrangement Act relates to the transfer of stable waste, causing harms to prepare were misdemeanors ("Railway and Interstate Arrangement Act, B.E. 2464,").

Mostly, laws govern the disposal of litter in public areas, water sources, canals, wilderness along the way. The local government requires residents to separate waste before discarding defined by the Public Health Act 1992. The local government organizes to issue local ordinances for determining the dumping points, specifying the date and time of waste collection, and specifying the waste type discarded into general waste to the waste treatment plant at the waste disposal center. BMA has issued the notification to set the collection point, time, and date of waste collection, but BMA has not yet announced to the type of waste separation by people before littering to the authorities for disposal with appropriate technology.

According to an interview with the Secretary of the Bangkok Governor, he mentioned that:

> It is time for BMA to implement legal measures in the WRS process. In the past, although we were successful in reducing the amount of waste disposal by the BMADOs, it was not a sound management system. Due to the ability of management personnel, if there are changes in personnel, the results also change, which is not sustainable. In enacting laws, people should sort waste at

the source before discarding for waste collection and officers should seriously enforce the law. This is under the authority of various section in the BMADOs, such as the City Law Enforcement Section to issue fines, the Environment and Sanitation Section can solve environmental problems, the Public Work Section oversees the construction plan to have sufficient rubbish shelters for three days, and waste trucks can be conveniently collected. However, there is no law requiring people to separate the waste before discarding and enforcing waste management laws.

While the BMAED executive, who has been authorized by the governor of Bangkok to specify the type of waste separation, explained that:

> The waste collection system is not ready for treatment and disposal, such as the lack of organic fertilizer factories that only accept organic waste. The waste treatment plants are using the compost method at On-Nut Waste Disposal Center, and a system that collects total waste can go through recycling and compostable waste separation systems, to nourish the soil and take the remaining waste to make RDF. The recycling waste is already compiled in the trading system from households and waste collection vehicles.

In summary, the laws for waste reduction and separation are weak. The laws on MSW of the Public Health Act, 1992 has focused on waste collection and waste disposal, but the law allows the local government to make the local law for the public to separate waste before authorities collect it. While BMA has enactment time and place of the collection as part of the waste collection policy, BMA still does not regulate the public policy to separate solid waste at the source.

4.2.2 Inputs Evaluation of BMAWM

The management of waste reduction in Bangkok has studied the inputs of the waste minimization management process of the BMADOs and the BMAED by using a 4M conceptual framework. This consisted of 4 main points include personnel, budget, material, and management—the results are shown below.

4.2.2.1 Personnel: Allocation and Personnel Development

The personnel of BMA staff is limited. The assigned group of personnel still lack the integration of cooperation from Bangkok government officials who are in the same office of department, and district level. BMAWM operations have personnel as follows.

1) Number of Personnel

The BMAED has assigned the PPD by the Public Participation Promotion section, and the Planning and Evaluation Section implements the waste minimization including formulating guidelines, targets, and indicators of operations. The Information Technology Section has responsibility for website development, information dissemination, and digital data collection systems. The Public Relations Section supports the procurement of supplies and the hiring of media. Moreover, there is the Research and Development Section, the Hazardous Waste and Nightsoil Section, Waste, Hazardous Waste, and Nightsoil Division (WHNMD), who also participate in the project of WRS. Therefore, personnel participation and tasks have already been set as part of the authority structure.

As for the BMADOs, assigned fewer little staff to responsible for waste reduction and separation. Some officials are assigned to responsible for waste collection activities according to integrate indicators, collect data, and report results. District offices' actions are primarily responsible for the control of waste collection, road sweeping, and cleaning work, which is a burden to be done continually. Therefore, there is no time for expanding areas and communication of results or creating a public participation process to reduce and separate waste.

According to an interview the Chief of the CPPS, BMADOs said that:

> The workload of the CPPSs in the waste collection has been continually increasing due to the sale of commercial buildings and residences, especially near the subway stations and suburbs, resulting in insufficient personnel in the collection of waste services and there are only ten civil servants. The remaining employees mainly work in public service areas. Also, they work to support the work of other parties in using community development labor, canal development, electoral support, and participation in Bangkok's various

> activities, so there are not enough personnel to manage the waste reduction and separation.

In summary, the number of personnel remains limited and restricted to the workgroup responsible for some government departments in the BMAED and the BMADOs. Also, the responsibility of some officers in these workgroups is full-time. This reflects the lack of personnel to conduct operations as well as drive the reduction and separation of waste of the BMADOs and in the entire Bangkok area.

2) Personnel Development

The BMAED has responsibility for the development of personnel who communicate with the residents of the BMADOs, including the CPPS, the Community Development and Social Welfare Section, the Environment, and the Sanitation Section. The training program increases knowledge and experience about CBM programs and techniques to then to be communicated to residents by creating a process of co-thinking, planning, decision making, cooperation, and solving issues. These programs operated during the years 2007-2012. BMA organized training courses, and field studies for CPPS personnel with all levels as chief of CPPS and staff in waste collection, road sweeping, and gardeners in the area. Also, BMA arranged an annual integrated workshop between the BMAED and the BMADOs.

During the period 2013-2019, there were newly commissioned officials in the CPPSs to replace the civil servants who retired or promoted or moved to another office. During this period, the BMAED did not provide training programs for speakers to promote public participation in CBM to the community. However, the new generation of personnel needs to be trained and developed in every aspect to create public participation. In an interview with the chiefs of CPPSs, they said that:

> New officers still lack knowledge and understanding of waste reduction and separation because there are no training courses provided. The district officials are learning by themselves because the new staff is not able to create participation processes for reduction and separation waste efficiently.

Therefore, during the years 2013-2019, the personnel of the BMADOs still lacked the knowledge and understanding of WRS. Because the BMAED that the center of SWM and WRS management did not have a training course, officers were not able to promote public participation efficiently.

3) Personnel Assignment

In reduction and separation of waste from the BMADOs, the guidelines for assigning additional missions to the former personnel were assigned by the district supervisor from the district director. Then the chief of CPPSs assigned 1-2 officers to be responsible for the district's WRS. Therefore, BMA lacks the personnel to carry out the campaign to promote public understanding, create participation and integration on reduction and separation waste at the source. Furthermore, there is insufficient personnel in the CPPSs as most of the staff have duties to service solid waste collection at disposal centers and must address the illegal dumping in public places. Also, personnel lacks morale and motivation due to less support from district administrators and Bangkok administrators. These include encouragement through promotion or rewarding low-income waste collectors that they still have extra work on separation recyclable waste during waste collection. As a result, residents understand that waste separation is the responsibility of BMA collection officers.

The results of the interview BMAED Administrators regarding the Bangkok administration process in implementing the Bangkok Governor's policy, government policy, and the BDP were as follows:

> BMA has many responsibilities. Agencies support the work. In general, BMA is the 14 department offices and there are the 50 districts, each of which has regular work according to the law. As for the urban development by the BMA's policy, the BMASED will be designated as a strategic work in the annual Bangkok operation plan and transfer tasks to other department offices as part of an annual government action plan. The bureau level acts as a unit to transform the policy and plan into action and is responsible for the overall achievement of BMA, which must define the framework of the bureau's operations and operate in the districts. Therefore, the 50 BMADOs carry out the specified guidelines. Also, the BMADOs can set additional projects to support the implementation of the strategy to achieve Bangkok's overall goals.

In conclusion, Bangkok personnel in promoting WRS are few and have not established specific waste reduction and separation organizations. There is assigned at the level of the BMA administrator. District personnel lacks to develop knowledge and understanding of WRS processes and public participation. Also, the proper attitude of the public toward waste reduction and separation before collection and disposal is lacking. Moreover, the assigned personnel in promoting WRS to public participation are unclear and uncover all target groups.

4.2.2.2 Budget: BMAWM Activity Budget

The budget for waste minimization was important in communication with people process. The interviews results reported that the BMA has lower budgets for waste reduction and separation implementation to reduce the amount of waste to the source. In the process of promoting waste reduction and separation, the BMAED is the research and development agency to create a framework for implementation. The BMAED request budget allocations to carry out educational and development programs, frameworks for action, prototype development, public relations campaign activities to communicate, create public understanding, and allocate budgets for the 50 BMADOs such as training, meeting, knowledge of waste reduction, and separation to community representatives, entrepreneurs, government agencies and state enterprises according to food waste utilizing processing project, 50,000 baht per year per BMADO. The BMADOs has promotes the processing of waste, vegetables, fruits into bio-fermented, and organic fertilizer. Nevertheless, during the years 2016-2017, the BMAED did not receive the project budget, causing BMADOs to refrain from organizing to training for community representatives, educational institutions, establishments, government agencies, and state enterprises. However, the BMAED has received a budget to conduct research and development of the prototype and organize public relations campaigns by publicizing activities through various media, creating publications, and delivering to the BMADOs to communicate with the public using direct communication by going into the community, schools, establishments.

According to an interview with the director of the Policy and Planning Division, he stated that:

> The budget WRS process used during 2013-2019 was the budget for the research and development of WRS prototypes by various organizations. BMA hired consultants from educational and private institutions to research all target groups and create public relations activities from time to time with the Policy and Planning Division. This project aimed to have a model for WRS in every specific target group. Its distributed plans for implementation during the 20-year DPBM for Bangkok, phase 2 (2018-2022) to every target group. It is necessary to use the budget. Nevertheless, from 2017 onwards, the BMAED was not allocated budgets to produce manuals, brochures, and DVDs and so it was impossible to distribute prototypes to all target groups. Also, other people who are not in the 14 target groups need to be informed as well. Most of the BMADOs have the staff to collect waste according to the appointment, date, time of disposal, date, and time of collection but not staff responsible for communication about waste separation. Therefore, it is necessary to use the publicity budget in the form to advise people on how to separate and dispose of waste.

Eventually, the budget for waste reduction and separation was not allocated to various organization groups, such as implementing the community based solid waste management (CBM) project in 2009-2011 and the BMADOs did not receive the food waste processing budget. During 2015-2017, the BMADOs did not have the budget to conduct group leaders' meetings and materials to demonstrate waste utilization. According to the interview of the Chiefs of the CPPS of 50 districts, they mentioned that:

> The BMADOs did not have a budget for organizing activities, meeting with community representatives, educational institutions, or establishments. Furthermore, there was no budget for purchasing waste demonstration materials. Typically, the BMAED will allocate budgets for food waste processing projects to use and allocate to the BMADOs every year with 50,000 baht to organize activities and educate people in the area to reduce and sort waste by utilizing it. Because most remaining budgets were allocated for the procurement of materials for solid waste collection, sweeping, clearing

roads, sidewalks, overpasses, planting, and maintaining gardens there were no budgets for the districts to carry out a campaign to promote public participation, reduce and sort waste to achieve the goal of waste reduction and separation of BMA.

In summary, budget allocation to reduce and separate solid waste was for research and development on the WRS model to have a prototype for all 14 target groups and produce publications. The budget for supporting WRS was insufficient. However, BMADOs have been widely organizing and encouraging activities to promote public participation in their areas of waste reduction and separation in communities, schools, and workplaces.

4.2.2.3 Materials: Communication Tool and Waste Utilization Capacity

1) Communication Tools

In the process of reduction and separation, it is necessary to use materials for communication such as media, documents, brochures, CDs, videos, portable computers, and projectors. These are tools for meetings and lectures and the Environment Agency provides only brochures and CDs. Also, in the process of organizing activities in the community, it is necessary to receive the support for composting equipment. For communication media, the BMAED has sponsored media, brochures, manuals, DVD media, and exhibition sets. Brochures have mainly been distributed to the BMADOs. The manual includes waste reduction and separation manual, environmental protection volunteer manual, community-based solid waste management manual, solid waste and environment management manual, solid waste, and wastewater management by the community manual. Nevertheless, during 2016-2017, BMA did not receive a budget to produce media sufficient to meet the needs of the BMADOs.

2) Waste Utilization Capacity

The BMAED has researched and developed WRS in all target groups. Due to an insufficient budget, it lacks guidelines for the implementation of the BMADOs. BMA is lacking materials such as guidelines or manuals, media publications for disseminating knowledge and understanding on solid waste reduction and separation methods to the public. Therefore, there has been less promotion for public

and private cooperation on waste reduction and separation. It found that the BMAED has tried to develop a form of practice to reduce waste by taking lessons from the BMADOs that have successfully implemented to reduce and sort waste. They used the cooperation principles of personnel, materials, and all the BMADOs equipment that promoted the dissemination through social media for the exchange of knowledge and experience.

Trash: The BMAED has allocated 80 liters of trash to the community to participate in the CBM project. The community will participate in the waste separation project to collect recyclable waste.

Vehicle: The BMAED has allocated various vehicles to support various types of waste collection and management, such as compact cars for general waste collection, the truck used to collect bulky waste, branches waste, and construction waste, open-side vehicles used to collect hazardous waste, and forklift trucks used to collect waste in places where there are high quantities of organic waste components such as s markets and shopping malls. The BMADOs must allocate the vehicles available for the collection and disposal of waste separately.

The waste separation system of the BMAED, which is the Waste Disposal Division (WDD) provides a waste disposal plant. These include waste separation plants. It found that BMA has eliminated most of the waste by the sanitary landfill method approximately 8,000 tons per day. Next, organic waste was utilized by fermentation in waste composting plant approximately 1,600 tons per day. There is also a factory that collects waste and separates it for recycling and sale. The waste disposal plants include incinerator 500 tons per day, which also collects waste from some factories to eliminate, such as branch processing plants into two fertilizer plants of 50 tons/day, and factory of construction waste processing plants of 500 tons per day (BMAED, 2019).

Executives of BMA said that:

> The BMAED provides media for communication to BMADOs that create public understanding, support speakers, and increase knowledge. The BMADOs manage using vehicles, personnel, existing budgets for waste reduction, and separation.

According to the interview from the BMADOs staff said that:

> The amount of solid waste of the BMADO has increased due to the expansion of housing and commerce that led to the use of vehicles, budgets, and personnel to solve and reduce solid waste problems. These include solving the problem of waste for illegal dumping in open spaces, ditches, discharge waste to canals. These led to inadequate management of personnel, materials, equipment, and budgets in management to reduce waste.

According to the interview from the BMADOs regarding reducing the amount of waste, they explained that:

> The BMADOs reduce waste by separating waste from the operations of the staff. We utilized it in the area that includes recyclable waste, food waste, fruit and vegetable waste, wood, and construction waste by using vehicles that are operating in the area to help collect and deliver to the collection point. We use human management principles by making everyone understand the concepts, principles, and divide the roles of each group. However, all groups must work and support each other. Also, it is necessary to receive cooperation from all parties in the BMADOs to support the operation by taking legal measures to proceed together with the promotion of public participation. The BMADOs must manage the waste of the BMADOs to be good first and then extend to the community, which should promote the potential target group, such as large amounts of organic waste.

In summary, most of the materials used in the WRS process are supported by the BMAED. This consists of communication media, including creating a folding plan document, a waste reduction, and a separation manual, knowledge of WRS. Media of waste bins is distributed to communities only once they have implemented CBM projects certified by government officials. For vehicles, BMADOs are using vehicles allocated for solid waste collection. While there are insufficient waste classification systems for properly separation waste, organic fertilizer production plants only accept organic waste. This study concluded that the supporting materials of BMA for reduction and separation waste are insufficient.

4.2.2.4 Management: Organization of BMAWM Management

Waste reduction and separation management is part of the implementation of Bangkok's policies and plans under the 20-year DPBM 2013-2032. The process of assigning work through the BMAED to transform the plan into action to BMADOs by the CPPS as the operating unit that follows the guidelines determined by the BMAED and Management in Bangkok (BMASED, 2013a).

The process of solid waste management of the BMAED has assigned responsible agencies in three agencies, which are:

The Policy and Planning Division (PPD) is responsible for waste reduction and separation systems.

Waste, Hazardous Waste, and Nightsoil Management Division is responsible for the collection system.

Waste Disposal Division (WDD) is responsible for waste treatment and disposal systems.

Although this seems clear in practice, each agency has unrelated work, with the PPD, creates a plan and promote public participation through online media and act on WRS in a wide area and pilot area. Meanwhile, the WHNMD focuses only on waste collection service. WDD focuses on waste disposal in landfills, composting, and incineration for power generation.

PPD is the primary division of the BMAED to transform waste reduction and separation policies into practice, with a staff member from each of the Public Participation Promotion section, Planning and Evaluation Section, and Information Technology Section. The Planning and Evaluation Section is responsible for setting goals, indicators, and integration between the BMAED and the 50 BMADOs. Also, the team must develop guidelines for management and monitoring.

The 50 BMADOs are the primary unit for implementing policy at the district area, with the chief of CPPSs who responsible for the WMS and WRS of BMADOs. There are approximately 10 officers in one CPPS, and approximately 300-500 people in the sweeping, waste collection, and park maintenance job. CPPS has responsibility for solid waste management waste includes waste reduction and separation, waste collection, waste transportation, roads, and canals cleansing to keep

the clean city. The responsible personnel for waste reduction and separation are not clearly defined; most are individual assignments directed by the leader.

According to interviews with BMA executives and BMAED officials said that:

> Personnel in the promotion of the WRS process of the BMADOs must develop the existing personnel from various sections of BMADOs to increase knowledge of SWM, WMS, and WRS. They must be using the knowledge to communicate and create understanding among the public, such as in the community, schools, establishments, or other target groups of the total of 14 target groups and visitors who contact BMA government offices.

Details of the Organization of BMA's solid waste management are shown in Figure 4.1.

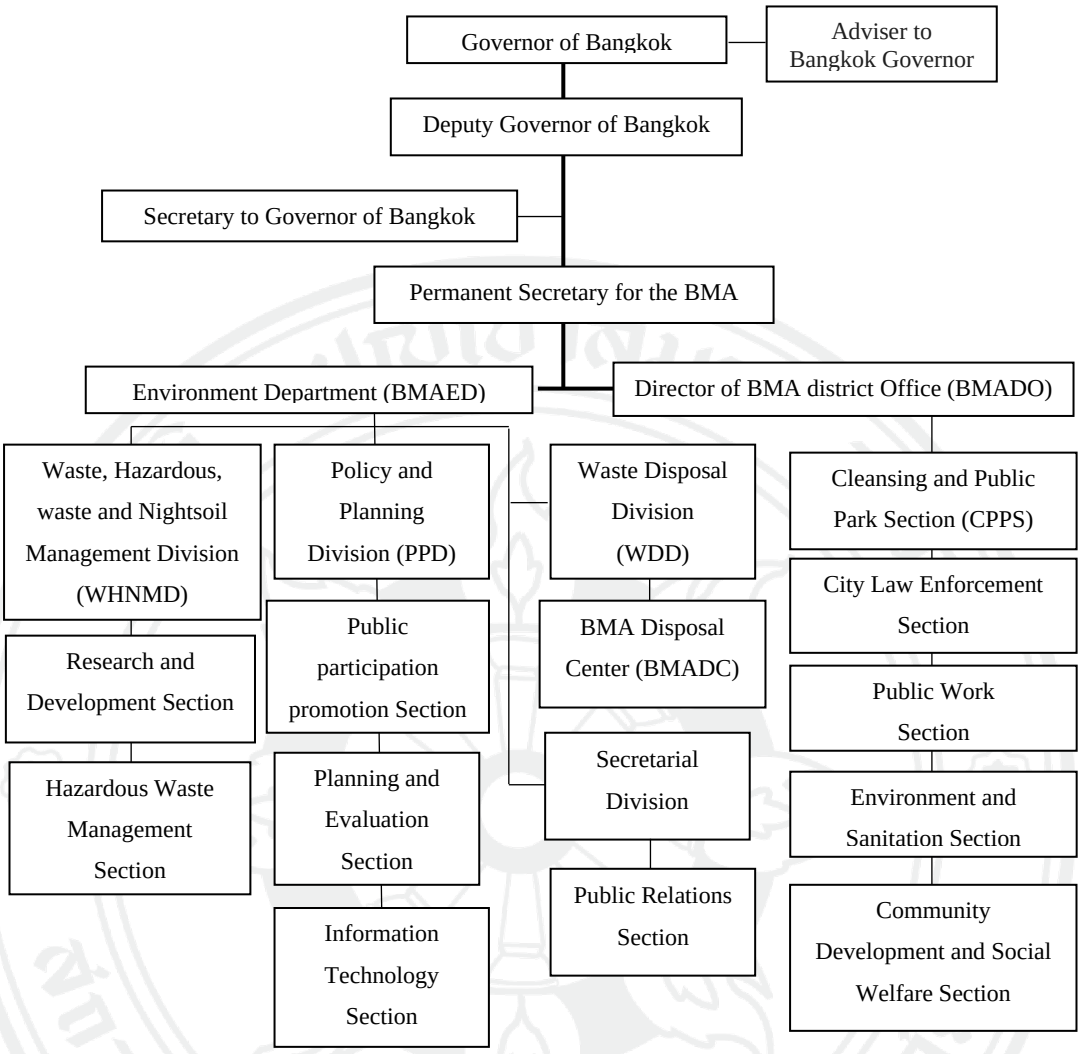

Figure 4.1 Organization of BMA's Solid Waste Management

According to the observations of the researcher, the BMAED has assigned work to the PPD to be the center responsible unit. However, the Public Participation Promotion Section, PPD has few officers and they often are terminated or resign from their job. This results in them conducting activities themselves. Therefore, the personnel development guidelines of the BMADOs can act as speakers to communicate, raise awareness, and participation of residents in the area. The Planning and Evaluation Section, PPD evaluates the indicators based on the integrated indicators, distributes the indicators to the 50 BMADOs, and follows up on the evaluation by collecting monthly performance data. At the same time, the waste collection management of the 50 districts is sent to the waste disposal center. That is

the responsibility of the WHNMD. The scheme of solid waste disposal systems is the role and duty of the WDD, which mainly responds to its mission and is not specified in the WRS guidelines. Therefore, the system of WRS is not related to both systems.

The Planning and Evaluation Section, PPD staff who are responsible for the annual government action plan for the BMAED between 2013-2019 said:

> According to objectives “Bangkok has reduced and controlled the amount of waste at the source, and increased the efficiency of SWM from the source to sanitary landfill and treatment by compost plant and waste to energy,” there are five strategies and eight indicators that are the responsibility of the BMAED to define using targets. All indicators included as indicators of the annual action plan of the BMAED. The BMAED must specify the project guidelines and the target indicators to the 50 BMADOs and conduct ongoing monitoring and evaluation.

The BMAED director said that:

> The BMAED has the characteristic of being an agency, with staff responsible for studying and developing guidelines for WRS, supporting equipment, materials, and supporting knowledge in personnel development of the BMADOs. The BMADOs are a line agency that leads the way. While the BMAED does not have direct power to control the BMADOs, it is the Permanent Secretary who proposes the guidelines for the Permanent Secretary of Bangkok and orders the BMADOs to operate, with important tools to supervise the BMADOs. Then they operate as an integrated indicator, office, and BMADOs, where such indicators can be. There are ongoing improvements to the guidelines every year.

The BMADOs do not have an organization responsible for the reduction and separation of waste. This is conducted on an individual assignment basis with the department head setting the direction.

In an interview with the CPPS, BMADOs, it was found the BMADO SWM has been by the target, the indicator set by the BMAED as the annual integrated indicator. Then the BMADOs will be responsible for indicators set by the chief of the CPPS. Typically, staff will collect data monthly for performance reports from each group and report to them.

In summary, WRS operations under the BDP are not organized to set up and drive waste reduction and separation operations directly. Nevertheless, tasks are assigned by the BMA administrators and action plan are implemented. BMAED that annually assigns a task to the PPD who are responsible for the indicators of BMA. The CPPS, BMADOs are responsible for the goals and indicators of the BMADOs. Therefore, it can be concluded that KPIs for the BMA district on WRS operations remain unclear to define in terms of the leading organization.

4.2.3 Process Evaluation of BMAWM

4.2.3.1 Plan: The BMAWM Action Plan

The BMAED was assigned as the agency to implement environmental policies by setting targets for waste reduction and separation. The annual action plan was established by the BMADOs to prepare the annual year BMA action plan. The BMADOs have set the BMADO's goals as specified in the annual year BMA action plan. The BMAED has prepared to integrate indicators to transfer the target indicators to the BMADOs and determine the project activities that the BMADOs must implement to achieve the goals. This includes formulating a report on the results of each activity.

In the interviews with the director of the Environment, she concluded that:

> WRS activities established in the 20-year DPBM 2013-2032: on the strategy of a safety metropolis, the target to reduce waste by 20% in 2032. While the target of waste utilization is increased by 50% and required an increasing rate of communities, organizations, public and private agencies to participate in WRS by 50% in 2032. In terms of economic measures, only 20 baht per household per month has been collected for waste fees, although the law stipulates that not more than 40 baht. Also, social measures on participation in

WRS are shallow. Because the frequency of waste collection is high on the main roads and sub-main road, residents can throw away waste every day. There is a trashcan in alley communities that allows people to litter every day. The 20-year DPBM has divided the development into four phases with five-year periods. BMA developed the Solid waste management of Bangkok plan 2015-2019 as an action plan that focuses on targets to reduce waste by 7% in 2019 and set targets for the utilization of waste of not less than 20%. Moreover, the number of communities participating in WRS shall increase by 5%. The number of government agencies, private sector organizations participating in WRS increased by 5%. The hazardous waste separation will separate by 20%; and electronic waste reuse will by 20%. Also, BMA prepares an annual year BMA action plan and sets the same goals, which gradually increases each year. After that, the BMAED and BMADOs used the targets and indicators as specified in the annual year BMA action plan in the BMAED and BMADOs action plan for setting work goals and being the target in assessing the achievement of work of the BMAED that also consist of activities under the Bangkok Governor's policy and regular projects and activities. The result is a heavy workload plan, and a mission to reduce and sort waste will be small parts of the work in the action plan. Therefore, the BMAED has decreased and, therefore, it has received little attention from the district administrators. Also, the target indicators in the 20-year DPBM are used to measure the performance of the BMAED that is assigned to be responsible for the indicators to determine measures and guidelines for the BMADOs on implementation. However, the BMAED assigned the target indicators responsibility, distributing the indicators to the BMADOs by assigning them as integrated indicators of the office. BMADOs evaluated and calculated the amount of waste in each area as the base number. For example, the target has been set at 3% of the amount of waste per year.

The integrated indicators of BMAED and BMADOs between the years 2013-2019 that had the operating model changed by specifying activities. The support for waste reduction activities and projects were, for example, promoting waste separation and recycling activities, food waste separation activities, microbial fermentation, branching activities for fertilizer composting plants, hazardous waste separation activities, promotion of reduction, and separation in the community, and 14 target groups. The main activities or projects to reduce organic waste were the branching project to make fertilizer from leaf composting, fruit, and vegetable fermentation. Moreover, projects have encouraged farmers to receive food waste to feed their animals. It found that the integrated indicators in 2014 were only one year for the BMADOs to create waste reduction and separation plans with a sample project for the BMADOs. However, the next year later, BMAED did not require the BMADOs to make plans for implementing activities or projects in their area. Nevertheless, BMAED has been set goals, projects, and the main activities for the BMADOs to set the goal and project in the BMADOs annual year plan.

According to the interview of the CPPSs, most BMADOs have no action plans. However, the plan has designed the activities or projects on waste minimization by BMAED with the integrating indicators between BMASED, BMAED, and 50 BMADOs. And entry the goals and projects of WRS in the BMADOs annual year action plan. Then they reported the operational results monthly with the specified information. By the Chief of CPPS, Khlong Toei District said that:

> The District has an annual action plan. The CPPS has led the project, activities, including goals and indicators set by the BMAED for integrated indicators and implementing the action plan. The action plan does not explicitly plan for waste reduction and separation. However, the CPPS head must specify the activity project that will be organized and could effectively reduce the SWM system. All related staff including waste collection, sweeping, and park care must all work to separate waste at the specified point. This includes communication about waste separation and utilization, such as in the market as fruit shops. The CPPS has prepared compostable litter boxes on the main roads and in the park. When workers sweep the leaves, they put it in the bag and put it on the designated road, the gardeners will collect leaves from

while cutting trees. Therefore, when the waste truck passes through, they will collect it and deliver it to the compost pickup truck. They also have sweeping staff who pour compostable material into the litter boxes to make the leaves decompose faster. Moreover, the waste collector during rush hours will collect fruit peels such as orange peels, pineapples, papaya to deliver to the composting point for transportation for mixing with the leaves. This makes it decompose faster without causing a bad smell that disturbs people. The durian rind sent to the composting point in the park is crushed before composting to make fertilizer. Also, the maintenance department will collect waste in the canals such as weeds and water hyacinths. Officials will separate the water hyacinth and weeds into another vehicle and then deliver it to the compost points in the park to import the granulator before composting. Thus, there was a meeting to clarify the guidelines and delegate the duties to all groups to act concerning daily waste operations to make fertilizer.

In conclusion, the BMADOs by CPPSs have implemented the plan but did not make an action plan for waste reduction and separation in general. Bangkok only has a framework of guidelines for evaluating annual government performance in the form of integrated indicators. Moreover, the BMADOs modifies the operation details every year and does not have a specific plan for waste reduction and separation. Then there is the role of the head of BMADOs in guidelines and supervision. The success of reduction and separation waste partially depends on the intention of the district director and the chief of the CPPSs. This is an essential factor, which is not compulsory or requires implementation in every area. Therefore, this does not lead to sustainability.

4.2.3.2 Do: BMAWM Activity

1) Personnel Acceptance

Making a 20-year DPBM 2013-2032 started with brainstorming ideas from representatives of public organizations by using the concept “Looking from an outsider's perspective” to determine the future together in the next 20 years. This is called the “Bangkok Vision Plan 2032,” which was prepared in 2012 and aimed over the next 20 years. The objective is that the city will become “The

metropolis of Asia.” In implementing the plan, BMA has developed the 20-year DPBM during 2013-2032 with the Bangkok Governor imitating the Bangkok City business community to support this development plan through joint action. The BMASED and the Faculty of Political Science, Chulalongkorn University collaborated in preparing the plan (BMASED, 2013a).

The researcher's observations of the BMA’s waste minimization implementation by the target of 20-year DPBM (2013-2032) found that:

> The organizers brainstormed ideas from government officials from all offices, including the 50 district officers, to consider the possible goals and indicators, mainly the target of reducing solid waste by 20%. That is quite unlikely due to lack of BMADOs acceptance from different management problems such as the problem of waste separation, the population increase leading to the amount of waste increasing, higher economic growth, high consumption, ineffective public relations, lack of supporting the law, ineffective law enforcement, separation support system, inadequate utilization of waste, and staff collectors separating recyclable waste to sell.

In an interview with the Director of Policy and Planning Division, he mentioned that:

> The BMADOs needs to accept the implementation of waste reduction targets. The PPD of BMAED is responsible for the WRS goal that promoted waste utilization at the source. They tried to create acceptance from the person responsible for the WRS to the 50 district offices, such as arranging training and field trips for the CPPS and relevant officers in foreign countries. For example, a field study trip visited WRS with 3R Principles in Tokyo, Japan, waste and wastewater management in Shanghai, China, sustainable environmental management in Australia, and others. Furthermore, there have also been workshops in Bangkok and training and field trips at successful reduction and separation waste projects of various local administrative organizations in upcountry areas for civil servants and employees of the CPPS every year from 2013 onwards.

The observation results from the meeting of the CPPSs to select the integrated indicator for 2017 found that the most of head CPPS, BMADOs did not select to implement the goal of reducing the amount of waste by only 4%. Most district officers have a continually increasing amount of waste. The remainder has chosen 96% of the target utilization of waste from the evaluation of using waste utilization numbers from many channels such as branches for fertilizer at factories, vegetable waste, fruit for fertilizer, animal waste, and organic waste that people use. The results in BMADOs must focus on the reduction of waste and management. Therefore, only the waste utilization from some projects can achieve the goal. This shows that the number of personnel assigned to reduce, and separate waste was too few. Most of the officers did not agree with most of the WRS goals. Also, the BMA and district directors did not recognize them as relevant policies.

In conclusion, the acceptance of responsibility by the personnel of BMA is an essential factor in WRS operations. CPPS plays an essential role in driving WRS. However, most of the staff still do not accept the evaluation of government performance by measuring the amount of waste because of the continuing increasing quantities of waste. Nevertheless, they accepted the goal of waste utilization.

2) Law Enforcement

Laws of solid waste management have the objective to control the people waste littering behavior in a public place and specific area that has enforcement the local government and specific government sector such as to cover the transfer of stable waste, creatures, and plant remains, fiery remains, or waste within the water system canals or danger for water to farming or utilization were precluded. Violators found guilty can be punished with imprisonment not exceeding 10 days or a fine, not more than 50 baht or both imprisonment and fine (Article 36 ("Regal Water System Act, B.E. 2485,") that to enforces by the Metropolitan Waterworks Authority. For Water Supply and Canal Treatment transfer of stable waste, creatures, and plant remains, ash or trash within the water system canals, canals, or canals for water supply precluded. Violators found guilty can be punished with imprisonment not exceeding one month or a fine, not more than 2,000 baht or both imprisonment and fine (Article 19) ("Water Supply and Canal Treatment Act, B.E.2526,") that to enforces by the Department of Irrigation. And to the transfer of stable waste, causing

harm were misdemeanors ("Railway and Interstate Arrangement Act, B.E. 2464,") that to enforces by the State Railway of Thailand.

BMA is a local government that has law enforcement for waste management for cleanliness and tidiness of the city that established cleanliness, and prohibited waste disposal such as Article 31 provides that disposal of sewage or solid waste in the public area was prohibited. Moreover, the penalty with a fine was established in case the violation in Article 15 provides that those who saw the offender can notify the authorities ("Act on the Maintenance of The Cleanliness and Orderliness of the Country B.E. 2535,") and law for Public Health established waste management that empowered the local government in the operation of solid waste such as Article 18 provides which solid waste and sewage management in any local area, the authority belonged to that local government. Article 20 (2) provides that solid waste containers be provided in the public area. It had a central point of establishing waste management and empowering the local government in operation ("Public Health Act B.E.2535,").

The Governor of Bangkok can assign the Bangkok Permanent Secretary, the Deputy Permanent Secretary of Bangkok, the district director, and assistant district director to assist in the execution of duties. Moreover, the Interior Minister has the power to advise the Bangkok Governor to correct deficiencies in the maintenance of cleanliness and tidiness as provided in this Act. The local official and the competent official shall have the power and duty to publicize to the public of their duty to comply with this Act. The powers include strictly monitoring, preventing the violation, warning the offender, or ordering the person who commits an offense to remedy or eliminate dirt or disorder, and to seize offenders who do not obey the injunction and prosecute them under this Act. If an offense under this Act occurs in any locality, and the competent official may not be aware of the offender, all the officials of that locality shall jointly eliminate or remedy the illegal things appearing in public places or public places. The local official shall provide equipment and facilities for the competent official to operate ("Act on the Maintenance of The Cleanliness and Orderliness of the Country B.E. 2535,"). Waste collectors must organize the legal issues that affect the clean-up and park operations that people break regularly, but no offenders were found because they often dumped during the night.

According to the interview, the BMA staff found that:

> There is illegal dumping in open spaces, resulting in BMADOs staff having to clean and store what has been dumped regularly. This is caused by cleaning up dirty, cluttered vacant land, which they do not know where the waste comes. Most of the waste comes from small-scale entrepreneurs that work in gardening, building extensions, and cleaning that we cannot collect fees from them. This is resulting in an increasing amount of waste.

By the way, illegal dumping has been done for a long time, and BMA could not control some people who do not comply with the law. According to the interview found that:

> For law enforcement, BMADOs officer's response to monitor and arrest violators. However, BMA officials themselves set a primary mission to control the hawker trade, stalls, and driving or parking on the sidewalk. This means that most BMA officials must work in these areas more, and the dumpsters often dump waste at night.

Public Health Act requires that the Bangkok representative be a local official in Bangkok or an officer delegated by the Bangkok representative ("Public Health Act B.E.2535,"). According to the interview, the BMA staff found that:

> The public health officer was appointed by the BMA official of the Environment and Sanitation Article and Municipal Police Section, BMADOs. Most of them supervise and ensure hygiene operations and solve nuisance problems from public complaints such as loud noise, dust, smoke, food smells, junk smells, and chemical smells. The BMA appoints the CPPS staff of BMADOs. However, most of them did not perform the above duties because of the waste collection workload, cleaning the area together with a few numbers of staff.

Also, law enforcement requires people to dispose of the waste following the schedule. For the main roads, secondary roads, and markets waste disposal must be between 8.00 p.m. to 3.00 p.m. The BMADOs will finish waste-collecting before 5.30 p.m.. These succeed because the BMADOs has organized a waste collection truck twice daily, once in the morning and once in the afternoon. Meanwhile, some BMADOs collect waste up to four times a day. This shows that BMADOs cannot control waste disposal. BMA is focusing on addressing the problem by arranging vehicles and additional collection staff that does not follow a regular schedule.

In summary, during the day, the BMA district must arrange a vehicle to collect rubbish on the roadside twice to four times per day because people dump waste without regard for the schedule of the waste collection. BMA could not leave the waste on the roadside because it will make the road dirty. Therefore, they arrange for regular collection without announcement. This indicates the ineffectiveness of law enforcement. From this, it can be concluded that law enforcement is ineffective in controlling people's behavior from dumping waste in the right place. Illegal waste dumping regularly occurs in public areas, water sources, and outside of the scheduled collection points. The BMADOs must arrange vehicles and personnel to collect waste outside the specified time. Moreover, it found that there was a great deal of dumping due to the lack of laws that specify the types of waste that must be sorted before being discarded. Also, there are no clear punishment measures.

3) Public Participation

BMA has been promoting public participation in various sectors on WRS at source since 1999 as follows:

In 1999, 14 groups were target consisting of schools affiliated with BMA Schools under the Office of the Basic Education Commission, private schools, colleges and universities, hotels, shopping mall, and convenience stores, markets, banks, temples, hospitals, communities, housing villages, flats and condominiums, and high buildings or office building. BMA communicated with these target groups and instilled an understanding of waste separation efficiently. The waste was separated into four types: recyclable waste, food waste, hazardous waste, and general waste. Household waste was put in bags and placed at a specified place on a specific

date and time. However, most participants or stakeholders could not separate properly, resulting in the collection of only general waste.

WRS in the 14 target groups was unsuccessful in achieving the goals. The study of the waste composition found that approximately 10% was recyclable, and approximately 50% was waste mixed with general waste, food waste, twigs, and leaves.

During the years 2009-2012, BMA developed a model for the community on the concept of Community Based Solid Waste Management (CBM) that conducted experiments with a German Agency for Technical Cooperation (GTZ) and Mueang Phitsanulok Municipality to be implemented according to the processes below:

(1) Principles of waste separation, utilization at the source by separation of recyclable items for sale and food waste for fertilizer or animal feed.

(2) Create a participatory process in the community with the encouragement of the community to seek problems, find solutions, and make plans to implement the plan in their area.

(3) Solve waste overflowing, dirty, lousy environment problems with two types of household waste, including general waste and food waste. This resulted in the road being free from the trash bin by setting an appointed date and time for waste collection. For food waste, it was utilized as compost fertilizer, animal feed, and bio-fermented daily. The recyclable waste was separated into other containers that could be sold, such as bags, boxes, and bottles. This resulted in household waste in their community decrease of 39% after six months of operation.

In 2010-2011 BMA has developed the speaker's process from the CPPS, Community Development, and Social Welfare Section, and Environment and Sanitation Section to understand the principles of CBM in community and implement it into 50 districts around 6-7 communities that total was 314 communities. That consisted of 35 schools, 12 establishments, two markets, and 265 communities. In 2012, the community guidelines on CBM were developed by the Thai Environment Institute and BMA that 12 communities have produced manual of the CBM and community environment and distributed to 2,000 communities. Also, there practice

for two communities in each district, with a total of 100 communities. The result showed that community waste was reduced by 25% after six months of operation.

In 2012-2017, the BMADOs expanded the target area to cover all target groups by using trained personnel to communicate with the residents. In 2016, due to many target groups, there were 14 target groups with a total of 37,000 locations that had already operated at approximately 12,000 locations.

According to an interview with the Director of PPD, the BMAED explained that:

> Promoting participation in the process to create cooperation in WRS used the 3R principles: reduce, reuse, and recycle. The communication process used mass media and direct communication with the 14 target groups representative to announce the date and time for waste collection on waste collection routes. Moreover, it used the promotion of the development of community prototypes to participate in waste management in the community. The process of WRS used the community based solid waste management (CBM) concept for the main project design. These include a waste separation and management learning center that also served as a learning center for schools, the waste, and environment management center in the Bang Sue Environmental Education and Conservation Center. According to Green Office Guidelines, this is a learning center for Environmental Management Implementation, which uses the concept of CBM to promote public participation. This concept aims to reduce the amount of waste at source in the specific target groups. The essential processes consisted of: (1) raising awareness on the problem of waste and the environment in communities, establishments, schools, and others; (2) finding solutions to problems in the community, deciding to solve problems according to the guidelines set by themselves; and (3) creating knowledge and understanding of recycling and waste separation before discarding, such as a waste sale to recycling shops, junk banks, recycling processes or donation to the ragpickers or waste collection officer. Organic waste such as food scraps, twigs, and leaves are composted to make fertilizer for use in households. This can reduce the waste collected for disposal.

According to the study of specific target groups, the BMADOs promoted waste reduction and separation following the Ministry of Interior's local state guidelines in 2018 that consisted of government, educational institution, private sector, religious groups, community, and civil society. The results conclude that the target group has increased to 37,000 including a range of target groups in each area. Wang Thonglang district has the least target groups at 165 target groups, while Chom Thong district has the most target groups at 1,675 target groups, including the office of the industrial factory (BMAED, 2019). The details are as shown in Figure 4.2.

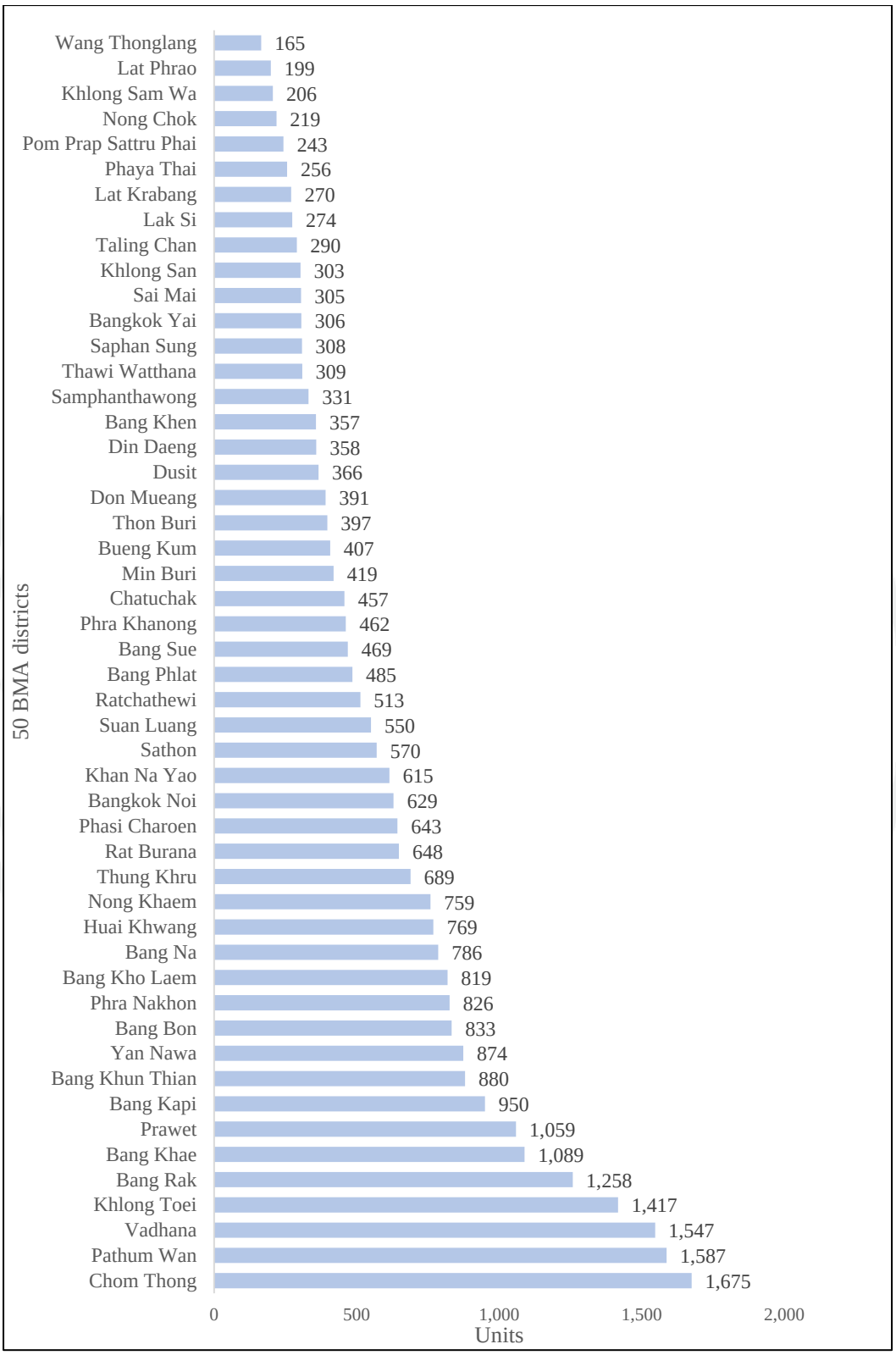

Figure 4.2 Total Communities and 14 Target Groups in BMA District

Source: BMAED, 2019.

The BMAED developed guidelines for promoting public participation by focusing on raising awareness of both the waste problem and WRS methods among various organizations. In 2012, Bangkok collaborated with the Thai Environment Institute to study and develop the Waste and Environment Management Community of five types of communities include slum communities, village communities, urban communities, suburban communities, and flats and condominiums communities. These follow principles of creating a livable community and good quality of life by developing cooperation from all parts of the community. These have three operations consisting of strengthening community, mechanisms that can develop CBM activities in the community, and cooperation development from external agencies, as well as creating a manual on Waste and Environment Management Community to distribute in communities and BMADO officials.

Also, the BMAED improved the information of the project implementation to promote food waste processing. This project provided a budget of 50,000 baht per year for 50 BMADOs. The objectives were to disseminate waste processing knowledge to all regions and hold a variety of waste processing activities, including bio-fermented detergent, home composting from dry leaves mixed with food or vegetable waste, animal food, and biogas production.

The process of promoting public cooperation creates public understanding by inviting leaders of various organizations to realize the impact of waste on the environment of communities, schools, and organizations. BMADOs personnel has been continuing to promote public participation.

The director of PPD in an additional interview said that:

> In the past, the 50 BMADOs received a budget to organize activities to promote food waste utilization every year for 50,000 Baht per year. Most of BMADO's organized meetings, including community representatives, educational institutions, government agencies, and private organizations. This provided knowledge about the processing of food waste, fruit and vegetable scraps, and leaves and branches for use in the household by demonstrating bio-fermentation, composting of dried leaves, animal feed, and bio-gas fermentation for participants to increase their knowledge and make it available to members of the organization. Regarding performance, the utilization of waste is relatively

small at only 400 tons per day compared to the total amount of waste in 2014 (9,940 tons per day), but the budget expenditures under the said project ceased in 2015, so the BMADOs no longer have a budget for organizing such activities. However, even though the BMADOs do not receive the budget for a project to process food waste into utilizing waste, the BMAED still arranges meetings with the chief of CPPS, BMADOs to develop a prototype implementation of WRS of the district with two districts including Chatuchak district and Suan Luang district that was studying and developing the SWM system encourages the people to reduce and separate the waste by reusing and sale it for recycling continuously.

In summary, communication enhances cooperation, creates understanding, especially among community leaders, school administrators, organizations, and religious leaders to have knowledge and understanding of WRS principles. The BMADOs must assign staff to create processes even when the process is complicated. District officials can expand the number of communities and organizations who participate in reduction and separation waste more efficiently by communication to conscientiously participate in waste reduction and separation.

4) Public Communication

The Information Technology Section, PPD, BMAED has created a website http://www.bangkok.go.th/environment to disseminate the mission of the BMAED and to disseminate knowledge of waste and environmental management. The website also includes an annual action plan for the BMAED Affairs, annual environmental quality report, monthly waste quantity, annual waste quantity, CBM action by the community, best practice place on waste separation and SWM, and reports on SWM learning from foreign countries. This website is a source of information to access quickly and facilitates self-study for residents and organizations. Moreover, they were created the Bangkok Green City website to share knowledge and information on environmental management by communities such as waste management, energy conservation, wastewater management, green space, greenhouse gas emission reduction, water conservation, sanitation, and governance. BMAED encourages various groups of organizations to carry out activities that are environmentally

friendly by applying to join the network and publish the results of the organization's website. The above website is linked to the Facebook account page that is Bangkok green city. The aim is to communicate and disseminate knowledge of waste and environmental management, as well as disseminate information on the success of waste and environmental management activities of various groups. Also, they would like to reach more diverse target groups and raise awareness through social media. The BMADOs has created the Facebook page called CPPS to disseminate information on the mission of SWM and the environmental management of the BMA district.

The researchers' observation of the usage of media and IT of the BMADOs found that online communication such as lines groups online application, Facebook, and websites increase knowledge and understanding. However, the media has not reached all the population because of its diversity. Most of the information comes in the form of daily operations reports rather than sharing knowledge and presenting ways to reduce and separate waste. While another section of the BMA district still not responds to share the information of waste minimization for sufficient to distribute to target groups that each section is responsible for. For example, the Environment and Sanitation Section respond to private and commercial organizations, the Education Section responds to schools, temples, foundations, and societies. BMADOs communicated directly with community leaders and organizations and rely on district administrators. These include district directors and heads of the CPPS to integrate all parties. The BMAED has promoted integration work by all parties, which governs the people in the different target groups.

In summary, the BMAED and BMADOs have been using IT to communicate with people to build public awareness, including Facebook, websites, and YouTube. However, these are focused on waste collection services, but they are less focused on waste reduction and separation information to increase understanding of waste separation, utilization at source, and waste separation for collection by the government.

5) Waste Separation Collection

The BMAED specifies the type of waste that the BMADOs regularly collect. These consist of two types of waste, namely general and hazardous waste. Other types of waste services for the public include occasional collection arranged by telephone with fees paid, including bulky waste, branches, wood, and construction waste. However, the state of the environment in Bangkok 2017-2018 states that the type of waste collected will include hazardous waste will be collected every 15 days, recyclable waste will be collected every Sunday, food waste, and general waste will be collected every day along the main roads, sub-main roads, and in communities. For the alley communities, waste will be collected approximately 2-3 times a week. From the results of document studies, interviews, and observation, the 50 BMADOs have created a route map with a total of 1,800 routes for waste collection. Each route has a 5-tons compact and 2-tons compact waste truck along with staff waste collectors. Generally, the date and time for waste collection is specified by the BMADOs and notified to the public, such as along main roads, sub-main roads, and markets will be collected daily before 05.30 a.m.; and alley/sub-alley/community will be collected 2-3 times a week. This study found that only three BMADOs as Sai Mai District, Don Mueang District, and Lak Si District organized vehicles to collect the only hazardous waste regularly covering all routes. The study found the BMADOs have arranged a vehicle to collect only vegetables and fruit peel waste of significant stakeholders such as markets/fruit shops on the main road and transport to the fertilizer plant of BMADCs.

The Director of PPD, BMAED stated in an interview that:

> Particularly, the BMADOs have contacted and cooperated with markets, department stores, supermarkets, fruit shops, to separate vegetables, fruit peels for vegetable/fruit scraps. There is a large amount for the BMADOs to collect and deliver BMADOs' compost points for making organic fertilizer at the BMADCs. Around 60 tons per day is delivered to the fertilizer plant at the BMADCs, but the organic fertilizer plants have a capacity of only 50 tons per day only. Therefore, the BMADOs could not collect more vegetable/fruit scraps and is unable to deliver at the same time.

At present, the suburbs have a great deal of population growth as do the central areas such as Nong Chok District, Prawet District, Lat Krabang District, Khlong Sam Wa District, Sai Mai District, and Thawi Watthana District leading an increase in waste. It is necessary to expedite the waste collection service more frequently than an average of 2-3 rounds per day. This affects the employees' tasks as they are unable to separate waste during duty hours. The Nong Chok District office has implemented the CBM concept to communicate with residents to manage waste and reduce the waste discarded with the BMADOs. The head of the CPPS, Nong Chok District who responded to an interview that:

> The amount of waste in the Nong Chok District area is increasing rapidly, but the number of staff, vehicles, and materials are not increased. The vehicles are used 2-3 times a day. The waste collector does not have time to sort the waste during the collection. Nong Chok District will focus on building community cooperation in reduction and separation waste at the source by using the concept of CBM to promote various waste to be more utilized in the community by inviting religious and community leaders to visit the screening of Wong-Phanit Group. Then they can then raise awareness and encourage residents.

Existing policies and laws place importance on waste collection services thoroughly. Nevertheless, there are no laws requiring waste separation following the type of waste. Moreover, Bangkok provides other types of waste collection services, but it does not regularly service vegetable/fruit scraps, large pieces of waste, tree waste, construction waste, hazardous waste, or infectious waste. From the interviews with Bangkok executives, it can be concluded that there are many types of waste in Bangkok such as organic waste, recyclable waste, hazardous waste, general waste, branch waste, a large piece of waste, infectious waste, and some types of storage systems, as outlined below:

1) Hazardous Waste: The 50 BMADOs will schedule with the collection of hazardous waste, usually every 15 days or every month. At present, all communities are registered as communities under Bangkok regulations 1991. A total of 2,066 communities have established hazardous waste receiving locations and

Bangkok has signed a cooperation agreement with the Shell Company of Thailand Limited to establish hazardous waste receiving locations in their stations. Shell has 106 gas stations located in 44 areas across Bangkok. Other service locations are at department stores and convenience stores.

2) Branches: The BMADOs will store the branches and make smaller pieces using a crusher and branch grinder. If it has many leaves, the BMADOs will transfer it to an organic fertilizer factory at the On-Nut or Nong Khaem Waste Disposal Center. However, if there are still a few branches, it will be thrown away with general waste at approximately 6%.

3) Bulky Waste: There is a policy for BMADOs to schedule extensive daily waste collection in the community every Sunday. This is a solution to prevent the dumping of rubbish on vacant land, disposal out of the schedule, and dumping into the water sources and obstructing the water flow.

4) Infectious Waste: This is waste from human and animal hospitals both large and small, clinics/polyclinics, and laboratories. BMA requires all stakeholders to separate infectious waste and store it in a temperature-controlled room, and it will be collected across Bangkok. For infections waste, Bangkok has hired Bangkok Thanakom Company to manage, store, and dispose of via the incineration method at On-Nut and Nong-Khaem disposal centers.

5) Fruit and Vegetable Scraps: BMADOs choose to collect fruit and vegetable scraps from markets, hotels, and department stores because of their large quantity of waste. This will be utilized in the area by composting, making fertilizer, or sending organic fertilizer composting factories at On-Nut and Nong-Khaem waste disposal centers. This type of waste has not been collected from general households yet because of less volume.

6) General Waste: This is waste left after recyclables have been separated. It accounts for a large amount of waste disposed of in the BMADCs. This type of waste is likely to increase continually. Thus, the BDP has set a target to reduce this waste in 2032 by 20% and to decrease 1,993 tons per day to 7,970 tons compared to the base year of 2013, which was 9,963 tons per day. To achieve this, there must be an increase in the efficiency of the separation of usable objects and

hazardous waste from this type of waste. The composition of waste consisted of approximately 13% of recyclable waste, organic waste 54%, and plastic bag waste 18%.

BMA municipal solid waste collection system does not have service to collect two types of waste that are:

1) Recyclable Waste: Mostly, this waste is collected for sale and many people work in recyclable waste shops. Bangkok had arranged a service for recycling waste every Sunday. However, there is little in the collection point because people collect it before the arrival of the waste truck. Nevertheless, some people still throw away recyclable waste together with the general rubbish. Recyclable waste found at the waste disposal center accounted for approximately 13% of waste disposal.

2) Food Waste: the food waste from households has not been collected due to the lack of a system for collecting and processing. BMA will separate it from large buildings with a cafeteria for animal feed in cooperation with the BMADOs, the building manager, and farmers to receive food waste. However, food waste composition accounts for more than 40% at the waste disposal center.

In summary, BMA does not yet have transparent waste separation services that cover all areas. Organic waste from vegetable and fruit scraps was collected only at large places such as markets and fruit shops on main roads because the disposal system of BMA has limited capability. Moreover, there is no collection vehicle for organic waste, which is used mostly for hazardous waste and general waste collection. Waste collection trucks are divided and used for the general waste collection, large waste, branch waste, and construction waste. While recycling waste is not classified as a separate collection vehicle, but is included in the general waste, with collection staff separating the recycling waste during the conduct of their duties.

4.2.3.3 Check: Monitoring and Evaluation

Monitoring and Evaluation of BMAWM: The BMAED, additionally, is the primary unit for policy implementation. Also, they monitor and evaluate the implementation of environmental policies and programs. In the process of BMAWM, the BMAED has set it as a measure. The Planning and Evaluation Section is

responsible for BMAED and BMADOs policy and plan evaluation. The staff of the Planning and Evaluation Section mentioned evaluation tasks as follows:

> Monitoring and evaluation of solid waste reduction have been carried out in various ways. For example, statistical evaluation is used for evaluating the amount of waste disposed at the disposal center. The computerized database is used to evaluate the amount of general waste and disposed of waste of the BMADOs by the monthly report and then compared to BMA district goals. The BMADOs waste report is submitted through the Google drive system, which contains information on the number of waste types such as recyclable waste collected from recycling stores, utilized organic waste used as fertilizer in the area or at the factory in the waste disposal center, food waste for farm animal feed, wood waste/tires, and BMADO's hazardous waste. Fat and sewage data are also collected. The BMAED summarizes and processes every three months and notifies the results to the BMADOs. The evaluation results will impact the performance of the BMADOs' annual action plan and year-end bonus considerations. So, this causes the BMADOs to specialize in reporting results.

The Director of the BMAED also appointed a working group to monitor, evaluate, reduce, and separate waste in six districts. They must monitor the evaluation, problems/obstacles, and recommendations for development and inclusion in the report for the Director of the BMAED.

4.2.3.4 Action: Improving and Development the Action Plan

Action Plan Implementation: The BMAED has been assigned by BMA to determine the operational guidelines for waste reduction by establishing an integrated indicator of the BMAED and the BMADOs. The BMAED specified guidelines in detail of the indicators and measurements by improving the methods every year, such as:

1) The problem of illegal tree branch dumping along roads or private vacant land. Because BMADOs have services for tree cutting, with branches delivered to the mill for use in composting and mixing with sludge, waste, and sewage. The head of the CPPS, Sai Mai District, said about the problem that:

Sai Mai District office has a great deal of vacant land, so the rubbish, branches, and construction materials are dumped daily, and we are unable to make arrests or prosecutions. Therefore, the problem was solved by installing signage on disposal of waste with contact numbers of those who take the branches to the Sai Mai disposal center. Branch crushers and compost transform it into fertilizer in the same place, so people no longer must dump it on the roadside. As a result, some of the dumpers left it at the learning center, while others continued to dump it on the roadside, which the BMADO has responded to with strict law enforcement, warnings, and serious punishments. This method has also been implemented in the Nong Chok District with four disposal points, where residents can throw their waste, branches/construction material, and scraps/tires/foam boxes. The authorities have directed the litter and control systems to prevent litter in the same spot.

Chief of the Department Nong Chok District explained that:

Nong Chok District is a vast area with more than 130 square kilometers and has a great deal of vacant land leading to it being difficult to control the illegal waste dumping. The BMADO has set up a space to support waste branches/ construction, waste/tires/foam boxes, including the old shrines from household gods, which currently operates at four points to facilitate convenience. This can reduce the problem of illegal waste dumping along roads and vacant lots.

2) Small branches, scraps of leaves, grass, weeds are crushed by BMADOs and reused as composting organic fiber in the area and then distributed to the public as much as possible.

3) Hazardous waste is targeted by comparing the amount of general waste in each area, which is different. The capacity is only 0.14 tons per day. The BMAED, therefore, has established a project to increase the efficiency of hazardous waste collection. They found that Sai Mai BMADOs can collect the most hazardous waste and storage services covering all dwellings. From the interview with the head of the department, Sai Mai District summarized the guidelines for hazardous waste storage as:

Sai Mai District office has set up a system for hazardous waste collection by using a 1.5-ton open-side pickup truck with two staff. They voluntarily collect hazardous waste, a task that requires a lot of effort and patience in the first phase of operation. Before starting the operation, the BMA district office surveyed the area to determine the waste collection area and announced the date and time for hazardous waste collection, which will be collected every 15 days. During storage, a hazardous waste collector distributes documents, pamphlets, and announcements with portable amplifiers. By regularly entering the area on time for three months, the residents directly took the hazardous waste to the hazardous waste collection truck.

The BMAED has suggested guidelines for other BMADOs to apply and, currently, the same system is being implemented in Don Mueang District and Lak Si District.

Many BMADOs have developed guidelines for reduction and separation of waste and achieve BMADOs goals. The heads of the BMADOs explained that the amount of waste has decreased, and the targets have been achieved as follows:

In the process of waste reduction, the BMADOs classified the waste from waste collection to be utilized in the district. For example, organic waste: branches from parks, dry leaves from roads, water hyacinth/weeds from waterways, and durian peel in the fruit season that are separated, collected, transported, and ground, composted, and used in the area or sent to an organic fertilizer composting plant at BMADCs. Construction waste can be used as fill in the area or send to plants at On Nut Disposal Center. Large pieces of wood waste from the communities are collected and taken to a waste disposal center where it can be used as fuelwood or turned into pallets/logs, and tree stumps can be transformed into creations such as tables, benches, compostable pickup boxes, or pot for a plant. For vegetable scraps/fruit peels from markets and fruit, shops are a significant part of composting at organic waste disposal center. BMADOs will arrange for the staff to communicate with the stakeholders for collecting vegetables and fruits that they must separate and

put on the main roads. After that, the staff will do the campaign in the area to encourage people to reduce and sort waste by meeting the community leaders, schools, organizations, and arrange collection points in places such as in front parks, shopping malls, or markets. However, there still has problems in the process of reduction and separation waste to achieve the goal, such as law enforcement can only control illegal dumping in public places, roadside areas, and the enforcement of the dumping law is still not fully implemented and weakly enforced. People are always able to litter. The people lack understanding and acceptance of waste reduction and separation operations.

The working group monitors evaluates and collects data to reduce the amount of BMADOs waste. They summarized the solution to improve the method of reduction and separation waste as follows:

1) The policy announcement of BMADO's Director on waste reduction and separation to zero-waste is necessary. The district administrators strengthened cooperation as well as encourage all departments to concretely implement BMAWM to be a model and extend the results to all people in every region. BMADOs must promote waste utilization at its source, using appropriate forms and methods for classification of waste type and conditions to minimize the amount of waste for the waste disposal center.

2) Campaigning to encourage citizens and society to participate in continuous WRS, including the classification of hazardous waste, organic waste, recycled waste, and sort waste at the source. Moreover, BMADOs encourages people, especially food stakeholders, to reduce, discontinue, or stop using plastic and foam.

3) Promoting and incentivizing civil society groups to reduce and sort waste or process waste into various products and cooperate with the private sector to support the activities of the group sustainability and expand the results to the next target.

4) Using legal measures to promote BMAWM at the point of origin by communicating and publicizing to raise public awareness about the laws/regulations related to BMAWM. Also, waste collection fees could create

awareness and responsibility under the Pollution Pay Principle and the enforcement of laws and regulations by charging seriously and continuously.

5) Communicating and raising awareness for the cleaning staff to recognize the importance of waste reduction and separation. They must be aware of and be a good model for the public. The BMAED proceeds as follows:

(1) Converting policy into action to develop, promote, and support the WRS at the source with BMADO participation.

(2) Amend laws and regulations related to BMAWM, including waste recycling and waste fees.

(3) Procurement of waste collection vehicles and materials to support concrete BMAWM policy.

(4) Campaign/publicize to increase knowledge and understanding of people to be aware of the importance of cooperation on waste reduction and separation at the source.

In summary, the process of waste reduction, including promoting public participation in the community, government, and private agencies. This is still only done in pilot areas that do not cover most of the population while the BMADOs have been using the CBM for their work on BMAWM. There is a system to monitor both the quantitative and qualitative dimensions of the BMAWM process which has been continually improved to enable waste separation. However, there are still many issues regarding operational staff readiness in areas that have uncertainty and have less incentive for the separation of recyclable waste. Moreover, the public does not understand Bangkok's waste collection system and lacks communication from BMA.

4.2.4 Product Evaluation of BMAWM

4.2.4.1 Public Participation for BMAWM

The number of CBM Participation: The number of communities, as well as public and private agencies that are encouraged to participate with BMA, remains low. The BMA conducted a CBM project to develop waste separation at the source and BMAWM model in the communities in 50 BMADOs during 2009-2011. The target of CBM had 6 communities per district including schools, communities, villages, hotels, and others. The target of community and organization participation

increased by 278 units in 2015 to 330 units in 2017, and 359 units in 2019. Results of the CBM implementation successes by the target was 282 units in 2015 to 339 units in 2017, and 389 units in 2019 (see Figure 4.3).

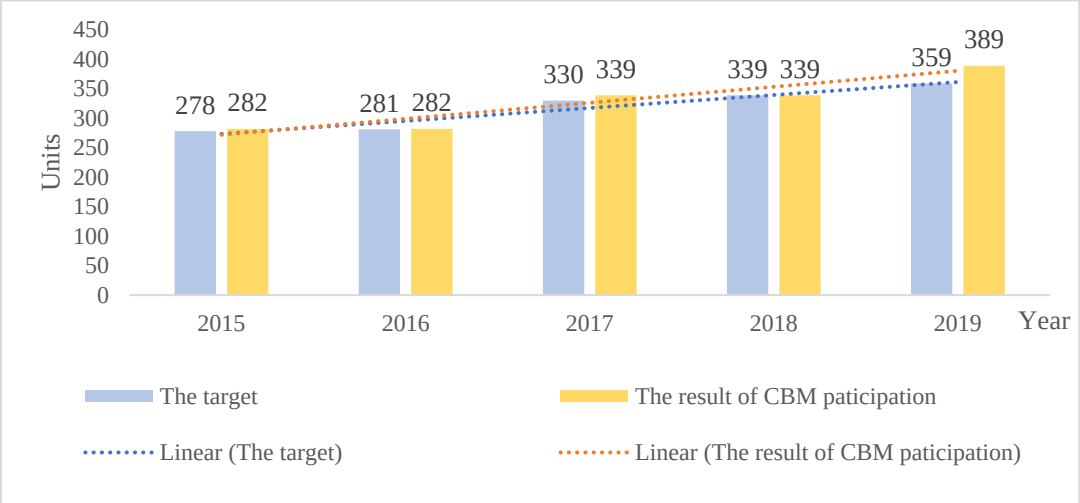

Figure 4.3 Number of Communities and Organization to CBM Participation
Source: BMAED, 2019.

However, the CBM project was successes for the community waste minimization model but it lows off the units when compared with all of the group (14 target groups) with 37,000 targets in 50 districts which include BMA schools, general education schools, private schools, colleges, and education institutions, department stores, banks, hotels, minimarts, markets, hospitals, temples or religious place, communities, housing estates, and high rise buildings (8 stories up). This means that BMA still not yet to encourage and educate the people.

4.2.4.2 Public-Private Partnership for BMAWM

The number of Agencies Cooperation: BMA collaborates with private organizations, government agencies, educational institutions, and NGOs on SWM and separation. BMA receives some financial management and academic support. The objective is to develop a model for sustainable SWM by focusing on the reduction and separation of waste at the source to be reused and adequately disposed of. This included communication, creation of public understanding, and promotion of public participation in specific target groups and the public in all target groups. Government

agencies, private organizations, NGOs, and educational institutions have worked with BMA since 2013, consisting of.

1) Coca Cola Company (Thailand) is the sponsor of the budget and management on the ISWM project at Chatuchak District called “Recycle 360 degrees.” The Packaging Institute for the Environment, Federation of Thai Industries, Volunteer Foundation, and the BMAED joined the operation. The result of the project was the amount of waste decreased in the buildings with community participation. The project could reduce the recyclable waste and hazardous waste in the waste component leading to reduced greenhouse gas emissions and increased revenue from the sale of recycling materials.

2) Shell Thailand Company has been supporting the waste collection points, classification, and waste classification signs. BMA provides three types of waste bins: hazardous waste, recyclable waste, and general waste in 106 gas stations. The staff at the gas stations have communication with customers to create an understanding of the disposal of hazardous waste.

3) The Department of Pollution Control and several stakeholders such as gas stations, shopping malls, and convenience stores have been supporting the drop off collecting hazardous waste. Types and categories of waste depending on the type of stakeholders and adequacy of the location.

4) Thai Siam Cement Public Company Limited (SCG) has implemented a pilot project with BMA to collect combustible waste for making fuel in cement plants.

Mostly, combustible waste cannot be general waste and cannot be recycled, such as plastic bags, Styrofoam, leather scraps, rubber scraps, wood scraps, and paper. The project has been operating in two communities: Khet-Phairao, 3-5 Community, and On-Nut 14 rai Community.

5) TPBI Public Company Limited launched the “WON” project to reduce plastic waste in Bangkok. The project sets drop off points for soft plastic such as plastic bags, shockproof bags, bread bags, zip lock bags, and medicine sachets. The soft plastic will serve as a material to produce new plastic bags (WON bags). The soft plastic 1 kg has a 5-baht value and will be donated to a charity that is participating in the project. The company is supporting vinyl signs, plastic receiving

bin, and arranging the vehicle to collect plastic waste at BMA city halls, BMADOs, and private companies who join the project.

6) Thai Wacoal Public Company Limited has been supporting the boxes in 50 district offices to collect used women's bra and arranging the vehicles to collect them and use them to make fuel.

7) Kasetsart University has collaborated with BMA to study and develop an environmentally friendly SWM system. Moreover, they developed the Suan Luang District Office as the prototype district office on environmentally friendly SWM.

8) Mahidol University has collaborated with Bangkok to develop SWM systems in BMA's schools as learning centers with 30 schools participating in the project.

9) BCI Thailand Co., Ltd. developed the study of CBM in 14 target groups and 14 canals. It conducted lessons with various target groups to promote the reduction and separation of waste efficiently.

10) Thailand Environment Institute developed a model for SWM and the environment for the community in Bangkok.

11) Chulalongkorn University studied and developed green city activities in Bangkok by creating a network of entrepreneurs. Community educational institutions have monitored environmental problems and joined in solving them. Waste separation is one of the eight indicators of organizational development of green organizations.

12) The Federation of Thai Industries and Networking Parties has cooperated in the implementation of programs with the government, business, and civil society to manage plastics and waste. There is a working group project to set the framework for working, planning the direction, and following up on project performance. The program also considers developing waste disposal systems within the building, such as reduction and separation at the source by the 3Rs principle, reduction of single-use plastic, and waste separation for recycling—including a campaign to build awareness and understanding of people in the building via public relations. The project was successful in the promotion of public participation in sustainable SWM.

The participation of government, private organizations, educational institutions, and NGOs with BMA has initiated activities that have encouraged society to realize that waste is a major problem and seek solutions to the management of waste at the source. There has been a prototype of BMAWM at many levels, such as district level, sub-district level, community-level used as a tool to create public awareness about reducing and separating waste at the source.

4.2.4.3 BMA's Waste Utilization

Amount of Waste Utilization: The quantity of waste at the BMA disposal center would be reduced if the performance capabilities of BMAED and BMADOs to separate and utilize waste at the source, including recyclable waste, food waste, and yard waste. The data on waste utilization of BMA during 2013-2019 by BMAED shows that the quantity of waste utilization was higher than the target every year. In 2014, the waste utilization was 1,587 tons per day, above the target of 1,481 tons per day, which was above the target by 106 tons per day or 7.2%. In 2015, the target was 15% of the based the year 2013 or 1,548 tons per day and there was amount waste utilization of 2,829 tons per day, higher than the target by 1,281 tons per day or 82.7%. In 2016, the target was 18% or 1,588 tons per day, and there was an amount of waste utilization of 3,005 tons per day, higher than the target by 1,417 tons per day or 89.2%. and in 2019, BMA had a target of 2,661 tons per day and there was amount waste utilization of 3,029 tons per day, higher than the target by 368 tons per day or 13.8%. Although the overall quantities of BMA waste utilization had increased, the amount of waste disposal was increased. Details are shown in Figure 4.4.

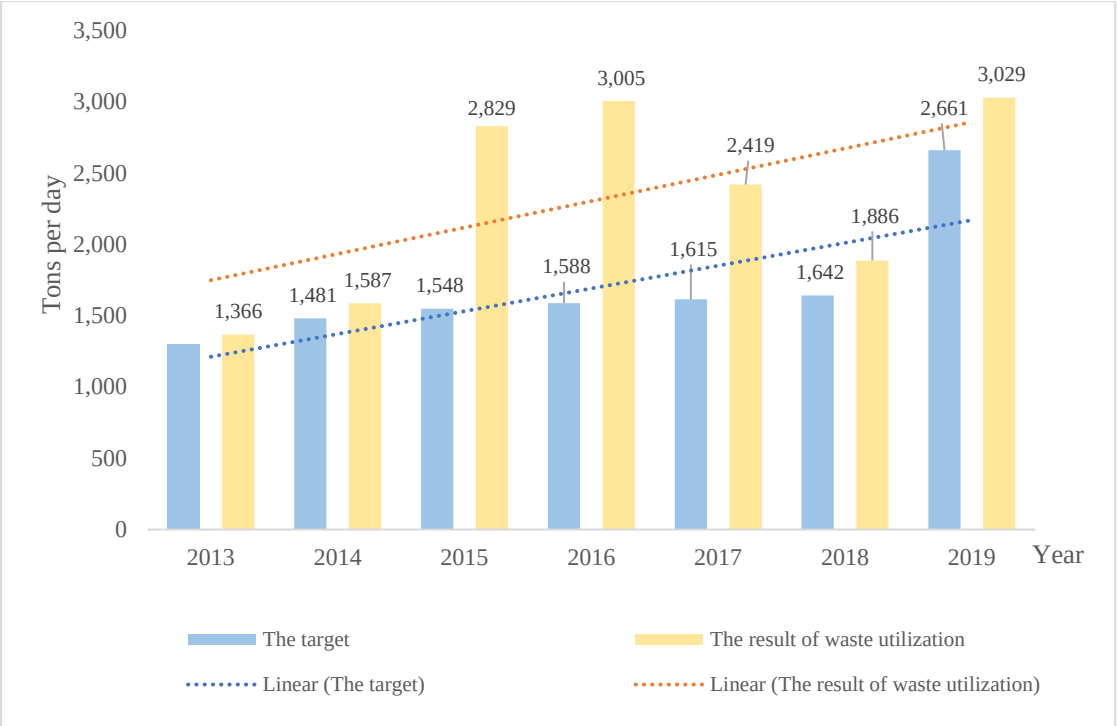

Figure 4.4 Quantity of Waste Utilization by Target 2013-2019
Source: BMAED, 2019.

4.2.4.4 BMA's Waste Separation

Amount of Waste Separation Type: The overall study of waste separation type found that waste utilization at source increased compared with the base year of 2013. The components of waste utilization were recyclable waste 14.93% and organic waste 4.72%. However, the BMA collected two types of waste for disposal consisting of hazardous waste 0.02% and general waste or non-recyclable waste 80.32%. Details are shown in Table 4.3.

Table 4.3 Solid Waste Separation Type in Bangkok (2013-2019)

Type of MSW Year	Recyclables (t/d)	Organic waste (t/d)	Hazardous waste (t/d)	General waste (t/d)
2013 (base year)	946	400	1.66	9,963
2014	1,766	334	1.68	9,940
2015	2,293	536	1.95	10,167
2016	2,248	715	2.27	10,130
2017	1,793	590	2.72	10,526
2018	1,228	657	2.68	10,705
2019	2,208	821	3.55	10,564
Average	1,922	608	2.48	10,338
Percentage	**14.93**	**4.72**	**0.02**	**80.32**

Source: BMAED, 2019.

4.2.4.5 BMA's Waste Composition

Amount of Waste Composition: The MSW in Bangkok consists of mixed waste resulting in large increases in the volume of waste collection and disposal. The composition of MSW at the BMA disposal center includes raw material that has not been separated for utilizing at the source and disposed of by households including recyclables, organic waste, and general waste or non-recyclable waste. The data on solid waste composition during the fiscal years 2013-2019 indicates that raw material disposed of with general waste averaged 66.19% and mostly consisted of organic waste 53.48% and recyclables waste 12.71% with 33.82% being general waste or non-recyclables. In comparison to 2013, raw material disposed of with general waste averaged 61.07% and mostly consisted of organic waste at 49.78% and recyclable waste at 11.29% and general waste or non-recyclable general waste was 38.93%. This means that BMA was unsuccessful in the waste separation at the source. The details are shown in Table 4.4.

Table 4.4 Waste Composition of Waste Disposal (2013-2019)

Type of MSW year	Recyclables (%)	Organic waste (%)	General waste or non-recyclables (%)
2013 (Base year)	11.29	49.78	38.93
2014	14.28	48.29	37.43
2015	13.13	49.10	37.77
2016	14.57	53.55	31.90
2017	12.62	57.15	30.23
2018	11.71	59.09	29.20
2019	9.95	53.69	36.36
Average	12.71	53.48	33.82

Source: BMAED, 2019.

Table 4.4 shows the proportion of MSW composition that was recyclable and organic waste has increased at the BMA disposal site. BMA did not have a collection system for recyclable and organic waste for utilizing. Meanwhile, people did not utilize food waste at home and did not separate waste before disposal to a collection point or public bin because they understood that BMA workers would separate mixed waste at the collection point, illustrating BMA's inability to communicate with the population regarding SWM.

4.2.4.6 BMA's Waste Disposal

Amount of Waste Disposal: The MSW amount decreased during the period of targeted waste minimization between the years 2013-2019. The waste minimization target set during 2014-2019 was 2% or less than 9,764 tons per day in 2014; 3%, or not less than 9,664 tons per day in 2015; 5%, or less than 9,465 tons per day in 2017, and 7%, or the less than 9,266 tons per day, respectively. The MSW must decrease by 2-5% year by year. The amount of MSW during 2014-2019 decreased by 0.2% in 2014, after that the amount of MSW increased annually by 2%, 1.7%, 5.7%, 6.9%, and 6.0% in 2015-2019 indicating that the BMAWM was unsuccessful in meeting the targets of the 20-year DPBM during 2013-2019. Details are shown in Figure 4.5.

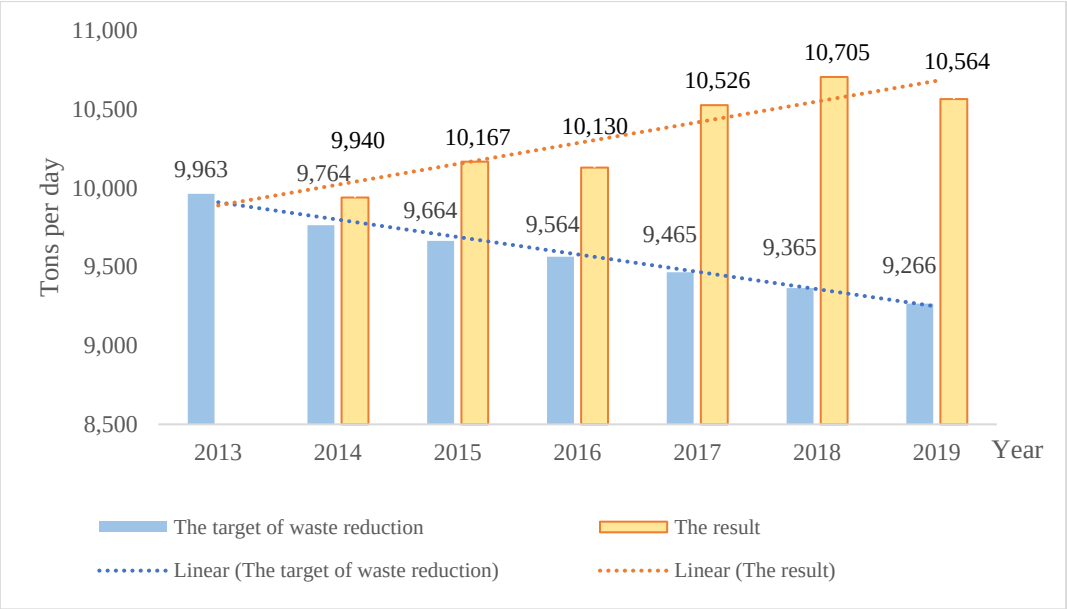

Figure 4.5 Amount of Waste Disposal During the Year 2014-2019

Source: BMAED, 2019.

4.2.5 Impact Evaluation of BMAWM

4.2.5.1 Impact on the Environment

CO_2 Emissions: Waste utilization could reduce CO_2 emissions by the amount of waste utilization 1,785,215 tons as recyclables 1,575,340 tons and organic waste 209,875 tons. When compared with the base the year of 2013, BMA could reduce CO_2 emission by 99,754.5 tonsCO_2e to the environment using the User Manual Estimation Tool for Greenhouse Gas (GHG) Emissions from SWM in a Life Cycle Perspective (Nirmala & Sang-Arun, 2013).

One kg of solid waste releases CO_2 0.3 KGCO_2e (Nirmala & Sang-Arun, 2013). The amount of waste during 2014-2019 increased 767,250 tons compared with the base year, so the release of CO_2 emission to the environment was 230,169 tonsCO_2e. Especially in 2014, the amount of waste decreased 7,300 tons from the base year, reducing CO_2 emissions by 2,190 tonsCO_2e. Details are shown in Table 4.5.

Table 4.5 Increasing of Amount of Solid Waste Releases CO_2 Emission

Year	Amount of waste (t/d)	Amount of waste increased or decreased (-)		Total ($kgCO_2e$)	Total ($TonsCO_2e$)
		(tons per day)	(tons per year)		
2013 (Based year)	9,960	-	-	-	-
2014	9,940	-20	-7,300	-2,190,000	-2,190
2015	10,167	207	75,555	22,666,500	22,667
2016	10,130	170	62,050	18,615,000	18,615
2017	10,526	566	206,590	61,977,000	61,977
2018	10,705	575	209,875	62,962,500	62,963
2019	10,564	604	220,460	66,138,000	66,138
Total			**767,230**	**230,169,000**	**230,169**

Source: BMAED, 2019.

The number of waste collection vehicles for collecting waste from households and transporting to the BMADCs also increased. This led to using more fuel, and thus more release of CO_2 emission by each liter of diesel fuel by 2.7 $KGCO_2e$ (Nirmala & Sang-Arun, 2013). During 2014-2019, the BMA used 2,078,193 liters of diesel fuel, so the transportation accounted for 268,843.2 $tonsCO_2e$ by using the User Manual Estimation Tool for Greenhouse Gas Emissions from Municipal Solid Waste (MSW) Management in a Life Cycle Perspective (Nirmala & Sang-Arun, 2013).

4.2.5.2 Impact on the Economic

1) Collection and Disposal Cost

The amount of waste has increased, impacting BMA's budget for operation, management, and maintenance from the perspective of personal, material, and equipment for waste. The budget for collection and disposal during 2014-2019 increased year by year from 6,519 to 6,568, to 6,913, to 7,143, to 7,924, and 6,846 million baht. It was higher than the budget in the year 2013 (6,119 million baht).

2) Renewable Resources

Bangkok's mixed waste had a composition of raw material such as recyclables and compostable waste 66.19%, including recyclable 12.71% and compostable 53.48% (Table 4.4). In 2019, BMA had the amount of solid waste disposal of 10,564 tons per day (Table 4.5) that utilized in plants at BMADCs for 2,900 tons per day that are treated in compostable plants 1,600 tons per day, MBT plant 800 tons per day, and incinerator plant 500 tons per day. While the amount of solid waste 7,664 tons per day eliminated in landfills that eliminated by without utilizing it both recyclables and compostable waste. It lost the recyclables 9.95% (Table 4.4) (739 tons per day) and compostable waste 53.69 (Table 4.4) (4,114 tons per day) These brought to lost renewable resources for raw material in the factory, or compost plant, and the incinerator plant.

3) Collection and Disposal Fees

The amount of solid waste of BMA collected from households to BMADCs treated it by sanitary landfill, composting, and incineration that receives the collection fee by without disposal fee. These led to a small collection fee increase in 2013 for 455, to 466, to 476, to 495, to 509, 523, and 535 million Baht, respectively, as shown in Table 4.6.

Table 4.6 Cost of the Waste Management and Waste Collection Fee

Year	Amount of waste (t/d)	Collection cost (MB)	Disposal cost (MB)	Totals (MB)	Cost per ton (B)	Collection fee (MB)
2013 (Based year)	9,960	3,667	2,451	6,119	1,682	455
2014	9,940	3,925	2,593	6,519	1,796	466
2015	10,167	3,926	2,641	6,568	1,769	476
2016	10,130	4,157	2,755	6,913	1,869	495
2017	10,526	4,189	2,953	7,143	1,859	509
2018	10,705	4,271	2,652	7,924	1,772	523
2019	10,564	4,295	2,551	6,846	1,775	535

Source: BMAED, 2019.

4.2.5.3 Impact on the Society

The waste minimization system could impact the lives of the population as described below:

1) CBM Social Participation

CBM concept had resulted in all sections of the community participate in waste reduction and separation such as recyclable sale markets, recyclable banks, and community composting points. These create a good connection in the community and for resolving problems and strengthening the community.

2) Low-Income People

The value of recyclable waste contributes to the income of low-income residents. The selling of recyclables is an occupation of low-income people and workers in the recycling business. Separation activities create public discipline for waste disposal according to the law. It decreases illegal dumping and contributes to general cleanliness and hygiene.

3) BMA's Waste Collection Workers

BMA's waste collection workers are incentivized to separate waste, but this increases the collection time. There has been a shortage of collection workers was the new generation people did not apply for jobs in waste collection for many reasons such as low salary, heavy work, and high risk. Meanwhile, the current group of workers is increasing in age and some have illnesses. This represents a trend toward a lack of waste collection workers, leading to an increase in residual waste in the community and public areas.

4) Recycling Business

BMA's collection workers separately collect recyclables during regular waste collection. The ragpickers (a push-tricycle worker who purchase recyclables or directly door to door and share the waste bag in the trash) collect recyclables for sale. However, they have a high risk of injury from sharp objects and contamination from waste that might affect their health.

In summary, the CIPP-I evaluation results found that the context, input, and process indicators have both strong and weak as follows:

1) The context had seven strong indicators, including national waste minimization policy and plan, BMA's waste minimization policy and plan, industry collaboration, private sectors participation, IT communication, Bangkok area environment, and waste management laws; and it also had two weak indicators, including local politicians unstably, and public behavior on mixed waste littering.

2) Input had seven weak indicators, including the number of personnel, personnel development, personnel assignment, waste minimization project, communication tools, waste utilization capacity, and organization management was insufficient to supply for BMADO's needs.

3) The process had two strong indicators, including BMA was properly on monitoring and evaluation, and waste minimization guidelines; and it had six weak indicators, including an action plan, personnel acceptance, law enforcement, public participation, public communication, and waste collection system were insufficient for BMAWM of the BMADOs.

4) The product had two strong indicators, including the number of agencies cooperation and amount of waste utilization was increased; and it had four weak indicators, including the number of CBM participation, amount of waste separation types, and amount of waste composition was few changed, and amount of waste disposal were increased.

5) The impact had four strong indicators, including the values of waste utilization were benefited to CBM social participation, low-income people, BMA's waste collection workers, and recycling businesses while it had four weak indicators, including CO_2 emissions, and collection and disposal cost were increased, renewable resources lost, and collection and disposal fees unsuitable with the cost of waste management.

The details are shown in Table 4.7.

Table 4.7 Result of CIPP-I Analysis for BMAWM

Issues	Indicators	Result to the CIPP-I evaluation	
Context		**Strong**	**Weakness**
Policy and plan	National waste minimization policy and plan		
	BMA's waste minimization policy and plan		
	Local politicians		
Economic growth	Industry collaboration		
Public participation	Public behavior		
	Private sectors participation		
IT infrastructure	IT communication		
Environment of Bangkok	Bangkok area environment		
Waste management laws	Waste management laws		
Input		**Strong**	**Weakness**
Personnel	Number of personnel		
	Personnel development		
	Personnel assignment		
Budget	Waste minimization project		
Materials	Communication tools		
	Waste utilization capacity		
Management	Organization management		
Process		**Strong**	**Weakness**
Plan	Action plan		
Do	Personnel acceptance		
	Law enforcement		
	Public participation		
	Public communication		
	Waste collection system		
Check	Monitoring and evaluation		
Action	Waste minimization guidelines		
Product		**Strong**	**Weakness**
Public participation	Number of CBM participation		
Public-private partnership	Number of agencies cooperation		
Waste utilization	Amount of waste utilization		
Waste separation	Amount of waste separation types		
Waste composition	Amount of waste composition		
Waste disposal	Amount of waste disposal		
Impact		**Strong**	**Weakness**
Impact on the environment	CO_2 emissions		
Impact on the economic	Collection and disposal cost		
	Renewable resources		
	Collection and disposal fees		
Impact on the social	CBM social participation		
	Low-income people		
	BMA's waste collection workers		
	Recycling businesses		

4.3 Factors Affecting Analysis of BMAWM

4.3.1 Internal Factors Analysis of BMAWM

Internal factors affect BMAWM implementation arising from the internal environment of BMA that has an essential role in management. The researcher used McKinsey's 7S theory to analyze the internal factors and the results of the analysis can be summarized as follows:

1) Strategy: The highlight of this factor is that BMA is a specialized local administrative organization with self-management, policymaking, city development plan, budget allocation, and resources. Reduction and separation of waste have been identified as an essential strategy in the 20-year DPBM with a target of 20% waste reduction. The strategies and plans for BMAWM are essential for setting the management direction and work direction framework of BMA personnel. The BMA has a 20-year DPBM with a vision of Bangkok having the SWM system with a zero-waste concept and the goal of reducing waste by 20%, which is a strength of SWM and separation.

2) Structure: The BMA’s structural strength is that the governor is elected, with departmental and district offices implementing policies and plans and who are ready to carry out their mission and solve problems. While there are significant weaknesses in the large organizational structure, there are many civil servants, many professions, and the decision-making power is in the hands of the sole governor of Bangkok, resulting in decision-making to address problems requiring more time, a lack of follow up and insufficient supervision of officials resulting in reduced efficiency. An appropriate organizational structure enables the administration of the agility to quickly make decisions. Bangkok has a formal structure. There are many departments and personnel that have precise mission tasks, but the number of agencies responsible for waste reduction and separation is few. This is considered a weakness in BMAWM management.

3) System: The administration system is an integrated management system that empowers the governor as the center of authority, with the BMAED level as a support unit and to implement policy. The BMA district office is the operational unit in the area, in which each district is divided into ten divisions, which are

responsible for operating duties under standards, positions, and as directed by administrators. However, there are weaknesses in that BMA is larger than its administrative capacity. Although the provincial government has a clear division of labor, the department lacks integration and spatial development and there is a limited group who are responsible but who lack power. The Governor has the power to allocate personnel, budget, job assignment integrated management, organize collaboration from all appropriate departments, which has helped manage the BMAWM successfully. This is considered a strength that the governor uses their authority to develop BMAWM systems.

4) Style: The practice of the governor and the deputy governor influence the consciousness of the personnel. The governor and executives in the environmental department are determined to drive various tasks to achieve the goals. Quick fix behavior as a role model in personal such as reuse of glass and water bottles and reuse of cloth bags to reduce plastic bags is a strong point for the governor and executives to play a role in leading the change to a zero-waste society with sustainable SWM. However, the administration style has a distinct advantage is that the governor is elected, ensuring a governor is a person with knowledge, ability, and experience in administration in the public and private sectors. However, the weak point is that politicians are concerned about popularity, so avoid legal enforcement measures. Moreover, the election of the governor takes place every four years which may lead to new policies that are not conducive to SWM and waste separation.

5) Staff: Personnel is vital for communication to create public understanding by building a collaborative waste minimization network. Bangkok has not explicitly specified personnel in BMAWM leading to a lack of success of reduction and separation operations. This is considered a weakness in Bangkok in the management of BMAWM. Personnel responsible for the SWM and SWM of Bangkok have assigned the government office in the BMAED to be responsible for the overall Bangkok and BMA district offices but there are weaknesses in lack of staff. The direct responsibility and lack of teamwork in the form of a working group with all parties involved results in a lack of power to drive the strategy, with personnel frequently rotated resulting in a lack of continuity.

6) Skill: BMA has a system to develop personnel skills on SWM, including communication skills to create public understanding. Simultaneously, a weakness is that the development of BMAWM skills remains limited, and new officials lack the skills and knowledge. Therefore, there is a reduction in SWM and separation efficiency. The skill of personnel includes their knowledge and ability to help achieve effective communication and operations. Bangkok has trained personnel responsible for BMAWM, who can serve as guest speakers to encourage public participation, such as at meetings, seminars, and study tours for related parties. Most of the personnel responsible for this field have knowledge and understanding of BMAWM. This is a strength for SWM and WRS management.

7) Shared Value: The Governor establishes measures to reduce the use of plastic and foam by using glasses of water in meetings, using cloth bags instead of plastic bags, and announced the intention to stop using plastic bags. However, there are weaknesses because Bangkok has a variety of missions, causing a lack of oversight by senior management, and resulting in agencies lacking shared values in reduction and separation waste. Bangkok's personnel do not respond to SWM, but they could communicate to residents about their service. Most personnel do not yet share the values of reduction and separation of waste and do not communicate with people who meet the government in various fields about it, which is considered another weakness.

The summary of the internal environment factors affecting BMAWM implementation is shown in Table 4.8.

Table 4.8 Summary of Internal Issues Factors Affecting for BMAWM

Issues	Strength	Weakness
1. Strategy	S1: BMA has a policy, strategic plan, long-term goals, and has a precise evaluation and tracking system.	.
2. Structure		W1: BMA has a large structure. Chain of command delivering jobs to departmental and personnel levels
3. System	S2: BMA has the power to set policies, allocate budgets, materials, equipment, personnel, and can issue ordinances to solve problems.	W2: BMA has many related agencies but lacks integration of collaboration with different characteristics and actions unable to have an overall effect.
4. Style	S3: BMA governors and executives are committed and act as role models.	
5. Staff		W3: BMA has not yet determined the official position of the officer responsible for BMAWM.
6. Skill	S4: BMA develops personnel responsible for SWM to have the knowledge and ability to create participation in WRS.	
7. Shared values		W4: Most BMA personnel responsible for public services have not yet been cultivated in the shared values of BMAWM.

The internal factors ranked the priorities of the opportunities and threats that weigh on each issue, from the interviews with 15 BMA officers. Details are shown in Table 4.9.

Table 4.9 Ranking the Priority Internal Issues of BMAWM

Factors	Frequency	Percentage
Strengths		
S1: BMA has a policy, strategic plan, long-term goals, and has a precise evaluation and tracking system.	13	86.67
S2: BMA has the power to set policies, allocate budgets, materials, equipment, personnel, and can issue ordinances to solve problems.	12	80.00
S3: BMA governors and executives are committed and act as role models.	10	66.70
S4: BMA develops personnel responsible for SWM to have the knowledge and ability to create participation in WRS.	10	66.70
Weaknesses		
W1: BMA has a large structure. Chain of command delivering jobs to departmental and personnel levels.	13	86.67
W2: BMA has many related agencies but lacks integration of collaboration with different characteristics and actions unable to have an overall effect.	12	80.00
W3: BMA has not yet determined the official position of the officer responsible for BMAWM.	12	80.00
W4: Most BMA personnel responsible for public services have not yet been cultivated in the shared values of BMAWM.	10	66.70

4.3.2 External Factors Analysis of BMAWM

For the analysis of external factors, the researcher employed the PESTEL theory to study the six main factors: political, economy, society, technology, environment, and legal, summarized as follows:

1) Political Factors: Opportunities are that the Government attaches importance to the problem of waste as part of a national agenda. These included the Roadmap for SWM and Hazardous Waste of the Country, the National master plan for solid SWM 2016-2021, which stipulates measures to promote reduction and separation at the source by the 3R principle, and establishes the discipline of waste disposal by the public through knowledge and law enforcement. There is also the Action Plan “Thailand zero-waste 2016-2017, Clean Province Action Plan” (The

Secretariat of the Prime Minister, 2019). However, there are still obstacles, including lack of integration of related agencies and political instability, which may result in changes in SWM policies, especially in reduction and separation waste, causing a lack of continuity. The government policies and plans and the governor's political policy set the administrative direction of the political department that agencies implemented. The Government attaches importance to the waste problem by announcing it as a national agenda and a master plan for SWM, which promotes reduction and separation at the source by the 3R principle, and the Thai Government has to follow up on the results of the policy and plan continuously. This is an opportunity to manage the BMAWM in Bangkok by BMA.

2) Economic Factors: Opportunities are the Thai economy is entering a new industrial period with high economic growth rates (Siamrath, 2019), in which Bangkok has a mass product of up to 32% of the value of mass production. Domestic tax increases Bangkok’s revenue. However, the main obstacle is that the activities resulting from economic expansion affect the quantity and increased waste. Tchobanoglous et al. (1993) and Leblanc (2019) stated that the waste collection mission has a significant impact on BMAWM activities. Also, the price of recycled materials has decreased the income of the ragpickers, causing them to change their occupation or recycling shops to close and waste separation activities to decrease, resulting in increased waste (Thai PBS News, 2019b).

The country's economic growth has resulted in more production and consumption, causing more municipal waste. Manufacturers are still not responsible for product recall and the SWM agencies lack efficient waste separation collection systems. Waste separation depends on the value of recycled materials, and expensive recycled materials are more efficient to separate than cheap recyclable materials. Most of the recyclable waste materials have been separated by the ragpickers and the BMA staff who collect it from the mixed waste resulting in low-quality recyclable materials. Furthermore, recyclable materials from foreign countries affect the price of recycled materials in Thailand. This results in the ragpickers and waste collector’s incentive to collect only high-priced recyclable waste. Due to fewer ragpickers, there is an increased amount of waste. This is considered a hindrance to BMAWM management.

3) Social Factors: An opportunity is the country's education system. Many higher education institutions are helping to increase knowledge of people in society BMASED (2013b). People understand the waste reduction concept and are interested in participating in the administration of Bangkok and participating in various activities, including examining government officials and traditional values. Thais see the value of used utensils to repair and reuse things until they cannot be repaired and finally discarded as waste leading to a reduction in the amount of waste (Leblanc, 2019). There is also a view that waste is detrimental and discarded waste combined with food waste in odious. The collection must be convenient as the public does not like the hassle of separating recyclable materials worth so little and leave their waste in bins in front of the waste ledger building (Tchobanoglous et al., 1993). Social characteristics, culture, and behavior of mixing waste with litter for disposal affect the BMAWM. Although there are separate types of waste bins, most Thais do not dispose of waste according to the categories specified. This causes waste collection officers to separate the waste during the collection which wastes time and is considered a significant obstacle to the management of BMAWM. There is an opportunity for BMA to cooperate with people, communities, educational institutions, government agencies, and the private sector to minimize BMA's waste.

4) Technology Factors: Opportunities are the rapid development of ICTs, with most of the population in Bangkok using mobile phones and having access to the Internet BMASED (2013b). Communication can increase public understanding of BMAWM, but there are still obstacles: personnel still lack knowledge and understanding about waste. The online communication techniques are mainly used for public relations communication, which is changing rapidly with the rapid technological change, but the bureaucratic system cannot keep up due to the lack of integration of work and government regulations that divided the work, resulting in information disruption, unnecessary problems and a variety of data, including threats to the online systems. IT helps to communicate more efficiently and quickly. This is an opportunity for Bangkok to use social media as a tool for communication to increase participation in the reduction and separation of waste.

5) Environmental Factors: Opportunities are Bangkok is a tropical city, therefore the relative humidity will be high throughout the year BMASED (2013b), facilitating the utilization of organic waste by composting, bio-fermentation or biogas as natural microbes can grow leading to highly efficient organic decomposition, in which the aeration temperature is between 27-39 degrees Celsius (Rangseesuriyachai & Saricheewin, 2018). The utilization of organic waste by composting is an opportunity for Bangkok to provide a system for separating organic waste for composting and producing biogas for electricity generation and promoting composting for home use or agricultural plots.

6) Legal Factors: The Thai Government announced the Ministry of Interior on SWM B.E. 2560 ("Announcement of the ministry of Interior Re: Solid Waste Management B.E.2560,") by separation of four types of waste: recyclable waste, hazardous waste, organic waste, and general waste. Moreover, the Thai Government announced the Ministerial Regulation Hygienic SWM 2017 ("Ministerial Regulation Hygienic Waste Management B.E.2560,") requiring people to separate hazardous and recycle waste from the general waste before disposal. Also, BMA can issue additional regulations under the Public Health Act 1992. This is a critical opportunity for BMAWM.

The summary of external environment factors affecting BMAWM implementation is shown in Table 4.10.

Table 4.10 Summary of External Issues Factors Affecting of BMAWM

Issues	Opportunities	Threats
1. Political factors	O1: Government has a national agenda on SWM policy, SWM master plan, and a follow-up.	
2. Economic factors		T1: Manufacturers are not responsible for the waste by recalling for reuse or disposal T2: Recycle material collection system depends on the material price. The cheapness of recyclable materials means less collected for recycling. T3: Lack of control of materials import operators causing a low price for Thai recyclables. T4. Economic growth causes more consumption, more waste, and more SWM cost.
3. Social factors	O2: People, the private sector, and various organizations have participated in SWM activities with Bangkok in many areas.	T5: Thai society is familiar with discarding waste together, even with separate bins. Waste by type is still not separated into the correct bin
4. Technology factors	O3: Most of the population has access to the Internet to communicate and access a personal level. There are more communication channels.	
5. Environmental factors	O4: Temperature and humid weather suitable for composting in household and organic waste treatment system at the source.	.
6. Legal factors	O5: Government issues legislation to separate waste and requires separation of hazardous waste and recyclable waste before disposal.	

The external factors ranked the priorities of the opportunities and threats weighted by each issue, from interviews with 15 BMA officers. Details are shown in Table 4.11.

Table 4.11 Ranking of Priority of External Issues of BMAWM

External Factors	Frequency	Percentage
Opportunities		
O1: Government has a national agenda on SWM policy, SWM master plan, and follow-up.	13	86.67
O2: People, the private sector, and various organizations have participated in SWM activities with Bangkok in many areas.	13	86.67
O3: Most of the population has access to the Internet to communicate and access on a personal level. There are more communication channels.	12	80.00
O4: Temperature and humid weather suitable for composting in household and organic waste treatment system at the source.	12	80.00
O5: Government issues legislation to separate waste and requires separation of hazardous waste and recyclable waste before disposal.	10	66.67
Threats		
T1: Manufacturers are not responsible for the waste by recalling for reuse or disposal.	13	86.67
T3: Lack of control of materials import operators causing a low price for Thai recyclables.	12	80.00
T5: Thai society is familiar with discarding waste together, even with separate bins. Waste by type is still not separated into the correct bin.	12	80.00
T2: Recycle material collection system depends on the material price. The cheapness of recyclable materials means less collected for recycling.	10	66.70
T4. Economic growth causes more consumption, more waste, and more SWM cost.	10	66.70

4.3.3 Summary of Factors Affecting of BMAWM Implementation

The analysis of the internal and external environment of the BMA's waste minimization implementation is summarized in Table 4.12.

Table 4.12 Summary of Factors Affecting the BMAWM

Strengths	Weaknesses
S1: BMA has a policy, strategic plan, long-term goals, and has a precise evaluation and tracking system.	W1: BMA has a large structure. Chain of command delivering jobs to departmental and personnel levels.
S2: BMA has the power to set policies, allocate budgets, materials, equipment, personnel, and can issue ordinances to solve problems.	W2: BMA has many related agencies but lacks integration of collaboration with different characteristics and actions unable to have an overall effect.
S3: BMA governors and executives are committed and act as role models.	W3: BMA has not yet determined the official position of the officer responsible for BMAWM.
S4: BMA develops personnel responsible for SWM to have the knowledge and ability to create participation in WRS.	W4: Most BMA personnel responsible for public services have not yet been cultivated in the shared values of BMAWM.
Opportunities	**Threats**
O1: Government has a national agenda on SWM policy, SWM master plan, and follow-up.	T1: Manufacturers are not responsible for the waste by recalling for reuse or disposal.
O2: People, the private sector, and various organizations have participated in SWM activities with Bangkok in many areas.	T2: Recycle material collection system depends on the material price. The cheapness of recyclable materials means less collected for recycling.
O3: Most of the population has access to the Internet to communicate and access on a personal level. There are more communication channels.	T3: Lack of control of materials import operators causing a low price for Thai recyclables.
O4: Temperature and humid weather suitable for composting in household and organic waste treatment system at the source.	T4. Economic growth causes more consumption, more waste, and more SWM cost.
O5: Government issues legislation to separate waste and requires separation of hazardous waste and recyclable waste before disposal.	T5: Thai society is familiar with discarding waste together, even with separate bins. Waste by type is still not separated into the correct bin.

4.3.4 Strategies of BMA's Waste Minimization

The internal and external factors of SWM in Bangkok were studied by SWOT Analysis to determine strategies for BMAWM management by using the TOWS Matrix technique. The results of the TOWS Matrix analysis for the strategies of BMAWM include four strategies consisting of SO strategies, WO strategies, ST strategies, and WT strategies. The details are shown in Table 4.13.

Table 4.13 Strategies Formulation of the BMAWM Using TOWS Matrix

Internal factor / External factors	S	W
	SO strategies	**WO strategies**
O	**S1S2O1O2:** BMA raises Bangkok's zero-waste to be the agenda of the city, the cooperation of all agencies, and support budgets, personnel, and resources in SWM and WRS. **S2S3O3O4O5:** BMA develops mechanisms to communicate with online media awareness. Creating a participatory process WRS by law enforcement measures. Economic measures promote recycling fees and social measures to cover 50 areas. **S3S4O4:** BMA develops mechanisms to promote the organic biodegradable to utilize by composting at home and build a processing food waste to compost in the BMA waste disposal center. **S3O5:** BMA develops legal measures related to waste before littering. determination of collecting points, definite date and time for littering classification, and enforcement system efficiently.	**W1W2W3O1O2:** The governor of BMA empowers district directors to integrate government officials, private agencies, communities into networks or working groups for BMAWMS management in the area. **W3W4O1O2O4O5:** BMA establishes a zero-waste city and zero-waste district under public participation, targeting a measure of the success of the department heads that affect to the higher position and an annual bonus of all BMA officers. **W3O2O3:** Develop communication application to create public understanding of BMAWMS at source, littering waste separation method, and sales and bought channels to the advantage of the recycling and organic waste.
	ST strategies	**WT strategies**
T	**S1T1:** BMA develops a network of cooperation with product manufacturers to be aware of packaging that is reused into the new production process and urges the government to restore the remains of the legislation to be recycled or treated. **S1T2T3:** Collaboration with manufacturers and networks collect recyclable that collected by recycling storage systems directly from the household to get clean and high-quality raw materials that are comparable with those abroad. **S1S2T2:** Improving the law on antique junk shops in Bangkok facilitates the purchase of recycled materials and develop a green antique store. **S3S4T6:** Develop communication to the public by the governor to recognize the value of recyclable materials as a resource, separate the waste, and discard it into the right bin.	**W1W3T5:** BMA's authorizes the BMADOs to be responsible for promoting waste reduction and waste separation who manage waste minimization effectively and continuously. **W4T2T3T5:** Develop the separated waste collection system of Bangkok to accommodate the waste of the public. There should be waste separation systems in all offices and communicate to the public thoroughly with BMA officials and other social media. **W4T4:** Improve the quality of life of the BMA's waste collectors to an infection prevention system, reduce waste separation during waste collection, and develop knowledge of BMAWM.

According to the TOWS Matrix analysis, both internal and external factors can be summarized as follows:

4.3.4.1 SO Strategies

1) BMA raises zero-waste to be the city's agenda, with the cooperation of all agencies and support budgets, personnel, and resources in SWM and waste separation.

2) BMA develops mechanisms to raise online media awareness. Creating a participatory process and separation by law enforcement measures. Economic measures promote recycling fees and social measures to cover 50 areas.

3) BMA develops mechanisms to promote the reduction of organic waste and biodegradables to utilize by composting at home and build a food waste processing facility to compost in the BMA waste disposal center.

4) BMA develops legal measures relating to waste before disposal. Determination of dumping points, definite date and time for disposal classification, and efficient enforcement of the system.

4.3.4.2 WO Strategies

1) The governor empowers district directors to integrate government officials, private agencies, communities into networks or working groups for BMAWM management.

2) BMA establishes a zero-waste city and zero-waste district with public participation, targeting measures for the success of the department such as an annual bonus for all BMA officers.

3) Developing communication applications to create public understanding of BMAWM at source, disposal of a separated waste method, and sales channels that promote recycling and organic waste.

4.3.4.3 ST Strategies

1) BMA develops a network of cooperation with product manufacturers to be aware of packaging that can be reused in a new production process and urges the government to legislate the return of products to the manufacturer to be recycled or treated.

2) Collaboration with manufacturers and networks to collect recyclable data via a recycling storage system with data directly from households to collect reliable and high-quality raw materials comparable to those abroad.

3) Improve the law regarding junk shops in Bangkok to facilitate the purchase of recycled materials and develop a green junk store.

4) Develop communication by the governor with the public to recognize the value of recycled materials as a resource, separate waste, and discard it into the correct bin.

4.3.4.4 WT Strategies

1) BMA's reorganization of the BMADOs is responsible for promoting waste reduction and waste separation, manage waste minimization effectively and continuously.

2) Develop a separate waste collection system to accommodate the public. There should be waste separation systems in all offices and communication with the public via BMA officials and social media.

3) Improve the quality of life of the BMA's waste collectors via the introduction of infection prevention systems, reduction of waste separation during collection, and develop knowledge of BMAWM.

4.4 Draft of an Appropriate System of BMA's Waste Minimization

According to the SWOT analysis and TOWS Matrix, a draft of an appropriate system for BMAWM is proposed based on the Input-Process-Output: I-P-O model. The framework for the development of action plans covering three dimensions comprised of input, process, and output is detailed as follows:

4.4.1 Inputs Dimension

This dimension is an internal factor that consists of four elements: man, money, material, and management. The inputs are the internal factors for BMAWM that must be supported by BMA to the BMAED and 50 BMADOs for achieving the product. The inputs for BMAWM consist of four elements: man, money, material, and management. The details are:

1) Man

(1) BMA Allocate the personnel for the BMAWM system, especially for 50 districts to manage the BMAWM in their districts.

(2) BMA Develop the personnel of BMAED and 50 BMADOs to manage the BMAWM.

2) Money

(1) BMA Allocate the budget for the BMAWM system sufficiently and continuously, especially for 50 districts SWM committees to manage the BMAWM in their districts.

(2) BMA Allocate the budget to the BMAED for the public awareness process, which supports the information communication process to the public to BMAWM.

3) Material

(1) Support the facility for waste separation collection include organic waste vehicles, and hazardous waste vehicles to 50 BMADOs to sufficiently support organic waste collection, hazardous waste collection, bulky waste collection, and branches waste collection.

(2) Support the facility for waste separation treatment plant include organic waste plants, and hazardous waste plant to sufficiently support organic waste treatment, hazardous waste treatment, bulky waste treatment, and branches waste treatment.

(3) Support WRS communication tool to BMADOs, such as leaflet guides, posters, labels, digital communication to residents.

4) Management

(1) BMA governor appoints the BMA's zero-waste city Committee with the BMA governor as a chairman and the BMA district's committee director of BMA district as the chairman. The BMA committee and BMA district committee should include the representative of BMA staff, NGOs, industry council, educational administrators, religious leaders, government agencies, executives of department stores, minimarts, supermarkets, hotels, hospitals, and markets, as well as community leaders and others.

(2) BMADOs director appoints the District’s zero-waste committee comprising of the BMA district director, deputy director, all of the section heads, government agencies, state enterprises, private agencies, schools, universities, and community leaders to cooperate for the zero-waste district policy by 3R.

4.4.2 Process Dimension

This process under Deming Wheel or Deming Circle includes Plan, Do Check, Action (PDCA) for an effective solution for BMAWM. Details are as follow:

1) Plan

(1) The BMA's zero-waste committee makes the BMAWM action plan and guidelines for the BMAED and BMADO implementation.

(2) The district zero-waste committee makes the district action plan for BMAWM under the BMAWM action plan to implement.

2) Do

Do dimension is a process of BMAWM action plan which includes:

(1) Define the waste separation types collection to the public especially hazardous waste, yard waste, bulky waste, infectious waste from hospital public health service, fruit peel and vegetable scraps from fruit and vegetable shops on the main roads, market, supermarkets, and department stores by announcing the district regulation on waste separation before disposal, time and place for disposal to all be conducted seriously and continuously.

(2) BMADOs define the two types of public waste bin service, namely recyclable waste by yellow color bin and general waste by using blue color bin or green color bin everywhere that have a waste bin and communicate to people to separate waste before disposal, conduct campaign, and publish on social media continuously.

(3) Using law enforcement measures to control people's behavior of illegal dumping in the wrong place and time by enforcing the law to control illegal dumping and the law on a waste collection fee.

(4) BMADOs encourage the people focusing on 14 target groups awareness and concern on WRS by the CBM concept that focuses on the participation of community or other group members to have the awareness that understands the waste problem, waste separation at source, waste bin management, time, and place for waste disposal to BMA district collection and clean up their community and other groups.

(5) BMADOs promote people to WRS on public media include reducing single-use plastic and Styrofoam, and separate waste before littering such as recyclable waste for sale or donation and organic waste from household to compost for fertilizer at their home. If they cannot make home compost, they can dispose of it at the general waste bin or general waste collection point near their homes.

(6) BMADOs organize the meetings of all sectors to promote the BMAWM participation such as schools, supermarkets, department stores, hotels, hospitals, markets, communities, office buildings, and government offices to participate in waste separation and contribute to district's BMAWM network to work with BMA district.

(7) Provide knowledgeable people including students in the BMA schools, community leaders, condominium committees, village housings, office buildings, and other agencies to have awareness and skill on BMAWM and utilization, especially organic recyclable waste and hazardous waste.

3) Check

Check is the stage of monitoring and evaluation of the BMAWM plan implementation of district and improvement the best practice to make a guideline of BMAWM. Monitoring and evaluation of BMAWM launched by the BMAED and deputy BMA governor, and Permanent Secretary of Bangkok. Details are as follows:

(1) The BMADOs collects data of activities that respond to the KPIs of WRS and enter data to the BMAED online report for evaluating the success of the waste separation process.

(2) The BMAED evaluates the data and reports the result of the BMAWM evaluation to the BMA governor every three months.

4) Action

The action is implementing a guideline for BMAWM of the district that is the result of the discussion as follows:

(1) The BMAED administrator and staff, the head of cleansing and public park sectors, 50 BMADOs, have a meeting discussing the improvement of the guideline for BMAWM.

(2) The BMA governor approves a guideline for BMAWM of the district and BMAED, which is offered by the BMAED.

(3) The BMADOs and BMAED implement a new guideline for BMAWM. The BMADOs then collects data of any activity that responds to KPIs of waste reduction and wastes separation and entry data to the BMAED online report for evaluating the success of the waste separation process.

(4) The new BMAED evaluate the data and report the result of new BMAWM evaluation to the BMA governor and the vertical meetings of the BMA governor, BMAED, and BMADOs.

4.4.3 Output Dimension

This output of BMAWM should have the result by setting the targets and indicators for monitoring and evaluation of the success such as the amount of waste reduction, amount of waste utilization, waste separation type, the ratio of waste composition, communities participating to WRS, the number of 14 target groups participating, the number of BMADOs has waste decreased, and others.

The proposed new system of BMAWM for Bangkok is illustrated in Figure 4.6.

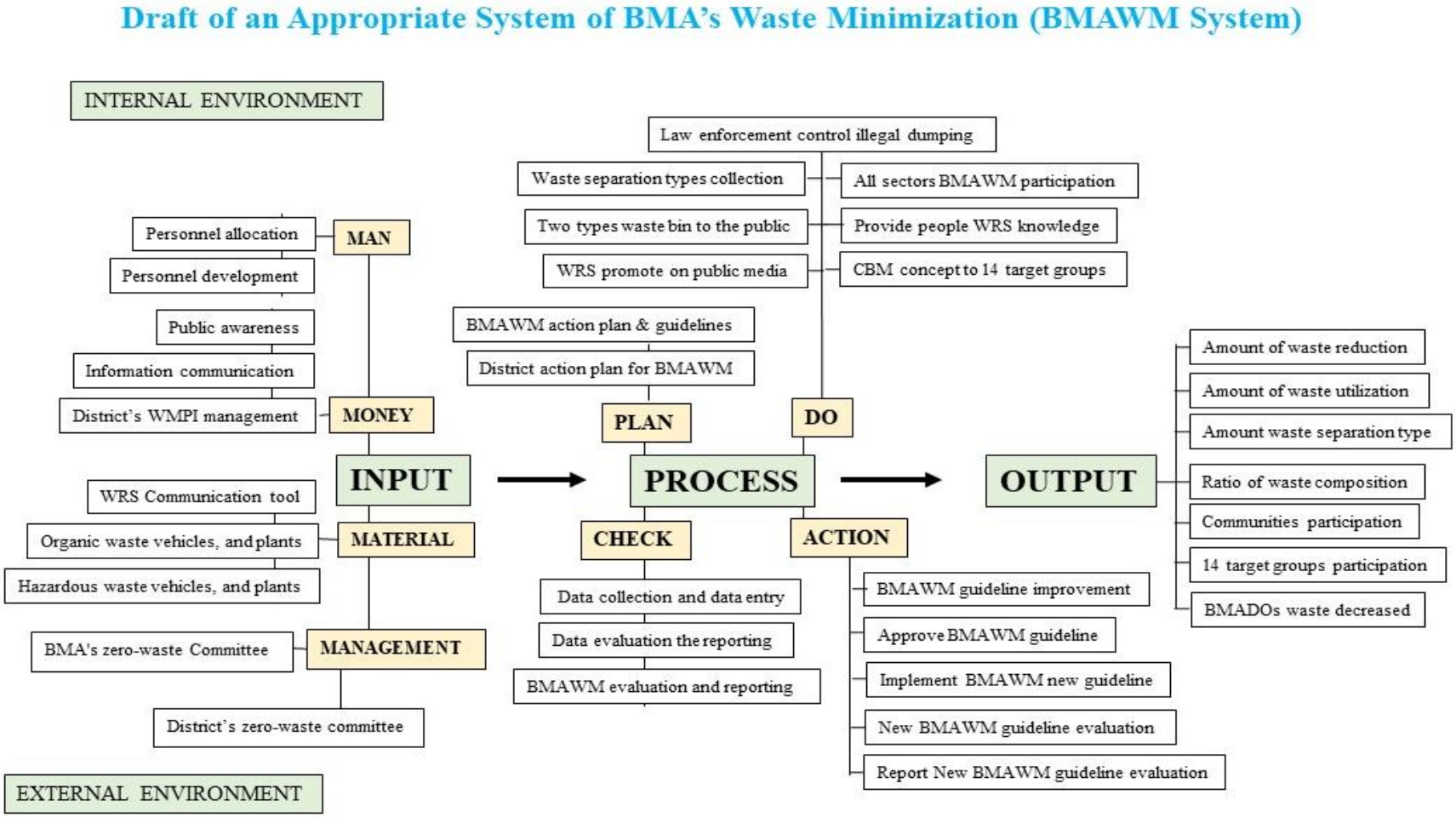

Figure 4.6 Draft of an Appropriate System of BMA's Waste Minimization

4.5 Appropriate BMA's Waste Minimization System Confirmation

A trial of the proposed system of BMAWM was conducted in Khlong Toei District because the district had the best practice on district waste minimization and worked with BMAED with the researcher's coordination. Moreover, the director of Khlong Toei District announced a zero-waste district policy. The was policy managed by the head of CPPS using existing resources. It supported the proposed system of BMAWM experimentation for resource management and process operation.

The researcher asked for permission from the director of the BMAED, director of Khlong Toei District, and head of the CPPS to study and develop the best practice of the waste minimization of the district. The process was undertaken from 2016 and launched under as part of the policy of the BMA and policy of the director of Khlong Toei District. The draft of an appropriate system of BMAWM was developed in 2016 and which BMA governor approved for implementation in the 50 districts on 19 July 2018.

4.5.1 Guideline of Waste's Minimization to BMA District

The guideline of BMA's waste minimization included:

1) The district's waste minimization policy implementation target is to reduce the amount of waste from the base months that were changed from the base year of 2013 of the 20-year DPBM 2013-2032.

2) The director of the BMA district announces the WRS as an essential policy. Integrating the cooperation from 10 head sections of the BMA district to WRS in their offices to serves as an example for residents.

3) Encourage district officers to have knowledge and awareness to practice WRS and waste utilization at the source, both the waste in their offices and the waste from collection service.

4) The BMA district staff reduce and separate the waste from daily work and choose the appropriate techniques and methods with the type of waste and context of the district's location for reducing the amount of waste sent to the disposal site.

5) Encourage all of the residents in the district area to reduce waste at source by reduction and refusing single-use plastic bags and Styrofoam for food

containers and encouraging waste separation for utilization such as recyclables, yard waste, vegetable and fruit peels, food waste, bulky waste, construction waste, and separation for disposal of include hazardous waste and general waste.

6) Promote the motivation of private companies and civil society for group cooperation for WRS or waste processing into new products and support the activities to promote WRS in the district.

7) Communicate with people for knowledge and understanding about the law on SWM, waste separation, rate of a waste collection fee, and law enforcement.

8) Communicate with collection truck drivers to discharge wastewater before weighing waste from the truck and strictly following the signage and traffic rules within the disposal center.

9) The district reports the result of the guideline of BMA's waste minimization implementation to the BMAED every month since September 2018.

The details of BMA, SWM, and WRS are shown in Figure 4.7.

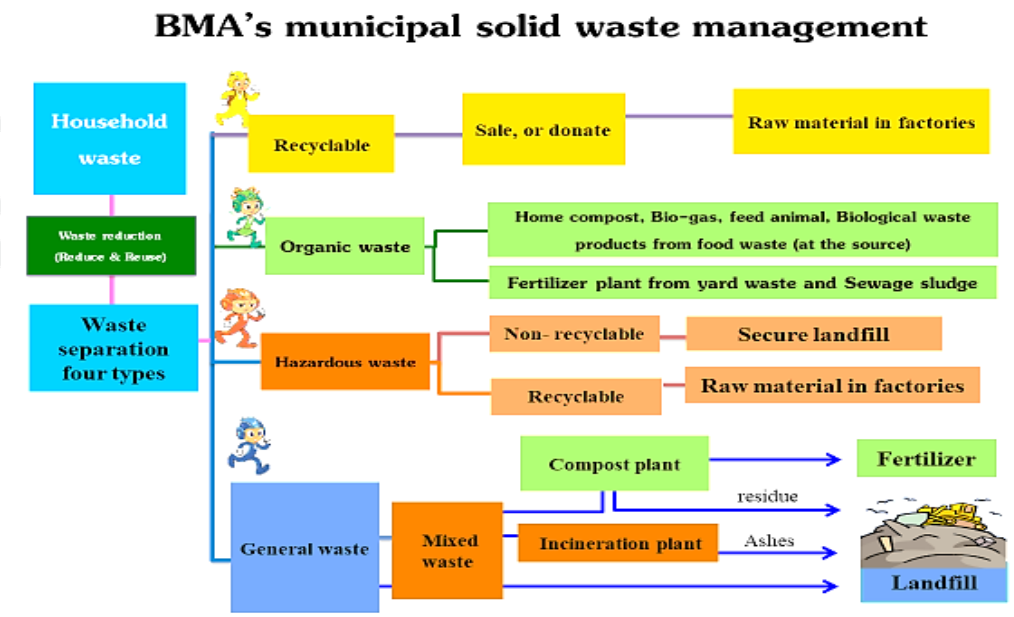

Figure 4.7 BMA's Waste Reduction and Separation Concept

Source: BMAED, 2019.

4.5.2 Experiment an Appropriate BMA's Waste Minimization System

The director of Khlong Toei District announced the zero-waste district under the guidelines of BMAWM for the district. The district has WMPI which used WRS activities according to the guideline as follows:

1) The Khlong Toei District director announced the zero-waste district policy and defined the policy target to reduce the amount of waste from the base year of 2013.

2) The director has integrated all officers under the control of the Klong Toei District director by building their awareness and skill on WRS utilization in their offices. They must communicate the information on waste utilization as an example to residents in daily work (Figure 4.8).

3) The director of Khlong Toei District appointed the district waste reduction committee comprising of the district director, deputy director, all heads of BMA district sections to cooperate in the zero-waste district policy by 3R.

Figure 4.8 District Director Increased Awareness Officers on WRS

4) The district organized meetings with representatives of 68 private companies, commercial buildings, office buildings, condominiums, and department stores. It aims to increase understanding of the participants on the law of SWM relevant to waste in buildings, the new collection fee law, and the method to reduce the amount of waste to reduce collection fees by waste separation (Figure 4.9).

5) The district enforced the law on waste to control illegal dumping and the law on a waste collection fee. The district must collect any material illegally dumped every Saturday (Figure 4.10).

6) The district increases the efficiency of hazardous management by separating hazardous waste form daily general waste collection and define collection points in the communities, shell gas stations, department stores, and government offices by appointing date to collect or call for the collection.

7) The district appointed dates to collect general waste or non-recycling waste for disposal at collection points and communicate with residents about waste disposal times.

Figure 4.9 Private Organizations Participated in WRS

Figure 4.10 District Officers Collect Illegally Dumped Rubbish

8) The district encourages people in communities, department stores, and government offices to separate four types of waste: (1) recyclable waste such as glass, paper, metal, plastic separated for reuse, sale, or donation at the sources; (2) organic waste separate for home compost or wait for farmers to pick up for feeding animals; (3) hazardous waste; and (4) general waste separated to put in closed bags and put at the collection points for BMA waste collection (Figures 4.11-4.13).

Figure 4.11 District Officer Communicate Waste Collection to Residents

Figure 4.12 District Officers Encourage Students to WRS

Figure 4.13 Encouraging People to WRS

9) The district has cooperated with the BMAED and the Industry Council to launch the pilot project on plastic management and sustainability that focuses on plastic management and sustainable waste management by collaborating with the private sectors, civil society. The project had the target for project implementation in seven agencies: Emporium department store, White Group building, Thai TV3, Shell Thailand company, Tobacco Authority of Thailand, Marriott Executive Apartments, and Oakwood Residence Sukhumvit 24 (Figures 4.14-4.18).

Figure 4.14 Privat Sector Cooperation on Plastic and Waste Management

Figure 4.15 Communication the Waste Separation in Pilot Organizations

Figure 4.16 Knowledge Sharing and Understand the BMAWM

Figure 4.17 Waste Composition Before and After of PPP Project

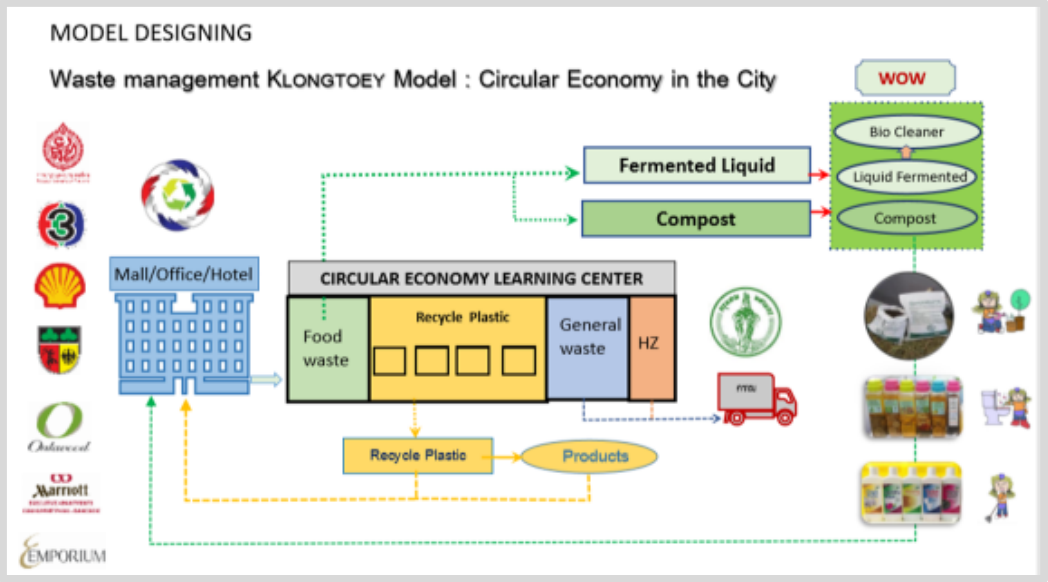

Figure 4.18 Waste Separation Prototype of the PPP Project Working Group

10) The district communicated with the market owners and fruit and vegetable shop owners along the main roads to separate only fruit peels and vegetable scraps and put them in the waste bin or plastic bag. The staff of the district collects them every day. The staff takes the fruit peels and vegetable scraps to the compost in the district and transfers to the fertilizer plant at the On-Nut BMADC (Figures 4.19-4.20).

Figure 4.19 Collecting Vegetable Scraps to Compost in Disposal Center

Figure 4.20 Collecting Fruit Peels to Compost in the District Area

11) The district organized meetings for the staff working under the CPPS including collection workers, swipe workers, and public park workers to build an understanding of the method to reduce waste by waste separation for utilizing in the district area every day. The types of waste separated for utilizing consists of: (1) recyclable waste for sale and donation; (2) vegetable scraps and fruit peels for composting; (3) yard waste and weeds for composting; (4) construction waste for low landfilling; and (5) dry wood and tires to fuel (Figures 4.21-4.23).

12) The district defined the authorized construction and waste collection service, providing waste separation type stores to reduce the amount of waste for disposal.

13) The district increased waste bins by two types around the district, including yellow recyclable bins and blue general waste bins (Figure 4.24).

Figure 4.21 District Waste Separation to Utilize in the District Area

Figure 4.22 Organic Waste Utilization in District Area

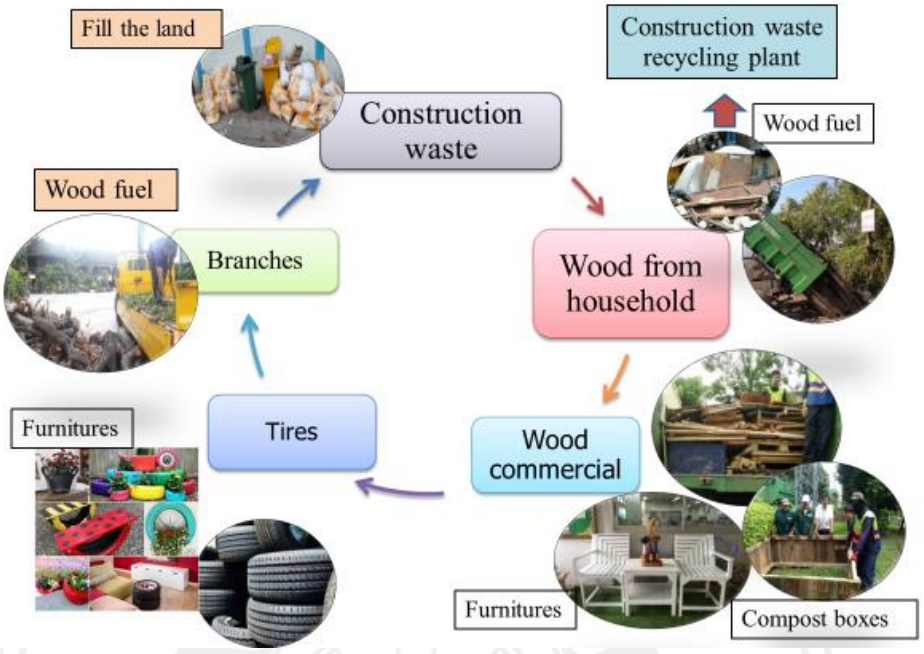

Figure 4.23 Wood, Tires, and Construction Waste Utilization by the District

Figure 4.24 A District Placed 2 Types of Waste Separation Bins All Areas

4.5.3 Results of Experiment Appropriate BMAWM System

The results of the implementation of BMAWM guideline of BMAWM of the Khlong Toei District from the year 2016 to 2019 are as follows:

1) The district officers of all sections cooperated in WMPI, such as using cloth bags to carry things to the office for reduction of plastic bags and set waste separation bins in the office, including an organic waste bin, recyclable bin, and general waste bin.

2) The district has the process of organic waste collection separated from the general waste along the main roads and around Khlong Toei market and take it to the composting point in the district and composting plant at the On-nut disposal center.

3) The network of public-private participation on district WMPI of their places has 87 organizations including ten communities namely Khaoklang community, Flat 23-24 community, Rim Khlong Phi Singto community, Reamcharean community, Rimkhlong Phakanong community, 70 Rai community, Phatanamai community, Lock 1,2,3 community, Pramruathai community, and Rhomkhao community; one market namely Khlong Toei market; one department store namely the Emporium; three office buildings namely White Group building, Thai TV3, and Shell Thailand company; one state enterprise namely Tobacco Authority of Thailand; three residences namely Bangkok Marriott executive apartments, Oakwood Residence Sukhumvit 24, and Emporio condominium, and 68 private companies who participated in the district meeting.

4) The amount of waste disposal of seven companies of the cooperation for sustainable plastic and sustainable waste management project was reduced by 30%.

5) The amount of waste disposal of Klong Toei District reduced after lunch the from the base year 2013 amount of solid waste 340 tons per day in 2013 by shown the amount of solid waste by the year 2014 and 2015 which still not launch the activity under cooperating between the BMAED by the researcher and Klong Toei District that could not waste reduction. After the Klong Toei District launch the zero-waste policy of the district director that could reduce the amount of waste to 319 tons per day in 2017, to 300 tons per day in 2018, and 295 tons per day in 2019 (Figure 4.25).

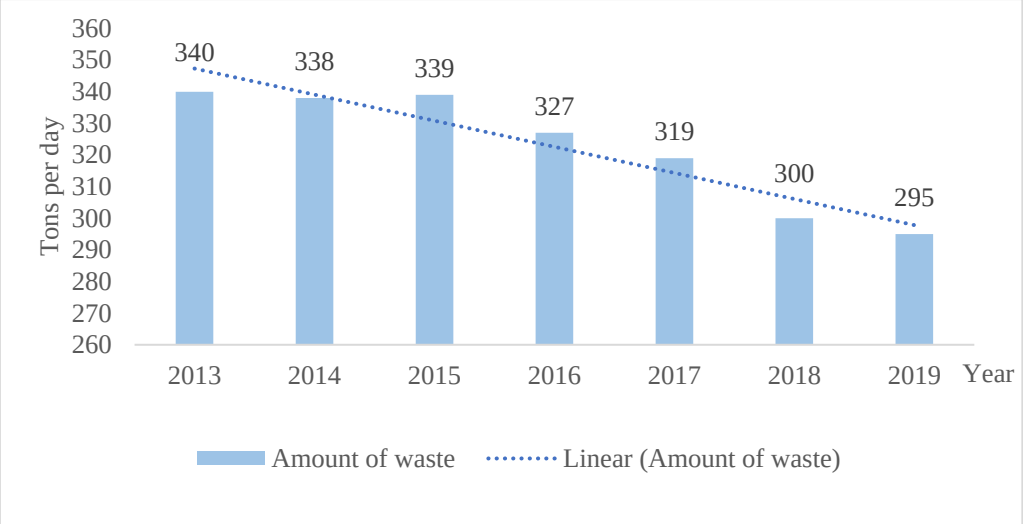

Figure 4.25 Amount of Waste Disposal of Klong Toei District (2013-2019)
Source: BMAED, 2019.

6) The amount of waste utilized includes (1) recyclable to be sold or donated; (2) organic waste including yard waste, vegetable scraps, and fruit peel for composting; (3) yard waste and weeds for composting; (4) construction waste to landfilling; and (5) dry wood and tires to energy from 26,296 tons per year to 30,378 tons per year in 2019 (Table 4.14).

Table 4.14 Amount of Waste Utilization (2015-2019)

Year	Recyclable	Yard waste	Food waste, vegetable scraps, fruit peel	Total
2015 (based year)	19,889	2,471	3,936	26,296
2,016	13,351	3,678	3,894	20,923
2017	19,095	4,116	4,468	27,679
2018	16,060	2,097	6,581	24,738
2019	22,101	1,820	6,457	30,378
Average	**17,652**	**2,928**	**5,350**	**25,930**

Source: BMAED, 2019.

7) The amount of waste reduction of Klong Toei District from 2016-2019 saved cost for collection and disposal of 46,873,573 baht and CO_2 reduction per year was 7,624,200 $KgCO_2e$ as shown in Table 4.15.

Table 4.15 Impact of the Klong Toei District WMPI (2013-2019)

Fiscal Year	Amount of waste (T/D)	Amount of waste reduced		Cost of SWM (B/T)	Save the cost of SWM (B/Y)	CO_2 reduced per year ($KgCO_2e$)
		(T/D)	(T/Y)			
2013 (Base year)	340	-	-	1,682	-	-
2016	326	14	5,110	1,869	9,550,590	1,533,000
2017	318	22	8,030	1,859	14,927,770	2,409,000
2018	300	43	10,449	1,772	18,515,628	3,134,700
2019	295	5	1,825	1,772	3,233,900	547,500
Total					**46,873,573**	**7,624,200**

Source: BMAED, 2019.

4.5.4 An Appropriate System of BMA's Waste Minimization

According to SWOT analysis and TOWS Matrix analysis, this study has developed the appropriate system for BMAWM based on the I-P-O model. All dimensions have affected each other significantly under the same environment. The proposed system was confirmed by trialing in the Klong-Toei District from 2016-2019. The results of the trial were adopted to improve the system to be more appropriate and effective. The improved system has integrated the three dimensions as follows:

4.5.4.1 Inputs Dimension

This dimension is an internal factor that consists of four elements: man, money, material, and management. The inputs are the internal factors for BMAWM that must be supported by BMA to the BMAED and 50 BMADOs for achieving the product. The inputs for BMAWM consist of four elements: man, money, material, and management. The details are:

1) Man

(1) BMA Allocate the personnel for the BMAWM system, especially for 50 districts to manage the WMPI in their districts.

(2) BMA Develop the personnel of BMAED and 50 BMADOs to manage the BMAWM.

(3) Integrate all officers under the control of BMA district directors for awareness and practice on WRS to the participation of BMAWM in their offices, fieldwork, and BMA office visitors in daily work.

2) Money

(1) BMA Allocate the budget for the BMAWM system sufficiently and continuously, especially for 50 districts SWM committees to manage the BMAWM in their districts.

(2) BMA Allocate the budget to the BMAED for the public awareness process, which supports the information communication process to the public, and research and develops innovation to BMAWM.

3) Material

(1) Support the facility for waste separation collection include organic waste vehicles, hazardous waste vehicles, bulky and branches vehicles to 50 BMADOs to sufficiently support organic waste collection, hazardous waste collection, bulky waste collection, and branches waste collection.

(2) Support the facility for waste separation treatment plants include organic waste plants, hazardous waste plants, bulky waste plants, and branches waste plants to sufficiently support organic waste treatment, hazardous waste treatment, bulky waste treatment, and branches waste treatment.

(3) Support WRS communication tool to BMADOs, such as leaflet guides, posters, labels, digital communication to residents.

4) Management

(1) BMA governor appoints the BMA's zero-waste city Committee with the BMA governor as a chairman and the BMA district's committee director of BMA district as the chairman. The BMA committee and BMA district committee should include the representative of BMA staff, NGOs, industry council, educational administrators, religious leaders, government agencies, executives of

department stores, minimarts, supermarkets, hotels, hospitals, and markets, as well as community leaders and others.

(2) BMADOs director appoints the district's zero-waste committee comprising of the BMA district director, deputy director, all of the section heads, government agencies, state enterprises, private agencies, schools, universities, and community leaders to cooperate for the zero-waste district policy by 3R.

4.5.4.2 Process Dimension

This process found that Plan-DO-Check-Action (PDCA) was an effective solution for solid management in Bangkok. The details are:

1) Plan

(1) The BMA's zero-waste Committee makes the BMAWM action plan and guidelines for the BMAED and BMADO implementation.

(2) The district zero-waste committee makes the district action plan for BMAWM under the BMAWM action plan to implement.

2) Do

Do dimension is a process of BMAWM action plan which includes:

(1) The BMA governor determines Bangkok's zero-waste agenda, which focuses on waste separation at source by 3R to be the city of raw material that complies with government policy. After that BMA announces the zero-waste as BMA's agenda and BMADOs announce the zero-waste as BMADOs policy. BMA and BMADOs integrate all sectors into BMAWM to support public awareness activities and develop BMAWM to the zero-waste city and zero-waste district that invites all sectors representative to participate in the BMA's zero-waste Committee and district's zero-waste Committee.

(2) Provide knowledge to all BMADOs, BMAED, and all BMA officers to have awareness and skill on WRS for utilization at source and support BMAWM.

(3) BMADOs manage waste separation in daily work of BMA's officers for utilizing in their district or sending to BMA's disposal center such as recyclable waste for sale or donation, branches, brown leaves, weeds, fruit peels, and vegetable scraps for composting for fertilizer in their district or transfer to fertilizer plant at disposal center.

(4) Define the waste separation types collection to the public especially hazardous waste, yard waste, bulky waste, infectious waste from hospital public health service, fruit peel and vegetable scraps from fruit and vegetable shops on the main roads, market, supermarkets, and department stores by announcing the district regulation on waste separation before disposal, time and place for disposal to all be conducted seriously and continuously.

(5) BMADOs define the two types of public waste bin service, namely recyclable waste by yellow color bin and general waste by using blue color bin or green color bin everywhere that have a waste bin and communicate to people to separate waste before disposal, conduct campaign, and publish on social media continuously.

(6) Using law enforcement measures to control people's behavior of WRS and SWM such as illegal dumping in the wrong place and time by enforcing the law to control the illegal dumping, waste separation before littering, and the law on a waste collection fee.

(7) BMADOs encourage the people focusing on 14 target groups awareness and concern on WRS by the CBM concept that focuses on the participation of community or other group members to have the awareness that understands the waste problem, waste separation at source, waste bin management, time, and place for waste disposal to BMA district collection and clean up their community and other groups.

(8) Build public participation in BMAWM under the zero-waste city campaign by disseminating information on how to separate waste and how to dispose of waste at the public collection point and builds awareness about the adverse effects of waste. Build coordination with government agencies, private companies, and NGOs. Industry Council to work to move forward the BMAWM

system with the BMA governor and staff for the sustainability of BMA solid waste management.

(9) BMADOs promote people to WRS on public media include reducing single-use plastic and Styrofoam, and separate waste before littering such as recyclable waste for sale or donation and organic waste from household to compost for fertilizer at their home. If they cannot make home compost, they can dispose of it at the general waste bin or general waste collection point near their homes.

(10) BMADOs organize the meetings of all sectors to promote the BMAWM participation such as schools, supermarkets, department stores, hotels, hospitals, markets, communities, office buildings, and government offices to participate in waste separation and contribute to District's BMAWM network to work with BMA district.

(11) Provide knowledgeable people including students in the BMA schools, community leaders, condominium committees, village housings, office buildings, and other agencies to have awareness and skill on BMAWM and utilization, especially organic recyclable waste and hazardous waste.

3) Check

Check is the stage of monitoring and evaluation of the BMAWM plan implementation of district and improvement the best practice to make a guideline of BMAWM. Monitoring and evaluation of BMAWM launched by the BMAED and deputy BMA governor, and Permanent Secretary of Bangkok. Details are as follows:

(1) The BMA decides the monitoring and evaluation committee monitor and evaluate the implementation and give advice in more detail in the process of WMPI of the districts.

(2) The BMA decides KPIs of BMAWM of BMADOs and BMAED, including the amount of reduction, amount of waste utilization, reduction of recyclable and organic waste in waste composition, waste separation type number of communities participating to WRS, and the number of other organizations participating to WRS to be increased, number of BMADOs that can increase the rate of waste reduction, and people behavior changes.

(3) The BMADOs collects data of activities that respond to the KPIs of WRS and enter data to the BMAED online report for evaluating the success of the waste separation process.

(4) The BMAED evaluates the data and reports the result of the BMAWM evaluation to the BMA governor every three months.

(5) The BMA discussion on the result of BMAWM evaluation in the vertical meetings for BMAWM improving. BMA vertical meetings include the BMA governor as the chairman, Permanent Secretary of Bangkok, The BMAED administrator and staff, and the head of CPPS, 50 BMADOs.

4) Action

The action is implementing a guideline for BMAWM of the district that is the result of the discussion as follows:

(1) The BMAED administrator and staff, the head of cleansing and public park sectors, 50 BMADOs, have a meeting discussing the improvement of the guideline for BMAWM.

(2) The BMA governor approves a guideline for BMAWM of the district and BMAED, which is offered by the BMAED.

(3) The BMADOs and BMAED implement a new guideline for BMAWM. The BMADOs then collects data of any activity that responds to KPIs of waste reduction and wastes separation and entry data to the BMAED online report for evaluating the success of the waste separation process.

(4) The new BMAED evaluate the data and report the result of new BMAWM evaluation to the BMA governor and the vertical meetings of the BMA governor, BMAED, and BMADOs.

4.5.4.3 Output Dimension

This study has suggested and indicators for monitoring and evaluating success. The evaluation of success can be the quantitative or qualitative outputs and it should be compound with product and impact such as:

1) Amount of waste reduction: the household waste collection for general waste to BMADCS for treatment and disposal should reduce the volume because some parts of waste separated to utilize at the sources.

2) Amount of waste utilization: Most of the waste composition can be utilized at sources such as recyclable waste, brown leaf, bulky waste, branches, construction waste, and food waste. It should be utilized at the source by people in communities and organization agencies and households.

3) Amount waste separation type: The solid waste separation to utilized at source and plant in BMDDC by type could be increased especially organic waste, hazardous waste, bulky waste, and branches waste.

4) The ratio of waste composition is the percentage of recyclable waste and organic waste in general waste for disposal should be reduced from before lunch the appropriate BMAWM system.

5) The successful of BMAWM by new WMS with WRS cloud have participated all parties of Bangkok to WRS and SWM under waste management law, economic incentive, social awareness to participation on WRS, and sustainable waste management that should behave participation KPIs such as the number of community participation, number of 14 target groups participation, number of BMADOs have amount of waste reduction, and the ratio of the number of people change behavior on WRS and SWM cloud be increasing.

The proposed new system of BMAWM for Bangkok is illustrated in Figure 4.26.

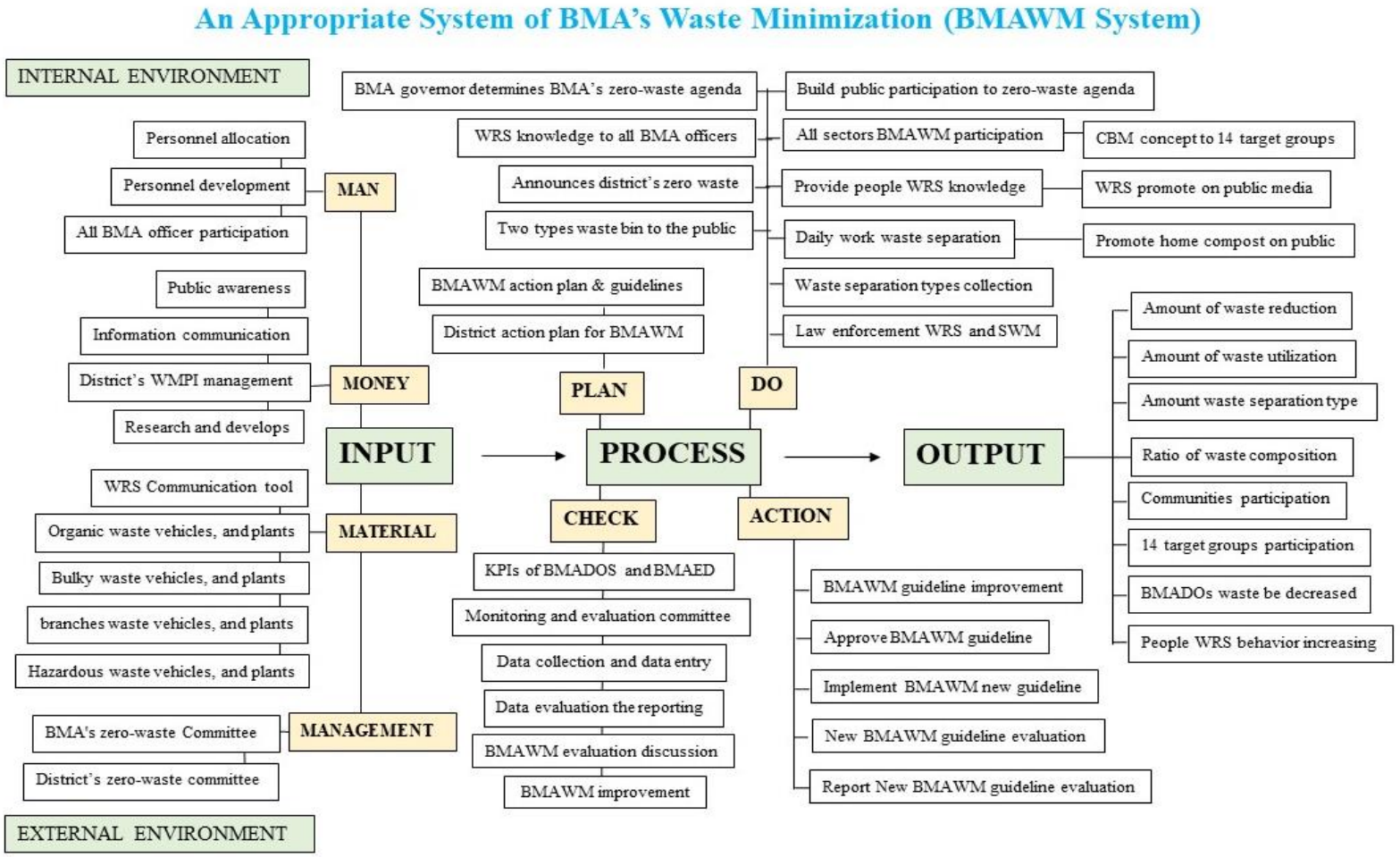

Figure 4.26 An Appropriate System of BMA's Waste Minimization

CHAPTER 5

CONCLUSION, DISCUSSIONS, AND RECOMMENDATIONS

This research aimed to assess the effectiveness of the BMAWM, investigate the influencing factors, and establish an appropriable BMAWM that can be applied for policy proposals of BMA and other cities in Thailand. This could lead to sustainable SWM and the welfare of society. The research used the qualitative method based on primary data collected through interviews, participatory observation, and data from secondary sources. The main objective was to evaluate the effectiveness of waste minimization implementation of the 20-year DPBM (2013-2032). The key informants were the BMA administrators, the Strategy and Plan Department administrators, the BMAED administrators and staff, the BMADOs and staff, and the community leaders of the zero-waste communities and green communities. The research methodology employed four methods. For BMAWM evaluation, the CIPP-I framework was used for determining the effectiveness of BMAWM in Bangkok including Context (political, economic, social, technological, environmental, and legal), Input (man, money, materials, and management), Process (plan, do check, action), Product (KPIs of the BMAWM), and Impact (environment, economic, and society). The factors analysis used SWOT analysis which included the internal factor analysis that used the McKinsey 7S framework (strategy, structure, systems, shared values, staff, skills, and style), and the analysis of the external factors which used the PESTEL (Political, Economic, Social, Technological, Environmental, and Legal). The strategy formulation used the TOWS matrix model for four dimensions including SO Strategy, ST Strategy, WO Strategy, and WT Strategy. For appropriate BMAWM development, the Input-Process-Output (I-P-O) model was used based on the system management theory that believes that the success of management depends on input and process under the external and internal environment of an organization. The input used 4M resource management (man, money, materials, and management). PDCA (plan, do

check, action) was adapted to suggest the process development and the output (KPIs of the plan) developed by targets for the plan that included product and impact (impact on the environment, economy, and society). The appropriate BMAWM development from this research has been applied as a guideline for district WMPI approved by the BMA governor to implement in the Klong Toei district for three years (2016-2019). Moreover, a guideline for district WMPI has been improved for policy implementation of BMA and could be extended to other cities for their municipal SWM toward sustainable SWM.

5.1 Conclusions

Currently, Thailand is facing a waste crisis from rapidly increasing amounts of waste and inappropriate disposals such as illegal dumping, burning, litter in public areas, and waterways. 2,881 municipalities do not have waste collection systems and disposal stations. This increases illegal industrial waste dumping. Also, the volume of collected hazardous waste from communities is still very low, because people do not separate and throw it in the general waste bins. Electronic wastes are harmful to the environment because they contain chemicals. Several companies and people have disassembled the electronics into smaller parts following improper disposal methods that do not adhere to sanitation principles. Some infectious wastes are also not reported in the disposal system (PCD, 2019). Although BMA has a decent waste operation that follows sanitation techniques, the amount of waste is still increasing rapidly. The problems are disposing of waste at the wrong time, illegal dumping, unseparated hazardous wastes (BMAED, 2019). The SWM of BMA has established in the 20-year DPBM 2013-2032, Solid SWM Plan 2015-2019, 5-year BDP, and Annual BDP. All the plans were made according to the Bangkok Metropolitan Administrative Organization Act, 1985; Public Health Act, 1992; and Cleanliness and Tidiness of the Country Act, 1992. The Department of Environment and 50 district offices are responsible for the management of wastes. For enforcement of the legislation, the BMA has assigned the responsibility among different departments, such as the BMAED (PPD, WHNMD, and WDD), Health Department, City Law Enforcement Department, BMADOs (CPPS, City Law Enforcement Section,

Environment and Sanitation Section, Public Work Section, and Community Development and Social Welfare Section. BMA has been focusing and working on clean up the city. Most of the tasks emphasize the cleanliness and tidiness through collecting all wastes form households, roads, and public areas. Also, BMA has routinely collected bulky wastes from communities and cleaned up weeds to prevent blocking and contamination in the waterways.

Due to the enormous increase in the volume of MSW in Bangkok, the BMA has implemented policies to cope with the problem. For example, the 3rd BDP 1987-1991 and the 4th BDP (1992-1996) focused on controlling the amount of MSW by establishing public relations policies, campaigns, and encouraging people to separate MSW for utilization at the source and avoiding using plastic and Styrofoam to reduce the amount of MSW disposal and to save cost. After that, the BMA created the 6th BDP (2002-2006) with the target of reduction of MSW by separating it at the source for recycling at least 15% in 2006. Then, the Bangkok Administration Plan (2005-2008) changed the target to reduce MSW at least 10% per year. The result of the past operations has not succeeded as the amount of MSW has decreased by only 8.57% and 6.16% respectively, while the targets were 15% during the years 2002-2006, and 10% per year during the year 2005-2008. In 2013, The 20-year DPBM (2013-2032) decided the target to reduce MSW by at least 20% by 2032 based on the year 2013. To achieve the target, the amount of MSW should decrease by at least 7% by 2019.

5.1.1 Effectiveness of BMA's Waste Minimization

The study found that the amount of waste in Bangkok did not decrease by the target of the 20-year DPBM (2013-2032) on waste minimization between the years 2014-2019. This meant BMA was unsuccessful in waste separation at the source. By the results of the CIPP-I evaluation revealed that the context, input, process, product, and impact of BMAWM indicators were both strong and weak as follows:

1) The context had seven strong indicators, including national waste minimization policy and plan, BMA's waste minimization policy and plan, industry collaboration, private sectors participation, IT communication, Bangkok area environment, and waste management laws; and it also had two weak indicators, including local politicians unstably, and public behavior on mixed waste littering.

2) Input had seven weak indicators, including the number of personnel, personnel development, personnel assignment, waste minimization project, communication tools, waste utilization capacity, and organization management was insufficient to supply for BMADO's needs.

3) The process had two strong indicators, including BMA was properly on monitoring and evaluation, and waste minimization guidelines; and it had six weak indicators, including an action plan, personnel acceptance, law enforcement, public participation, public communication, and waste collection system were insufficient for BMAWM of the BMADOs.

4) The product had two strong indicators, including the number of agencies cooperation, and amount of waste utilization was increased; and it had four weak indicators, including the number of CBM participation, the amount of waste separation types, and amount of waste composition was few changed, and amount of waste disposal were increased. Product of waste minimization between the year 2014-2019 as the MSW increased annually by 2%, 1.7%, 5.7%, 7.4%, and 6% from the annual target amount for waste reduction of 3%, 4%, 5%, 6%, and 7%, which means that the BMA was not successful according to the target of the 20-year DPBM.

5) The impact had four strong indicators, including the values of waste utilization were benefited to CBM social participation, low-income people, BMA's waste collection workers, and recycling businesses while it had four weak indicators, including CO_2 emissions, and collection and disposal cost were increased, renewable resources lost, and collection and disposal fees unsuitable with the cost of waste management.

5.1.2 Factors Affecting of BMA's Waste Minimization

This study has analyzed the internal and external factors of the BMA related to waste minimization at source and separation. The results found that the strengths of internal factors were obvious and included 1) BMA has a policy, strategic plan, long-term goals, and has a precise evaluation and tracking system; 2) BMA has the power to set policies, allocate budgets, materials, equipment, personnel, and can issue ordinances to solve problems; 3) BMA governors and executives are committed and act as role models, and 4) BMA develops personnel responsible for SWM to have the

knowledge and ability to create participation in WRS. However, this study found that weakness of the internal factor includes 1) BMA has a large structure. Chain of command delivering jobs to departmental and personnel levels; 2) BMA has many related agencies but lacks integration of collaboration with different characteristics and actions unable to have an overall effect; 3) BMA has not yet determined the official position of the officer responsible for BMAWM, and 4) Most BMA personnel responsible for public services have not yet been cultivated in the shared values of BMAWM.

The opportunities for external factors include 1) Government has a national agenda on SWM policy, SWM master plan, and follow-up; 2) People, the private sector, and various organizations have participated in SWM activities with Bangkok in many areas; 3) Most of the population has access to the Internet to communicate and access a personal level that is more communication channels; 4) Temperature and humid weather suitable for composting in household and organic waste treatment system at the source, and 5) Government issues legislation to separate waste and requires separation of hazardous waste and recyclable waste before disposal. However, the study found the threat factors effected by the BMAWM include 1) manufacturers are not responsible for the waste by recalling for reuse or disposal; 2) recycle material collection system depends on the material price. The cheapness of recyclable materials means less collected for recycling; 3) lack of control of materials import operators causing a low price for Thai recyclables; 4) economic growth causes more consumption, more waste, and more SWM cost; and 5) Thai society is familiar with discarding waste together, even with separate bins. Waste by type is still not separated into the correct bin.

5.1.3 Strategies of BMA's Waste Minimization

Overall, the results of an internal and external factor were evaluated by SWOT analysis. The completed matrix consisted of the marriage of both factors as strengths with opportunities, strengths with threats, weaknesses with opportunities, and weaknesses with threats. This study summarizes the four strategies for improving the waste minimization strategies of the BMA as below:

1) SO Strategies: the BMA should establish new strategies for BMAWM implementation by using strengths with opportunities situations such as 1) to raise zero-waste to be the city's agenda, with the cooperation of all agencies and support budgets, personnel, and resources in SWM and waste separation; 2) to develop mechanisms to raise online media awareness. Creating a participatory process and separation by law enforcement measures. Economic measures promote recycling fees and social measures to cover 50 district areas; 3) to develop mechanisms to promote the reduction of organic waste and biodegradables to utilize by composting at home and build a food waste processing facility to compost in the BMA waste disposal center; and 4) to develop legal measures relating to waste before disposal and to a determination of dumping points, definite date and time for disposal classification, and efficient enforcement of the system.

2) WO Strategies: the BMA should establish new strategies for BMAWM implementation by using opportunities situations resolve weaknesses situations such as 1) to integrate government officials, private agencies, communities into networks or working groups for BMAWM management; 2) to establish a zero-waste city and zero-waste district with public participation, targeting measures for the success of the department such as an annual bonus for all BMA officers; and 3) to develop communication applications to create public understanding of BMAWM at source, disposal of a separated waste method, and sales channels that promote recycling and organic waste.

3) ST Strategies: the BMA should establish new strategies for BMAWM implementation by using strengths situation resolve threats situations such as 1) to develop a network of cooperation with product manufacturers to be aware of packaging that can be reused in a new production process and urges the government to legislate the return of products to the manufacturer to be recycled or treated; 2) to collaborate with manufacturers and networks to collect recyclable data via a recycling storage system with data directly from households to collect reliable and high-quality raw materials comparable to those abroad; 3) to improve the law regarding junk shops in Bangkok to facilitate the purchase of recycled materials and develop a green junk store; and 4) to develop communication by the governor with the public to recognize

the value of recycled materials as a resource, separate waste, and discard it into the correct bin.

4) WT Strategies: the BMA should establish new strategies for BMAWM implementation to reduce weaknesses with threats situations such as 1) to the reorganization of the BMADOs is responsible for promoting waste reduction and waste separation, manage waste minimization effectively and continuously; 2) to develop a separate waste collection system to accommodate the public that should be waste separation systems in all offices and communication with the public via BMA officials and social media; and 3) to improve the quality of life of the BMA's waste collectors via the introduction of infection prevention systems, reduction of waste separation during collection, and develop knowledge of BMAWM.

5.1.4 The Appropriate System of BMA's Waste Minimization

According to SWOT analysis and TOWS Matrix analysis, this study has developed the appropriate system for BMAWM based on the I-P-O model. All dimensions have affected each other significantly under the same environment. The proposed system was confirmed by trialing in the Klong Toei District from 2016-2019. The results of the trial were adopted to improve the system to be more appropriate and effective. The improved system has integrated the three dimensions as follows:

1) Input Dimension: this dimension is an internal factor of BMA that consists of four main elements: man, money, material, and management. The man aspect to personnel allocation, personnel development, integrates all officers of BMA participation by raising awareness for waste reduction. The money aspect considered to allocate budgets to enhance public awareness activities, support information communication, research and development for WMS, and support sufficient for districts' WMPI management. The material aspect considered new facilities for waste separation management of BMA such as vehicles and plants for waste separation collection and treatment by type (organic waste, hazardous waste, bulky waste, and branches waste) and communication tool. The management aspect considered BMAWM participation management by all sectors to partnership on BMAWM management of BMA and BMADOs includes the BMA zero-waste committee and district zero-waste committees.

2) Process Dimension: this process found that PDCA was an effective solution for solid management in Bangkok. The First, Plan: that is considered to make the BMAWM action plan & guidelines for the city level and make a district action plan for BMAWM for the district level. Second, Do: that considered to make the activities of BMAWM include BMA governor determines BMA's zero-waste agenda, share WRS knowledge to all BMA officers, announces district's zero waste, practice daily work waste separation, practice waste separation types collection, set two types of the waste bin to the public, strictly and continuous on law enforcement of WRS and SWM, build public participation to zero-waste agenda, promote the CBM concept to 14 target groups, promote all sectors to BMAWM participation, provide people WRS knowledge, WRS promote on public media, and promote home compost on the public. Third, Check: that considered to set the KPIs of DMADOs and BMAED for BMAWM, Monitoring and evaluation BMAWM implementation by the committee, Data collection and data entry, Data evaluation the reporting, BMAWM evaluation discussion, BMAWM evaluation, and report BMAWM to BMA governor and the BMA vertical meeting. Finally, Action: that is considered to have BMAWM guideline improvement, approve BMAWM guideline by BMA governor, implement BMAWM guideline, new BMAWM guideline evaluation, and report new BMAWM guideline evaluation.

3) Output Dimension: this process is the product of the BMA,s BMAWM from input dimension and process dimension the should behave the result both product and impact include the amount of waste reduction, amount of waste utilization, amount waste separation type, the ratio of waste composition, communities participation, 14 target groups participation, the number of BMADOs waste decreased, the ratio of people WRS behavior increasing. The output cloud shows the success of the BMA's BMAWM both quantitative and qualitative output.

5.2 Discussion

The researcher analyzed the strength factors of waste minimization. This study reported that the BMA has distinct and persistent strategies, long-term goals, and a monitoring and evaluation system. The target was zero-waste by recycling and reusing waste and promoting effective technologies. As the reports of USEPA (2011), and Leblanc (2019) suggested, the ISWM Hierarchy principle by Field and Field (2012) and Bonciu (2014), the solution begins with waste minimizing, reusing, recycling, and recovering to be energy efficient and lastly relies on sanitary disposal. Also, the 3R principle recommends for waste minimization at the source to be more productive. The organization management aspects evaluated the Bangkok governor and executives and revealed that the governor has direct authority over establishing policies, legislations, allocating budgets, and employees on SWM. The governor is a role model for reducing waste and implements the policies for all administrative levels. That is in line with the study of Ngernklay (2008) who found that leaders were essential elements in cooperation and partnerships to solve the problems and accomplish missions. Also, the leader must create examples of solutions in practice.

The weakness factors on waste minimization in BMA were that it had no specific waste separation information at the source. There are several weak factors, such as organizational structure, with several levels, and many civil servants and employees. The leading organizations responsible for waste minimization are BMAED and district offices, but they do not have authority over waste collectors who handle an enormous amount of waste, and they are not mainly responsible for communication on waste separation. Therefore, this could be partly responsible for the failure to meet goals. Also, BMA lacked creative communication with the public to encourage waste minimization. This is in line with (Chantasorn, 2008) who compared the organization structure sizes and found that small organizations have more success in practice on SWM than large organizations. Also, Chuntaviboon (2016) presented that government officials either are involved or have a significant effect on the accomplishment or failure of policy implementation. As people have different motivations, goals, and values; therefore, the executives of Bangkok must create civil service values to promote public participation in BMAWM.

For the essential external factors contributing to the management of BMAWM, this study reported that the central government has a clear policy declaring waste as part of the national agenda. Also, there is a master plan for SWM in Thailand that has established measures to reduce and sort waste at the source following the 3R principle. Moreover, the legal enforcement factors have been implemented for the separation of hazardous waste and recyclable waste from general waste before disposal. As mentioned above, Bangkok could directly enforce this legislation. It found that various sectors and the public have cooperated and are involved in SWM in many areas of Bangkok. Also, the Internet accessibility of Bangkok residents is very high, especially social media. That is an opportunity for BMA to use as a channel to create public understanding at a personal level which complies with Ontes, Poboon, Phoochinda, and Kunta (2018) who stated that the factors affecting the reduction of solid waste were (1) communication to communities; (2) the districts collected waste by types and made use of them; (3) district administrators paid attention and implemented the policy seriously; (4) adjustment of activities to be related to the growth of the areas both business and housing; (5) the policy of Bangkok Metropolitan Administrators supports the implementation seriously; (6) serious law enforcement; (7) management of waste collection that was responsive to waste separation; (8) district staff had knowledge and understanding of waste minimization; and (9) clarity of practice guidelines from BMA. These coincided with MEJ (2005) studied the management of a renewable resources society and stated that the central government of Japan has enacted relevant laws for making a national action plan and established a council to promote the creation of a circular resource society. Later, local governments created action plans for a co-driven leading network, including communities, the private sector, central government, NGOs, and local government. The policy was driven by five factors: raising awareness in society, information dissemination, seeking partnership from all sectors, stimulating motivation, developing technology, and seriously using law as an instrument for the enforcement of SWM and coincided with Yavaprabhas (2014) state that the factors affected the success or failure of policy implementation include the nature of the policy, policy objectives that have a clear purpose (Thamrongtunwong, 2005), the political possibility must be supported by the business sector, technical feasibility and theoretical reliability are important, human behavior

will be changed from effective theoretical and policy implementation, sufficient finances are needed for resources, manpower, and quality of personnel, the necessity is one of the factors to consider such an adequate role, specific knowledge, the services as to materials, offices, tools, land, and other facilities, the structures of institutions play an important role in implementation, the attitude and understanding of leaders are a necessity in practice, and relationships between the various agencies must concern success or failure. For example, if an organization has several units and different tasks, this could result in a delay in operation or ineffective implementation.

Regarding the threat of external factors to waste minimization and separation, this study found a lack of precise measurements in the production process and disposal system, and manufacturers are not responsible for their used products as part of an environmental system. That is consistent with Malikamal and Kanjanawat (2000) who stated that the government of Japan and Germany require manufacturers, importers, and distributors to recall products. Additionally, in Canada, the government requires manufacturers to reduce unnecessary packaging and design products to be as recyclable as possible. That is also the following EC (2015) and Bonciu (2014) who described the circular economy principle in which the primary method is to reduce unnecessary materials and to make more eco-friendly and durable products.

Additionally, the threat factors for waste minimizing found that Thais are familiar with disposal of all wastes in one bin. Even where BMA has provided separate types of bins, the population largely still does not discard correctly. Waste separation at the source depends on the motivation and price of recycled materials; for example, cheap materials will not be collected for recycling. Moreover, the government lacks sufficient control over the import of recyclable materials. Thus, this has a considerable impact on the price of recyclable waste and lowers the efficiency of the material collection system. This directly affects the amount of waste when combined with rising levels of economic prosperity and concomitant consumption of Field and Field (2012) reported that the economic growth that causes higher production and consumption could generate more waste from the production-consumption process.

5.3 Recommendations

The results of this study revealed that the waste minimization target set during 2014-2019 was 2% or less than 9,764 tons per day in 2014; 3%, or not less than 9,664 tons per day in 2015; 5%, or less than 9,465 tons per day in 2017, and 7%, or the less than 9,266 tons per day, respectively. The MSW must decrease by 2-5% year by year. The amount of MSW during 2014-2019 decreased by 0.2% in 2014, after that the amount of MSW increased annually by 2%, 1.7%, 5.7%, 6.9%, and 6% in 2015-2019 indicating that the BMAWM was unsuccessful in meeting the targets of the 20-year DPBM during 2013-2019. The results of the BMAWM evaluation based on CIPP-I model revealed that including the context had nine indicators, were seven strong and were two weak; the inputs had seven weak indicators (the number of personnel, personnel development, personnel assignment, budget of waste minimization project, communication tools, waste utilization capacity, and organization management); the process had two strong indicators (properly on monitoring and evaluation, and waste minimization guidelines) and it had six weak indicators (an action plan, personnel acceptance, law enforcement, public participation, public communication, and waste collection system were insufficient); the product had six indicators, were two strong (the number of agencies cooperation and amount of waste utilization was increased) and four weak indicators (the number of CBM participation, amount of waste separation types, and amount of waste composition was few changed, and amount of waste disposal were increased); and The impact had eight indicators, were four strong indicators (CBM social participation, low-income people, especially of BMA's collection workers and those in the recycling business) while it had four weak indicators, including CO_2 emissions, collection and disposal cost were increased, renewable resources lost, and collection and disposal fees unsuitable with the cost of waste management. Regarding the effectiveness of BMA's waste minimization system according to zero-waste vision, and waste reduction and separation on the 20-year DPBM (2013-2032), this research has recommendations as follows.

5.3.1 Policy Level

1) The Governor of Bangkok should announce a policy on waste reduction and separation as a mandatory process on SWM. Also, BMA could prioritize the significant policy of zero-waste Bangkok Metropolitan and zero-waste district offices by enhancing waste separation as an important part of Bangkok waste management.

2) The administrative structure should be in the form of the Bangkok SWM committee, which broadly integrates cooperation from the Bangkok government, the central government, the private sector, NGOs, community leaders, citizens, and other relevant parties for greater policymaking.

3) All BMA government offices could be involved in the waste minimization procedure by appointing a committee in each office. The committee responsible for enhancing knowledge and understanding of SWM could not only be applied in offices but could also be applied in all areas of daily life. Moreover, the motivation to reach outcome indicators could be set in terms of extra money or bonus.

4) Manufacturing network development is an integral requirement for successful policy implementation. The government should pass legislation requiring manufacturers to recall products for recycling. The recycling shop network should be developed by directly buying recyclable waste from households. This could also improve the quality of recyclable waste as is the case in other countries.

5) The relevant legislation can be revised, such as laws governing waste separation at source, schedule of collection of different waste types, littering, waste to landfill, and incineration. Also, the laws for recycling shops can support the use of recyclable materials for new products. Moreover, the Polluter Pay Principle can be incorporated into the legislation.

6) The policy of organic waste needs to be reconsidered to reduce organic waste going to landfills and incinerators. Several methods for utilizing organic waste have been researched, such as home composting and biological fermentation. Legislation should have measures to prohibit organic waste disposal mixed with other waste bins, and every site could set a composting area or organic waste collection points. Moreover, BMA could cooperate with the private sector to improve composting technology and operational efficiency.

7) An effective monitoring system is necessary for BMA executives and all departments to facilitate continual checking of results according to indicators.

5.3.2 Operation Level

1) The director of the BMA district should announce a zero-waste district office policy on waste reduction and separation on waste management that support the BMA's zero-waste policy. BMA district can establish the committee for driving the district's waste minimization network for zero-waste in their district. The relevant sectors include BMADO officials, the central government officials, the private sector, NGOs, community leaders, citizens, and social organizations.

2) As suggested in number 1, the district office directors could establish subcommittees by cooperating with relevant sectors to cover all areas in the district.

3) Improving and restructuring the CPPS is required, primarily by providing it with sufficient resources so it can minimize waste at source and manage the waste system effectively.

4) Public relations and applications are needed by increasing various channels for communication and sharing information on SWM efficiency with the public.

5) The safety and quality of life of waste collection workers must be improved. According to occupational health and safety, personal safety equipment is essential for preventing harm from waste collection. Also, they should not be responsible for waste separation at collection points if the policy of waste separation at the source is sufficient.

6) BMA districts develop a waste collection system by supporting suitable waste separation containers and collection points. In the district offices, good practices should be followed to set the example for the public on waste separation at source.

7) BMA districts integrate for the public by enhancing waste utilization of both non-recyclable and recyclable materials such as composting from food wastes, selling recyclable wastes, product reuse, organizing hazardous waste collection points, and setting specific date and time for different types of waste collection.

8) BMA districts should effectively monitor and evaluate systems that are necessary for district offices to evaluate the success of the district's WMPI and continually improve efficiency.

5.4 Recommendations for Further Studies

For future studies, good practices of WMS, and WRS by different institutions could be researched such as communities, schools/campuses/universities, shopping malls, condominiums, and hotels. For the BMA organization, researchers could study the implementation of the policy by the BMA and the 50 district offices for measuring the effectiveness and success of SWM in BMAWM of BMA. This could also create a standardized measurement for BMA. The WMS and BMAWM of other cities could also be investigated.

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APPENDICES

Appendix A

The Result of Delphi-Technique

Issues	Indicators	The point, and Number of experts					Total (point)
		5	4	3	2	1	
Context of the BMA's waste minimization							
1. Policy and plan	National policy and plan And BMA policy and plan support to the BMA's waste minimization	18	4	2	0	0	112
2. Economic growth	Industry collaboration	18	6	0	0	0	114
3. Public participation	Public behavior and Private sectors participation	20	4	0	0	0	116
4. IT infrastructure	IT communication	16	5	3	0	0	109
5. Environment of Bangkok	Bangkok area environment	16	4	4	0	0	108
6. Waste management laws	Waste management laws	24	0	0	0	0	120
The input of the BMA's waste minimization							
1. Personnel	Personnel, personnel development support and sufficient for the BMA's waste minimization	19	2	3	0	0	112
2. Budget	Budget for the BMA's waste minimization: waste minimization project	21	1	2	0	0	115

Issues	Indicators	The point, and Number of experts					Total (point)
		5	4	3	2	1	
3. Materials	Materials for the BMA's waste minimization: communication tools,	20	3	1	0	0	115
	Materials for the BMA's waste minimization: waste utilization capacity	18	4	2	0	0	112
4. Management	Organization management	19	4	1	0	0	114
Process of the BMA's waste minimization							
1. Plan	Action plan	18	2	4	0	0	110
2. Do	Personnel acceptance	17	5	2	0	0	111
	Law enforcement	24	0	0	0	0	120
	Public participation	24	0	0	0	0	120
	Public communication	24	0	0	0	0	120
	Waste collection system	24	0	0	0	0	120
3. Check	Monitoring and evaluation	20	4	0	0	0	116
4. Action	Waste minimization guidelines	19	3	2	0	0	113
Product of the BMA's waste minimization							
1. Public participation	Number of CBM participation	20	3	1	0	0	115
2. Public-private partnership	Number of agencies cooperation	22	2	0	0	0	118
3. Waste utilization	Amount of waste utilization	23	1	0	0	0	119
4. Waste separation	Amount of waste separation types	24	0	0	0	0	120
5. Waste composition	Amount of waste composition	22	1	1	0	0	117
6. Waste disposal	Amount of waste disposal	24	0	0	0	0	120

Issues	Indicators	The point, and Number of experts					Total (point)
		5	4	3	2	1	
Impact of the BMA's waste minimization							
1. Impact on the environment	The impact on the environment: CO_2 emission	24	0	0	0	0	120
2. Impact on the economy	The impact on the economy: collection and disposal cost and renewable resources	24	0	0	0	0	120
3. Impact on society	The impact on society: CBM social participation, Low-income people, BMA's waste collection workers, recycling businesses	24	0	0	0	0	120

Appendix B

Observation Form

Issue	Result of Observation
1. Policy and plan support the BMAWM or not? How?	
2. Economic growth supports the BMAWM or not? How?	
3. Public Participate supports the BMAWM or not? How?	
4. Technology infrastructure support the BMAWM or not? How?	
5. The environment of Bangkok support the BMAWM or not? How?	
6. SWM law supports the BMAWM or not? How?	
7. Is personnel sufficient for the BMAWM or not? How?	
8. Personnel developed sufficiently for the BMAWM or not? How?	
9. Is budget sufficient for the BMAWM? How? or not? How?	
10. Are materials sufficient for the BMAWM or not? How?	
11. Is organizational structure appropriate for the BMAWM or not? How?	
12. Waste collection infrastructure supports the BMAWM or not? How?	
13. Is an action plan appropriate for the BMAWM or not? How?	

Issue	Result of Observation
14. Personnel accept the BMAWM or not? How?	
15. Law enforcement on BMAWM effective or not? How?	
16. Public participation supports the process of BMAWM or not? How?	
17. Communication to the public on the BMAWM effective or not? How?	
18. Separated waste collection practiced for BMAWM or not? How?	
19. Monitoring &Evaluation of the BMAWM effective or not? How?	
20. New guidelines for the BMAWM effective or not? How?	
21. Percentage of the communities participated in BMAWM appropriate or not? How?	
22. Percentage of government and private organizations participated in BMAWM appropriate or not? How?	
23. Percentage of waste utilization appropriate or not? How?	
24. Percentage increase in the amount of waste separation type appropriate or not? How?	
25. Percentage of the composition of MSW appropriate or not? How?	
26. Percentage decrease in the amount of waste in the district? How many districts have decreased waste?	

Issue	Result of Observation
27. What Environmental impact of BMAWM? How?	
28. What are the economic impacts of BMAWM? How?	
29. What are the social impacts of BMAWM? How?	

Appendix C

Semi-Structure Interview Question

1. Do the policy and plan, economic growth, citizenry participate, technology infrastructure, an environment of Bangkok, and SWM law support the BMAWM? How?
2. Are personnel sufficient and personnel developed for the BMAWM? How?
3. Are budget and materials sufficient for the BMAWM? How?
4. Is the organization structure appropriate for the BMAWM? How?
5. Does waste collection infrastructure support the BMAWM? How?
6. Is the action plan appropriate for the BMAWM? How?
7. Do personnel accept the BMAWM? How?
8. Is law enforcement on BMAWM effective? How?
9. Do public participation support the process of BMAWM? How?
10. Is communication to the public on the BMAWM effective? How?
11. Is separated waste collection practiced for BMAWM? How?
12. Is there M&E of the BMAWM? How?
13. Are there new guidelines for the BMAWM? How?
14. What percentage of the communities participated in BMAWM? How?
15. What percentage of government and private organizations participated in BMAWM? How?
16. What was the percentage of waste utilization? How?
17. What was the percentage increase in the amount of waste separation type?
18. What was the change in the percentage of the composition of MSW?
19. What was the percentage decrease in the amount of waste in the district? How many districts have decreased waste?
20. What is the environmental impact of BMAWM? How?
21. What are the economic impacts of BMAWM? How?
22. What are the social impacts of BMAWM? How?

Appendix D

Structure Interview Question

1. Do the policy and plan, economic growth, citizenry participate, technology infrastructure, an environment of Bangkok, and SWM law support the BMAWM? How?.....
……..
2. Are personnel sufficient and personnel developed for the BMAWM? How?
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……..
3. Are budget and materials sufficient for the BMAWM? How?
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……..
4. Is the organization structure appropriate for the BMAWM? How?
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5. Does waste collection infrastructure support the BMAWM? How?
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……..
6. Is the action plan appropriate for the BMAWM? How?
……..
……..
7. Do personnel accept the BMAWM? How?
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……..
8. Is law enforcement on BMAWM effective? How?
……..
……..
9. Do public participation support the process of BMAWM? How?
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10. Is communication to the public on the BMAWM effective? How?

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11. Is separated waste collection practiced for BMAWM? How?

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12. Is there M&E of the BMAWM? How?

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13. Are there new guidelines for the BMAWM? How?

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14. What percentage of the communities participated in BMAWM? How?

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15. What percentage of government and private organizations participated in BMAWM? How?

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16. What was the percentage of waste utilization? How?

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17. What was the percentage increase in the amount of waste separation type?

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18. What was the change in the percentage of the composition of MSW?

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19. What was the percentage decrease in the amount of waste in the district? How many districts have decreased waste?

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20. What is the environmental impact of BMAWM? How?

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21. What are the economic impacts of BMAWM? How?

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……..

22. What are the social impacts of BMAWM? How?

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Appendix E

IOC Testing Results of Question Validity

Question	Experts Opinions Scores			Average Scores of IOC
	+1	0	-1	
1. Do the policy and plan, economic growth, citizenry participate, technology infrastructure, an environment of Bangkok, and SWM law support the BMAWM? How?	3	0	0	1
2. Are personnel sufficient and personnel developed for the BMAWM? How?	3	0	0	1
3. Are budget and materials sufficient for the BMAWM? How?	3	0	0	1
4. Is the organization structure appropriate for the BMAWM? How?	2	1	0	0.67
5. Does waste collection infrastructure support the BMAWM? How?	3	0	0	1
6. Is the action plan appropriate for the BMAWM? How?	2	1	0	0.67
7. Do personnel accept the BMAWM? How?	3	0	0	1
8. Is law enforcement on BMAWM effective? How?	3	0	0	1
9. Do public participation support the process of BMAWM? How?	2	1	0	0.67
10. Is communication to the public on the BMAWM effective? How?	2	1	0	0.67
11. Is separated waste collection practiced for BMAWM? How?	3	0	0	1
12. Is there M&E of the BMAWM? How?	3	0	0	1

Question	Experts Opinions Scores			Average Scores of IOC
	+1	0	-1	
13. Are there new guidelines for the BMAWM? How?	2	1	0	0.67
14. What percentage of the communities participated in BMAWM? How?	2	1	0	0.67
15. What percentage of government and private organizations participated in BMAWM? How?	3	0	0	1
16. What was the percentage of waste utilization? How?	2	1	0	0.67
17. What was the percentage increase in the amount of waste separation type?	3	0	0	1
18. What was the change in the percentage of the composition of MSW?	3	0	0	1
19. What was the percentage decrease in the amount of waste in the district? How many districts have decreased waste?	3	0	0	1
20. What is the environmental impact of BMAWM? How?	3	0	0	1
21. What are the economic impacts of BMAWM? How?	3	0	0	1
22. What are the social impacts of BMAWM? How?	3	0	0	1

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