Knowledge Based Service Provision for the Enhancement of Municipal Solid Waste Management System

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Doctoral Dissertation

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Abstract

In the world's most advanced economies, over 70% of their gross domestic product (GDP) generates by service, which ultimately influences societal outcomes. According to the significance of service in global economy, a large number of questions have raised upon ways of having sustainable service leading to substantial outcomes for firms' success, well-being of consumers, and society. Fortunately, scholars and researchers have been focusing more on service study. Trends, challenges, or potential implementation processes of countless services have been researched. Regrettably, out of the vast amount of studies providing environmentally sustainable public service and emphasizing on enhancement of societal well-being through involvement of stakeholders has been slightly tapped on. It is undeniable that humans live in service economy; however, people have to admit that nowadays they also live in knowledge society. In any management systems, to be successful and effective, knowledge is essentially needed for well management. This is to make the right knowledge available to the right people at the right time. In other words, the making available process is universally known as knowledge management (KM).

In public service perspective, provided services such as sanitation, water supply, city planning, health care, and security are mostly overseen by government. Although it is a fundamental factor for well-being of society, public sector is unlikely to implement comprehensive sustainability performance evaluation. Therefore, it is important that government provide effective and sustainable service in an innovative co-creation way to increase the overall well-being of the society in this era that service and knowledge are ubiquitous. Being as one of the most profoundly important public services, municipal solid waste management (MSWM) is selected as the studied environmental service. It is in need that the provided MSWM service be sustainable and affordable by community.

An overwhelming amount of generated waste is a serious side effect of increasing consumption and production. The demand for more goods and services to meet human needs is creating a huge amount of waste that is being disposed of into the environment. Accordingly, the provided MSWM service does not go in the same pace with increasing amount of waste. As a result, ineffective of MSWM system has become a problem posing pollution to all mankind. Due to the inefficiency, along with more awareness of human health, environmental impacts, social problems, and depleted natural resources; these have created desires for strategies and techniques to enhance the performance of MSWM system and sustainably alleviate MSW related problems.

To enhance the effectiveness of MSWM service provision, this study adopts the combined essence of two important fields of concepts. The first field is sustainable service concepts, which are tripartite service concept and partnership concept. Therefore, this study aims to identify impacts of having relating stakeholders namely service providers, service recipients, and service ecosystem to corporately work together in providing MSWM service. The second field is KM concept. Through the interactions of all related stakeholders in the MSWM system, there is knowledge creation process. This study aims to shed the light on identifying co-created knowledge that can enhance the performance of MSWM service.

Through the multifaceted research methods, this study employs triangulation research method as the main research framework. This is to validate and increase credibility of the obtained data through cross verification from different sources of information. By integrating all analyzed results, influential factors that have impacts on MSWM system are identified;

possibility of partnership implementation, roles and responsibilities of involved stakeholders, together with potential service policies to be applied in MSWM are explained; needed knowledge and co-created values of adopting the combined concepts are discussed. In addition, the study proposes a knowledge based service provision conceptual model in the perspective of enhancing MSWM service performance.

The results reveal that applying service and KM concepts is explicable to alleviate the complexity of MSWM system and eventually enables the improvement of the management processes as a whole. This study provides comprehensive practicalities for researchers and practitioners to apply the knowledge based service provision approach through practicing or implementing the proposed knowledge based service provision model. Accordingly, the provision of MSWM service will be enhanced in a sustainable value co-creation way.

Keywords: Environmental service provision, municipal solid waste management, knowledge based service, tripartite service concept, value co-creation.

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Introduction

1.1 Introduction

In the intense market situation, firms aim to gain competitive advantages to increase their values, attract more customers, keep and gain more market shares. As such, firms have been trying to find innovative ways to exercise their current resources. Innovation has received attention from firms as they introduce innovation through strategic plan and implementation in business processes. According to Vargo and Lusch (2004), innovation has tended to be conceptualized to good dominant logic (G-D Logic), where firms mainly focus on, for example, tangible products, operand resources, and profit maximization. Firms have learned that only product oriented cannot lead to sustainable business growth. As a result, firms have turned to focus on providing innovative service, which seems more effective in perspectives of competitive advantages and business growth in long-term. Service dominant logic (S-D Logic) focuses on relationships and interactions among related actors that lead to co-creation of values through innovative resource integration (Vargo et al., 2008). Therefore, traditional business operation has obviously shifted towards an emphasis on collaborative business processes, mutual satisfaction, and co-created values.

In the world's most advanced economies, over 70% of their gross domestic product (GDP) generates by service, which ultimately influences societal outcomes (Hill and Macan, 1996; Economy Watch, 2010). Not only does the growth continue to increase in developed

countries, but also service is very important to emerging countries (UNCTAD, 2013). According to the significance of service in global economy, a large number of questions have raised upon ways of having sustainable service that leads to substantial outcomes for firms' success and well-being of consumers and society (Bitner and Brown, 2008). Fortunately, scholars and researchers are focusing more on service study. Trends, challenges, or potential implementation processes of many services have been researched. Regrettably, out of the vast amount of studies, providing environmentally sustainable public service emphasizing on the enhancement of societal well-being through involvement of stakeholders has been slightly tapped on.

In public service perspective, provided services such as sanitation, water supply, city planning, health care, and security are mostly overseen by governments. Although it is a fundamental factor for well-being of the society, public sector is unlikely to implement comprehensive sustainability performance evaluation. Despite the fact that increasing attention has given on the ineffective service performance provided by the sector, several governments have not perceived the need even though they are involved in services every day. Therefore, it is important to provide effective and sustainable service in an innovative co-creation way to increase the well-being of people and the society in this era that service is ubiquitous.

It is undeniable that humans live in service economy. However they have to admit that, at the same time they also live in knowledge society. For all types of firms or institutions, knowledge is the most vital and valuable capital where the main competitive advantage is an intangible asset. In any management systems, knowledge is essentially needed to be well managed. This is about to make the right knowledge available to the right people at the right time. In other words, this making available process is universally known as knowledge management (KM). KM has been widely used as a new concept or a new arising management term in the past two decades. The importance of effective KM has increasingly been recognized in both business viewpoint (Deng, 2010; An et al., 2013) and academic viewpoint (Nonaka and Takeuchi, 1995). KM is fragmented across industries. Many factors are important to KM, for example, KM strategies (Shih and Chou, 2012), KM processes (Grover and Davenport, 2001), or KM enablers (Choi and Lee, 2002).

In service sector, environmental services have gained much recognition in recent years especially on a Payments for Environmental Service (PES) perspective (Kumar, 2013; Legrand et al., 2013). PES has rapidly developed all over the world as a mechanism of a new type of

subsidy objects to protect the environment and ecosystem services based on provision of economic incentive. It is considered as a new market based initiative for conservation and environmental management (Fauzi and Anna, 2013).

Regardless of the popularity of studies having on PES, there have been only a few studies related to municipal solid waste management (MSWM). In those studies, PES is widely adopted in many applications; however, in MSWM, it has been mostly applied in economical prospect such as willingness to pay for improving waste collection service or incentive based MSWM system. Despite the fact that PES schemes can improve municipal solid waste (MSW) collection service in some cases, it is insufficient to say that an economic based incentive system can be applied to all cities, especially in developing ones.

MSWM is one of the most important basic public services that should be provided to residents to make the system effectively run itself and eventually contribute to better system for quality of life. Knowledge, in the same way, is needed in all processes to make service run smoothly, consistently, reliably, and sustainably. Thus a good management of knowledge is very essential for successful MSWM, as it is one of the most vital factors showing the performance of a MSWM system. In the same way, applying a concept of sustainable environmental service is a key to increase performance of MSWM system in long-term. The concept of service sustainability is to satisfy the need of current providers and recipients to practice mutual value co-creation without decreasing the quality of future value co-creation. In other words, the provided service should meet the society needs, conform to standards, and most importantly cause no harmful impacts to society, economy, and the environment.

Therefore, it is noticeable that, for enhancing the society well-being in a case of an environmental service perspective the combination of the very important two concepts which are sustainably environmental service and KM is significant. This is also to clarify the importance and how these concepts have impacts on the well-being of individuals, families, communities, the environment, and the society as a whole.

1.2 Research Problem

An overwhelming amount of generated waste is a serious side effect of increasing consumption and production. The demand for more goods and services to meet human needs is creating a huge amount of waste that is being disposed of into the environment. The increase in waste tends to correspond with economic development and rapid urbanization of society (Ahmed and Ali, 2004; Beolchini et al., 2012). The amount of generated MSW has been rapidly increasing in the past few decades (EPA, 2011). Worldwide, approximately 1.3 billion tons of MSW is generated per year, and this number is expected to reach 2.2 billion tons by 2025. With a conservative forecast, approximately 1.8 million tons of MSW is generated per day from urban areas in Asia (Hoornweg and Tata, 2012). This increasing generation of MSW is a serious problem, particularly for urban areas in developing countries with depleting landfill spaces and limited capacities (OECD, 2013). The increasing waste, along with more awareness of human health, environmental impacts, social problems, and depleted natural resources has created desires for strategies and techniques to reduce the amount of waste and sustainably alleviate MSW related problems (UNHCR, 2013).

To have an effective MSWM system that provides reliable services, it is imperative to identify influencing factors that affect the performance of the service activities. Studies have shown that having accurate waste generation amount is the most important factor for effective planning of MSWM system (Rotich et al., 2006; Kapepula et al., 2007). In general, waste generation prediction models and conventional analysis are estimated based on demographic and socio-economic factors on a per capita basis (Fritz and Vollmer, 2006; Johansson, 2006; Aguilar, 2013). Studies have shown that taking into account of waste generation factors is vital, but the same importance should also be given to the concerns of other factors including appropriate applications of management techniques and involvement of all related stakeholders.

A number of methods such as supply chain management, life cycle analysis, partnership, and integrated waste management system have been mapped into MSWM to deal with the inefficiency of the system (Johansson, 2006; Aguilar, 2013). Improved MSWM is a critical component of efficient city management, but it requires a high investment in terms of workforce, equipment and infrastructure, and other operating costs (Fritz and Vollmer, 2006). This has necessitated calls for an improvement to the currently inadequate level of MSWM services being

provided by authorities. Difficulty in providing waste management services corresponding to demand is typically due to institutional, technical, and financial constraints at the levels of national to local government, as well as in private sector (Durant, 2009; DOPA, 2013).

Management systems and techniques are currently being developed to decrease the environmental burdens of waste generation. It is essential to apply appropriate technologies to waste management system. Cities in developing countries have encountered technological gaps in management processes, which are one of the main causes of poor performance in MSWM. Accordingly, identifying the success factors for a sustainable MSWM technology transition is in an urgent need.

MSWM is dynamic along its process and involves multisector stakeholders in the system. Public-private partnership has increasingly been applied in MSWM service provision to improve ineffective situation. Therefore, involving related stakeholders from both private and public sectors to show how partnership can improve the ineffective MSWM and to identify roles and relationships of stakeholders who are essential in making MSWM effective are imperative.

According to the aforementioned constraints of inefficiency in providing effective MSWM service that eases human living condition and the viability of the society, there is a serious need of a reliable service management system that allows appropriate combination of use and application of available knowledge and resources with the current situation of MSWM, characteristics of the community, and norms of the society. By accumulating literature reviews of previous studies based on sustainable service and suitable use of KM concepts, there are some research gaps that are of concern to researchers. Accordingly, research insufficiencies are listed out on the basis of basic research structure covering three major issues, namely influencing factors on MSWM system, stakeholder attitudes towards collaboration in MSWM, and optimal co-created values in the management processes of the MSWM system. This is to ultimately create the knowledge based service provision for the enhancement of MSWM system.

As demonstrated in Figure 1.1, this study aims to enhance the effectiveness of MSWM service provision by encapsulating the essence of sustainable service and KM concepts with the ultimate goal of introducing the knowledge based service provision for MSWM system. There are three main research areas (Studies A, B, and C), touching upon influencing factors that have impacts on MSWM service activities, knowledge, and values that can be co-created through the dynamically interrelated collaboration of stakeholders.

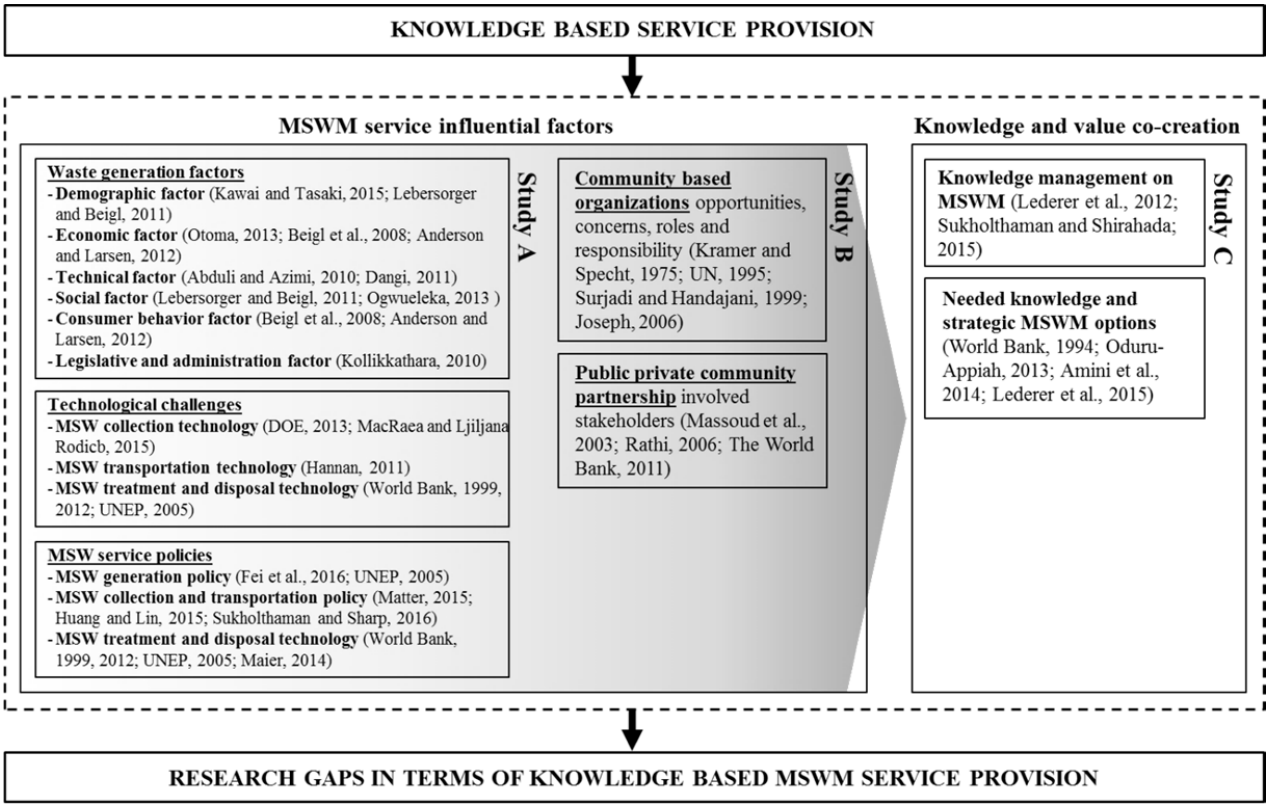

Figure 1.1: Overview of research gaps

A number of studies have conducted research on environmental service provision in the perspectives of MSWM system (UNEP, 2005a,b,c; Beigl et al., 2008; Kollikkathara, 2010; Hannan, 2011; Anderson and Larsen, 2012; DOE, 2013; Ogwueleka, 2013; Otoma, 2013; Kawai and Tasaki, 2015; Sukholthaman and Shirahada, 2015a; Maier et al., 2016; Sukholthaman and Sharp, 2016), sustainable service provision (Kramer and Specht, 1975; Surjadi and Handajani, 1999; Massoud et al., 2003; Rathi, 2006; World Bank, 2011), and KM (Levine, 1994; Lederer et al., 2012; Lederer et al., 2015; Sukholthaman and Shirahada; 2015b). Adopting research methods used in the previous studies allows explicable research overview. However, there is no complete solution that makes the MSWM system sustainable in a way of incorporating knowledge based management and service provision towards enhancing the well-being of the society. Accordingly, the presented research gaps should be taken into consideration and given a thorough investigation.

1.3 Research Questions

There are evidences of ineffective waste management causing socio-economic and environmental problems. Increasing generation of MSW is one of the serious problems particularly for urban areas in developing countries. It has become problematic as its level of seriousness is driven by high growth of population, urbanization, and economic development (Afroz, 2011). No participation and collaboration is also one of the essential factors causing ineffective waste management. The effectiveness of providing MSWM service is an important factor making cities sustainably livable and far from consequences of MSW problems (UN HABITAT, 2010). According to the abovementioned background and research gaps, it is inevitably to deny that sustainable service strategies and well-planned of KM are critically important to the effectiveness of provided MSWM service performance.

Though there is no single solution that enables MSWM system effective for every city, having a conceptual knowledge based service provision framework is a potential alternative for MSWM stakeholders from both public and private sectors to have a holistic view of MSWM system. By taking essential factors into account, this study ultimately aims to propose a framework that consists of influential factors of MSWM system, possibility of having all stakeholders involved in a form of partnership, and co-created values that will enhance the effectiveness of MSWM service provision. To fill up the research gaps, this study encompasses the essence of the tripartite service concept that allows stakeholders' interactions in a way of creating mutual benefits among three main actors, including service provider, service recipient, and service ecosystem without deterioration the possible welfare of future generations (Shirahada and Fisk, 2011). By applying this concept, MSWM system is studied in a way to enable sustainable service provision by integrating resources of each actor to co-create values for the society as a whole.

Another important concept that is embraced in this study is KM concept. In a MSWM system, there are various interrelated factors that have dynamic behaviors over time. Moreover, in each and among processes of MSWM activities, stakeholders interact to each other. These interactions are considered a kind of knowledge exchange that is also reflected as value in the system. Accordingly, it is highly essential to suitably capture, use, and distribute these exchanged knowledges by making them available to the right stakeholder at the right time.

1.3.1 Main Research Question

Broadening the application of service and KM concepts, this study aims to enhance the effectiveness of MSWM service provision to improve human and societal well-being. The main research question (MRQ) is 'How to enhance the effectiveness of MSWM service provision by applying the service and KM concepts?'. To achieve the MRQ, the study involves related viewpoints of influential factors in MSWM system on the basis of knowledge based management service approach.

1.3.2 Subsidiary Research Questions

To achieve the MRQ, this study identifies the key influential factors on the performance of MSWM service provision through a number of aspects, including waste generation factors, technological challenges, inclusive informal sector, MSWM service policies, stakeholder attitudes, partnerships, co-created values, and strategic MSWM options. Shortly, this study consists of threefold sub-research questions (SRQs), which are explained as following points:

1. What are the imperative factors effecting MSWM system in three perspectives namely waste generation factors, technological challenges, and policy design for inclusive informal sector?
2. How to broaden the service based approach by analyzing stakeholder attitudes in forming a coherent and structured manner in MSWM through partnerships?
3. Based on KM and sustainable service concepts, what are the co-created values of the knowledge based service provision for MSWM system and the needed knowledge and strategic MSW management options?

1.4 Structure of the Study

This dissertation contains eight main parts which are 'Introduction', 'Research Background', 'Research Methodology', 'Results' of three studies, 'Implications', and 'Conclusion and Recommendations', as presented in Figure 1.2. Details of each part are explained in the following paragraphs.

The first part starts with 'Chapter 1', this introductory part contains the overview of MSWM and urgency of having effective MSWM service provision. It discusses the relationships of sustainable service concept and KM concepts with MSWM. This is to emphasize the importance of adopting the usefulness of these two applications to enhance the performance of provided MSWM service. The Chapter also consists of research problem and research questions of this study.

The second part is 'Chapter 2', which provides research background in detail. It can be categorized into several viewpoints that relate to KM, environmental service, MSW, Bangkok MSWM, and practical issues on MSWM service. For each viewpoint, there is explanation on the overview information, definition, and important elements.

Followed by the third part, 'Chapter 3', research methodology, the chapter explains the sequences of methods, techniques, and approaches conducted in the study. Information regarding the main study site of this research is also discussed here.

The fourth to sixth parts are about dissertation results. There are three studies in this dissertation, which each study is thoroughly explained in Chapters 4, 5, and 6, respectively. 'Chapter 4,' 'Study A,' aims to answer the first SRQ of this research, which is the three aspects of influencing factors on MSWM system. 'Chapter 5' consists information of the second study, 'Study B'. It is designed to evaluate the possibility of having partnership in MSWM system. And the last part, 'Study C' which is presented in 'Chapter 6,' is to achieve the third SRQ, in which needed knowledge, co-created values, and strategic management options are identified and demonstrated as a knowledge based MSWM service framework. Explaining in a step by step sequence, each chapter explains data collection, data measurement, and data analysis procedures. As there are many sources of data, triangulation research method is applied to ensure that the results of each study are robust, comprehensive, and well-developed.

The seventh part is ‘Chapter 7’, which discusses implications of the study in a number of aspects. The chapter explains strategic development plan for MSWM system enhancement which encompasses the social, economic, environmental, technological, and legislative aspects. In addition, the potential knowledge creation process for MSWM system is provided.

The last part is ‘Chapter 8’ that concludes both contributions and limitations of the study. The MRQ and SRQs are precisely emphasized. Additionally, academic and practical implications of the study are explained. At the final part of this chapter, recommendations on enhancing MSWM system performance is presented as it can be adopted as a useful profound study of future research.

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Figure 1.2: Structure of the study

Chapter 2
Research Background

2.1 Introduction

This chapter embraces key elements of this study in detail, including the KM viewpoint, the environmental service viewpoint, the MSW viewpoint, and the Bangkok MSWM viewpoint. Practical issues on MSWM service are discussed in the last section of this chapter. The seriousness and urgency to enhance the effectiveness of MSWM service is firstly emphasized in the chapter. This is to clarify why sustainable service and effective KM are needed as imperative solutions. Gradually accumulated, the enormous amount of MSW has caused tremendous adverse impacts to the world. Not only poorly managed does waste stream generate a vast amount of MSW, but it also causes a remarkable environmental pollution and jeopardizes mankind's health (Batool and Chuadhry, 2009).

With the ever-increasing trend of waste generation and the more complexity that comes with generated waste, cities and responsible authorities all over the world, especially in developing countries find it difficult to manage the vast amount of waste whilst they have to find ways to minimize adverse impacts. Thus to alleviate the problems, an effective MSWM system is needed to solve problems and to prevent all possible risks that can happen in the future.

According to the United States Environmental Protection Agency (USEPA) (USEPA, 2003), the current MSW generation amount has increased by 2.6 times from 1960. This amount of new generated waste is an additional to the already huge amount of waste that has been

discarded in many landfills. In fact, governments and communities in most countries have been struggling to handle the increasing amount of MSW (Dhokhikah and Trihadiningrum, 2012). Therefore, determination of waste generation quantity is one of the most important factors for further MSWM planning and operating processes.

MSWM is one of many disciplines associated with the controlling of MSWM processes from generation to disposal, in a manner that is in accordance with the best principles of public benefits in terms of health, economics, conservation, aesthetics, and environmental considerations, which is responsive to public attitudes. In the simplest sense, MSWM incorporates waste management hierarchy by considering direct and indirect impacts (Turner and Powell, 1991). In spite of the fact that local authorities and related stakeholders have put more attention and awareness on the effectiveness of MSWM system (Seik, 1997; Wilson, 2007), the provided MSWM service does not go in the same pace with the increasing amount of waste. As a result, ineffective MSWM system has become a problem posing pollution to the society.

Thailand has implemented a number of plans to ensure reliability and effectiveness of MSWM system. The plans include, for example, to promote solid waste minimization and source separation; to establish networks to increase the efficiency of MSW reduction; to provide regular waste collection service; to develop a collection and disposal system for hazardous and infectious waste; and to increase the efficiency of waste treatment and disposal by applying advanced technologies and encouraging private sectors involvement in MSWM system. In case of Bangkok, one of the world's mega urban cities, the Bangkok Metropolitan Administration (BMA) and the 50 district offices have responsibility for waste management. The authorities try to enhance its effectiveness of MSWM system by encompassing various strategies such as 3Rs, efficient waste collection and disposal system campaigns, and community based management (CBM). However, the implementation results of these strategies are not as successful as planned.

In order to alleviate MSWM problems and increase societal well-being, MSWM strategies used in developed countries have been widely applied as solutions in developing countries. However, problems arising in these countries, especially in urban areas, are different from those in the developed world. Therefore, different solutions that suit ways of life, norms of society, basic infrastructure, laws, and MSWM processes are needed.

Studies have shown that having accurate waste generation amount is the most important factor for effective planning of MSWM system (Babayemi and Dauda, 2009; Thanh et al., 2010).

Besides knowing the amount of waste generation, involvement of related stakeholders and implementation of practical MSWM policies are imperative keys that increase effectiveness of MSWM processes. To be able to achieve the ultimate goal, it is important to conduct MSWM research in different ways. Broadening the application of service research, value co-creation, tripartite service, and partnership concepts are helpful to be applied as research methods in MSWM study. Thinking in an aspect of service providers, service recipients, and service ecosystems, there will be a better understanding in terms of categorizing and prioritizing roles and responsibilities of involved stakeholders in MSWM system. Consequently, values of each stakeholder are integrated and co-created in the mutually agreed management process. In any systems, knowledge is the most valuable asset that should be utilized at the right time with the right people. Ensuring that the knowledge is utmost beneficial to all related stakeholders, the KM concept should be applied to properly manage the creation and the flow of knowledge in the systems.

This study, therefore, combines the two important concepts to enhance the effectiveness of MSWM system. In this study, the city of Bangkok is selected as an urban city in developing countries that has coped with the impacts of MSW and ineffective provided services.

2.2 Knowledge Management Viewpoint

As discussed earlier that MSWM is one of the most important basic public services that all residents should receive. Knowledge, in the same way, is needed to make service run smoothly, consistently, reliably, and sustainably. Since each process requires different knowledge to effectively manage waste, this is one of the most vital factors showing the performance of MSWM system. To emphasize its importance, knowledge sharing (KS) and knowledge transfer (KT) are factors that should be taken into account of KM in order to avoid occurrence of knowledge gaps and hidden knowledge.

2.2.1 Concept of Knowledge Management

As aforementioned, KM has widely been recognized in both business and academic arrays. Having effective KM, it is important to be noted that KS and KT are important factors that propel the creation of knowledge, which should be understood and accepted by all involved stakeholders. Knowledge is a mix of framed experience, values, contextual information, and expert insights that provides a framework for evaluating and incorporating new experience and information (Davenport and Prusak, 1998).

Tacit and explicit knowledge are two types of knowledge having been suggested in Nonaka's work (Nonaka et al., 1994). Tacit knowledge more or less related to personal knowledge. It is subjective and experienced based knowledge which cannot be expressed explicitly in words. It includes cognitive skills which are intuitions, images, or beliefs. On the other hand, explicit knowledge is easy to express in words. It is objective and rational. This type of knowledge includes theoretical approaches, databases, and problem solving. By applying the KM concept, it can be referred as a process of using knowledge to produce wealth for improving and developing organizations (Nonaka and Takeuchi, 1995).

Transforming from one's tacit knowledge to be used as understandable explicit knowledge is a key for successful KM. Polanyi (1967) state in his work that tacit knowledge is the fact that "we can know more than we can tell". He also emphasizes the importance of dialogues among individuals to groups and finally to organizational levels (Polanyi, 1964). This

is a way to share, transfer, and transform personal tacit to explicit knowledge. In other words, the process of sharing, transferring, or transforming individual knowledge to broader levels is knowledge dissemination. Nonaka (1994) prescribes this process by categorizing the process into four modes as demonstrated in Figures 2.1 and 2.2.

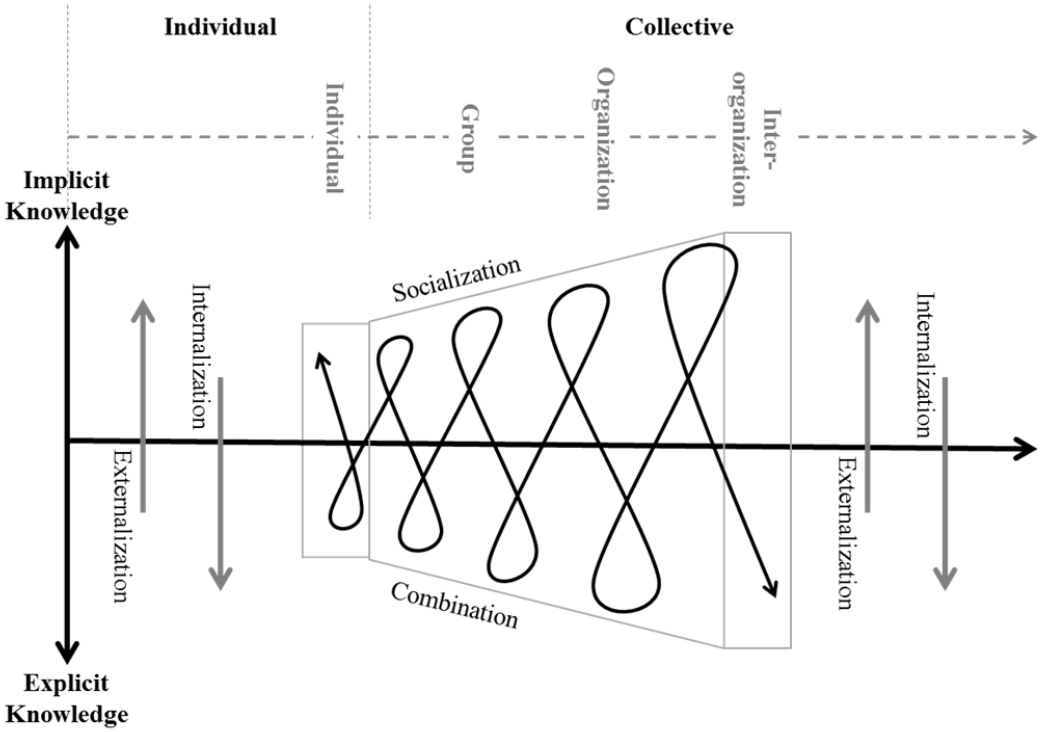

Figure 2.1: Spiral of organizational knowledge creation (Nonaka, 1994)

Figure 2.1 represents how knowledge is transferred from individual level to collective level. Along the flow of knowledge from left to right, the knowledge can also be shared across the same level or among different levels through the four modes which are socialization (S), externalization (E), combination (C), and internalization (I). For a better understanding, the four modes are combined together as SECI model, which is shown in Figure 2.2 (Nonaka, 1994).

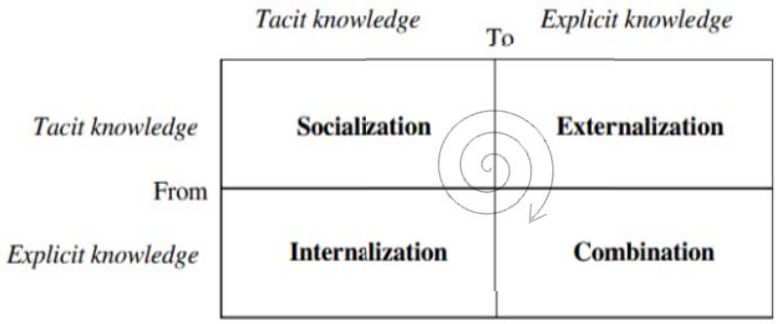

Figure 2.2: SECI model – Four modes of knowledge creation (Nonaka, 1994)

In knowledge creation system, along the processes of sharing and transferring of information and knowledge there is disseminated knowledge that occurs within the system. In knowledge dissemination (KD) process, the shared or transferred knowledge will be used through the process of learning, enlightenment, or modified practices.

When it comes to reality, it is important that knowledge should be verified, justified, and accepted. Applying the KM concept to MSWM is a very new field of research. This study focuses on roles of KM on each process of waste management. Before going into detail of those processes, it is inevitable to discuss about related actors in the provision of MSWM service. Starting from the very first to the last waste life cycle, MSW is generated by residents, collected by district offices, and processed and disposed of by the BMA and designated companies. These four sectors are main actors that directly contribute to the effectiveness of provided MSWM service. Indirect actors are also important to service performance. Non-governmental organizations (NGOs) and private sectors, for example, act as a catalyst that makes MSWM system run smoothly and transparently (Heap, 1998). Above all, ecosystem is one of the most important actors acting as a service provider and at the same time, a service recipient. The only difference of ecosystem among other actors is that ecosystem does not have explicit roles or activities. Instead of that, it is the source of raw materials that are produced, used, and discarded as waste. And it is the end of waste management process where all waste is disposed to.

For firms, gaps of knowledge usually happen among theories, practices, and employees in different levels. Hidden knowledge is also a form of knowledge gap when knowledge is kept individually. Other than that, it is treasure hidden in employees' minds (Greiner, 2007). As tacit

knowledge is a key of personalization strategy, it is important to share this hidden tacit knowledge. Sharing hidden knowledge can be done by socialization or sharing and creating knowledge among related members. KS through socialization can be easily done by many communication channels such as participation in social networks, informal meetings, or group works (Teigland and Wasko, 2003).

KS distributes knowledge among individuals in an organization. Sharing of knowledge encompasses various kinds of techniques ranges from simple ones to advanced ones. People and business practices represent organization cultures which are driving factors that determine the success or failure of KM. KT is a mechanism of selective knowledge exchanges. Not everybody in a company needs to know everything at all times. Related stakeholders should be aware of knowledge exchange opportunities during work. KT needs to be worthwhile for all related parties by applying it into their activities (Krogh et al., 2001).

Applying KM concept to MSWM, involved stakeholders are automated to facilitate collaboration and learning by conduction KT and KS. Ultimately, as an intelligent support, KM is to increase the effectiveness of MSWM system and at the same time to create a sustainable waste management service.

2.2.2 Practices of Knowledge Management

Knowledge, as a vital strategic resource for individuals and organizations, has power because it controls access to opportunity and advancement (Drucker, 1969). In the world's economy, business operation of firms or service providers has shifted from product oriented to service oriented (G-D Logic to S-D Logic), and the value is determined by customers or service recipients (Vargo and Lusch, 2004). KM has become a new management paradigm for knowledge society in the 21st century. The concept has been applied in industries to generate value from their intellectual capital and knowledge based assets (Jelenic, 2011). In knowledge society, intangible resources are decisive factors for organization success. Knowledge is recognized as the source of competitiveness that provides way of understanding other data or knowledge that enables performance enhancement, problem solutions, decision making, experiencing, and learning (Beckman, 1997; Trninic, 2008).

New knowledge that is used in organizations can be converted to a commercially applicable knowledge and can increase the organizations' competitiveness up to 80% in global business conditions (Jelenic, 2011). Applying the KM concept, a focus on innovation and encouraging free flow of new ideas is the key factor that organizations should consider. For example, KM helps increasing revenues, reducing costs, enhancing service performance, boosting employees' productivity, and improving working environment (Dalkir, 2005). Ultimately, KM process increases overall value of the organization and its competitiveness as a whole (Tisen et al., 2006).

KM concept can be applied to all types of organizations in all industries. However, each organization has different culture that influences the KM practice and success level. Therefore, it is important to leverage and improve the organization's knowledge to effectuate better practices, improved organization behaviors, and also the overall performance.

In terms of applying KM to MSWM system, Lederer et al. (2012) apply the concept to establish knowledge based oriented for MSWM in the town of Busia, Uganda in the views of human health, environment protection, and valuable resource preservation. The results of the study show that through knowledge creation and dissemination processes, information and knowledge, which is required for effective MSWM, is generated from three main sources, including domestic knowledge generation through knowledge exchange among stakeholders; applied actions and reflections among stakeholders; and transferred knowledge from external sources.

2.3 Service Concept Viewpoint

It has articulated that in global service economy, organizations put substantial amount of resources to ensure that the offered services satisfy customers. In this section, three important service concepts are explained in terms of their importance and practicality to be applied to MSWM service provision. The three concepts are value co-creation concept, tripartite service concept, and partnership concept.

2.3.1 Value Co-Creation Concept

Value co-creation has gained much attention from academics and practitioners as a predominant service concept that describes collaboration between multisector stakeholders (Prahalad and Ramaswamy, 2004). Investigations on the concept have been conducted in a number of contexts such as customer relationships, stakeholder interactions, self-service, and co-production (Morgan and Hunt, 1994; Cova, 1997; Fournier, 1998; Ford, 1999; Oliver, 1999; Grönroos, 2012; Leroy et al., 2013). In the concept, consumers or service recipients have an active role that creates value together with the organizations or service providers through direct and indirect interactions along the production and consumption processes (Prahalad and Ramaswamy, 2004; Hoyer et al., 2010; Tynan et al., 2010; Kohler et al., 2011). Important elements in the process of co-creating values are involvement, interaction, self-service, and experience (Bendapudi and Leone, 2003).

Value co-creation relates to KS, a process of KM, as it is a basic operant resource happens during the sharing knowledge or ideas among service recipients and providers in the articulation of current and future needs in services or products (Zhang and Chen, 2008). Another important factor of value co-creation is equity. The ultimate goal of co-creating value is to share control in favor of empowerment for stakeholders in co-creation activities on the basis of equity (Payne et al., 2009; Hoyer et al., 2010; Fisher and Smith, 2011; Storbacka and Nenonen, 2011). The last essential factor is interaction of stakeholders. It is the primary interface among stakeholders, as it allows sharing, understanding, integrating, and satisfying needs of each sector (Merz et al., 2009). In other words, an interaction happens through the process of participation,

discussion, transaction, or involvement, in which it enables exchanging knowledge and ideas and generating desired solutions (Payne et al., 2008; Kohler et al., 2011; Bagozzi et al., 2012).

As other industries, value co-creation also emerges in environmental service provision, including MSWM service (Gröönroos and Voima, 2012). The concept has been applied in the contexts of process improvement, incentive motivation, and marketing potential in both individual and organizational levels (Sukholthaman et al., 2014).

2.3.2 Tripartite Service Concept

There are three essential components of service. First, physical evidence is the service environment and other tangible aspects of service that facilitates or communicates the nature of service. Second, participants are people who involve in the production of service. Third, process is the procedures and flow of activities (Boom and Mary, 1981). Service activities require value co-creation between exchanging parties and a win-win relationship (Shirahada and Fisk, 2011). Broadening service provision perspective, the tripartite concept will enhance collaboration of these parties. The concept is created to satisfy the needs of current service providers and service recipients to engage in mutual value co-creation without decreasing the quality of future value co-creation process. It emphasizes on the importance of parties being shared in value co-creation.

In the concept, there are three inseparable elements, including service providers, service recipients, and service ecosystems or natural capital. Service providers collaborate with recipients to improve mutual values and enhance the values of natural capital by creating a voice for nature along the service process (Shirahada and Fisk, 2014). A service system should be sustainable and designed according with norms and values of a society by focusing on value co-creation among related stakeholders.

Sustainability is one of the five global service trends. It links to increase collaboration and relationship among parties based on the concept of sharing co-created values (Edvardsson et al., 2013). The goal of sustainable service is to improve services in terms of safety, integration, economic, effectiveness, and efficiency. In terms of MSWM service, material efficiency concept has been introduced to many manufacturing industries (Ligon et al., 2000; USEPA, 2014). For example, Sukholthaman and Shirahada (2014) apply the concept to the analysis of tire scrap management network and propose an eco-value co-creation tire scrap recovery network model.

The results of the study reveal that the tripartite concept helps describe how value are co-created in the interactions between service recipient and provider along the scrap recovery network.

2.3.3 Public-Private-Community Partnership Concept

In the past few decades, partnership is gaining more significant role in infrastructure development and providing services while government ownership has declined. Today, partnership is a significant running factor for urban development at all levels, especially community ones. Partnership has been widely applied in infrastructure sectors, such as transportation, education, healthcare, water, wastewater treatment, and MSWM. It has found that partnership can be used as a potential solution to improve societal well-being. However, partnership practices have not always yielded satisfactory outcomes, with a number of failed cases. A significant constraint for using partnership as a governance tool relates to inefficiencies and ineffectiveness in proposing processes that have lengthy durations, lacks of competition and transparency, and risks of excessive transaction costs (Dixon et al., 2005 and Chan et al., 2010). International practices suggest that if these concerns are not addressed properly, partnership may lead to sub-optimal value for money outcomes (Liu, 2016).

The challenge of MSWM is principally peculiar to developing countries, where resources are limited but urbanization is occurring rapidly and inefficiency rate of management system is high (Ahmed and Ali, 2004). Partnership has become a potential MSWM alternative to the traditional service provision made by the government. Private and public sectors are partnered to set plan, co-create value, and share responsibility in providing MSWM service. Developing countries in Asia and Africa have found that, with appropriate use of resources and a well management plan, it is successful to apply partnership in MSWM service provision (Massoud et al., 2003; Rathi, 2006; World Bank, 2011).

Focusing on MSWM at a community level, public-private-community partnership (PPCP) is studied as a potential way to alleviate impacts of ineffective waste management. PPCP is the collaboration of related stakeholders in MSWM processes range from MSW generation at source, collection, transportation, treatment and disposal, and also monitoring and mitigation. Related stakeholders are residents, communities, NGOs, private organizations, and government

authorities. In other words, entities from public, private, and community sectors contribute impacts on efficiency and effectiveness of MSWM. As quality and quantity of waste generation determines the effectiveness of other following management processes, it is essential to encourage residents who are the main waste generators to participate in goal and policy setting and also to be an active actor in MSWM activities, such as conducting proper waste separation at source and waste disposing. In other words, residents are stimulated to contribute in PPCP principally in practice.

2.4 Municipal Solid Waste Viewpoint

In the past, as humans began to settle in permanent communities with higher concentrations of waste generating activities, the need for waste management became evident. By 500 B.C., Athens organized the first municipal dump in the western world, and waste pickers were required to dispose of waste at least one mile from city walls. During the middle ages, waste disposal continued to be an individual responsibility with the lack of government authority. In 1388, the English Parliament banned waste disposal in public waterways and ditches. This indicated a desire on the part of government to assume responsibility for waste generators to ensure societal well-being (Solid Waste Management, 2008).

The growth in governmental concern for health and safety with regard to waste disposal led to additional regulations and operations. By the 1840s, the western world started to enter the age of sanitation as filthy conditions began to be seen as a city nuisance and the public demanded that government resolve it. Government's increasing assumption of MSWM let to systematic approaches, including the destructor, an incineration system in Nottingham, England, in 1874; and America's first municipal incinerator, on Governor's Island in New York, in 1885 (Solid Waste Management, 2008).

The fast growing population, vastly enhanced scientific understanding of the environment, and the concept of finite resources were influencing MSWM factors that combined to afford an opportunity for a conscious examination of the detrimental nature of disposal practices, which occurred after World War II. However, in many areas open dumping of MSW were still acceptable practices in the 1970s. The inability of local government to deal with these increasing problems quickly became a federal interest. In the U.S., the Solid Waste Disposal Act (SWDA) of 1965 which authorized research and provided state grants was the first federal MSWM law. In 1968, the U.S. National Survey of Community Solid Waste Practices was the first comprehensive data on MSW on a national level (Lund, 2001; Solid Waste Management, 2002).

2.4.1 Definition of Municipal Solid Waste Management

Municipal Solid Waste

According to the Chapter 21.3 of Agenda 21 (United Nations Conference on Environment and Development, Rio de Janeiro, June 14, 1992), MSW can be defined as all domestic refuse and non-hazardous waste such as commercial and institutional waste, street sweepings, and construction debris. MSW primarily comes from households, but also includes waste from offices, hotels, shopping complexes, shops, schools, institutions, and from municipal services such as street cleaning and maintenance of recreational areas (UNEP, 2004).

Cointreau (1982) defines MSW as materials for which the primary generator or user abandons within the urban area and requires no compensation upon abandonment. Rhyner et al. (1995) state that MSW are durable goods, non-durable goods, containers, and packaging materials, food waste and yard trimming, and miscellaneous organic waste arising from residential, commercial, institutional, and industrial sources. Industrial waste produced by manufacturing and processing operation, construction and demolition waste, agricultural waste, oil and gas, and mining waste are not considered as MSW. According to the USEPA (1995), MSW means household waste, commercial solid waste, non-hazardous sludge, conditionally exempt small quantity hazardous waste, and industrial solid waste. The World Bank defines MSW as waste generated from the process of residential, commercial, industrial, institutional, construction, demolition, process, and municipal services (World Bank, 1999).

It is imperative to concern about details of MSW classification and definition. Incorporation of any secondary data requires extensive care, judgment, and moral sense (Tchobanoglous et al., 1993). The research area of this study is conducted in the city of Bangkok, Thailand. Thus, it is necessary to know what MSW is in the context of Thailand. According to Thailand Public Health Act, MSW includes waste generated from community activities, residential households, commercial and business establishments, fresh markets, institutional facilities, and construction and demolition activities, but excludes industrial waste (Bangkok Environment Report, 2012; PCD, 2014).

Municipal Solid Waste Management

In the simplest sense, MSWM incorporates waste management hierarchy by considering direct and indirect impacts (Turner and Powell, 1991). Tchobanoglous et al. (1993) define MSWM in detail as a framework that can be built to optimize the existing MSWM systems. It is the discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of MSW in a manner that is in accord with the best principle of public health, economics, engineering, conservation, aesthetics, and other environmental considerations and is also responsive to public attitudes. MSWM encompasses the sum of all measures of waste avoidance, non-harmful treatment, recovery, reuse, and final disposal of all types of waste while giving consideration to ecological and economic aspects (Rhyner et al., 1995). Whereas Bhide and Sundaresan (1983) state that MSWM is activities involved with generation, storage, collection, transfer and transport, processing and disposing of MSW which are environmentally compatible with principles of economy, aesthetics, energy and conservation. Zsigraiova et al. (2013) provide that MSWM is an intensive energy-consuming activity, aiming at preserving sustainability of life on earth and creating better habitats, efficiency improvement of waste management systems, and related processes.

The developed strategy of MSWM was coined a new term called the integrated solid waste management (ISWM). ISWM includes all administrative, financial, legal, planning, and engineering function involved in solutions to all problems of MSW. Solutions to the problems involve complex interdisciplinary relationships among different fields such as political science, city and regional planning, geography, economics, public health, sociology, demography, communications, conservation, engineering, and material science. Therefore, ISWM is a process of change that gradually brings in the management of all states (solid, liquid, and gas) of waste (UNEP, 1996; UNEP, 2002).

ISWM is the selection and application of appropriate techniques, technologies, and management programs to achieve specific MSWM objectives and goals. Understanding the interrelationships among various activities makes it possible to create an ISWM plan which individual components complement one another. In every MSWM system, waste hierarchies are established to identify key elements of an ISWM plan. The USEPA established waste hierarchy which has been widely accepted by industrialized countries (USEPA, 2013). As shown in Figure

2.3, the hierarchy consists of the following order: source reduction and reuse, recycling and composting, recovery, and treatment and disposal.

Figure 2.3: Waste management hierarchy (USEPA, 2013)

Ranking from the most preferable to the least preferable methods, each hierarchy is explained as follows:

- *Source reduction and reuse*: This is also known as waste prevention or minimization. This hierarchy aims to reduce waste at the source of generation, which can be done by many ways, including reusing or donating items, buying in bulk, reducing or reusing packaging, redesigning products, changing consumption styles, and reducing toxicity.
- *Recycling and composting*: In this hierarchy, recyclable or compostable waste is either processed into raw materials and remanufactured the recycled materials into new products or turned into compost which can be used as soil conditioning or fertilizer.
- *Energy recovery*: This hierarchy is about transforming waste through physical, biological, or chemical processes into useable heat, electricity, or fuel. A variety of processes is, for example combustion, gasification, pyrolysis, anaerobic digestion

(AD), and landfill gas recovery. Energy recovery process is commonly known as waste to energy (WTE).

- *Treatment and disposal*: This hierarchy relates to waste treatment and disposal methods, in which landfill is the most common form of waste disposal. Although it is the least preferable waste disposal solution due to potential environmental risks, developed and developing countries have applied landfill as their primary waste disposal method.

2.4.2 Municipal Solid Waste Management System

According to the study of Garrod and Willis (1998), there are six functional elements grouped by activities associated with MSWM, including waste generation, waste storage, waste collection, waste transfer and collection, waste processing, and waste disposal. In order to have an effective and sustainable MSWM system, it is important that all applied and social studies are linked with a good management plan that involves all sectors from all levels (Buenrostro and Bocco, 2003). As the first element of MWM system, many studies have shown that waste generation is the most important factor for successful planning (Zia and Devadas, 2008). It depends mostly on the accuracy of MSW generation data set (Chang, 2000; Buenrostro and Bocco, 2003; Dyson and Chang 2005; Chen and Lebersorger and Beigl, 2011). Thus, the prediction of MSW is a very important factor to understand MSW distribution and its characteristics in order to develop effective and practical MSWM strategic planning (Thanh et al., 2010; Sakawi and Gerrard, 2013). In general, waste generation prediction models and conventional analyses are estimated based on demographic and socio-economic factors on a per-capita basis (Chen and Chang, 2000; Buenrostro and Bocco, 2003; Eriksson et al., 2005).

Altaf and Deshazo (1996) state that MSWM is a kind of public service that should be efficiently provided to all people to live in a good environment, good hygiene, and good standard of life. The successfulness of the MSWM system highly depends on the effectiveness of MSW collection. Unfortunately, MSWM system in many developing countries is relatively ineffective despite a relatively high investment. This leads to an incomplete long-term planning which impacts the effectiveness of the MSWM system as a whole (Dyson and Chang, 2005).

2.4.3 Municipal Solid Waste Management Methods

The demand for more goods and services to serve human's need creates a huge amount of waste being disposed of into the environment (Ahmed and Ali, 2004; Beolchini et al., 2013). Gradually accumulated, the enormous amount of MSW has caused tremendous adverse impacts to the world. In fact, governments and communities in most countries have been struggling to handle the increasing amount of MSW (Dhokhikah and Trihadiningrum, 2012). There are a number of MSWM techniques available. However, dealing with dynamic and interrelated complex MSWM process is not an easy task.

Functional methods of MSWM system are waste generation, waste handling and disposal at source, collection, transfer, transportation, processing, treatment, and disposal. The following section describes each processing method in details.

Waste Generation

MSW generation has been increasing in an alarming rate which the generated amount is parallel to the growth of urbanization, industrialization, and economic development. An effective MSWM system is needed for all municipalities; otherwise its failure would contribute social and environmental burdens as pressing issues threatening the environment and the people health (World Bank, 1999).

Tchobanoglous et al. (1993) categorize classifications of waste generation into eight sources, including residential, commercial, institutional, construction and demolition, municipal service, treatment plant, industrial, and agricultural. Sources of MSW in a community are generally related to land use and zoning. The amount of waste generation varies from place to place due to both controllable and uncontrollable factors, such as geographical location, seasonal variation, recycling rate, economic condition, education and social status, legislation and administration (Vesilind et al., 2002; Alam et al., 2008; Abel, 2009; Lebersorger and Beigl, 2011; Anderson and Larsen, 2012; Ogwueleka, 2013).

Waste Handling and Disposal at Source

Waste handling and separation involves activities associated with managing storage and processing waste at the source of generation until waste is stored in containers for collection. Handling also encompasses the movement of loaded containers at the point of collection. Separation of waste at source is a highly important step of this functional process as it ensures the effectiveness of waste collection, which matters public health concerns and societal aesthetic.

Waste Collection, Transfer, and Transportation

MSW collection process includes gathering activities of all types of waste storing to be collected. The process starts from collecting discarded materials and transporting these materials to specified locations where collection vehicles are emptied. The locations to empty waste are normally transfer stations, waste treatment sites, or landfills.

Waste transfer starts when collected MSW is transferred from smaller collection vehicles to larger vehicles. In terms of waste transportation, as a subsequent transport of waste, the process usually refers to transporting waste over long distances, such as to waste processing, waste treatment, or disposal sites. Trucks are normally vehicles for waste transfer. However for waste transportation, trucks, rails, or barges are currently used as means of transporting collected waste.

Waste Processing and Transformation

This process of MSWM is normally applied to MSW that is separated at source. Then, further separation and processing takes place at material recovery facilities, transfer stations, combustion facilities, or disposal sites. Waste processing and transformation processes are conducted to reduce volume and weight of MSW that is going to be treated or disposed of.

Waste Treatment and Disposal

This is the final process of MSWM. Discarded waste that is usually mixed after being processed is treated by various methods, depending on amount and characteristics of waste.

Open dumping

Some components of MSW such as street sweepings, ashes, and noncombustible materials are suitable for open dumping. Other mixed MSW is not suitable because of nuisance and health hazard creation. Applying this method, MSW is generally spread over a large area. Carefully selected MSW must be disposed in order to prevent fire accidents. The location of open dumping is one of the top priorities that must be carefully chosen to prevent all possible risks that might happen to the residents and the environment. Concerns of selection and locating open dumping sites are, for example, source of water supply and its distance; wind direction; distance from residential and farm areas.

Good points of open dumping method are: it is easy and requires less resource; it can manage all types of MSW; it needs less labor and supervision. However, points to concern for this method are: it attracts flies, mosquitoes, insects, rats, dogs, and other animals; it will be breeding sites for rodents and other vermin; it is a source of nuisance and odor; it has high potential of fire; and it creates pollutions to the environment.

Composting

A definition of composting or aerobic digestion as applied to MSW management is the biological decomposition of the biodegradable organic fraction of MSW under controlled conditions to a state sufficiently stable for nuisance-free storage and handling and for safe use in land applications (Golueke, 1972; Diaz et al., 1993). Composting is an element of the ISWM strategy that is widely applied to manage compostable commingle or separately collected organic waste.

Composting is an effective method to utilize waste. In composting, biodegradable materials break down through natural processes and produce humus. Materials that are non-biodegradable must be separated out from the degradable materials and disposed of with other treatment techniques. There are four basic functions of composting, including preparation,

decomposition, post-processing, and marketing. However, the level of technology and mechanization applied to composting varies widely; and so do the costs of composting operating systems.

Anaerobic digestion

Anaerobic digestion (AD) is a controlled microbiological process, in which digestible materials decomposes in the absence of free oxygen. The best practice for AD process is separation of MSW at source, as feedstocks need to be of high quality to ensure stable operation of the digestion process. The process usually takes place in large scale as a specially designed digester tank is needed, which is part of a biogas plant. A variety of AD technologies is available for the treatment of the organic fraction of waste based on the digestion method and the dry matter content of the substrate. Comparing to composting, AD is a time consuming and an expensive process to complete. It requires a consistent and a large amount of feedstock. In addition, technical and skillful staff are needed to closely monitor the system, as the gas within the system is highly explosive. Success factors of AD are many; however, the general ones are: separated organic MSW, size of feedstock, moisture and temperature content, destruction of pathogenic organisms, time required for composting, reclamation of gas, and testing contamination condition of final compost (UNEP, 2005a,c).

Mechanical biological treatment

Mechanical biological treatment (MBT) is a treatment method using a combination of mechanical and biological processes to separate and transform MSW residual into several outputs. The method does not give a final disposal solution for treated waste. The mechanical processes are designed to separate out dry recyclable waste such as glass or metals, whereas the biological processes are to reduce water content and to handle organic rich fraction. Together with non-organic waste, the MBT technique processes compostable waste fraction, which will be further composted or treated by AD. Composting and AD processes can integrally implement in the same MBT facility. The quality of the products produced by MBT can be problematic due to its safe hazard and contamination concerns when applying on soil (Friends of the Earth, 2008, Maier et al., 2016).

Recycling

Every country recognizes the importance of recycling as an effective means to reduce waste, energy use, and also GHG emissions. In most countries, plastic, glass, paper, and metal are well collected by either the informal sector or municipalities, and these materials are recycled. Nonetheless, not as many countries record data on recycling rates for each type of material. Only between 1% and 2% of the urban population in developing countries is involved in waste recycling. The recyclable waste produced in developing countries, in particular in Asian cities, is generally managed by reuse and informal recycling methods (World Bank, 1999; Routray and Mohanty, 2006).

Incineration

Incineration is a process of burning combustible components. Generally, this method is operated under either open or closed systems. In the open system, MSW is incinerated in a chamber open to the air, whereas the closed system contains a special chamber designed with various parts to facilitate incineration. Incinerators in both systems require a chimney with appropriate height to provide a good flow of air through the combustion chamber. Sizes of incinerators can be varied depending on waste volume.

Incineration is a widely treatment method. This is because it requires less land for operating. After treated, the residue is free of organic materials and nuisance; climate is not an influential factor; and it provides opportunities of energy generation. Getting a proper site as a location for incineration can be burdensome. To have a proper management, skilled staff are highly important for operating and maintaining the system. Incineration needs high initial cost for investment. Another disadvantage of this method is that only combustible materials are incinerated, therefore, a need for separation of the waste into combustible and non-combustible is required. The noncombustible waste needs separate disposal (Hoornweg and Tata, 2012).

Landfill

Sanitary landfill is one of the most widely applied methods of MSW disposal. A properly operated sanitary landfill eliminates insects, rodents, hazards, fire, and other problems existing in open dumping. The method can be used in any community where sufficient and suitable land is available. The method consists of four steps: to deposit of waste in a planned and controlled

manner; to compact waste in thin layers to reduce volume; to cover each layer of waste with a layer of soil; and to compact the top surface with soil. In most cases, the method has proved to be the answer for economical solid waste disposal.

Site selection for sanitary landfills is based on, for example, hauling distance from MSW collection points or transfer stations; availability and accessibility of suitable roads; type of soil for covering; groundwater level; traffic situation; drainage channels; available land areas; geologic and hydrologic condition; surface water; local climatic condition, and local environmental condition. In spite of those facts, decomposition and stabilization of landfill depend on compaction of waste, degree of compaction, amount of moisture, inhibiting materials, rate of water movement, and temperature. Normally, type, size and required facilities or equipment will be governed based on size of community served, amount of waste, and size of the landfill.

Advantages of sanitary landfill over other treatment methods are: it is a more economical; it requires less initial investment; the operating system is flexible; it enables reclaiming of depression and sub-marginal lands. With proper management, the completed areas can be used for agricultural and other purposes. Despite those good facts, concerns needed of considerations are lack of suitable land to be landfill sites; risks of seepage into natural waterbody; good management system and skilled staff are required; special facilities and equipment are required especially for landfill gas generation (UNEP, 2005a; Hoornweg and Tata, 2012). Landfill is the most applied MSW disposal method that is able to handle mixed commingle or residue from combustion process.

2.4.4 Influential Factors on Municipal Solid Waste Generation

There have been a number of studies focusing on identifying influencing factors of MSW generation. The studies have been done at a national level (Daskalopoulos et al., 1998; Mazzanti and Zoboli, 2008), a regional level (Beigl et al., 2008; Kaosol, 2009), a household level (Benítez et al., 2008), and settlement areas (Emery et al., 2003). Quantity of MSW generation depends primarily on human activities.

Influencing waste generation factors can be grouped into six categories. First, demographic factors consist of gender, age, occupation, income level, expense, number of

household and household size, and number population (Lebersorger and Beigl, 2011; Kawai and Tasaki, 2015). Second, economic factors are economic growth, GDP, consumer price index (CPI), and budget (Beigl et al., 2008; Mundo et al., 2009; Anderson and Larsen, 2012; Otoma et al., 2013). Third, technical or technological factors include lack of standards, engineering problems, and inefficient facilities and equipment (Abduli and Azimi, 2010; Dangi et al., 2011). Fourth, social factors are awareness, public cooperation, religion, urbanization, number of tourists, and political situation (Bach et al., 2004; Lebersorger and Beigl, 2011, Ogwueleka, 2013). Fifth, consumer behavior factors include consumption pattern, cooking activity, lifestyle, and disposal pattern (Beigl et al., 2008; Anderson and Larsen, 2012). And the last group, legislative and administration factors are strategies, policies, laws, enforcement level, and management institution (Kollikkathara et al., 2010). Accordingly, it is unfortunate to identify waste generation factors that can be used for estimation of waste generation in all areas.

Demographic Factors

The theory of demographic transition explains that number of population changes over time. The growth or decline of population effects well-being of that population (Eakin and Luers, 2006). For example, without a proper MSWM system, MSW generated in an overpopulated city can cause significant social, economic, and environmental impacts such as water pollution, unsanitary environment, higher health risk for the society, or higher investment on MSWM processes. All of these potential adverse impacts can slowly degrade societal development as well as people well-being. Emphasizing the demographic transition theory, population is one of the variables that has impacts on the environment, which in this context is MSW related problems (Sherbinin et al., 2007).

Rapid population growth leads to more consumption of goods and services, in which there are more impacts on the environment and society as a whole. Jolly (1994) states that intermediate variables are included in which a population's impact on the environment is represented by other variables such as consumption behavior, technology, or culture. Studies show that demographic variables have very high impacts on MSW generation. Population size, population density, number of households, household size, age structure, and urbanization rate are proved to be significant factors (Dennison et al., 1996; Kaosol, 2009). Impact of population

including registered and nonregistered MSW generation is high (USEPA, 1997; Bach et al., 2004).

Economic Factors

The economic growth theory refers to growth of potential output which is generally distinguished from development of economy (Oded, 2005). Higher GDP or income level reflects a better economic situation of a country. The higher purchasing power people have leads the more possibility of higher consumption. Economic growth is a key driving force behind the increasing MSW generation quantity (European Commission, 2010). According to previous studies, influential economic factors of MSW generation such as income (Benitez et al., 2008; Kaosol, 2009), consumption expenditures, GDP, and GDP per capita (OECD, 2004; Daskalopoulos et al., 1998) have a positive relationship to MSW generation but not for all cases. The USEPA (1997) finds that employment, taxable transactions, and use of CPI are strongest predictors of MSW generation.

Social Factors

Since 1960, social scientists and psychologists have defined attitude as a predisposition to a specific kind of behavior, a kind of mental set to form a certain opinion, the neutral state of mind organized through experiences exerting a directive or dynamic influence upon individual response to all objects and related situations (Kelly, 1971; Peter and Olsen, 2005). Theory of planned behavior in Ajzen (1991) shows that an individual's attitude towards behavior, subjective norm, and perceived behavioral control has influences in shaping his or her behavioral intentions. As an individual's behavior is subjectively based on his or her readiness to perform a given behavior or intention, there is a need to give more attention on identifying behavioral variables that are influential on MSW generation.

Human attitudes are subjective and are a matter of psychological tendency expressing by evaluation of a specific entity with different degree of favor or disfavor (Eagly and Chaiken, 1993). Like other social system studies, a close investigation is needed for understanding human's intentions on behaviors of MSWM (Ajzen , 1991). Previous experiences from MSWM

service provision, both negative and positive, have high influence on people perceptions of performance of MSWM. The perceptions are considered as human attitudinal ambivalence on MSWM system. Factors that affect human attitudes are habit, attitudes towards target, punishment or reward, social norms, and self-identified outcomes.

Many MSWM problems happen because of bad attitudes or misperception of people. According to Afangideh et al. (2012), people are ignorant of the danger associated with indiscriminate waste disposal; they dump their refuse inappropriately. In some cases, residents play a passive role in waste generation activities such as refusing to cooperate with other sectors in cleaning up residential surroundings. It is a result of the ignorance of some dwellers towards the effect of indiscriminate dumping of waste and careless attitudes of what should be done (Simon and Smoll, 1974). Regarding to MSW, people are the main actor or waste generator who has a significant role in MSW generation amount (Jibril et al., 2012). Thus, learning public attitudes towards MSWM is a means to understand the way of thinking of people about MSW situation and MSWM provided services. Therefore, learning public attitudes is an essential source of information to find possible influential factors that affect MSW generation quantity.

Waste Separation at Source

Waste separation is considered as human attitudinal ambivalence on MSWM. Perception of waste separation is influenced by many factors, among many of them, incentive and knowledge factors are the potential ones (OECD, 2012; Shirahada and Fisk, 2014).

Researches have proved that source separation is an effective MSWM factor or method that enhances waste reduction to landfill and increases recyclable and organic waste amount (Tai et al., 2011; Boonrod et al., 2015; Rousta et al., 2015). Developing countries have applied the method as an element of ISWM system in pilot source separation programs in potential cities (Tai et al., 2011), whereas, a low volume of incoming separated waste is a major concern for cities in developing countries. This is because lack of public participation and understanding of the importance of waste separation at source (Hoornweg and Tata, 2012; Boonrod et al., 2015), outdated laws and regulations, and unavailability of facilities and infrastructures (Sukholthaman et al., 2015), lack of market for recyclables (Belton et al., 1994), and inconsistent of waste separation campaigns (Miller Associates, 1999).

2.5 Bangkok Municipal Solid Waste Management Viewpoint

In the past few decades, local authorities and related stakeholders have put more attention and awareness on all processes of MSWM, including waste generation, collection and transportation, treatment, and disposal (Seik, 1997; Zurbrugg and Schertenleib, 1998; Wilson, 2007; Faccio et al., 2011; Sukholthaman and Chanvarasuth, 2013; Sukholthaman et al., 2015). As the processes are imperative elements of MSWM system, responsible authorities have tried to find the optimal methods to manage waste effectively to increase quality of life of the people and the society. However, most of the municipalities have coped with difficulties in the management which the problems arise from many factors both controllable and uncontrollable such as social, economic, technical, environmental, and legislative and administration.

In this study, the city of Bangkok, Thailand, is chosen as a representative of an urban city of a developing country coping with serious MSW problems due to the vast amount of waste generated, ineffective and improper waste management system.

2.5.1 Bangkok Municipal Solid Waste Management System

The City of Bangkok

Bangkok is the capital city of Thailand and one of the world's megacities. The city's features as being the institutional and financial center for both private and public sectors have attracted people to come and earn their living temporarily or permanently. The city is the 69th largest province among all 77 provinces of the country. Bangkok is divided into 50 districts with a total area of 1,568.74 sq. km. The city has the largest size in population quantity and density (Bangkok Statistics Report, 2014; NSO, 2014). As of 2013, the population density was 4,051 people per sq. km and there were 5.7 million registered population which accounted for 9.0% of the total population in Thailand. However, taking into account of non-registered population which was about 3.2 million people, it made the city one of the World's largest populated urban cities (Bangkok Statistics Report, 2014).

As it is the fastest growing city, Bangkok has continuously witnessed accumulating MSWM problems. The amount of generated MSW mainly depends on population, economic growth, and the efficiency of the reuse and recycling system. The growth of economic development and the population really enlarge MSW generation. Currently, there are more than 300,000 tons of MSW generated in Bangkok each month, which represents more than 20% of the total waste generated in the country (DOE, 2014a). In other words, average generation of MSW in Bangkok is slightly over 10,000 tons per day (WMS, 2015).

MSWM service is provided to most of the areas of the city. However, levels of effectiveness of the provided service are unequal. The inefficient management process has caused a large amount of incurred costs (DOE, 2014b). Inefficient MSWM is caused by many reasons along management processes, for example, time taking in MSW transportation process is longer than planned because of traffic congestion. In some cases, during collection process waste collection staff spend some time segregating and gathering recyclable or valuable waste for sale as another source of income.

Municipal Solid Waste Management System the Case of Bangkok

The BMA is organized in accordance with the Bangkok Metropolitan Administration Act 1985 to be responsible for the management of the city and the well-being of Bangkok residents. Under the BMA, the Department of Public Cleansing (DPC) together with the 50 district offices, are responsible authorities for overall environmental management and improving performance in MSWM by promoting reduction and waste separation, collecting waste on a regular basis, and applying appropriate technology that increases efficiency of MSWM processes (Bangkok Environmental Report, 2012).

MSW collection and transportation process starts after residents put generated waste, either sorted or unsorted, in a container in front of their households or at designated locations. Then waste collection staff collect disposed waste as scheduled. At the point of collection, staff roughly sort out recyclables and put into big bags or containers placed beside or on rear of the truck before moving to next collection locations. Types of separated recyclable waste depend on accepted types of buying waste by junk shops, collected amount, and market price of recyclables. After selling, the staff equally share the amount of retrieved benefits.

The commingled MSW is then transported to three MSW transfer stations, namely Saimai, Onnut, and Nongkhaem, based on distance of transportation. At this process, waste will be managed by contracted companies which will dump all mixed waste into 22 wheel-trucks and transport to landfill sites either in Nakhonpatom or Chachoengsao provinces, according to the contracts made between the BMA and waste transportation companies (Jungrungrueng, 2014a). Approximately 90% of the collected waste is managed by sanitary landfill and the rest is treated by composting (PCD, 2014).

However, before waste is dumped at the transfer stations, groups of waste pickers are waiting to sort out recyclables mixed in the vast amount of waste. In detail, before waste is being collected by the BMA staff, waste pickers are the main player sorting out recyclable waste in public MSW disposal locations. It can be concluded that after MSW is disposed of, recyclables can be separated out by three different ways, by waste pickers in public disposal points; by the BMA waste collection staff during collection and transportation to transfer stations; and by waste pickers at transfer stations.

Municipal solid waste generation

MSW in Bangkok is classified into three types as general and recyclable waste, hazardous waste, and infectious waste.

- *General and recyclable waste*: general waste is non-hazardous, noninfectious, or non-recyclable waste that poses no risk of injury or infections. Examples of this type of waste include used paper towels, wet plastic and food waste. Recyclable waste is waste that can be processed into raw materials. Examples of this type of waste are paper, metal, non-ferrous scrap, glass, or plastic.
- *Hazardous waste*: waste that is generated from households that is contaminated with hazardous, explosive, flammable, or radioactive materials. Examples of this type of waste include light bulbs, batteries, or spray bottles.
- *Infectious waste*: waste that is contaminated with body fluids containing disease causing microorganisms or viruses. Examples of this type of waste are band aids, gauze, sanitary napkins, or diapers

MSW comprises about 70% of the total waste generated, while the remaining 30% consists of hazardous and non-hazardous industrial waste. Bangkok has the MSW generation rate of a typical metropolis in comparable with other developing countries (World Bank, 2002, 2003). According to the PCD's study, the average per capita generation rate changed from 1.19 kg per capita per day in 1995 to 1.08 kg per capita per day in 2013 (PCD, 2014). On the basis of municipal area, Table 2.1 presents amount of MSW generation in Bangkok, Pattaya, other regions of Thailand, and consolidated amount from cities outside municipal area. It can be seen that MSW generation in all areas have gradually increased over time.

Table 2.1: Waste generation in Thailand (PCD, 2014a, b)

Area	Waste Generation (Tons/Day)							
	2005	2006	2007	2008	2009		2010	
Bangkok	8,291	8,403	8,532	8,780	8,834	21%	8,766	21%
Pattaya	12,635	12,912	13,600	14,915	16,368	40%	16,620	40%
Central and Eastern	5,499	5,619	5,780	5,258	5,830	14%	5,918	14%
Northern	2,148	2,195	2,346	2,931	3,255	8%	3,315	8%
North Eastern	2,906	2,970	3,167	4,267	4,700	11%	4,768	11%
Southern	2,082	2,128	2,307	2,459	2,583	6%	2,619	6%
Outside municipal area	18,295	18,697	18,200	17,369	16,208	39%	16,146	39%
Total	39,221	40,012	40,332	41,064	41,410	100%	41,532	100%

Municipal solid waste collection and transportation

Curbside collection is used as a collection method for mixed waste according to the setting routes and schedules. In a MSW collection system, it consists of household waste bins, waste collecting equipped trucks, and waste collection staff. Currently the BMA possesses 2,031 waste collection trucks in total, of this amount they can be classified into five types including 2-ton compacting truck, 5-ton compacting truck, 8-cubic meter lifting truck, 6-ton dumping truck, and 1.5-ton side loading truck. In terms of MSWM frontline staff, there are 2,587 collection drivers, 7,591 collection staff, and 9,042 street sweepers (DOE, 2013; PPD, 2015).

The BMA then allocates these resources to all 50 districts for waste collection and transportation. The BMA collects waste in two ways: directly from households and from community dumpsters. Collected MSW is transferred to three transfer stations and is separated into recyclable, organic, and mixed waste. After that, mixed waste is transported to designated disposal sites by contracted private companies.

The BMA hires private companies to collect and transport around 3,300 tons per day of waste from Onnut transfer station, where it is compacted before transferring, to Latkrabang landfill in Chachoengsao province, and around 5,200 tons per day from Nhongkhaem and Sai Mai transfer stations to Kampangsan landfill in Nakhonpatom province (PCD, 2009; Pharino and Jaranasaksakul, 2009; DOE, 2012a).

Municipal solid waste disposal

Four disposal methods have been implemented in Bangkok, namely landfill, composting, incineration, and open dumping.

- *Sanitary landfill*: sanitary landfill is considered the main and cheapest method of waste disposal in Bangkok, as most of the solid waste is disposed of by this method. Bangkok's two sanitary landfills are located far from the sources of waste, resulting in increasing transfer costs and additional investment in infrastructure. Presently, there is a capacity crisis at both landfill sites and this is becoming more serious because of the rapid growth of population, economic development, and poor utilization of the facilities.
- *Composting*: MSW composition trends in Bangkok reveal that the composition of solid waste is largely organic waste, which is suitable for composting, due to its high moisture content (40-60%). About 60% of MSW contains organic matter, which can be used to produce natural fertilizer (PCD, 2014). Currently, two approaches are being used in the composting of MSW: the typical window system (piling on the ground); and utilization of mechanical equipment to facilitate the composting process, such as the rotating drum, which is being used at the Nongkhaem transfer station.
- *Incineration*: currently for the context of Bangkok, incineration is only used to manage infectious waste. The high moisture content of MSW in Bangkok causes a low calorific value. Therefore, pre-treatment of waste should be considered

(Muttamara et al., 2004). In a short term, the first pilot project of a 300-ton per day incinerator will have been operated to manage solid waste at Nhongkhaem transfer station (Jungrungrueng, 2014b).

- *Open dumping*: due to waste collection services being unavailable in some areas, open dumping and burning are still used by some Bangkok residents as MSW treatment methods (PCD, 2014).

All in all, the management of the large volume of MSW generated in a big city like Bangkok is complicated and relatively expensive. In the current situation of MSWM, landfill is the predominant treatment method. The city has to prepare preventive action plans to manage the risks from the effects of environmental degradation.

2.5.2 Municipal Solid Waste Composition

One of the most important steps in MSWM is quantifying and qualifying the different types of MSW being generated. Regarding MSW characteristics in Bangkok area, MSW generated from some districts is different in terms of waste composition. For example, high proposition of recyclable waste is generated from center city districts more than other areas, such as paper, plastic, or beverage container. This is because the center city is a populous area and consumption styles and behaviors of habitants have adapted to fit with urban life. However, considering characteristic of collected MSW at transfer station, it is fairly homogeneous and does not have significant difference in terms of composition. It is highly biodegradable; the organic waste is the largest portion. Food waste, plastic, paper, rubber, foam, glass, metal, stone, and clothes are the common MSW components.

According to Jungrungrueng (2014a), recyclable waste quantity disposed at source before collection is estimated to be about 20% of MSW composition in Bangkok. As presented in Figure 2.4, the amount of MSW is the amount of collected waste at source represented by weight percentage, the highest proportions of generated MSW are organic and food waste, non-recyclable plastic, and non-recyclable paper. Average moisture content of waste is high, which is 55.6%, with density of 0.38 kg per liter, and heat value of 1,373 Kcal per kg (PCD, 2014). This

implies MSW situation in Bangkok as, there is more potential for waste separation at source, which is currently conducted by waste pickers.

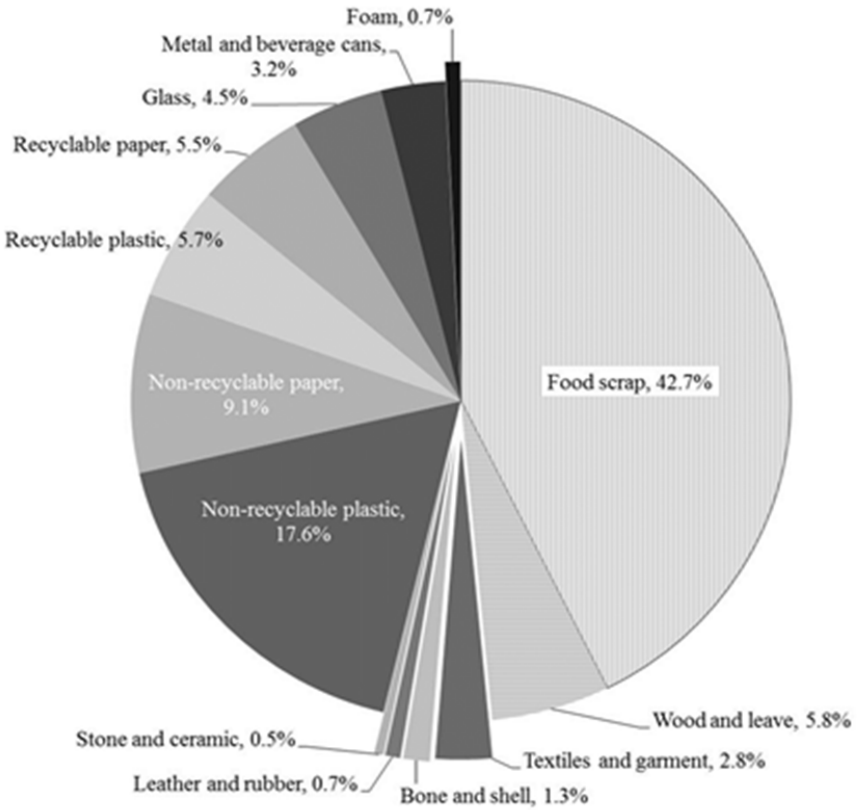

Figure 2.4: MSW composition (% weight) at source (Jungrungrueng, 2014b)

Table 2.2: MSW composition (% weight) in developing and developed countries

	Germany [a]	USA [a]	Japan [a]	Singapore [a]	Australia [a]	Bangkok [b]	Myanmar [a]	Vietnam [a]	Brazil [a]	Indonesia [a]	China [a]
Organic	14	25	26	44	47	49	54	60	61	62	65
Plastic	23	12	9	12	5	23	16	16	15	11	13
Paper	34	34	38	28	23	15	8	2	14	6	9
Glass	12	5	7	4	7	4	7	7	3	9	2
Metal	5	8	8	5	5	3	8	6	2	8	1
Other	12	16	12	7	13	6	7	9	5	4	10

[a] World Bank, 2012
[b] Jungrungrueng, 2014b

From Table 2.2, it can be seen that generally developed countries generate less proportion of organic waste than developing countries. In terms of recyclable waste, apart from the fact that developed countries generate this amount of waste higher than those in developing countries, they also generate more on recyclable paper than recyclable plastic, which the situation is opposite to those countries in the developing world.

Although there have been a number of campaigns encouraging residents to reduce waste generation and conduct waste separation before disposing of (Bangkok Environmental Report, 2012), there is only 8% of total population who conducts source separation in Bangkok (Jungrungrueng, 2014a). This percentage is very small comparing to other urban cities (Teodorita et al., 2013).

2.5.3 Management Strategies and Future Plans

The BMA is able to manage more than 90% of the waste generated in service provided areas. Nonetheless, the ineffective management and continually increasing amount of waste in the city causes serious problems in the management system, for example, in some areas the amount of generated MSW outstrips the collection capacity. Accordingly, the BMA has specified strategies and goals to deal with such problems in the Bangkok Metropolitan Development Plan, some of the strategies are explained as follows:

- Collecting solid waste regularly, sweeping, cleansing, and vacuum cleaning walkways and bridges frequently.
- Promoting of waste minimization and separation for the purpose of 3Rs, including campaigning for public awareness and cooperation.
- Enhancing the efficiency of MSW disposal by adopting appropriate technology and by encouraging the private sector to participate in improving MSWM.
- Developing a hazardous and infectious waste collection and disposal system that collects all materials and disposes of by appropriate methods.
- Developing an information technology system as the cleansing network center and community based management for supporting MSWM.
- Aiming to reduce the amount of waste by10% per year.

In the current situation of MSWM, the interrelated MSWM processes still originate with problems, as they are influenced by many factors such as complexity of commingle in waste stream, insufficient trucks and equipment for collection and transportation, limited budget for operation; or lack of public participation and collaboration among stakeholders.

In the current situation of MSWM, there are a large number of appeals made by the residents and MSWM stakeholders. The appeals relate to ineffective management system caused by mainly poor management process itself and unqualified staff. In terms of waste generation factors for Bangkok, unfortunately, there have been only a few studies that conducted research on this issue (Kaosol, 2009; Udomsri et al., 2011; Sukholthaman and Chanvarasuth, 2013; Sukholthaman et al., 2015). MSW problems in Bangkok are still in need for further attention

through the involvement of related sectors. In addition, the BMA also needs an ISWM plan that suits the characteristics of the city and works well with the residents.

2.5.4 Municipal Solid Waste Management Legislation and Policy

The regulatory framework related to MSWM in Thailand can be classified into three levels which are national, provincial, and local. There are a number of laws, regulations, standards, and technical guidelines to overlook the management of MSW in the country. Besides related national MSWM laws and regulations that are enforceable in the Bangkok MSWM system; the city has authority to grant license to private MSW operators and in creating local by-laws that govern MSWM. Therefore, the BMA has issued numbers of ordinances relevant to MSWM.

National Environmental Policies and Plans

All important aspects in governing the country normally follow the set of policies formulated. MSWM, with no exception, has to go along with the national MSWM policy. The policy aims to minimize MSW generation by promoting 3Rs hierarchy including promotion of source reduction and separation, waste recovery for composting, material and energy uses. For MSW treatment facilities, there should be an establishment of central MSW disposal facilities with appropriate technologies. For high efficiency of MSWM system, privatization of MSWM services is needed.

Additionally, participation between public and private sectors is emphasized. In terms of policy implementation, the MSWM employs Polluter Pay Principles (PPPs) for all sectors in the society. Privatization services are used as means to achieve effective MSWM. Database for MSWM system should be regularly updated and informed to all related stakeholders. The BMA should be responsible for the preparation of land area to be used as long-term waste treatment facilities. As for the implementation of law and regulation measures, related documents should be revised to be up to date, especially in terms of service fee or subsidy schemes for waste reduction. The promotion of local community participation in MSWM and monitoring of

environmental quality should be emphasized. Other kinds of implementation measures are promotion of environmental education, research and development in environmentally sound technologies, capacity building for government officers and related private sectors, and environmental awareness raising for the residents and local communities.

The Constitution of the Kingdom of Thailand, 2007

The Constitution of the Kingdom of Thailand 2007 provides the public right to participate the prevention and elimination of any action that is to deteriorate natural resources and to pollute the environment.

The Enhancement and Conservation of National Environmental Quality Act (NEQA), 1992

At the national level, the NEQA of 1992 is the basic environmental protection law for the country and establishes the role of Ministry of Natural Resources and Environment in environmental planning, standard setting, and monitoring. Key points in the NEQA 1992 include the provision of the right of individuals to information, compensation and redress against violators, and the duty of individuals to assist and cooperate in enhancing and protecting the environment (OCST, 1992). When focusing on MSWM issue, it specifies the role of the municipality in managing MSWM, contracting out MSWM services to private sector, and charging fees in accordance with ministerial regulations. The environmental fund can be used to finance MSW investments proposed by local governments.

Public Health Act (PHA), 1992

This is the most comprehensive laws dealing with MSWM. The PHA specifies that local government must provide disposal facilities for infectious and industrial non-hazardous waste and that healthcare facilities can treat and dispose of infectious waste with approval from the local government. It emphasizes the roles of the municipality in MSWM described in NEQA.
The PHA designates sewage and MSWM the responsibility of local authority. Therefore, MSWM in Bangkok area will be under the responsibility of the BMA. Accordingly, the BMA has authority in licensing private solid waste operators to work on its behalf. BMA also has the authority to prescribe any rules, procedure, and conditions governing the MSWM in its governing area.

Public Cleanliness and Orderliness Act (PCOA), 1992

The main content of this act is to prohibit any activity that is likely to cause dirtiness to streets and public places nationwide. It specifies how households should store solid waste and place it for collection. This act is one of the acts that prohibits dumping of solid waste and littering.

Factory Act, 1992

The act mainly controls and regulates the establishment and the operation of factories in Thailand by paying attention to the impacts of factory to the environment. Normally, factories are required to be clean and free from waste at all time. The Department of Industrial Works has authority to issue standards and specify methods for the control, handling, and disposal of waste by a factory and to license, permit, and inspect factory operations, including MSWM. It also governs the licensing, permitting, and inspecting waste treatment, disposal, and recycling facilities.

Hazardous Substance Act, 1992

The act governs a broad range of hazardous materials, including hazardous and infectious waste. It also allows the handling, storage, transport, and disposal of hazardous waste to be specified in a ministerial decree. The act describes hazardous substance control criteria for import, production, transportation, consumption, disposal and export not to influence and danger to human, animals, plants, properties or environment.

Industrial Estate Act, 1979

The act oversees authority of the Industrial Estate Authority of Thailand, including enforcement of regulations and taking action on hazardous waste practices within industrial estates.

Construction Building Control Act, 1979

The act controls the design, construction, renovation, remove and utilization of the building. The construction of waste treatment plant shall be considered as the construction of the building under this act.

Bangkok Environmental Policies and Plans

As aforementioned, the BMA has the authority in granting licenses and in creating local by-laws that govern MSWM. Some of the MSWM related ordinances are listed as follows:

- *Disposal of Garbage, Refuse and Unclean Thing, 1978*: garbage means waste from paper, cloth, food, merchandise, ash, animal droppings or carcasses, including things swept from streets, market places, animal stalls, or other places. Refuse means excrement or urine and includes anything which is unclean and has foul odor.

Articles of this Ordinance are as follows:

- *Control of Water Sewage System, 1991*: to control the water sewage systems in general types of buildings.
- *Specifying Requirements for Construction of Building and Public Utilities, 1996*: to control the construction of building and public utilities systems in Bangkok.
- *Control of Waste Collection, Haulage, or Elimination Business which is made for Consideration as Service Fee, 1998*: to control the waste collection, haulage, or elimination business, which is engaged by a private sector that provides waste collecting and hauling service in consideration of service fees. It requires that any person who wishes to provide the services must obtain a license from the BMA. The licensee shall enter into the agreements with the BMA in accordance with the standard agreements. It also states the obligations and responsibilities of the licensee.

Technical Guidelines

In addition to the laws and regulations, there are also technical guidelines prepared by relevant agencies covering several managerial aspects of various types of waste. Some of the guidelines are the Pollution Control Department's guideline for MSWM, the BMA's technical guideline for solid waste operator, the BMA's guideline and procedures for service fee collection, guide to the implementation of the notification of Ministry of Industry on Hazardous Waste Manifest System Notification, 2004, and guidelines for waste management in hospital.

2.6 Summary

A summary of the research background is briefly discussed here. The Chapter encompasses three main viewpoints, namely KM, service concept, and municipal solid waste. The first viewpoint entails the overview concept of KM. In knowledge society that is a key competitive asset driven the world's economy. In any systems, knowledge is considered as the most valuable asset that organizations need to properly manage to make it available at the right time to the right people. This section conceptually explains how KM is and discusses about its importance to innovatively increase the product or service provision effectiveness.

The second viewpoint discusses about service concept. As the world's economy has shifted its focus from G-D Logic to S-D Logic, organizations have tried their best to optimally utilize their resources to offer the best product or service that meet highest satisfaction of customers. Thus, a number of service concepts have applied in management processes. This chapter introduces three concepts that help improve the effectiveness of service provision, which in this case is MSWM service. The three concepts are value co-creation, tripartite service, and PPCP. Incorporating the essence of the three concepts, solutions of how service provision can be improved in terms of effective collaboration of all related stakeholders by sharing responsibilities, risks, and benefits without deteriorating the societal well-being or decreasing the quality of future value co-creation. In addition, examples of successful cases that adopted the service concepts as practices are given.

The third viewpoint mainly relates to MSW, its management, and MSWM in the perspective of Bangkok. For the sake of better understanding, detailed definition of MSW, MSWM, management processes, and influential factors on waste generation are explained.

As MSW has caused tremendous adverse impacts to cities all over the world, there is a serious need of effective MSWM system that sustainably provides reliable service in long-term. However, MSWM system consists of diverse and dynamic factors through interactions of multisector stakeholders for all of its processes. Thus, this study aims to apply the potential of service concepts along with the explicating capability of KM to enhance the service provision of MSWM, which ultimately prompts upbeat influences to individuals, families, communities, society, and the environment.

Chapter 3
Research Methodology

3.1 Methodological Sequences

To briefly explain, this study deals with multidisciplinary approaches to achieve the three main objectives which are to identify effecting factors on MSWM system, to apply service concept approaches on the analysis of MSWM partnerships, and to identify co-created values for the knowledge based MSWM service provision. All in all, the study aims to propose a conceptual model on knowledge based MSWM service provision that helps enhancing the effectiveness of providing service as a whole. Conducting research to answers the three aims, it cannot be done with a single source of information. In the same way, the research cannot rely on any specific research method. Thus, this study applies a mixed research method which is the triangulation research methodology to frame all research activities to be in an easy and understandably integrated way. The triangulation method is a methodological framework used to validate and increase credibility of the obtained data through cross verification from different sources of information.

The research sequences are graphically demonstrated as Figure 3.1 in an easy to understand way. The first study, ‘Study A’, provides results regarding the factors that influence the performance and effectiveness of MSWM. The results primarily are attitudes on current MSWM system, MSW generation factors, and factors relating technological challenges. The second part, ‘Study B’, relates to applying service concepts to identify the possibility of

implementing partnership as a solution that increases MSWM service performance. Thus, the main results include human attitudes on having MSWM partnerships, possibility of implementing partnerships, and essential policies for each process of MSWM when partnerships are in place. The last part, 'Study C', is about value co-creation on the perspective of knowledge based MSWM service provision. The studies provide results of essential knowledge for MSWM system, co-created values in MSWM when KM concept is applied, and strategic MSWM options. In other words, apart from interviews and discussions, the dissertation acquires primary data from four different sets of questionnaire, of these sets some of them are used to analyze results for multiple studies. For the secondary data, data and information are gathered from reliable sources, including published articles, books, and databases.

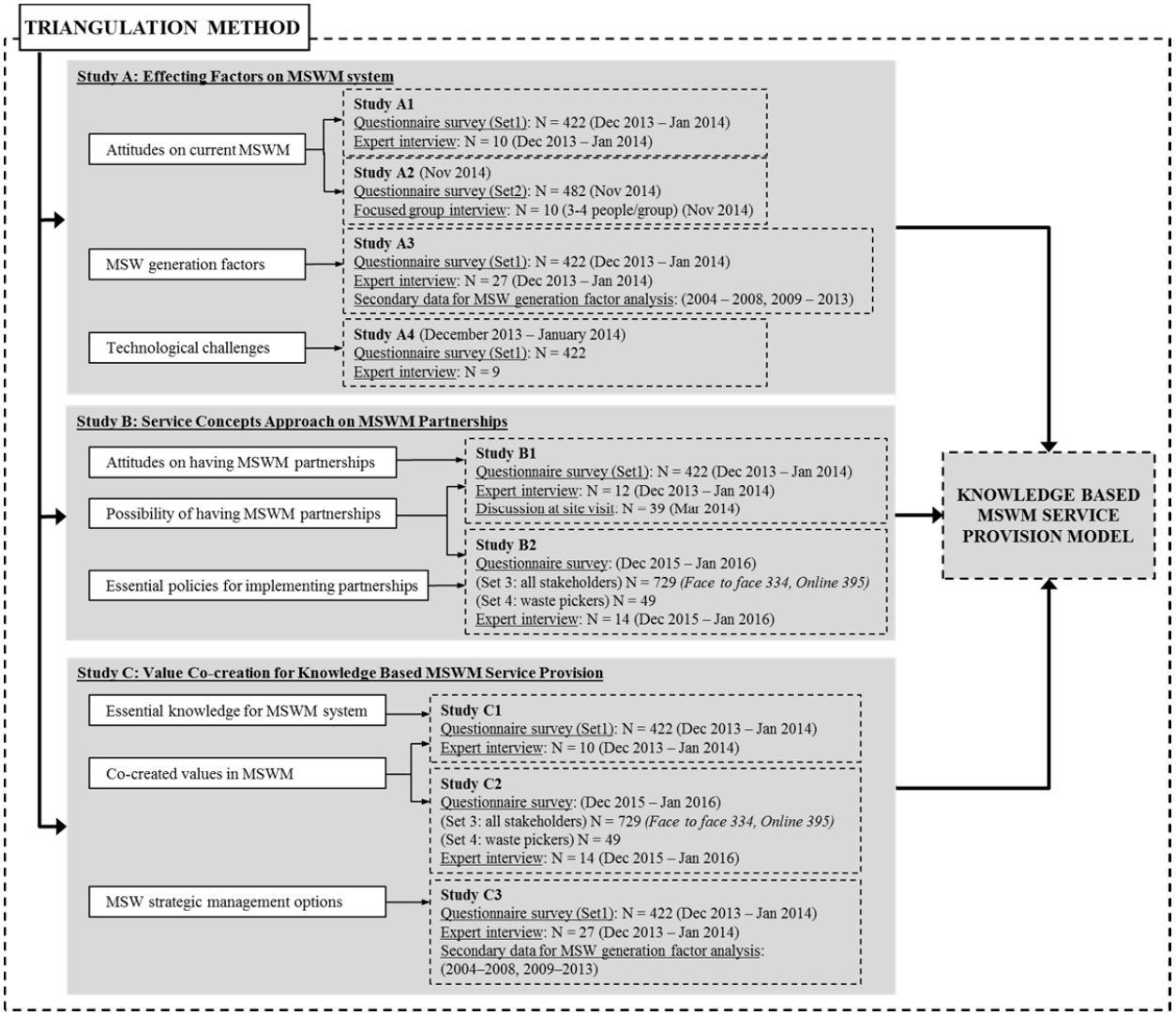

Figure 3.1: Research methodology overview

3.2 Research Boundary

The main goal of this dissertation is to enhance the effectiveness of MSWM service provision by applying the service and KM concepts. Accordingly, to find the analyzed results of all nine sub-studies, a number of influential factors are taken into account in order to be able to evaluate the effectiveness of the provided service and the management system. Being scoped by the two fundamental concepts, those factors and their roles are holistically presented in Figure 3.2.

Study A: Effecting factors on MSWM system

- A1: Current Performance of Municipal Solid Waste Management Service *(Q set 1)*
- A2: Waste Separation at Source *(Q set 2)*
- A3: Waste Generation Factors *(Q set 1)*
- A4: Technological Challenges *(Q set 1)*

Study B: Service concept approaches on partnerships

- B1: Municipal Solid Waste Management Partnerships *(Q sets 1, 3, 4)*
- B2: MSWM Service Policies and Practices *(Q sets 3 and 4)*

Study C: Value Co-Creation for Knowledge Based Service Provision

- C1: Essential Knowledge and Roles of Knowledge Management *(Q set 1)*
- C2: Co-Created Values *(Q sets 3 and 4)*
- C3: Strategic Municipal Solid Waste Management Options *(Q set 1)*

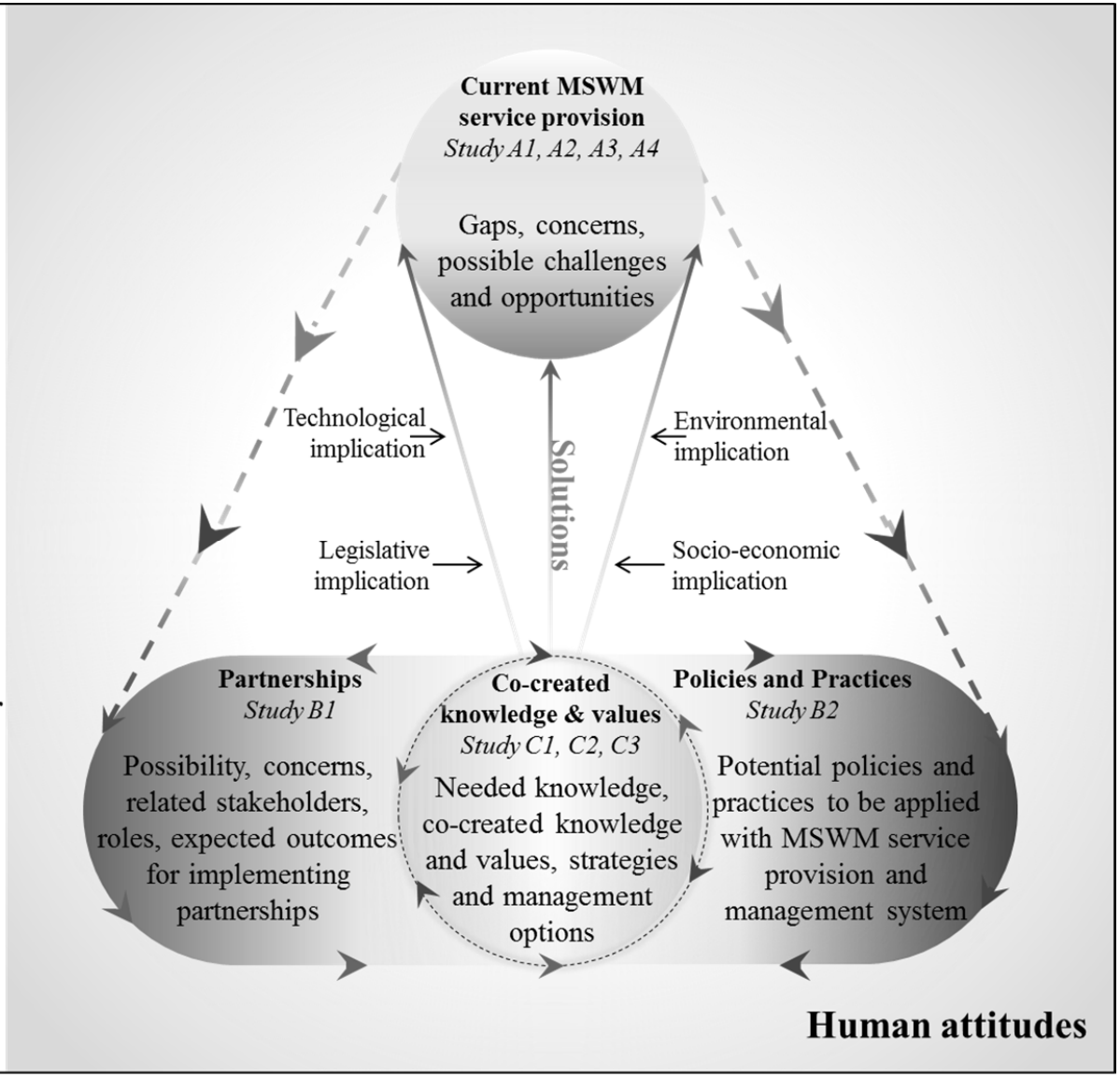

Figure 3.2: Research boundary

Figure 3.2 exemplifies details of how each sub-study links to others. Based on human or residents' attitudes and experts ideas and suggestions, the main source of primary data, all studies are linked together to achieve the goal of contributing co-created knowledge and values among all related factors that enhance the overall performance of MSWM service.

The first step is 'Study A' that consists of four sub-studies, which are 'Studies A1, A2, A3, A4'. The studies aim to identify influential factors that have impacts on the current MSWM system. The factors are, for example, MSWM gaps, urgent problems, waste generation factors, and possibilities of how to improve the current performance of provided MSWM services and the whole management system. After all the factors are identified, they are analyzed on the basis of service concepts.

As aforementioned, after all factors are identified, 'Study B' incorporates the importance of tripartite service concept to analyze the possible outcome of implementing partnerships for MSWM at a community level. To be specific by focusing on the possibility of involving related stakeholders, informal sector as the main service provider of MSWM service is studied and explained in 'Study B1'. The two forms of partnership that are studied in this dissertation are PPCP and CBO. In terms of potential MSWM service policies and practices, 'Study B2' identifies the policies and practices that should be adopted with each process of MSWM. The effectiveness of each policy implementation is discussed in this part. In addition, by incorporating each group of factors in terms of service actors, policies and practices, and roles and possibility of implementing partnerships, a service policy framework for enhancing the effectiveness of MSWM service provision at community level is proposed.

When possibility, concerns, related stakeholders, and expected outcomes of implementing two forms of partnership at community level, together with potential policies and practices that should be applied to MSWM system are identify, the next step is to integrate all results to find solutions or how to fulfill the gaps and concerned specified in the 'Studies A and B'. Accordingly, the third part, 'Study C' incorporates the concepts of value co-creation and knowledge management to identify the needed knowledge that should be available for each service actor in order to perform their MSWM related roles and responsibilities correctly. As a result, 'Studies C1, C2, C3' clarify the needed types of knowledge and values that are co-created from the collaborative partnerships. All knowledge and values are analyzed to find the solutions

for enhancing the MSWM performance, which MSWM strategies and management options are explained.

Implications that are analyzed in different viewpoints are described, which are represented in the Figure where the solutions are sending back to the gaps and concerns part. In the process of knowledge and value co-creation (Study C), KS and KT are the two most profound elements for having successful KM. Accordingly, potential knowledge creation processes that lead to the potential solutions for MSWM problems are proposed and illustrated as a conceptual model for knowledge based service provision of MSWM system that is formed by the effective KS and KT for having KD in MSWM at community level, which is presented in 'Implications' section.

3.3 Study Site

Jatujak district is selected as representative of Bangkok, as shown in Figure 3.3. The study site selection is based on several criteria including waste generation amount, number of households, number of MSW related appeals, number of population, and total area. Data in the selected criteria are compared among all 50 districts of Bangkok and focused on districts that are top ranked in such criteria. After ranking and comparing, Jatujak district is the top ranked district that has potential to represent the current Bangkok MSWM situation.

Figure 3.3: Location of Jatujak district in Bangkok, Thailand

According to the BMA ranking in 2013, Jatujak district was the 1st in MSW generation amount which was about 131,448 tons per year, as showed in Tables 3.1 and 3.2 ; the 1st in number of households which was 96,304 houses; the 1st on number of appeals related to MSW problems which was 1,513 cases (599 of ineffective management and 914 of ineffective staff). In terms of number of population, Jatujak district had 160,948 people, being the 9th rank where the highest population was Bangkae district (192,119 people). Jatujak district was the 14th rank in the total land area which was 32.91 sq.km comparing to Nongjok which was the largest district that had 236.26 sq.km (Bangkok Statistics Report, 2014; Bangkok Waste Generation, 2013). Hence, Jatujak district can be representative of an urban area that has been facing with MSWM problems and ineffective MSWM services.

Table 3.1: Top ten ranks of Bangkok districts in different criteria as of 2013 (BMA, 2014)

Criteria	1st Rank	2nd Rank	3rd Rank	4th Rank	5th Rank	6th Rank	7th Rank	8th Rank	9th Rank	10th Rank
Waste generation amount (tons/year)	Jatujak 131,148	Klongtoey 119,846	Bangkapi 116,414	Wattana 99,727	Bangkhuntien 98,947	Patumwan 98,768	Bangkae 96,320	Dindang 95,121	Bangkhen 91,608	Prawet 90,753
Number of households (Houses)	Jatujak 96,304	Bangkhen 95,741	Bangkapi 95,265	Saimai 89,604	Bangkae 77,864	Latkrabang 77,688	Bangkhuntien 77,350	Prawet 74,913	Klongsamwa 70,269	Bungkhum 67,801
Number of MSWM appeals (cases)	Jatujak 1,513	Bangkapi 1,443	Prawet 1,345	Wattana 1,345	Bangkae 1,211	Bangkhuntien 1,203	Bangkhen 1,094	Ladphrao 1,076	Pranakorn 1,063	Suanluang 1,014
Number of population (People)	Bangkae 192,119	Saimai 191,536	Bangkhen 190,544	Klongsamwa 174,197	Bangkhuntien 169,614	Donmuang 167,827	Latkrabang 165,724	Prawet 163,485	Jatujak 160,948	Nongjok 159,962
Total land area (sq.km.)	Nongjok 236.261	Latkrabang 123.859	Bangkhuntien 120.687	Klongsamwa 110.686	Minburi 63.645	Prawet 52.49	Taweewattana 50.219	Saimai 44.615	Bangkae 44.456	Bangkhen 42.123

Table 3.2: Top ten ranks of waste generation amount in Bangkok (BMA, 2014)

District	2009		2011		2013	
	Tons	%	Tons	%	Tons	%
Jatujak	120,313	4	121,823	4	131,148	4
Bangkapi	106,336	3	102,315	3	116,414	3
Klongtoey	104,987	3	101,396	3	119,846	3
Bangkae	91,574	3	91,790	3	96,320	3
Bangkhuntien	86,799	3	89,416	3	98,947	3
Dindang	85,668	3	83,473	3	95,121	3
Bangkhen	84,091	3	85,333	3	91,608	3
Wattana	80,427	2	80,695	3	99,727	3
Patumwan	80,231	2	76,844	2	98,768	3
Prawet	78,642	2	78,607	2	90,753	3
Total top ten districts	919,071	29	911,692	28	1,038,952	29
Total Bangkok	3,224,410		3,199,590		3,539,196	

3.4 Research Procedures

The primary data are mainly collected through questionnaire surveys, interviews, and discussion. In this dissertation there are four sets of questionnaire survey launched to the respondents in order to obtain primary data.

The first set of questionnaire, 'Appendix A: Questionnaire Set 1' is used for Studies A1, A3, A4, B1, C1, and C3. This set of questionnaire aims to obtain MSWM data in the perspectives of attitudes of respondents towards current Bangkok MSWM service provision and waste minimization, technological challenges, essential types of needed knowledge for MSWM system, and strategic management options.

The second set of questionnaire, 'Appendix B: Questionnaire Set 2', is used to obtain primary data to validate and verify that the respondents' attitudes on current MSWM system. The obtained data is used in Study A2, focusing on attitudes on waste minimization and recycling, possibility of implementing incentive recycling program, and the possible amount of collected recyclable waste.

The third set of questionnaire, 'Appendix C: Questionnaire Set 3', relates to essential policies and practices that should be applied in the Bangkok MSWM service provision, especially on the perspective of providing collaborative and inclusive partnership MSWM service. This set of questionnaire survey is used with Studies B1 and B2. The survey also applies to Study C2, as it aims to identify the co-created values in MSWM system when the combination of important service and KM concepts are adopted to enhance the effectiveness of MSWM system.

The fourth set of questionnaire, 'Appendix D: Questionnaire Set 4', is applied with Studies B1, B2, and C2. The obtained data are used in the analyses of possibility and concern of the implementation of collaboration of stakeholders at a community level, which is CBOs. In addition, possible values that are co-created through the involvement of all relating parties are identified and explained.

3.4.1 Questionnaire Set 1

Data Collection and Measurements

The questionnaire was conducted between December 2013 and January 2014. The population frame of the surveys was 422 people in Jatujak district. The surveys were conducted in eight different areas, based on geographic distribution and community style classified by the BMA (communities, schools and universities, temples, hospitals, department stores, companies, markets, and hotels) in order to represent population of the whole study area (Bangkok Environment Report, 2012; BMA, 2012). In the study, the surveys were conducted with many groups of people in different communities, ranging from slum dwellers to gated communities. This is to ensure that the study presents the results obtained from various types of residential in Bangkok.

The survey sample size was calculated with a 95% confidence level using Yamane's simplified formula (Yamane, 1983). The surveys were done by employing a random sampling method which target respondents were waste generators whose age was over 15 years. All surveys were conducted by direct interview. Therefore, there were no missing data. By applying the random sampling method, all respondents had the same probability to be selected for the survey. Accordingly, chances of coverage error and self-selection of distributed questionnaire were reduced. To measure the consistency of the questionnaire, Cronbach's alpha reliability test was done. The coefficient of internal consistency was 0.801. This means the questionnaire items were considered to be consistent and reliable.

To assess the influential waste generation factors, a list of MSW generation factors was developed based on literature review. This set of waste generation factors was considered as root causes of MSW generation in an overall situation. To verify MSW generation factors in the context of Bangkok, the root causes were analyzed to find generation variables that had impacts on Bangkok waste generation based on Bangkok secondary data.

In terms of expert interviews and discussion, each study was conducted differently in the aspects of the number of interviewees and questions given to interviewees. For 'Study A1', ten experts who have MSWM knowledge and experiences from academic, and private sectors were interviewed by employing semi-structured and open-ended interview methods. The questions

that were put on the questionnaire and given to the experts related to general information, household waste storage, disposal, and sorting behavior, and aspects on current waste management system and provided service. Besides, reliable secondary data are crucial to have meaningful results. Thus, data were collected mostly from government agencies, published journals, international databases managed by trustable organizations. Combining information from primary and secondary sources, results generated in this part of study are more useful.

For ‘Studies A3 and C3’, stakeholders having roles on MSW generation and MSWM from related sectors were interviewed, with the total number of 27 interviewees. These numbers included seven environmentalists from government institutions and BMA officers, five academic scholars from universities, six staff from NGOs, two CBM project leaders, four frontline MSW collection and transportation staff, and three waste pickers. The interview questions were related to MSW generation, impacts of MSW, current management system, and their attitudes on how effective and sustainable MSWM should be.

For ‘Study A4’, there were nine semi-structured expert interviews of various key stakeholders from government institutions, educational institutions, NGOs, and community based management projects. During the interviews, interviewees were able to freely express their opinions on the MSWM technological challenges as well as on any other topic related to MSW. The in depth interviews were conducted in order to obtain practical technological information, implications, and comprehensive thinking from people involving in waste management systems. The collected data were transcribed and incorporated into other analyses.

For ‘Study B1’, 12 expert interviews of various stakeholders from government institutions, educational institutions, private companies, NGOs, and CBM projects leaders were implemented. Site visits were conducted at three waste transfer stations and one landfill site throughout March 2014 in order to extract undocumented information. During the visits, 39 discussions were held with frontline staff, waste pickers, and local people. The discussions were conducted to obtain aspects on partnership potential implications, and comprehensive thinking from involved people in MSWM. Based on the respondents’ knowledge and experience, the respondents were required to answer questions related to the importance of collaboration among stakeholders; what roles of each sector should be to make the provided MSWM service effective, and finally what results or concerns of implementing partnerships should be. The experts were specifically asked questions about level of collaboration of multisector stakeholders regarding

MSWM, opinions on performance of MSWM service, and possibility of having partnerships at community level. Moreover, experts were asked about service actors that should exercise active roles in the service system. Besides questions relating to partnerships, there were also discussions with frontline staff, waste pickers, and local people on topics relating to their daily life or work condition, such as work satisfaction, quality of life, and MSWM service problem.

'Study C1' aims to obtain data in the perspective of KM. Accordingly, the questions used in the surveys were relating to needed knowledge on waste management and values of applying KM concept on MSWM. The respondents freely expressed their opinions on MSWM and what and how the system should be. Regarding the essential knowledge and roles of KM in the perspective of experts, the interview questions related to how KM would affect the performance of MSWM service. The interviews aimed to obtain three topics, including roles of KM and how to lessen knowledge gaps, impacts of KM on MSWM, and their opinions on implications in combining the concepts of sustainable service and KM.

To ensure accuracy and consistency, secondary data analysis was performed using literature and document reviews from reliable sources in published journals, reviews, and government databases. The collected data were subsequently used to validate and complement the studies, providing valuable insights into the research. In addition, the in depth information obtained from the interviews was transcribed and incorporated into the analysis.

Data Analysis

Data from the questionnaire surveys were analyzed by a statistical package for social sciences (SPSS®) program, version 20. For 'Study A1', respondents' demographic profile, and their concerns on MSWM provided service were analyzed by using descriptive statistics function, that allowed precisely analyzed results by checking validity and computing univariate statistics. In terms of waste generation factors, listed possible influential factors from reviewed papers were grouped into six categories of waste generation factors. The factors were analyzed to point out the potential root causes of waste generation factors. To identify root causes of waste generation for the city of Bangkok, a 108-data set obtained from published secondary data for each root cause was analyzed the descriptive statistics function. The 108-data set was a number of months from January 2005 to December 2013. For example, number of population was a

potential factor. Data of number of population from the month of January 2005 to the month of December 2013 were acquired. This set of data was subsequently analyzed to see the correlation with the amount of waste that was generated in that period of time.

In ‘Study A3’, Pearson correlation method was applied to determine relationships of linear dependence between paired data namely MSW generation quantity and MSW generation variables.

In ‘Study A4’, Pearson’s chi-square model fit tests were performed to screen the variables such as the needed technologies for each process of MSWM. For the preliminary screening, two-by-two tests of association between the current use of technology in MSWM and specific technologies used in each MSWM process were administered. In order to ensure that the data were analyzed effectively, some questionnaire items were eliminated by employing an explorative factor analysis (Principal Factor Analysis—Promax Kaiser Normalization Rotation method) to determine the technological challenges facing MSWM in Bangkok. In terms of the influence of technology on MSWM, a Likert type five-point scale was applied.

Methods that were used to analyze obtained data for ‘Study B1’ were also Pearson’s chi-square model fit tests and the two-by-two tests screened variables for roles of stakeholders. To organize experts’ opinions and ideas towards partnerships, the tripartite service concept was adopted. In addition, the tripartite service concept model was constructed. The model represents intertwined relationships and roles of the three elements of the tripartite concept under the three aspects of sustainability.

For human aspects on needed knowledge for sustainable MSWM, ‘Study C1’ employed a Likert five-point scale type was used for the answers, which were later grouped into six MSWM processes. Based on these six processes, answers of the aspects on value co-creation were grouped and analyzed using descriptive statistics function. The respondents also gave insightful data while they were completing the questionnaire survey. After getting all required data, important factors, concepts, and relationships were identified. Examining these relationships of the concepts of KM and sustainable waste management service, personal tacit knowledge was categorized and transformed to a more understandable explicit knowledge.

Achieving strategic MSWM options is one of the goals of this dissertation. Thus ‘Study C3’, integrated results from primary and secondary sources which were analyzed by using

qualitative research methods was conducted. Two management techniques, namely stakeholder analysis and TOWS analysis were employed.

Qualitative data were analyzed by using documentation and relationship examination techniques. Not only did questionnaire survey data obtain, but also the respondents gave insightful data while they were completing the survey. Apart from quantitative data analysis, documentation, conceptualization, and examining relationships were analyzed qualitatively. During conducting questionnaire surveys and expert interviews, by observing surroundings and listening to what the respondents or experts spoke out, data were jotted down and recorded.

3.4.2 Questionnaire Set 2

Data Collection and Measurements

Primary data was collected through semi-structured questionnaire surveys conducted throughout the whole month of November 2014 with the total sample size of 482. The population frame and method of launching the questionnaire were the same as 'Questionnaire Set 1'. The questionnaire assessed human attitudes on waste separation at source and willingness to join in recycling activities. To achieve this, a set of indicators was developed based on literature review and accumulated experiences from conducted projects and involvement in MSWM of research team.

To verify collected primary data, ten focused groups were conducted. The groups were selected as representatives from corresponding MSWM sectors in Bangkok (two groups from BMA officers, two groups from community leaders, three groups from waste collectors and frontline staff at transfer stations, and three groups from universities' professors). Their insightful views were used to support questionnaire outcomes.

Data Analysis

Statistical analysis was performed utilizing the SPSS® program. Descriptive Statistics function was used to organize and present the respondents' demographic profile. With the 482 samples, to ensure that the data are analyzed effectively, some questionnaire items were

eliminated by employing an explorative factor analysis (Principal Factor Analysis - Promax Kaiser Normalization Rotation method). Regarding human attitudes on source separation and influential factors for recycling, a Likert type five-point scale was used as a method to find the results.

3.4.3 Questionnaire Set 3

Data Collection and Measurements

'Questionnaire Set 3' was at first launched as a pilot test to ten university students as a trail survey, to ensure the consistency of the questionnaire. The sample size use in this set of questionnaire was calculated with a 95% confidence level according to Yamane's simplified formula (Yamane, 1983). The total number of answered questionnaire was 729, which was launched to residents residing in Bangkok areas during the months of December 2015 to January 2016. Of this amount, 334 survey results were obtained from face-to-face questionnaire survey and 395 results were obtained from online survey.

In the questionnaire, questions related to MSWM policies, in perspectives of partnership implementation and expectations towards the results of the new set of policies. Policies listed on the questionnaire questions were selected policies that are used or have been used in cities around the world. The selected policies obtained from secondary data sources were manipulated to get the results of potential MSWM policies in the perspective of Bangkok. The respondents of the surveys were those whose age was greater than 15 years. The samples were chosen randomly using stratification method, allowing low sample error and adequate representativeness (Sanchez-Perez et al., 2007).

In addition, there were 14 semi-structured expert interviews, which the authors asked questions about opinions and suggestions on potential service policies that should be in place in order to provide reliable and effective MSWM service. The interviewed experts consisted of three BMA officers who worked with MSWM policy and strategic planning for Bangkok; three academic scholars who were university professors that had expertise on MSWM; two governmental staff whose work related to MSWM service provision and evaluation of service performance; four NGO staff who worked on MSWM system and involvement of informal

sector at community level; and two manufacturing company officers who worked on strategic planning and resource management.

Data Analysis

The obtained collected data were analyzed for 'Studies B1, B2, and C2'. A number of functions of SPSS® Statistics version 20 software package were used to analyze obtained survey results. Descriptive statistics were used to organize and consolidate the 729 respondents' attitudes on existing MSWM service provision, MSWM policies, service actors, willingness to have active role in the system, and expectations of MSWM service. Pearson's chi-square model fit tests were performed to screen variables, which in this case were policies needed for MSWM service provision. In some questionnaire questions, a Likert five-level scale was applied. This was beneficial in terms of measurement the expectation of respondents which in this case they were service actors (Cronin and Taylor, 1992). Some questionnaire items were eliminated to ensure the reliability of the analysis. This was done by using an explorative factor analysis, Principal Factor Analysis – Promax Kaiser Normalization Rotation method (Shirahada and Hamazaki, 2013).

3.4.4 Questionnaire Set 4

Data Collection and Measurements

With the aim to analyze the possibility of implementing partnerships at community level (CBOs), the questionnaire survey was conducted with 49 waste pickers, whose roles will be the main waste collector at community level. In other words, waste pickers will be the main service provider in terms of waste collection at community level. The surveys were conducted in Bangkok areas during the months of December 2015 to January 2016. The respondents of both surveys were chosen from the people whose age was greater than 15 years. The questionnaire consisted of questions relating attitudes towards current provided MSWM service, willingness to join in partnerships at community level or the CBOs, together with concerns and expectations of the CBOs.

In the surveys, waste pickers did not answer questionnaire directly on the form, instead discussions were held with the waste pickers on issues regarding the prepared questions. This was to prevent bias and misleading answers.

Data Analysis

The obtained data were analyzed in the aspect of value co-creation when partnership is applied as a way to enhance MSWM system, which used in 'Studies B1, B2, and C2'. By employing the usefulness of statistical functions of the SPSS® Statistics version 20 software package, descriptive statistics were used to organize and consolidate the respondents' attitudes on implementing CBOs in Bangkok, policies and practices, stakeholders, willingness to have active role as the CBO member, and expectations of MSWM service.

In addition, respondents' experiences, knowledge, and ideas gathered from the semi-structured interviews and discussions were incorporated into the analyses to elicit more information. Incorporating the analyzed results obtained from the questionnaire surveys together with the qualitative data analyzed by using documentation and relationship examination techniques, co-created values were analyzed on different perspectives related to various stakeholders; a MSWM service policy framework and an overall synopsis of co-created value were developed.

3.5 Summary

As demonstrated in Figure 3.1, this chapter explains the sequences of methods, research boundary, analysis techniques, research activities, research procedures for all studies. Nine sub-studies were conducted with aims of achieving the three main objectives. Accordingly, the nine studies are categorized into three main parts. The first part is 'Study A', which consists of four studies that aims to identify effecting factors on MSWM system. The factors come from the combining influence of human attitudes on MSWM, MSW generation factors, and opportunities and challenges of technological factors.

The second part, 'Study B', consists of two studies that aim to clarify the importance and possibility of applying service concepts on MSWM partnerships. Consequently, this part of study provides details of methods that are employed to get human attitudes on having MSWM partnerships, possibility of having partnerships, and service policies that are needed for partnership implementation.

The last part is 'Study C', which has three sub-studies aiming to identify co-created values for MSWM service provision on the knowledge related basis. Thus, methods used to identify essential MSWM knowledge, co-created values, and strategic MSWM management options are explained.

The following three chapters, Chapters 4, 5, and 6, explain analyzed results obtained from the multifaceted research, which are on the basis of achieving the three main objectives.

Chapter 4

Study A: Effecting Factors on Municipal Solid Waste Management System

'Study A' aims to identify stakeholder attitudes on current MSWM situation, MSW generation factors, and technological challenges, which all of these can affect the performance of MSWM system. The study comprises of four parts. The first part includes aspects on current performance of MSWM service and concerns on the provided services. The second part consists of perspective on waste separation at source and waste minimization. The third part entails root causes of waste generation and waste generation factors for the city of Bangkok. The last part is about technological challenges.

4.1 Study A1: Current Performance of Municipal Solid Waste Management Service

4.1.1 Demographic Information

Presenting in Table 4.1, there were 205 male and 217 female respondents responded to the survey. The results of data analyses showed that the majority of respondents had an average monthly income of 10,001 to 20,000 baht or about 300 to 600 USD. Average household size was three people per house. In terms of household waste management, 51.2% of respondents performed waste separation. Putting waste in front of the house for collection and putting waste in public waste bins were the two main management methods, as there were 96.7% of respondents participating. Each household generated 1–3 kg of waste per day. Interestingly, the results showed that only half (48.1%) of the respondents paid waste collection fee at an average of 0.6 USD per month.

Table 4.1: Overview results from questionnaire survey

Potential causes of MSW generation	Unit
Male respondents	217 people
Female respondents	205 people
Average household size	3 people
Average monthly income per capita	300 – 600 USD
Average MSW generation per capita	1.08 kg per day
Respondents who sort MSW at source	216 people
Putting waste in front of their houses or in public dumpsters	408 people
Respondents who pay MSW collection fee	203 people
Average paid MSW collection fee	0.6 USD

4.1.2 Attitudes towards Current Performance of MSWM Service

In terms of attitudes on current provided MSWM service, Table 4.2 shows frequency results from all respondents. The respondents stated that the current provided MSWM service was at moderate level. Table 4.3 presents respondents' concerns on MSWM service and the current performance of MSWM system.

Table 4.2: Respondents' aspect on current performance of MSWM service

	Very good	Good	Acceptable	Bad	Very bad
Count	8	101	236	51	26
Percentage (%)	1.9	23.9	55.9	12.1	6.2

Table 4.3: Respondents' concerns on MSWM service

Performance level	Concerns				
	Not on time	Leftover waste	Falling waste	Odor	No service
Very good	3	2	3	1	0
Good	31	40	33	57	4
Acceptable	97	130	77	169	14
Bad	25	30	22	42	8
Unacceptable	9	14	9	20	6
Total	165	216	134	289	32

Table 4.3 shows that odor and leftover waste during collection process were the most two occurring problems that needed to be urgently solved. These results go in line with information provided by the PCD. In 2013, there were 180 environmental pollution cases appealed, which 135 cases were problems related to MSW, odor, and hazardous waste (PCD, 2014a). When asking about who should be the major parties to be involved in MSWM for a better waste management system, 87% of respondents thought that everyone from all sectors, including residents, NGOs, government, and private companies. Almost 80% of all respondents were willing to join in MSWM system for better management process.

The analyzed results of respondents' attitudes regarding gaps of the current MSWM system are presented in the following table.

Table 4.4: Respondents' perspectives on gaps of MSWM system

Respondents' perspective on MSWM	Percentage (%)
1. MSW generation should be reduced.	91.7
2. MSW should be managed effectively and efficiently.	90.3
3. MSWM should be effectively operated.	89.3
4. MSW causes environmental problems.	88.6
5. MSW is a great source of alternative energy.	80.6
6. MSW causes social problems.	66.9
7. MSW causes economic problems.	62.8

It is encouraging to see that most of all respondents thought that waste generation should be reduced. It is a good sign for Bangkok that the residents perceived MSW as a problem and were aware of its impact. The BMA experts stated that waste reduction should start with changing people's behavior to generate the minimum amount of waste. Moreover, other studies show that in Bangkok, waste reduction is a sound MSWM method and is more essential than landfills.

4.2 Study A2: Waste Separation at Source

4.2.1 Attitudes towards Waste Minimization and Recycling

Most of the respondents, 88.8%, would like to take part in source separation and minimize waste generation through 3Rs. However, there were some concerns as they would not be able to do the activities: sorting waste is complicated (69.3%); do not have time (65.3%); and no proper trash bins (78.5%). In terms of waste recycling, 69.3% of respondents answered that they knew about waste recycling, of this amount only 20.7% participated in recycling activities. Upon incentive recycling waste program, 46.5% of respondents had knowledge about this. However, 88.8% of respondents showed their interest in participating in incentive waste recycling activities.

In a case that recycling program was formally implemented with supports of government and private sectors in Bangkok communities, respondents stated that the program could be successfully implemented. Their answers were analyzed based on a five-point Likert scale as shown in Table 4.5. The results are cumulative percentage of those who answered agree and totally agree answers.

Table 4.5: Respondents' perceptions on participating in recycling activities

Benefits of the MSW recycling program	Percentage (%)
The program can increase the efficiency of MSWM	86.6
Participation will provoke people's intention in waste separation	86.1
The program can alleviate MSWM problems in long-term	77.9
The program concept can be adopted in other communities	77.3
People will get benefits from participating in waste separation with the program	56.7

Based on respondents' attitudes the program had potential to increase efficiency of MSWM in community level, provoke resident's intention in waste separation and recycling. They also believed that the program could solve MSWM problems in long-term and could be adopted in other communities when it was successfully implemented in Bangkok. And lastly,

people who participated in recyclable waste separation with the program would get benefits from incentives and better MSWM system.

By applying the explorative factor analysis (Principal Factor Analysis - Promax Kaiser Normalization Rotation method) to determine respondents' preferable incentives if the recycling program could be provided in communities in Bangkok area. The factors were cash, collective points, vouchers, discount coupons, tax deduction, and goods. These factors were analyzed into two groups of factors showing human attitudes on the willingness to participate in incentive waste recycling activity. Factor I showed that residents would like to have cash, tax reduction, and goods as incentives. Factor II showed that residents would like to get collectable points, gift voucher, and coupon as incentives to be redeemed later at convenient stores (75.7%), supermarkets (36.5%), and department stores (31.5%). It can be seen that Factor I and II had a weak correlation at 0.20. This might cause by a number of respondents (22.2%) who answered that they did not want any incentives.

Table 4.6: Statistical results of explorative factor analysis

Items – If there were incentive recycling programs, preferable incentives would be:		Factors	
		I Immediate use	II Later use
Cash		0.77	
Tax reduction		0.47	
Goods		0.33	
Collectable points			0.72
Gift voucher			0.71
Coupon			0.69
Correlation between factors	I	1.00	
	II	0.20	1.00
Total Variance	(%)	28.65	17.83

4.2.2 Possibility of Implementing Incentive Based Recycling Program

Regarding possibility of implementing incentive based recycling program, as stated in the attitude part, the majority of respondents (88.8%) would like to join in waste separation

activities. This infers high potential of introducing the recycling program to communities in Bangkok. Respondents agreed that waste recycling campaign should be promoted consistently with a monitoring system. As they would like to be part of the MSWM system, waste minimization and separation of waste at source would solve problem of mixed waste in collection process and also save time that waste collectors had to spend on sorting out recyclables. Despite the high potential of applying the recycling program as a means to let residents involve in MSWM system, there were several points to concern for having successful implementation. Utilizing five-point Likert scale type questions, points to concern for implementing the recycling program indicated by respondents are presented in Table 4.7, ranked from highest to lowest percentage.

Table 4.7 Influential factors for applying incentive based recycling program

Concerns	Percentage (%)
Acceptable types of recyclables for the program	53.1
Reliability and possibility of the program	49.2
Worthiness of provided incentives	37.2
Complexity of joining the program	35.1
Time consumed in joining the program	33.8

4.2.3 Possible Collected Recyclable Waste from Incentive Based Recycling Program

According to the information of MSW characterization in all districts of Bangkok, the main types of recyclable waste are plastic, paper, glass, beverage container, and metal. The information indicates that MSW composition is not significantly different from district to district. Proportion of the amount of recyclable waste is analyzed on the basis of discarded mixed waste transported at transfer stations. Thus, the actual amount of household recyclable waste should be in higher proportion as a large amount was sorted out and collected by waste pickers and collection staff.

According to Muttamara et al. (2004) amount of recyclable waste collected at source by waste pickers and collection staff in Bangkok is about 5% of the total collected waste. Regarding to the analyzed results of amount of recyclables generated in their house, 64.5% of respondents answered that the recyclable waste was about 10-30% of the total discarded waste. This data conform to the published data that possible recyclables generated at source is about 1,800 tons per day or about 20% of the total waste generation (Jungrungrueng, 2014b). This implies that if the average MSW generation is 1-3 kg, recyclable waste generated per day is approximately 0.1-0.9 kg. Currently, respondents mainly managed the separated waste by keeping the sorted amount to be sold (49.8%), putting the waste in front of their house (28.7%), and putting into public dumpsters (21.5%). Regarding to types of recyclable waste, results showed that plastic (38.3%), paper (26.9%), beverage can (18.7%), glass (12.7%), and metal (3.6%) were the primary recyclables that were discarded in Bangkok. The data implies that the recycling program should have facilities supporting these main types of discarded recyclables which in the context of Bangkok were plastic, paper, beverage can, and glass.

Regarding the results obtained from focused groups, the groups gave insightful opinions on moving forwards to effective MSWM at a community level. All prospect groups agreed that residents were willing to be involved in MSWM process and made their surroundings clean and lively. Community leaders stated that municipalities should be middleman by putting more efforts on involving the residents in the management chain. Conversely, waste collectors and frontline staff worried about loss of income from selling recyclable waste if the recycling programs were implemented in their areas. University professors and BMA officers shared that applying the recycling program concept in MSWM was another potential way linking residents and municipalities to work together.

Providing incentives was also a marketing tool that could draw peoples' attention in joining MSWM activity. Additionally, a thorough technical and financial analysis must be studied in order to make the program suit with waste characteristics and peoples' lifestyle. And also a concrete plan should be provided to prevent all possible consequences that might happen if there was a recycling program in place, for example, problems from waste pickers and those who collected recyclable waste from households, reliability of the whole recycling program, and monitoring system in long-term.

4.3 Study A3: Waste Generation Factors

4.3.1 Root Causes of MSW Generation

The potential MSW generation factors were listed out from literature review, categorized into groups, and analyzed. The factors were categorized into groups, including demographic, economic, technological, social, consumer behavior, and legislative and administration. Out of all listed factors, 14 factors were considered potential root causes for MSW generation in an overall situation, as presented in Table 4.8. The results indicated that the changes in economic situation had contributed to MSW generation the most.

Table 4.8: Root causes of MSW generation

Potential causes of MSW generation	Percentage (%)
1. Income level per capita	93.5
2. Economic growth (GDP, CPI)	91.2
3. Population size	90.8
4. Size and number of household	89.6
5. Consumption / lifestyle	88.4
6. Industrialization	86.1
7. Perception on impact of MSW	82.5
8. MSW related legislation	77.6
9. Number of tourists	75.9
10. Technology applied	68.8
11. MSWM related knowledge	63.2
12. Public involvement	51.1
13. MSWM fee	46.2
14. Seasons	37.1

4.3.2 Waste Generation of Bangkok

Based on the 108-data set of Bangkok available waste generation related data, Table 4.9 represents seven MSW generation variables which were analyzed from the obtained 14 root causes from the questionnaire surveys. For MSW generation, its kurtosis value indicated a higher peak than normal. This is because there was a significant peak in MSW generation quantity in December of 2011, in which this data was substantially different from other data of other months.

Table 4.9: Statistical parameters for waste generation of Bangkok

	MSW generation (Tons)	Population size (People)	Number of households (households)	Household size (People)	Avg. income/capita (USD)	GDP/capita (USD)	CPI (Points)	Number of tourists (People)
Sample size	108	108	108	108	108	108	108	108
Mean	273,189.124	5,691,187.111	2,336,047.222	2.450	1,113.278	11,007.842	95.369	2,354,605.065
SD.	23,101.265	18,078.574	162,927.242	0.172	166.664	1,079.089	6.392	393,533.200
Skewness	0.953	-0.337	0.061	0.012	0.254	1.013	-0.008	0.571
Kurtosis	2.335	-1.063	-1.245	-1.343	-1.189	-0.349	-0.934	-0.622

Table 4.10: Pearson correlation of MSW generation and influential factors

		MSW generation	Population Size	Number of households	Household size	Avg. income per capita	GDP per capita	CPI	Number of tourists
MSW generation	Correlation	1							
Population size	Correlation	-0.128	1						
Number of households	Correlation	0.659***	-0.137	1					
Household size	Correlation	-0.651***	0.143	-0.999***	1				
Avg. income per capita	Correlation	0.654***	-0.165	0.989***	-0.985***	1			
GDP per capita	Correlation	0.688***	-0.256*	0.908***	-0.892***	0.919***	1		
CPI	Correlation	0.702***	-0.089	0.967***	-0.964***	0.952***	0.912***	1	
Number of tourists	Correlation	0.585***	-0.444***	0.708***	-0.687***	0.764***	0.905***	0.716***	1

*** Correlation is significant at 0.1% level, ** significant at 0.5% level, *Significant at 1% level (2-tailed)

Table 4.10 presents the analyzed results of correlation of Bangkok MSW generation and influential factors. It is clearly seen that correlation coefficient values could be divided into three groups. First, CPI, GDP per capita, number of household and average income per capita, these four factors had very high impact on MSW generation. The positive coefficient values of the four factors were 0.702 ($P < 0.001$), 0.688 ($P < 0.001$), 0.659 ($P < 0.001$), and 0.654 ($P < 0.001$), respectively. Second, number of tourists, this factor had moderate relationship with MSW generation quantity, with correlation coefficient value of 0.585 ($P < 0.001$). Third, population size and household size, these two factors had negative correlation coefficient values which were -0.128 ($P < 0.001$) and -0.6 ($P < 0.001$). This means the two factors had diverse relationship with MSW generation quantity.

Regarding negative correlation coefficient values, there might be some multicollinearity problems. However, the results of multicollinearity measurements did not confirm multicollinearity. This could be attributed to negative relationship between variables.

4.4 Study A4: Technological Challenges

4.4.1 Technological Challenges Facing Municipal Solid Waste Management

Table 4.11 shows the factors that respondents thought they could increase MSWM service effectiveness and make the MSWM system sustainable.

Table 4.11: Potential success factors to increase waste management effectiveness

Success factors to increase waste management effectiveness	Percentage (%)
1. Effective machines and trucks	81.5
2. Strong enforcement of waste disposal of residents	77.3
3. Application of practical policies in all areas	76.8
4. Application of appropriate technology	75.8
5. Strong enforcement of waste separation	75.6
6. Enforcement of stringent waste collection laws	74.2
7. Enforcement of stringent waste transportation laws	72.1
8. Enforcement of stringent waste treatment laws	71.6
9. Qualified staff	66.3
10. Strong enforcement of waste collection payment service	60.5

According to the survey and the result presented in Table 4.11, most respondents felt that MSWM infrastructure, practical policies, and enforceable laws were essential for the effectiveness of the system. These factors also matched the insights gained from interviews, whereas experts indicated that the most urgent problem that required resolution for sustainable MSWM was suitable infrastructure. If the infrastructure was in place, there should be practical policies and strategies to manage the system. Dwivedy (2010) states in his work that successful implementation of waste management requires the establishment of an appropriate infrastructure. To make a system run smoothly, effective laws need to be enforced. A study by Roomratanapun (2001) shows that law enforcement is the third ranked solution to solve MSWM problems.

When asked about the level of technology applied to the current MSWM system, 51.7% of the respondents thought that the system should be operated with technology. However, when

asked into detail, 44% of those respondents thought that technology was applied at a moderate level in the MSWM system. This result highlighted the fact that Bangkok residents felt that technology should be applied a lot more to increase the effectiveness of the current system.

Table 4.12 shows a preliminary screening of the influential technologies that was significantly associated with applying new technologies to the current MSWM system at a 1% level of significance. The results showed 17 different technologies in three important management processes: collection, transportation, and treatment and disposal. Most of the respondents thought that waste separation and rear truck technologies were essential for waste collection process. Besides, semi-auto truck, GPS, RFID, and built-in compactor truck technologies were also indispensable for waste collection. Effective use of energy, GPS, and RFID technologies were needed for the waste transportation process. In terms of waste treatment and disposal, the respondents stated that waste recycling, composting, landfill, waste-to-energy, incineration, effective use of energy, open burning, and gasification technologies were important for MSWM.

Apart from the analyzed variables, respondents and experts commented that impacts caused by technology should be studied and have monitoring and mitigation plans to prevent any possible adverse impact. This result corresponded with the 2012 waste management performance analyzed by the BMA, which found that machines and trucks ran ineffectively due to their conditions and needed to be regularly maintained (DOE, 2013). This lessened the overall performance of waste collection, transportation, and treatment disposal processes.

Table 4.12: Statistical results of chi-square testing of associations with technologies for MSWM system

Collection technology	Sorting	Rear truck	Semi-auto truck	GPS	RFID	Built-in compactor truck
Count	156	104	53	41	22	27
Pearson chi-square	226.322	130.381	54.124	36.984	21.926	27.25
Contingency co-efficiency	0.591*	0.486*	0.337*	0.284*	0.222*	0.246*

Transportation technology	Effective use of energy	GPS	RFID
Count	85	60	30
Pearson chi-square	105.553	62.894	27.549
Contingency co-efficiency	0.439*	0.360*	0.248*

Treatment and disposal technology	Recycle	Composting	Landfill	WTE	Incineration	Effective use of energy	Open burning	Gasification
Count	186	156	108	98	62	54	32	8
Pearson chi-square	306.419	226.322	133.637	117.162	68.659	58.5	32.711	5.168
Contingency co-efficiency	0.649*	0.591*	0.490*	0.470*	0.374*	0.349*	0.268*	0.110*

* Significant at 1% level

4.4.2 Technological Impacts on MSWM

To emphasize the importance of the application of technology to MSWM systems, Table 4.13 shows the respondents' perspectives on how the MSWM in Bangkok would change if different technologies were applied.

Table 4.13 shows the results of explorative factor analysis of the influences of technology on MSWM. There were three factors showing aspects on the performance of technology on MSWM system. Factor I, technology for cost reduction, showed that applying technology to MSWM could save costs for waste transportation, collection, and treatment and disposal processes. Factor II, technology for social improvement, showed that applying technology to MSWM could alleviate social, economic, and environmental problems and reduced the amount of staff required in MSWM processes. Factor III, technology for sustainability, showed that the applying technology could make the MSWM system run sustainably and efficiently.

It can be seen that these three factors had a strong relationship with each other. Factors I and II had a relatively strong correlation at 0.54, Factors I and III had a marginally weak correlation at 0.48, and the correlation between Factors II and III was very strong at 0.61. In terms of applying technology to MSWM, Factor I could best explain respondents' attitudes on the impact of technology for cost reduction on MSWM, at 44.17%, compared to Factor II, which showed the impact on social improvement at 10.99%. Factor III showed that the impact on technology for sustainability of the MSWM system was at 6.45%. Overall, these results suggested that applying technology had the potential to optimize profit by reducing the expense in MSWM, which affected the whole system of collection, transportation, and treatment and disposal.

Table 4.13: Statistical results of explorative factor analysis

	Factors		
	I	II	III
Items – *Respondents agree that if technology is applied to waste management processes, the MSWM system would:*	Technology for cost reduction	Technology for social improvement	Technology for sustainability
- save cost for waste transportation	0.97	–0.03	–0.01
- save cost for waste collection	0.90	–0.04	–0.05
- save cost for waste treatment and disposal	0.81	0.01	0.08
- cause fewer social problems	–0.05	0.84	–0.04
- cause fewer economic problems	0.05	0.80	-0.07
- cause fewer environmental problems	–0.19	0.74	0.13
- require less staff	0.22	0.53	–0.08
- be sustainable	0.01	–0.03	0.87
- be implemented more efficiently	–0.01	0.01	0.85
Correlation between factors I	1.00		
II	0.54	1.00	
III	0.48	0.61	1.00
Total variance (%)	44.17	10.99	6.45

4.5 Summary

With an aim of finding influential factors that have impacts on the performance of MSWM system, based on the respondents' attitude, the analyzed results of this chapter show the current provided MSWM services are at moderate level of satisfaction. Odor and leftover waste are the most concerned problems. The respondents have positive perception on MSWM, as they answered that MSW generation should be reduced, the MSWM system should be effective, or MSW causes environmental, social, and economic problems. Residents also gave encouraging feedback on waste separation and minimization by showing willingness to join in incentive recycling program.

The study presents seven potential waste generation factors in the context of Bangkok, including population size, number of households, household size, average income per capita, GDP per capita, CPI, and number of tourists. Three main success factors to increase MSWM system effectiveness include functional MSWM infrastructure and enforceable laws and policies. In terms of technological challenges, there is a large gap that technology can help increase the effectiveness of MSWM system in Bangkok. The study shows potential technologies that should be appropriately applied to each process of MSWM. In addition, applying technologies to the management process of the system would be beneficial in terms of cost reduction, social improvement, and sustainable management system.

Chapter 5
Study B: Service Concept Approaches on Partnerships

'Study B' aims to identify stakeholder attitudes on partnerships in a general perspective and also the possibility of having collaboration in forms of PPCP and community based organizations (CBOs). The study comprises of two parts. The first part, 'Study B1', relates to aspects on having a multisector partnership in Bangkok MSWM. In this part of study, the tripartite service concept is applied to specified roles of stakeholders, which are service providers, service recipients, and natural capital. The second part, 'Study B2', identifies essential MSWM policies that are needed for the operation of partnerships, especially the ones at community level.

5.1 Study B1: Municipal Solid Waste Management Partnerships

5.1.1 Attitudes on Public Private Community Partnerships

Regarding the perspective of collaboration through partnership, 93.6% of the respondents thought that collaboration among communities, government authorities, private companies, and NGOs were important for effective service provision and sustainable MSWM. In terms of willingness to join the collaborative system, 78.7% of them would like to join. Residents and experts thought that PPCP was vital for MSWM in Bangkok and they would like to be part of the sustainable management system. Therefore, PPCP had high possibility to be implemented as a MSWM mechanism. Table 5.1 shows results from chi-square association tests indicating roles and relationships for each stakeholder on the basis of significant sense.

Table 5.1 demonstrates a preliminary screening of essential roles of each sector that was important to be done for an effective and sustainable MSWM at 1% level of significance. For roles of service recipients, respondents thought that waste separation, correct waste disposal, and reduce waste generation were top priority to take action. For NGOs, this stakeholder was very critical in contributing great performance of MSWM. From the results, NGOs should help promote sustainable MSWM, be an intermediary between service providers and service recipients, and be a party that monitors and assesses effectiveness of MSWM processes and performance of service provided. In service providers' standpoint, the government authorities and private companies should employ appropriate technologies, provide effective and reliable service, and be more service oriented.

Table 5.1: Results of chi-square tests of associations with roles of stakeholder for MSWM

(n = 422)

Roles for service recipients (Residents/communities)	Sort waste	Dispose waste correctly	Minimize waste	Work with govt to promote sustainable MSWM	Pay waste collection fee
Count	307	297	244	213	182
Pearson chi-square	299.735	271.809	156.815	112.596	86.752
Co-efficiency	0.644*	0.626*	0.521*	0.459*	0.413*
Roles for intermediary (NGOs)	Promote sustainable MSWM	Be an intermediary	Check effectiveness of system		
Count	248	238	216		
Pearson chi-square	163.049	143.600	119.951		
Co-efficiency	0.528*	0.504*	0.470*		
Roles for service providers (Govt/private companies)	Employ appropriate technologies	Provide effective service	Service oriented system	Traceable management process	
Count	283	282	229	226	
Pearson chi-square	227.717	230.429	135.736	127.726	
Co-efficiency	0.592*	0.594*	0.493*	0.482*	

* Significant at 1% level

5.1.2 Public Private Community Partnership on Tripartite Concept

By incorporating interview results, discussions, and literature reviews, this part graphically explains analyzed results as if there were PPCP in the Bangkok MSWM system. Figure 5.1 shows a modified tripartite service model representing a balanced importance of the three elements of sustainability, which are environment, society, and economy. Within these three aspects, collaboration between service providers and service recipients, and resources supported by the ecosystem lead to co-creation of values.

In the model, value-in-use refers to expertise and strengths of the providers and recipients that will be integrated and used in improving waste management system. In a community, actors from public, private, and community sectors mutually co-create values by integrating all resources that each sector has for a better and more effective MSWM. In other words,

sustainable MSWM is a factor that enhances societal well-being, for example, better health, more happiness, and less disparity.

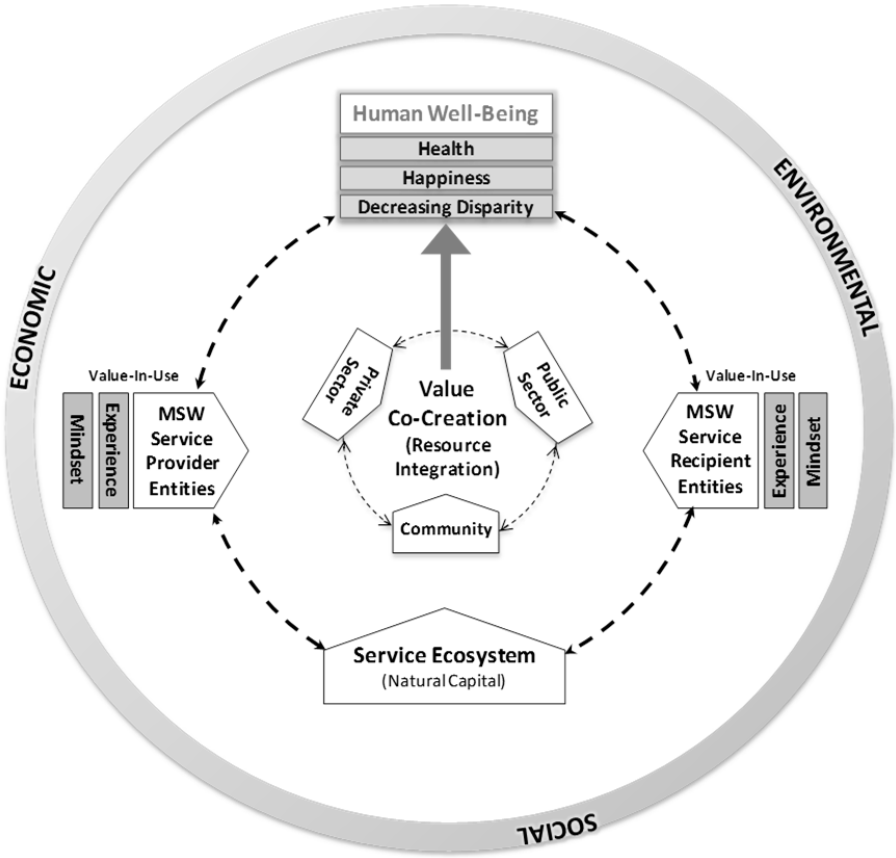

Figure 5.1: Tripartite service concept model
(Modified from Sukholthaman et al., 2014)

Perspectives of how experts thought towards each stakeholder who had different roles and responsibility in MSWM are demonstrated in Figure 5.2. The results showed that major problems of current MSWM were no collaboration among sectors, lack of involvement, and unpractical policy; whereas effective MSWM service could be achieved by having practical policy, providing MSWM knowledge, and most importantly, more involvement and collaboration within the same and different sectors.

Another perspective is PPCP attitudes on tripartite concept. To provide sustainably effective service, human-to-human and human-to-nature interactions should be logically integrated. To become voice for nature, service providers and recipients should ensure good

condition of the environment, which is the good condition of natural capital. (Shirahada and Fisk, 2014). As a result, the role of natural capital or 'Service Ecosystem' in the figure is to be a part that helps the service system run smoothly. This is explained as presented in the grey area of Figure 5.2, which covers all interactions of all sectors.

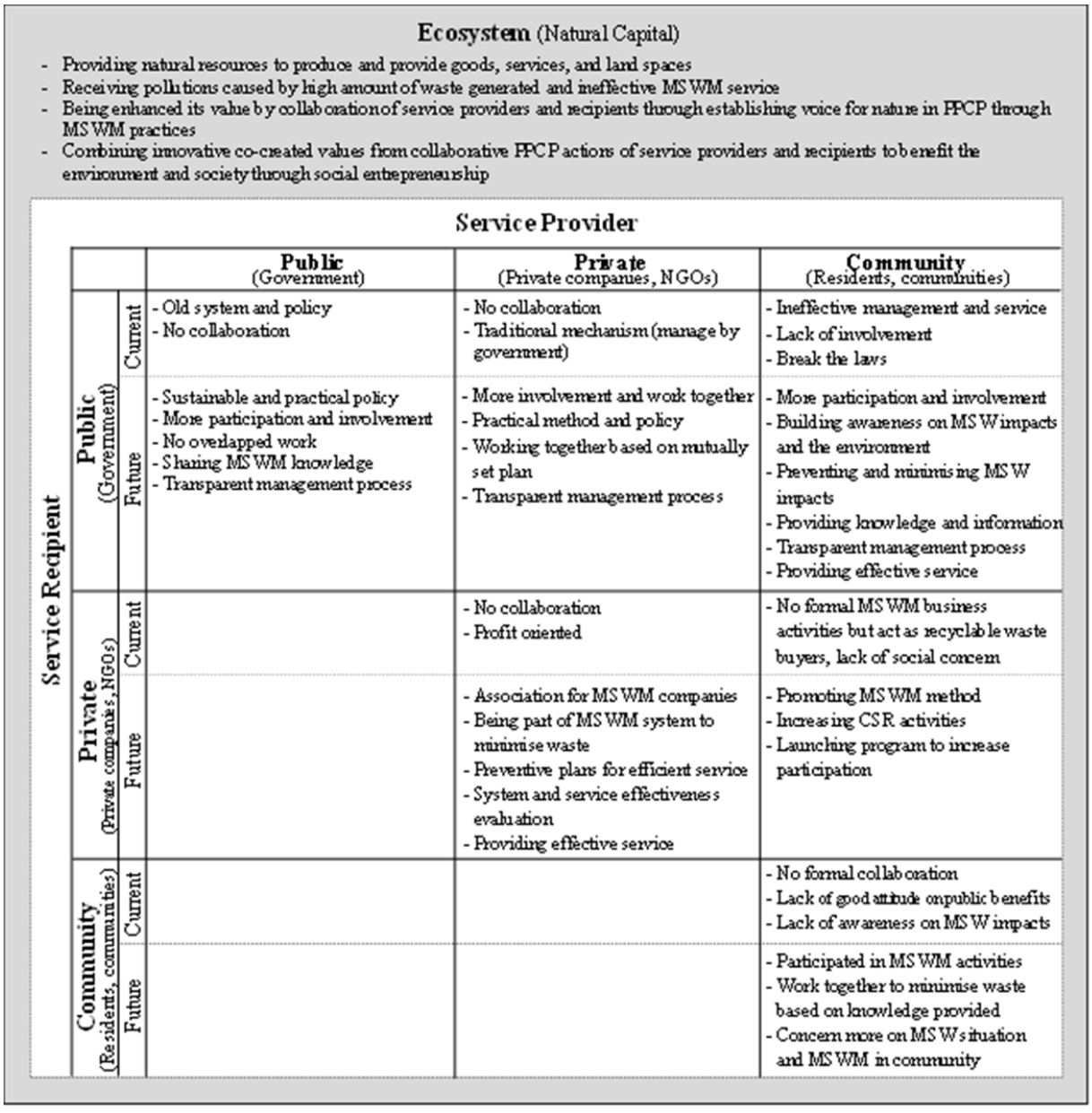

Figure 5.2: Relationships and roles of each stakeholder in PPCP on tripartite concept perspective

5.1.3 Attitudes on Community Based Organizations

This part of study consists of the results analyzed from the obtained data of the first and second sets of questionnaire surveys. To briefly explain, the data were analyzed using descriptive statistics function of SPSS® program to organize and consolidate the 729 (questionnaire set 1) and 49 (questionnaire set 2) respondents' demographic profiles as presented in Tables 5.2 and 5.3. To explain in detail, to have effective MSWM at community level, the CBO was introduced as a management mechanism that allowed waste pickers to be the active waste collection service providers. Thus, the second set of questionnaire was conducted specifically to waste pickers. This was to obtain insightful data directly from the correct prospect group of stakeholders.

Table 5.2: Overview results from questionnaire survey regarding all stakeholders

Respondents' general information	Units
Male respondents	339 people (46.5%)
Female respondents	390 people (53.5%)
Literacy level	334 people finished bachelor degree (45.8%)
Average monthly income per capita	300 – 1,000 USD (26.5%)
Average household size	4 people (28.7%)
Knowing of MSWM policy	444 people do not know (60.9%)
Knowing of MSWM policy is important	724 people think important (99.3%)
Willingness to join in policy setting	585 people would like to join (80.2%)

Table 5.3: Overview results from questionnaire survey regarding waste pickers

Respondents' general information	Units
Male respondents	34 people (69.4%)
Female respondents	15 people (30.6%)
Literacy level	28 people with primary school (57.1%)
Average household size	4 people (34.7%)
Conducting waste collection as main occupation	42 people (85.7%)
Average daily income for each time of collection	3 – 10 USD (30.6%)
Frequency of conducting waste collection per week	38 people collect waste every day (77.6%)
Means of transportation used in waste collection	Three-wheel motorcycle (57.1%)
Time spent on waste collection per day	6 – 8 hours (59.2%)
Collaboration in MSWM service system is needed	45 people think important (91.8%)
Willingness to join in CBOs	45 people would like to join (91.8%)

Table 5.2 shows that all stakeholders would like to be part of MSWM policy setting. Table 5.3 represents the potential of implementing CBOs on the perspective of waste pickers. The results imply a high potential of having CBOs as an operating agent in providing MSWM collection service, as about 92% of the respondents expressed their willingness to join in the organizations.

5.1.4 Possibility of Inclusive Community Based Organizations in MSWM Service System

In spite of the high willingness to join of the waste pickers, to be involved in the CBOs in recyclable waste collection at community level, waste pickers stated a variety of factors they expected to get after joining, which are summarized in Table 5.4.

Table 5.4: Potential success factors to implement inclusive CBOs

Success factors	Percentage (%)
1.Reliable buying price of collected recyclable waste set by municipal authorities	83.7
2.Clear roles and responsibilities in recyclable waste collection in the CBOs	63.3
3.Clear and transparent waste management process	55.1
4.No overlapping work with other stakeholders in the service system	51.0
5.Waste management knowledge to be applied in operation process	44.9
6.Opportunities of being trained or joining in waste management skill improvement activities	44.9
7.Career growth or job promotion in other waste management processes	32.7
8.Practical waste management policy	30.6

From the table, reliable buying price of collected recyclable waste was the factor that waste pickers concerned the most. As represented in Table 5.3, waste collection was their main source of income. Therefore, joining the CBOs should not cause any drawback for them. The waste pickers would also like to work in organizations when roles, responsibilities, management processes were clearly defined. They also would like to get proper MSWM knowledge and training opportunities that could be applied in the real working situation. However, practical waste management policy did not gain much attention as a success factor. From discussions having with the waste pickers, the low percentage (31%) caused by not knowing or skepticism of

what and how the policy should be. Experts suggested that, to have a successful PPCP, the partnership should not cause any drawbacks to the waste pickers; otherwise there should be well-off points that were beneficial and persisted them to willingly be part of the MSWM system.

Furthermore, waste pickers expressed their ideas about roles and responsibilities of acting as a CBO staff in conducting recyclable waste collection in their communities. The roles and responsibilities are listed out with potential values as shown in Table 5.5.

Table 5.5: Potential roles and responsibilities for value co-creation in CBOs

Roles and possibilities	Percentage (%)
1. Being the community central place to buy recyclable waste	73.5
2. Expanding waste collection service in the form of CBOs to all areas in the community	59.2
3. Being the community center for waste management	57.1
4. Promoting waste management knowledge creation within the community	53.1
5. Conducting and promoting waste separation at source	51.0
6. Sharing knowledge on making compost in the community	51.0
7. Sharing waste management knowledge to community members	49.0
8. Monitoring and controlling the effectiveness of waste collection service in the community	44.9
9. Disseminating or sharing waste collection performance to community members	36.7
10. Collaborating with local municipal authority	30.6
11. Holding periodic meeting to discuss and share experience to improve the service	26.5

The results show that waste pickers concerned more on economic related issues. From the survey, the waste pickers showed their willingness to learn about waste management knowledge, for instance, MSWM knowledge creation, waste separation at source, and composting. However, for the successful CBO implementation, waste pickers were needed to be trained on administrative processes, including information dissemination, collaboration with other sectors, and sharing experience. All in all, from the perspective of waste pickers who would be the primary waste collection service provider in the CBOs, there was high possibility in implementing the CBOs in community level, as it was considered as a source of income as long as waste pickers did not lose their current benefits. The results shed some light on a number of issues such as clear job description and management process, availability of basic infrastructure for being a community center, managerial capability, and practical policy.

The results show that there is high possibility of implementing CBOs as part of MSWM service provision in the city of Bangkok. Yet, the responsible authorities have to give a thorough consideration to each of the stakeholders' concern whether it is plausible to meet in the real waste management situation.

5.1.5 Involved Stakeholders in the Perspective of CBOs

In terms of potential stakeholders who should be involved in providing MSWM service, 70.1% of respondents of the first set of questionnaire thought that everyone should have an active role in MSWM system but in different processes. When asking specifically about who should be involved in the CBOs in a view of service actors, respondents and experts stated that there should be two groups of actors, including service providers and support functions, together with service recipients.

Service providers were government authorities, private sectors, NGOs, CBOs, and experts. Apart from providing major MSWM services such as waste collection, transportation, treatment and disposal, these service providers' responsibilities were relating to policy setting and updating, law enforcing, collaborating, promoting MSWM practices, applying appropriate technologies and methods, evaluating performance, monitoring and mitigating impacts, controlling standard, raising awareness, disseminating MSWM knowledge, scheduling workforce, controlling budget, and managing social welfare. Actors who were considered as support functions included those who had specific expertise, for example, engineers, technicians, mechanics, environmentalists, MSWM experts, pollution control experts, policymakers, strategic planners, accountants, lawyers, and managers. Interviewed experts referred responsibilities of service providers as factors that determine societal well-being or quality of life of all involved sectors.

In terms of service recipients, ranging from small to large scales, residents were the first group of recipients who received MSWM service. Communities and the society were the second larger group, whereas the environment was the third group. Recipients' roles in MSWM system were minimizing waste, conducting waste separation at source, focusing on public attitudes, sharing MSWM concerns and knowledge, and collaborating with other sectors in activities regarding sustainable MSWM issues. In other words, service recipients should exercise their

rights as being part of the MSWM system by helping each other to manage MSW at home and in their communities.

5.2 Study B2: MSWM Service Policies and Practices

5.2.1 Service Policies and Practices for MSWM

As being sourced out from many successful MSWM policy management cases and the BMA's strategic plans (DOE, 2012a, b; DOE, 2014b, c, d; Jungrungrueng, 2014a, b), the policies and practices were listed and put on the questionnaire as a question to get the Bangkok residents' thinking towards potential policies and practices that were essential for MSWM service system. Table 5.6 shows a preliminary screening of the policies and practices that was significantly associated with providing MSWM service at a 1% level of significance by applying chi-square association testing method.

As presented in Table 5.6, the results showed 27 policies and practices in three important management processes: waste generation (WG), waste collection and transportation (WC), and waste treatment and disposal (WD). Some of the policies and practices were classified to be in multiple processes of MSWM, such as environmentally friendly management service policy (WC4 and WD2) and CBOs in MSWM policy (WG8 and WC7). From the total 729 sample amount, 39.1% knew or learned about MSWM policy. Out of this number, the results showed that respondents knew 3Rs policy the most, and knew the least about infectious waste treatment policy. For waste generation process, 3Rs, source separation of waste, and waste minimization were the top three known policies. In terms of MSWM networking and local collaboration, a fewer number of residents knew about these policies.

For waste collection and transportation process, most respondents understood about waste collection frequency, fee payment for collection service, and collection scheduling policies. In the same way as waste generation process, respondents seemed to perceive less on MSWM network and collaboration policies and practices. Looking in terms of waste treatment and disposal process, fine collection for illegal disposal, environmentally friendly management, and appropriate use of technology in management process were the top policies and practices that caught respondents' perception. However, the treatment policies relating to composting, grease and infectious waste were not widely publicized.

Table 5.6: Statistical results of chi-square test of associations with policies and practices for MSWM services, (DOE, 2012a, b; DOE, 2014b, c, d; Jungrungrueng, 2014a, b)

Waste generation	WG1	WG2	WG3	WG4	WG5	WG6	WG7	WG8	WG9	WG10	WG11	WG12
Count	277	271	260	252	251	249	244	239	231	228	219	217
Total %	97.2	95.1	91.2	88.4	88.1	87.4	85.6	83.9	81.1	80.0	76.8	76.1
Pearson chi-square	696	672	629.6	600	596.3	589.1	571.4	553.9	526.8	516.8	487.7	481.3
Contingency co-efficiency	0.699*	0.693*	0.681*	0.672*	0.671*	0.669*	0.663*	0.657*	0.648*	0.644*	0.633*	0.631*

WG1: 3Rs, WG2: Source separation, WG3: Waste minimization, WG4: Organic waste composting, WG5: Public participation, WG6: Incentive based campaign WG7: Public relation campaign, WG8: CBOs in MSWM, WG9: MSWM research and development, WG10: MSWM network, WG11: MSWM in school curriculum, WG12: NGO collaboration

Waste collection & transportation	WC1	WC2	WC3	WC4	WC5	WC6	WC7	WC8	WC9	WC10	WC11
Count	264	263	248	248	245	237	239	229	228	226	217
Total %	92.6	92.3	87.0	87.0	86.0	83.2	83.8	80.3	80.0	79.2	76.1
Pearson chi-square	644.8	640.9	585.6	585.6	574.9	547.1	553.9	520.1	516.8	510.3	481.3
Contingency co-efficiency	0.685*	0.684*	0.667*	0.667*	0.664*	0.655*	0.657*	0.645*	0.644*	0.642*	0.631*

WC1: Waste collection frequency, WC2: Fee payment for collection service, WC3: Waste collection scheduling, WC4: Environmentally friendly MSWM service, WC5: Appropriate use of technology, WC6: Private sector collaboration, WC7: CBOs in MSWM, WC8: Waste collection service coverage area, WC9: MSWM network, WC10: Suitable waste bins in public areas WC11: NGO collaboration

Waste treatment and disposal	WD1	WD2	WD3	WD4	WD5	WD6	WD7	WD8	WD9	WD10
Count	251	248	245	243	238	237	232	206	188	185
Total %	88.1	87.0	86.0	85.3	83.5	83.2	81.4	72.2	65.9	64.9
Pearson chi-square	596.5	585.6	574.9	567.8	550.5	547.1	530.1	447.3	394.7	386.2
Contingency co-efficiency	0.671*	0.667*	0.664*	0.662*	0.656*	0.655*	0.649*	0.617*	0.593*	0.588*

WD1: Fine collection for illegal disposal, WD2: Environmentally friendly MSWM service, WD3: Appropriate use of technology, WD4: Waste to energy plant, WD5: Use clean technology, WD6: Private sector collaboration, WD7: Incinerators, WD8: Compost plant, WD9: Grease treatment facility, WD10: Infectious waste incinerator

* Significant at 1% level.

Knowing about what policies and practices that the respondents comprehended implies the performance of government authorities in promoting MSWM processes and activities. However, effectiveness that determines successfulness of the system actually depends on how good or bad each policy is implemented. Therefore, respondents were asked whether the MSWM policies they knew were effectively implemented. In this study, implementation effectiveness of each policy was how well the provided MSWM services the respondents perceived. Presenting in Figure 5.3, the line graph represents number of respondents who knew each policy, whereas the bar chart represents proportion of respondents who thought the policy was effectively implemented.

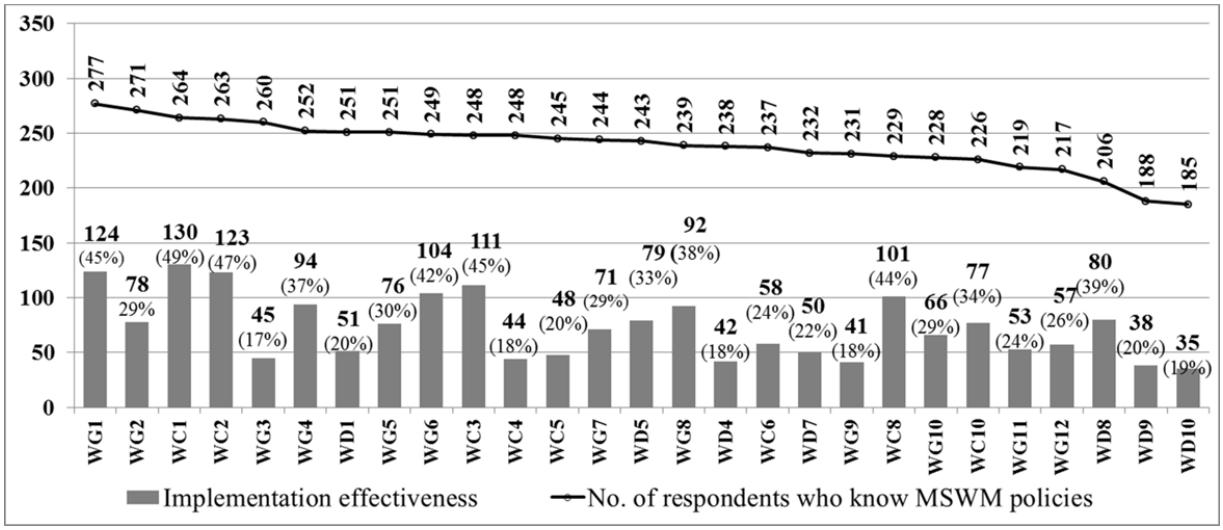

Figure 5.3: Human attitudes on MSWM policy effectiveness

It can be seen from the figure that the effectiveness of policy implementation did not correlate with how well the policy was publicized. In WG3: Waste minimization policy, 260 respondents knew about this policy however from their perception, only 45 people (17%) thought that the policy was effectively implemented; as they perceived that MSW has been increasing over time. In WC3: Waste collection scheduling; however there were only 248 respondents knew this policy, about half (45%) of them thought that it was effective. Respondents stated that their waste was collected as scheduled most of the time although there were some problems of uncollected waste or falling waste.

In Table 5.6, potential MSWM policies and practices are listed out for each MSWM process. However, it is helpful in a management perspective to group out these policies and practices. In this part, an explorative factor analysis is performed by categorizing policies into four groups of factors (as shown in Table 5.7), including 'Factor I', policies for collaboration and needed infrastructure; 'Factor II', policies relating to MSWM at household level; 'Factor III', MSW knowledge sharing and management policies; and 'Factor IV', policies for MSW collection and transportation. These groups of policies will be upwardly formed in the service policy framework (Figure 6.3). Reducing a large number of policies and practices into smaller sets of variables (Factors I, II, III, IV), Table 5.7 shows groups of potential policies and practices in MSWM service system. Factor I showed that policies relating to collaboration with NGOs, private sector, CBOs, and the communities had very high impact on MSWM system. In terms of basic infrastructure required for MSWM processes, policies relating to clean technology, appropriate technology, grease treatment facility, incinerator, waste to energy plant, compost plant were highly needed at first place. Factor II represented the influential policies that would have impact of MSWM at household level; the policies were 3Rs, source separation, organic waste composting, and waste minimization. Factor III related to policies that aimed to build MSWM awareness and raise the importance of environmental concerns. The policies were applying MSWM in school curriculum, emphasizing on incentive based and public relation campaigns, and giving importance on MSWM research and development. The last factor, Factor IV, represented MSW collection and transportation policies, including waste collection frequency and service coverage area, fine collection for illegal disposal, providing of public bins, waste collection scheduling, and payment for collection service.

These four factors had a strong relationship with each other. Correlation values between Factor I and II and Factor I and IV were relatively strong, which had the value of 0.74; whereas, Factor I and III had a very strong correlation of 0.77. Factor II and III, and Factor II and IV also showed strong correlation values of 0.75 and 0.73, respectively. For Factor III and IV, the correlation value was also strong, which was at 0.76. At 65.67%, it means that Factor I could best explain the likelihood of policies and practices that should be applied to MSWM system. Comparing to other factors, Factor II showed impact of MSWM at household level on system at 13.38%; whereas Factor III and IV showed relatively low impact on MSWM service system at 3.3% and 2.2%, respectively.

Table 5.7: Statistical results of explorative factor analysis for MSWM policies

		Factors			
		I	II	III	IV
Policies and practices		Collaboration & needed infrastructure	MSWM at household level	Knowledge sharing & management	Collection & transportation
NGOs collaboration		0.87	0.30	-0.01	-0.25
Use clean technology		0.86	0.07	-0.02	0.09
Private sector collaboration		0.85	-0.04	0.03	0.16
Appropriate use of technology		0.85	0.16	-0.05	0.05
Grease treatment facility		0.70	-0.17	0.11	0.20
Infectious waste incinerator		0.65	-0.18	0.45	-0.04
Incinerator		0.64	0.05	0.19	0.11
Public participation		0.57	0.43	0.13	-0.14
MSWM network in community		0.55	-0.08	0.49	0.06
CBOs in MSWM		0.55	0.38	0.05	0.01
Waste to energy plant		0.44	0.16	0.35	0.06
Environmentally friendly service		0.39	0.30	0.01	0.28
Compost plant		0.37	0.10	0.34	0.08
3Rs		0.00	0.89	-0.02	0.13
Source separation		-0.06	0.80	0.27	-0.03
Organic waste composting		0.24	0.80	-0.08	-0.02
Waste minimization		-0.03	0.56	0.28	0.15
MSWM in school curriculum		0.22	-0.04	0.79	0.01
Incentive based campaigns		-0.03	0.26	0.68	0.07
Public relation campaigns		0.01	0.24	0.68	0.06
Research and development		0.17	0.16	0.65	-0.01
Waste collection frequency		-0.03	0.17	0.00	0.89
Collection service coverage area		0.22	-0.06	0.10	0.69
Fine collection for illegal disposal		0.23	0.26	0.00	0.51
Waste bins in public areas		0.31	0.08	0.12	0.42
Waste collection scheduling		0.22	0.34	0.01	0.40
Payment for collection service		-0.04	0.32	0.33	0.36
Correlation between factors	I	1.00			
	II	0.74	1.00		
	III	0.77	0.75	1.00	
	IV	0.74	0.73	0.76	1.00
Total variance (%)		65.67	13.38	3.3	2.2

According to the analyzed results of potential policies and practices explained in this chapter, it can be seen that the most possible group of policies and practices relates to 'collaboration of multisector of stakeholders and the effective and appropriate use of technology' that suits for each MSWM process and causes no harm to the society and the environment. This group of policies and practices consists of 13 issues. Thus, for an effective MSWM system responsible authorities need to focus on implementing these policies effective and efficiently. For the effectively executed policies and practices, their usefulness is needed to be guaranteed. For example from the analyzed results, 'Compost plant' and 'CBOs in MSWM' are the policies and practices that the respondents thought that they were implemented at a satisfactory level, as the levels of effectiveness retrieved from the respondents were 39% and 38%, respectively. The authorities and stakeholders need to ensure that the policies and practices are updated and practically enforceable.

On the contrary, for the policies or practices that are ineffective; the responsible authorities need to find solutions of how to handle the problems. The interview results revealed that some of the unpractical practices or policies were needed to be amended or terminated. Therefore, collaboration of related stakeholders is needed in terms of policy setting, investigation, and formulation of the right to the point solutions. The 'Infectious waste incinerator' and 'Waste to energy' are the examples of policies and practices that the respondents thought they were ineffectively implemented in the MSWM system, as the results showed only 10% and 11% of respondents thought that they were well implemented.

5.3 Summary

‘Study B’ clarifies attitudes of respondents on applying tripartite service and partnership concepts on implementing PPCP and CBOs in the city of Bangkok. From the perspectives of all related stakeholders, the analyzed results showed that both PPCP and CBO have high possibility to be implemented. For PPCPs, roles of service recipients, intermediary, and service providers are identified, which the roles are presented in a proposed tripartite service concept model (Figure 5.1). This model represents the interrelationships of the three service sectors that mutually co-created values for the MSWM system. In terms of CBOs, most of waste pickers would like to join the organizations and be the main service provider, which in this case is to provide waste collection service at community level. The total of 11 potential responsibilities and roles of CBO members are identified. In addition, involved stakeholders and success factors for implementing CBOs as a MSWM mechanism are listed out.

The second part of this study presents 27 MSWM policies and practices that should be applied along the MSWM processes. These policies and practices are categorized to apply to each MSWM process, including waste generation (WG), waste collection and transportation (WC), and waste treatment and disposal (WD). All of these policies are grouped into four factors: collaboration and needed infrastructure, MSWM at household level, knowledge sharing and management, and waste collection and transportation. In the case of partnerships in Bangkok MSWM, policies or practices related to collaboration and infrastructure should be firstly applied before other groups of factors.

Chapter 6
Study C: Value Co-Creation for Knowledge Based Service Provision

To achieve the third objective of this study, 'Study C' objects to identify and explain co-created values for knowledge based MSWM service provision. There are three parts in this section, including 'Study C1', 'Study C2', and 'Study C3'. The first part is about KM, which is applied as a concept that enhances MSWM system. Therefore, needed knowledge for each process of MSWM is identified. The second part incorporates the concept of value co-creation presenting how KM can enhance the effectiveness of MSWM service provision in a form of co-created values through the interaction of stakeholders. Correspondingly, co-created values of applying KM in MSWM are explained. In the last part, by incorporating analyzed results obtained from qualitative research, the strategic MSWM options are explained. This is an alternative solution that can be used as fundamental basis for developing a MSWM service provision plan.

6.1 Study C1: Essential Knowledge and Roles of Knowledge Management

6.1.1 Knowledge Management for Municipal Solid Waste Management

In terms of KM, respondents thought that knowledge on MSWM should be consistently promoted to the public (all residents), to schools (lessons for students in curriculum), to waste management providers (direct and indirect staff). This mainly aims to ensure that both service recipients and service providers were aware of risks and impacts that would be generated by improper MSWM and the importance of the ecosystem which human had on them. Table 6.1 summarizes important types of knowledge for MSWM.

As shown in the table, there are 13 types of knowledge that residents thought the types were needed for having sustainable MSWM. The checked signs show the importance of needed knowledge for each process of MSWM based on residents' knowledge. The residents stated that there should be collaboration among all related stakeholders in each process along the management chain. They highlighted that all staff should be trained to provide efficient service. An example case that happened in the current waste collection process was that residents did waste separation and put sorted waste into different bags. But once the waste was collected, staff mixed all waste together and picked only materials that they considered valuable and put to big plastic bags. Those picked waste were later sold to small recycle shops before the mixed commingles were dumped out at a transfer station. According to experts' insights, they suggested that MSWM infrastructure be improved to be ready to support all types of waste. If all residents did waste separation and waste collection trucks were fully equipped to support various types of waste collection, situation like the example case would not occur. Experts also commented that at each step of waste management, KS and KT were needed for effective KM.

The interview results provided that KT could be done internally among service recipients or service providers, or externally between service recipients and providers or other indirect actors. All processes of waste management need KT to lessen knowledge gaps. Some residents

could transfer their knowledge on how to minimize waste generation by using reduce and reuse strategies. Staff in the same or different levels could train or suggest each other in order to have the same knowledge creating the norm in MSWM practices. KT could also be done when staff were retiring or moving to another position. They should transfer their knowledge to new comers who were going to take their positions in the near future. Thus, KT was a good and practical KM strategy that was beneficial to the management of knowledge.

KS in MSWM is practically done to give knowledge to a number of people (Piktialis and Greenes, 2007). It is a powerful way to prevent knowledge gaps, as everyone receives the same information at the same time. Experts commented that KS has been implemented in Bangkok MSWM but not so successful. For example, demonstration of waste separation had been done to encourage waste generators to sort their waste correctly. As time elapsed, this campaign was diminished. It can be easily seen in many places throughout Bangkok that waste is commonly discarded regardless of types of waste. Another KS in MSWM stated by the experts was training, which could be applied to both service providers and recipients. Staff were trained to do correct waste collection and transportation procedures, whereas residents, mostly in community level, were trained to launch projects related to the reduction of waste generation quantity and enhancement of the performance of MSWM services. Experts stated that CBM was an example of the projects. Correct practices, procedures, and important information were given by the BMA. The same knowledge of creating a CBM project should be shared to all residents.

Table 6.1: Respondents' aspects on needed knowledge for sustainable waste management

Needed knowledge	**Service recipients**		**Service providers**			
	Waste generation	Waste storage	Waste collection	Waste transfer	Waste processing	Waste disposal
1. Waste sorting		✓	✓			
2. Types of waste	✓	✓	✓	✓	✓	✓
3. Waste minimization	✓					
4. 3Rs	✓				✓	
5. Education in schools	✓	✓	✓	✓	✓	✓
6. Laws and enforcement	✓	✓	✓	✓	✓	✓
7. Public involvement	✓	✓	✓	✓	✓	✓
8. Training or demonstration of MSWM	✓	✓				
9. Consistent support and promotion			✓	✓	✓	✓
10. Basic MSWM in household	✓	✓				
11. Risks and impacts	✓	✓	✓	✓	✓	✓
12. Service mindset of staff			✓	✓	✓	✓
13. Mindset of waste and the environment of residents	✓	✓				

The results in Table 6.1 clearly represent the essential types of knowledge for both service recipients and service providers. For example for the service recipients, the knowledge that they have to know at the waste generation process includes types of waste, waste

minimization, 3Rs, education in schools, law enforcement, public involvement, training, basic MSWM in household, risks and impacts, and MSWM mindset. For service providers, needed knowledge that is essential for waste disposal process consists of types of waste, education, law enforcement, public involvement, consistent support, risks and impacts, and service mindset.

Out of all types of knowledge, six of them are considered as the fundamental ones; as all service actors need to be proficient to understand and apply the knowledge to deal with each process of MSWM from waste generation to waste disposal. The six types of knowledge are types of waste, education in schools, law enforcement, public involvement, risks and impacts, and mindset of the service actors.

Having knowledge to be able to deal with waste properly is the necessary factor making the related service recipients and actors ready to correctly perform MSWM practices. However, to make the whole system effective, collaboration of all related stakeholders is needed. In the collaboration, stakeholders integrate their different knowledge and expertise to enhance the overall MSWM capability.

6.2 Study C2: Co-Created Values

6.2.1 Co-Created Values on the Perspective of Knowledge Management

The BMA has tried to alleviate and solve the problems by having a long-term plan and policy and launching MSWM schemes by investing a large amount of budget trying to make the MSWM system effective and draw public participation. Unfortunately, the attempt has not successfully been implemented due to many obstacles. Analyzing MSWM in the perspective of the tripartite service concept, no co-created value occurs. This is due to the ineffective management system. The following demonstration, Figure 6.1, shows an unsuccessful MSWM system as there is no interaction among service providers and recipients.

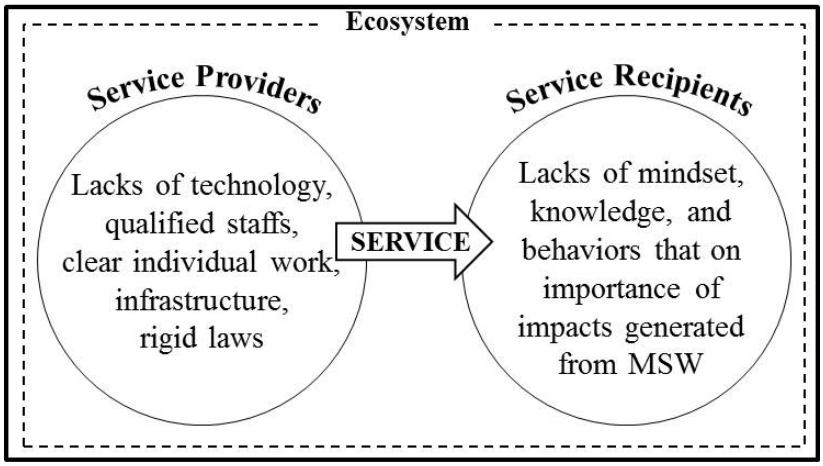

Figure 6.1: Ineffective waste management with no value co-creation

Applying KM as an alternative solution to increase the effectiveness of the MSWM system, a big concern for practically successful KM is to achieve an effective KS and KT. Avoiding hidden knowledge in MSWM is a vital factor as it reveals out such knowledge. According to Polanyi's study, dialogues among individuals or groups lead to transferring and sharing of knowledge (Polanyi, 1964). When it came to this question during the survey, residents responded that all processes should be transparent. They suggested that key waste management

stakeholders be involved to create mutual MSWM strategies which eventually provided mutual benefits.

Respondents stated that MSWM infrastructure should be more ready to support increasing amount and complicated types of waste. Laws should be more rigidly enforceable to ensure that everyone complied with. According to the interview, experts thought that the most urgent problem was to find resolution for a sustainable MSWM with suitable infrastructure. Dwivedy (2010) states that successful implementation of waste management, other than less generation of MSW, requires the establishment of appropriate infrastructure. The other two factors contributing to the success of MSWM are practical policies and strategies to manage the system. Having a smooth system, effective laws should be enforced. The study of Roomratanapun (2001) shows that law enforcement is the third rank solution to solve MSWM problems.

Effective KS and KT lead to successful KM. In the service provider side, if each MSWM process along waste management chain is transparently managed based on well-planned policies complying with all stakeholders requirements, provided MSWM service performance will be improved. On the service recipient perspective, if residents who are the main waste generators and any other generators are informed, educated, or know how to correctly manage the waste, waste generation rate will decrease. Furthermore, respondents and experts agreed that if they knew what or how to reduce waste, not only waste generation would reduce, but also consumption of natural resources would decrease.

As shown in Table 6.2, values that are co-created by related stakeholders for each MSWM process were identified. Applying the KM concept to MSWM service aimed for sustainable MSWM service in Bangkok. If KM was successfully applied, respondents thought that collaboration among key related actors was formed to create mutual benefits, which resulted in reduction of waste generation, better MSWM service, transparent and effective MSWM system as a whole, and less socio-economic and environmental risks and impacts. In terms of value co-creation, there would be better understanding of how sustainable waste management should be among all sectors. Consequently, awareness of impacts caused by waste would increase, so would awareness of the importance of ecosystem. Therefore, the better waste management system would eventually lead the better well-being of the society as a whole.

Table 6.2: Residents' aspects on value co-creation when applying KM concept

MSWM Process	Required knowledge/practice	Co-created values
Generation	- Campaigns to promote 3Rs or less packaging products - Information of adverse impacts caused by MSW	- Less raw material consumption - Less waste generation
Storage	- Information on suitable and practical waste sorting method - Information on waste management at home	- More recyclable waste to be used as raw materials - Better household WM - Less concerns on odor
Collection	- Information on waste collection place, date and time - Equally trained staff - Appropriate use of technologies, machines, and trucks	- Effective waste collection service - Optimal utilization of machines and trucks - Collecting cost and time reduction - Less concerns on odors, uncollected waste, and leftover waste - Less health risks and impacts to staff and residents
Transfer	- Equally trained staff - Sufficient transfer stations - Appropriate use of technologies, machines, and trucks	- Effective waste transfer service - Optimal utilization of machines and trucks - Transportation cost and time saving - Less concerns on falling waste - Less risks to staff who expose directly to MSW
Processing	- Equally trained staff - Appropriate use of technologies, machines, and trucks - Clear and practical policies and standards	- Effective waste processing - Optimal utilization of machines and trucks - Risks to frontline staff or workers are minimized - Less environmental concerns
Disposal	- Equally trained staff - Appropriate use of technologies, machines, and trucks - Clear and practical policies and standards - Mitigation and monitoring impacts in short, medium, and long-term policies	- Effective waste disposal - MSW is correctly managed and meets management standards - Less social, economic, and environmental concerns and impacts to the society

6.2.2 Co-Created Values on Inclusive Community Based Organizations

Analyzed results of values that are co-created through MSWM processes among interactions of related stakeholders in the MSWM system are presented in Figure 6.2. The presented values emphasized the win-win relationships that satisfied the needs of service providers and recipients to engage in mutual value co-creation without decreasing the quality of future value co-creation (Shirahada and Fisk, 2011).

- The collaboration of multi-sector partnership enables coordinated MSWM activities, shared experiences and knowledge among all sectors to create an optimal MSWM system in the community.
- The developing of community capacity for all sectors to be part of MSWM service system.

Perspectives	Co-created values	Main sectors
Economic	- An improved cost management for managing resources in MSWM system. - An additional source of income from selling recyclables. - Supplying of raw materials for manufacturing sector by using recyclables.	All stakeholders
Social	- Waste pickers are recognized as formal service actor. - Job creation - An increase in awareness of complexity and importance of effective MSWM system. - CBOs allow families and community cohesion. - Providing better health and safety working conditions for waste pickers and collection staff.	Waste pickers, Collection staff, Municipality, Private sector
Environmental	- Reduction of mixed MSW amount to be collected at source. - MSWM collection service is provided in more areas.	All stakeholders
Technological	- A development and appropriate use of MSWM technologies. - Affordable technical solutions are achieved to ultimately improve well-being of all sectors. - Extension of lifetime of capital investments for the municipality, such as finding new landfill site. - Less environmental impacts.	Waste pickers, Collection staff, Municipality, Private sector
Institutional	- A practical policy framework for enabling effective MSWM service provision at community level. - Including waste pickers in the CBOs allow provision of service at no-cost to the municipality. - An increase in political will by providing priority for city development.	

Figure 6.2: Co-created values for adopting inclusive CBOs in municipal MSWM system

Considering MSWM as a value based service that values are linked and understood within the system. The inclusive CBOs allow a number of opportunities as recyclable waste will be correctly sorted and properly managed; waste pickers will be more recognized and have a formal role in MSWM system without losing their source of income; waste collection staff take less time spent in collection process as they do not have to sort out the recyclables; residents

have proper MSWM knowledge and have environmental awareness; and less environmental concerns for the whole community. Therefore, all these benefits can be considered as co-created values that are beneficial to all involved actors, as the benefits lessen the threshold in having effective multisector partnerships.

6.2.3 Service Policy Framework for a Case of Inclusive Community Based Organizations

For a better understanding of how inclusive CBOs will enhance the effectiveness of MSWM service at community level, by integrating potential MSWM policies with all related stakeholders, Figure 6.3 demonstrates a conceptual service policy framework for MSWM system.

The figure represents multi-interpretation meanings. First, in the background of the framework, the left side represents current situation of MSW treatment in a form of the pyramid of waste management hierarchies which upwardly starts from landfill waste disposal, 3Rs, and waste minimization. On the right side, the framework shows the bottom-up pyramid waste management hierarchy, which implies that over time waste minimization is more environmentally preferable MSW treatment method over 3Rs and landfill. The second interpretation is the framework core elements. It includes: the bottom part, which shows implementation processes and involved stakeholders (support functions and service actors); the middle part, which consists of details of the bottom part: stakeholders including service actors and support functions (‘Study B1’, Section 5.1.5), MSWM policies and practices (‘Study B2’, Section 5.2.1), together with sizes and roles of CBOs (‘Study B1’, Section 5.1.4) that dynamically evolve over time; and the upper part, which represents the possible outcomes. In terms of framework components, all dashed lines represent non-fixed and interrelated relationships among factors; glowed edge borders refer to uncertainty of the factors, which can be changed or affected over time; a gap between two forms of waste management hierarchy shows possible fluctuations of applied MSW treatment methods depending on the effectiveness of all MSWM processes, whether landfill will be used as the main treatment method. In addition,

the framework represents a 20-year timeframe. This period of time is in accord with the 20-year vision of the Bangkok development plan (BMA and CU, 2013).

Generally in MSWM service provision; there are a number of service touch points occurring during the interactions of stakeholders being involved in the inclusive CBOs. The first point is at residents' households where CBO staff collect recyclable waste, promote suitable MSWM methods, share MSWM knowledge, or discuss with the residents. It is also a place that MSW collection staff collect commingled MSW. The second point is at a community center, which can be used as a recyclable waste station, a waste transfer point, a meeting point, and a knowledge or experience sharing point. The third point is a junk shop or a community waste buying shops, which is a place where CBO staff sell their collected recyclable waste and have interaction with other service actors, namely private sector or municipal staff. However, it depends on MSWM practices and situation of each community, whether they will use the community center as the shop or let existing junk shops perform this buying and selling process.

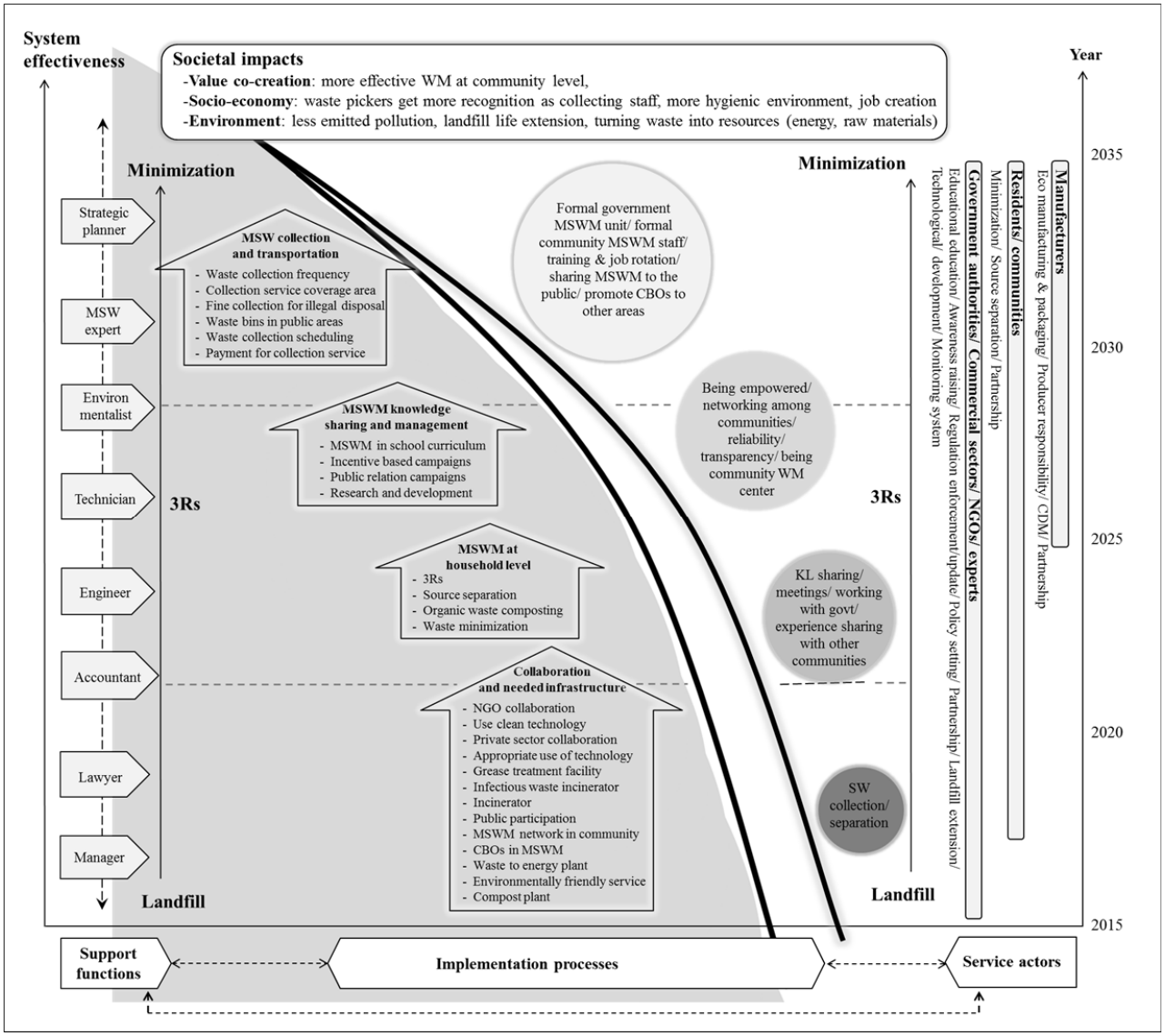

Figure 6.3: Conceptual service policy framework for inclusive CBOs in MSWM system

6.3 Study C3: Strategic Municipal Solid Waste Management Options

6.3.1 Stakeholder Analysis and TOWS Matrix

A matrix of MSWM stakeholders (Figure 6.4) and a variant of SWOT analysis, TOWS matrix (Figure 6.5) were applied to the study. The difference of SWOT and TOWS analysis is that all four elements namely 'Strengths', 'Weaknesses', 'Opportunities,' and 'Threats' are arranged differently. Insightful options obtained from all interviewees and the respondents were recorded and incorporated into this analysis. Stakeholder analysis matrix consists of three dimensions including 'Stakeholders', 'Issues', and 'Waste management stream' (UNEP, 2009). The matrix aims to analyze concerns of stakeholders (waste generators, waste pickers, waste collection and transportation staff, environmentalists and BMA officers, academic scholars, and NGOs) towards performance of each process of MSWM (waste minimization, waste separation at source, household waste disposal, waste collection, waste transportation, waste treatment at transfer station, waste transportation to disposal site, and waste treatment at disposal site) in different issues (social, economic, environmental, technological, and regulation). The matrix encompasses significant concerns of each level of stakeholders in different perspectives of different processes of MSWM stream.

From the interviews and discussions, waste generators would like to learn about proper household waste disposal methods and impacts caused by ineffective MSWM. Waste pickers concerned on opportunity loss on income of selling collected recyclable waste. Waste collection staff did not have sufficient knowledge on MSWM, especially on technological knowledge. Environmentalists, BMA officers, and academic scholars emphasized that waste separation at source was essential for enhancing the performance of other MSWM processes. In addition, stringent and enforceable waste management regulations should be in place for ensuring reliability of MSWM provided service and minimizing possible impacts caused by ineffective management system. NGOs pointed out that collaboration between service provider and service recipient should be strengthened. Residents should have more concern and involvement in waste management process, such as waste separation at source and policy setting. All aforementioned

results were analyzed and rearranged in a form of TOWS matrix. By using the TOWS matrix technique, MSWM options that are useful for strategic planning in MSWM system are listed out and explained.

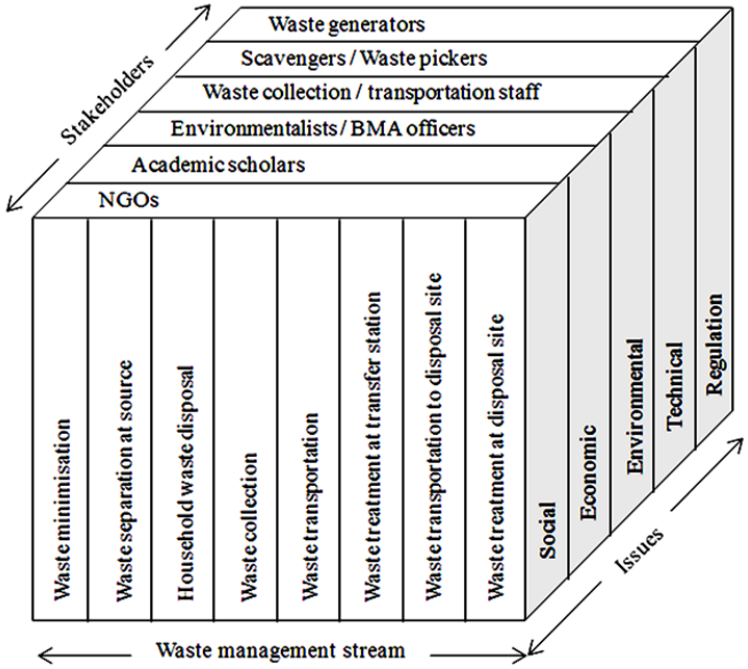

Figure 6.4: MSWM Stakeholder analysis matrix (modified from UNEP, 2009)

From the stakeholder analysis, stakeholders from different levels stated common and diverse opinions on MSW generation concerned issues. For examples, concerns for social issue were lack of awareness, lack of involvement, unqualified waste collection staff, increasing number of population and unsuccessful campaigns. For economic issue, common concerns were uncollected fee for waste collection service, new waste collection method, transparency in budget allocation, and source of income. For environmental issue, all stakeholders thought that MSW generation would affect following concerns: contaminated soil and water from hazardous waste, leachate, bad odor, pathogen, and health of staff and waste pickers. In terms of technological issue, most of the concerns related to lack of MSWM infrastructure, insufficient machines, trucks, and unsuitable technologies. For regulation issue, all levels of stakeholders but waste pickers gave their opinions that the current regulations and policies were ineffective and outdated.

Solutions were given as ways to solve the concerns to make the MSWM system more effective. The solutions were, for example, promotion of waste minimization, waste separation at source, revising regulation, minimizing pollutions, encouraging collaboration, launching education policy, and having impact mitigation and monitoring system.

	External Opportunities (O) 1. Technologies available to be adopted in the system 2. MSW related problems presenting to be solved 3. More public attention on participating in MSWM 4. Effective MSWM can lessen impacts, and is a great source of alternative energy 5. More investment interest from other sectors, i.e. investment and support from private sectors, collaboration with NGOs	**External Threats (T)** 1. Rapid growth of population and urbanization 2. Lack of involvement from the residents, i.e. waste separation at source, payment of collection fee 3. Uncontrollable factors, i.e. political situation, natural disasters
Internal Strengths (S) 1. Main responsible party for MSWM in Bangkok 2. Have power to manage and control the system, i.e. mandate regulation, issue policy, or monitor and mitigate processes and outcomes 3. Have resources to run all management processes, i.e. financial, human, machines and infrastructure	**Strengths – Opportunities (SO)** 1. As the main responsible party who has power to authorize or mandate, the BMA should allocate work or collaborate with other sectors to make the MSWM system more effective 2. Invest in advanced technologies or suitable MSWM methods to solve problems by appropriately using current resources 3. Issues policy or regulation to mitigate MSW problems and monitor the effectiveness of the system on the basis of mutual benefits of all stakeholders	**Strengths – Threats (ST)** 1. Upgrade or improve current MSWM capacity to be able to meet future demand 2. Effectively exercise power and resources to have preventive plans ready to cope with any impromptu situations 3. Employing resources to promote benefits of being involved in MSWM 4. Mandate or strengthen enforcement to encourage residents to pay collection fee or join MSWM program
Internal Weaknesses (W) 1. Inconsistent directions and management policies 2. Inconsistent promotion of MSW projects 3. Insufficient budget for new investments, i.e. WTE 4. Unqualified staff 5. Insufficient machines and infrastructure 6. Provided services are not covered in all areas 7. Ineffective service	**Weaknesses – Opportunities (WO)** 1. Consider investment from private sectors to operate and manage the system by adopting technologies that suit with MSW characteristics and employing qualified staff to provide MSWM services 2. Collaborate with stakeholders in policy and strategy setting to avoid conflict of interests or potential risks 3. Consistently work with other parties to share MSWM knowledge and benefits of joining MSWM projects	**Weaknesses – Threats (WT)** 1. Reorganization, set new directions and strategic plans for short, medium, and long term 2. Brainstorm for resolutions in MSWM by involving all levels of stakeholders

Figure 6.5: TOWS matrix of Bangkok MSWM

6.3.2 Strategic Municipal Solid Waste Management Options

By matching external opportunities and threats with internal strengths and weaknesses of the TOWS matrix (Figure 6.5), this analysis was to study the real or possible conflicts of interest and expectation of stakeholders. Consequently, options that the BMA can adopt as a useful set of MSWM actions are identified in order to make MSWM chain more effective and reliable. The options that can be adopted as a useful guideline in strategic planning for the BMA are listed out as follows.

1. *Consistent collaboration with other sectors*: MSWM knowledge sharing, mutual benefits in joining MSWM projects
2. *Appropriate use of resources*: advanced technologies and suitable management methods
3. *Private sector investment*: techniques and know-how that match with MSW characteristics, and qualified staff, and incentive schemes for investors
4. *Issuance of MSWM policies*: monitoring effectiveness of MSWM system and prevention of possible conflicts of interest or risks
5. *Preventive action plan*: capability to handle impromptu situations and consistent development of MSWM system
6. *Strengthening enforcement*: more participation from the public and increase in MSWM awareness e.g. pay collection fee and conduct waste separation at source
7. *Reorganization and setting new direction*: MSWM master plan for short, medium, and long terms

The above seven management options can be adopted with current policies and MSWM activities to increase the effectiveness and efficiency of the MSWM system. To apply the seven options, Figure 6.6 demonstrates what the BMA can do to increase the efficiency of MSWM chain and to ensure the effectiveness of the provided services.

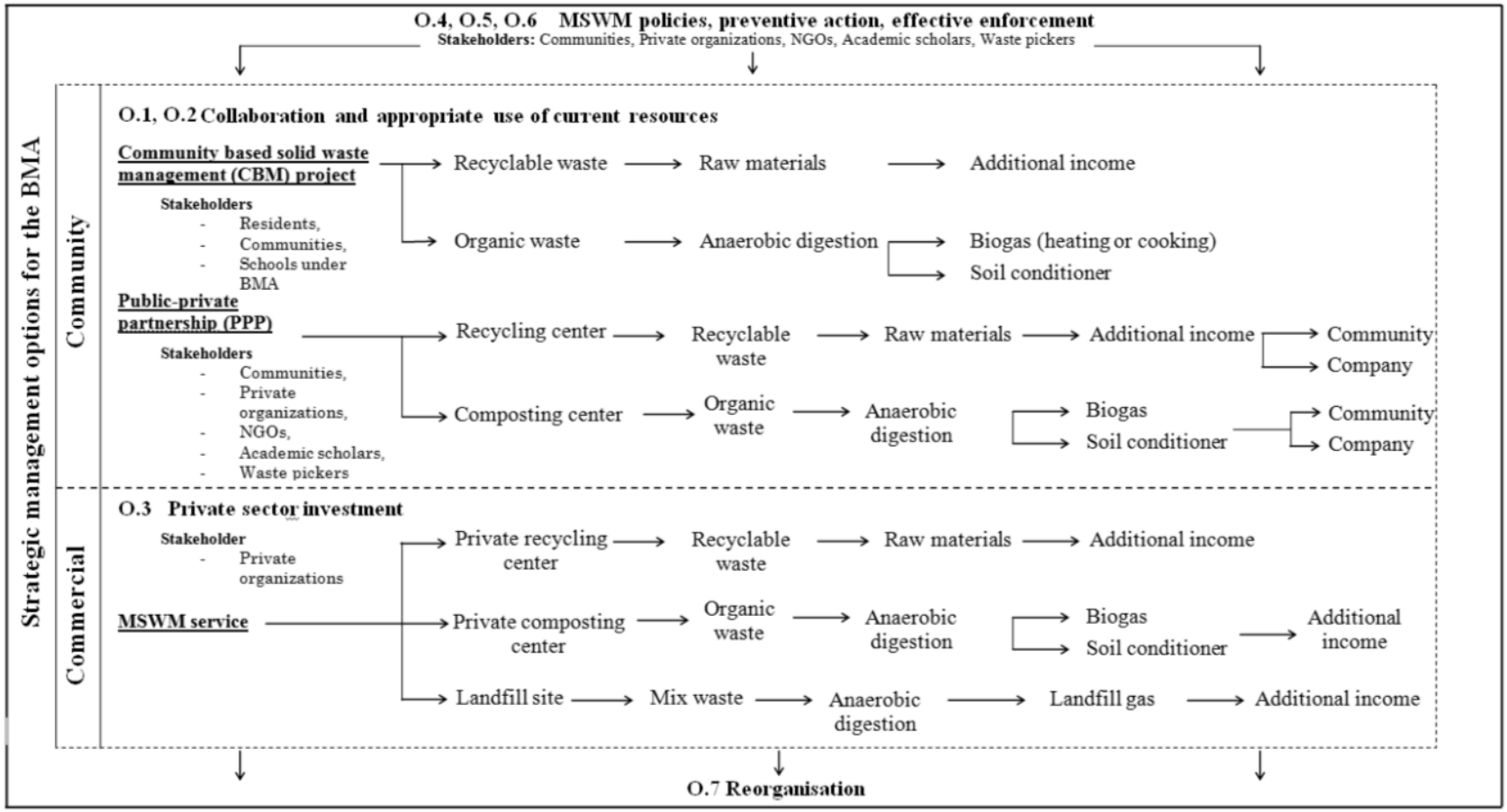

Figure 6.6: Strategic MSWM options for the BMA

As presented in Figure 6.6, the BMA can either adopt only some options to solve specific problems such as lack of collaboration and ineffective use of resources; or adopt all management options if the MSWM system highly needs to be restricted. In the figure it can be interpreted as, for example (‘Options 1 and 2’), in the CBM project there are two main types of generated MSW. Recyclable waste can be separated and sold to junk shop to be later used as raw materials, which is considered as an additional source of income for the project members. In terms of organic waste, after separation process it can be treated with anaerobic digestion method which gives the final result as biogas or soil conditioner.

In the figure, there are two approaches (community and commercial) that the BMA can apply the management options. According to ‘Option 1’ and ‘Option 2’, which are collaboration and appropriate use of current resources, the BMA can start through the current CBM network, by involving related stakeholders to utilize their resources in MSWM on the basis of mutually setting strategy. This can be done by promoting waste minimization and waste separation at source. For example, communities and the BMA can consistently work together to have a waste separation project. As a result, communities can get additional income from selling of sorted recyclable waste, which will be later used in manufacturing process.

Another solution, in larger scale, is applying PPCPs or CBOs to combine strengths of each sector to make the MSWM system reach higher standard and minimize adverse impacts. In the partnership, technologies that are more environmentally friendly, such as WTE, can be introduced to Bangkok MSWM system by private sector. In terms of cooperating with private sector, there are plenty opportunities available in Bangkok. For example, many organizations promote collecting recyclable waste campaigns, which residents can join by disposing of recyclable waste at designated locations such as department stores or convenient stores. Impacts of the system can be scrutinized and monitored by other sectors such as residents, NGOs, and the BMA. In addition to that, the BMA can use its authority to consistently ensure that every process is implemented with standards.

For ‘Option 3’, private sector investment is an alternative option for the BMA in MSWM system. In a case that a waste management company has major roles in MSWM, the company can fully use resources, technologies, or infrastructure that utterly provide benefits to the company itself and also increase the effectiveness of MSWM system.

Allowing private sector to exercise their strengths is good for the sake of management effectiveness. However, mutual benefits of all sectors should be a profound concept of MSWM service provision. Therefore, all stakeholders should ensure that they do not misuse their rights and suitably exercise their roles. In this case, the BMA can apply ‘Option 4’, ‘Option 5’, and ‘Option 6’ to the MSWM system to prevent conflicts of interest and risks that might happen in the future. For example, stringent and effective law enforcement is fundamental to regulate residents to manage and dispose of waste properly. It can be used as a monitoring tool to ensure the performance of private sector.

For ‘Option 7’, the BMA can reorganize its structure or set new management directions in order to have all processes functioned and efficiently managed. The interviewees suggested that there be a MSWM master plan that could apply to the management system in short, medium, and long terms.

6.4 Summary

‘Study C’ identifies essential types of knowledge and co-created values in MSWM when adopting service and KM concepts. ‘Study C1’ represents 13 types needed knowledge for each MSWM process which was analyzed on the basis of tripartite service and KM concepts. Based on the types of important knowledge to be applied to the management of each process of MSWM together with the incorporation of residents’ and experts responses, ‘Study C2’ presents the analyzed co-created values of MSWM system when the CBO form of partnership was implemented to deal with MSW at a community level. Incorporating the analyzed results from the interviews and discussions regarding the possibility of CBOs, potential four groups of MSWM service policies, and involved stakeholders, a conceptual service policy framework for inclusive CBOs in MSWM system is proposed in this study.

After identifying types of knowledge and co-created values, to prevent conflicts of interest and provide strategic MSWM options to tackle with MSWM problems, the chapter applies the two important management concepts which are stakeholder analysis and TOWS matrix in ‘Study C3’. MSWM strategies are analyzed by using stakeholder analysis method. The strategies are subsequently grouped into the elements of TOWS matrix and then grouped into seven strategic MSWM options. The BMA can adopt the options as fundamental solutions in management planning or apply with the current policies and MSWM activities to increase the effectiveness and efficiency of the MSWM system.

Chapter 7
Implications

7.1 Implications for Municipal Waste Management System Enhancement

To enhance the performance of MSWM system in the perspective of providing effective and efficient services, this section explains implications that can be potentially used for the city of Bangkok and also adopted to the MSWM system of other cities. Accordingly on the basis of retrieved information and analyzed results, implications in viewpoints of socio-economic, environmental, technological, legislative, and collaborative are discussed.

The analyses of the study highlight the experiences of Bangkok residents and show how they feel about the current MSWM service and how it should be improved. The respondents' attitudes indicate their awareness that an effective and sustainable waste management service is an important factor to achieve sustainable MSWM.

7.1.1 Socio-Economic Viewpoint

Social Viewpoint

Increasing economic inequality has strongly affected human well-being especially those who are unemployed or have low literacy skills. A large number of low to no income people have moved in or worked in waste station or landfill areas. They are inevitably influenced by adverse impacts, including bad odor, pathogen, or toxic waste. Frontline staff and waste pickers have been increasingly at health risk as they are directly exposed to MSW. Working in this environment prevents frontline staff and waste pickers from achieving full citizenship.

Waste pickers have gradually created complex forms of organization. They recover a large quantity of recyclable materials, which is of great positive impact to the environment (Buenrostro, 2001a). Taking this group of people into consideration of partnerships provides high influence of having better performance on MSWM. Forming a labor union and making it legitimate for both regulations and practices for these people are two potential solutions to lessen problems in terms of unorganized MSWM process, health risk, and quality of life.

In the real situation, working in an environment that has many sectors involved can cause conflicts of interest. To avoid such conflicts and overlapping difficulties or any problematic consequences, all sectors need to ensure that they are operating their businesses or performing their roles according to the mutually set plan. In case of implementing a recycling program, a PPCP, or a CBO, there should be a monitoring and mitigating system to scrutinize the performance of each sector to ensure transparency.

When stakeholders in the MSWM system have active roles and interact corresponding to their responsibilities on the basis of knowledge and resources they have, the MSWM process will run itself towards a sustainable system. Acting as a catalyst that links all elements together, each stakeholder shares both risks and benefits with other stakeholders. This would empower stakeholders to have sense of belonging and concern more on the public benefits. The MSWM system rolls forward by the corporation of stakeholders who aim at the same thing for MSWM, which is the effective and reliable system. The enhanced system will eventually reduce health impacts and nuisance for the residents, enable the community with more hygienic environment, and make the society more livable.

Economic Viewpoint

Municipal authorities, including the BMA for Bangkok, spend a large amount of budget on MSWM service provision. Likewise, the need of infrastructure concerning collection and transportation of waste seems overwhelmed by increasing demand for public sanitation and society well-being. Therefore, allowing more private investment, participation of people, and involvement of related sectors is an option. The government can attract private sector to have more investment on MSWM by offering incentives, such as tax, funding, or low interest loan (OECD, 2012).

For example through partnerships, growing level of trust between service providers and recipients occurs. The built up trust can reduce risk of uncertainty and conflicts of interest. In PPCPs and CBOs, relationships extend over time and each sector gradually becomes familiar with other sectors' roles and practices. This leads each sector in the PPCP to achieve greater co-created benefits. When MSW is managed properly at the beginning processes (waste generation and waste collection); it helps the effectiveness of provided service increases. Consequently, economic burdens that put on the municipality will be lessened. In this case, the municipality can use this saved amount of expense to invest on other city development projects.

In terms of other sectors such as individuals, waste pickers, or private sector, joining in waste separation at source or be a part in MSWM partnerships – PPCPs or CBOs, can provide them an additional source of income. This can be done by utilizing the separated waste, for example selling recyclable waste or making compost.

7.1.2 Environmental Viewpoint

In MSWM chain, governments, private waste management companies, NGOs, residents, and manufacturers are stakeholders that have high contribution to the amount of waste being generated (Brum and Hippert, 2014). At the same rate of consumption, if manufacturers use fewer resources for packaging goods and use environmentally friendly materials in production processes, waste generation will be reduced. Eventually, more effective and environmentally friendly MSWM service will be provided. Interviewees agree that monetary incentives can draw attention; however, it is not a sustainable way. On the contrary, they state that awareness

raising through KS and KT should be implemented. This can be done in a number of ways such as KS and KT in families or communities, included KM on MSWM in school curriculum, implementation of partnerships, or enforcing practical policies. The basic MSW knowledge that should be provided to all residents is, for example, types of waste, waste separation techniques, or MSWM processes. In addition, the importance of having effectively sustainable MSWM in the society, the environment, and well-being of all should be explained; this is to ensure that the residents have correct understanding towards MSW and the management.

The good condition of the environment is very important for all human beings in all types of systems. As one of the three key elements in the tripartite service concept, the environment or natural capital directly and indirectly provides resource which is its main value to service providers and service recipients at every stage in the systems. At the meantime with or without their intention, service providers and recipients deteriorate the well-being of the ecosystem in the over regeneration rate. As a result, future values that could have been used are deteriorated. Thus, the providers and recipients should collaboratively exercise their roles and utilize values in the innovatively co-created way. This is to ensure that all possible risks are kept to the minimum.

In manufacturer point of view, Nestlé's shared value activity is a good case example. Nestlé has implemented recycling initiatives including waste recycling in many countries across the world, such as Mexico, Chile, China, Malaysia, France, or Germany. As PET bottles and other product packagings are produced from recyclable raw materials, Nestlé has applied a number of technologies that allow the public to be part of the recycling chain. The company increases access to curbside recycling and recycling away from home by encouraging consumers to participate in waste recycling activities by segregating the company's recyclable containers and put in Nestlé's equipped facilities. In short, to promote sustainability by recycling, Nestlé has exploited its state of the art technologies to allow convenience and comfort to customers in using its goods and services in both pre and post usage (Nestlé in society, 2013).

7.1.3 Technological Viewpoint

In terms of the current performance, there are many urgent problems that need to be solved. Not only socio-economic and environmental concerns but also the low level of technology applied to MSWM operation cause ineffective waste management. The results of the study show that technology is a vital requirement of the MSWM system.

After MSW is generated, waste collection is a very important process of waste management. Effective collection service should be available in all areas of Bangkok, as the service is unreachable in some parts of the city. Waste should be picked up on time as scheduled. Moreover, to prevent bad odor and leftover waste, the BMA has to give serious attention to the standards and conditions of waste collection machines and trucks. The other point of concern is the qualification and performance of employees. Good employees can increase work productivity and eventually result in reduction of the required resources. In terms of technology, the appropriate types of trucks should be used in different operational purposes in different areas to ensure that no waste is left behind or falls during transportation. RFID and camera technologies are alternative technologies that respondents and experts suggest that they can solve these problems. For example, waste bins in the areas that have very high amount of MSW generation should be monitored for the prompt waste collection service.

Waste transportation is a crucial process of taking collected MSW away from the sources of generation and moving it to transfer stations. Expert opinions show that the time and transportation routes of the trucks in each area need improving in order to increase the effectiveness of waste transportation. The current technologies, GPS and LFD, should be optimally utilized. Waste transfer stations are currently located 10–110 kilometers away from landfill sites, which makes each round of waste transportation time consuming (McDonald and Oates, 2003; BMA, 2014). Thus, the BMA should consider having more transfer waste stations to alleviate uncollected waste on time problems. The number of transfer stations should be determined by the maximum distance between a transfer station and a landfill site to make waste transfer to stations economical. Beyond the maximum distance of waste transport, another transfer station is necessary (Muttamara et al., 1994). For example, to solve uncollected waste and delayed collection problems, the MSWM collection and transportation system of the city of Madras, India is divided into ten zones and each zone has a transfer station. This ensures that

having suitable number of transfer stations saves transportation costs and also increases waste collection and transportation performance (Hannan et al., 2012; OECD, 2014).

Waste sorting and recycling technology should be considered as an initial MSWM solution before dumping all waste into landfills. Both residents and experts state that not all the projects launched by the BMA attract people's attention, nor are they all successful. Such projects should be continuously promoted and the public should be consistently encouraged to participate. Residents would like to be educated and guided on how to reduce waste properly, with some supports or incentives provided. Waste treatment technology should provide benefits to all stakeholders. Finally, the experts answer that thermal waste treatment technology should be considered as an alternative treatment method to sanitary landfill.

Durant (2009) states in his work that waste management performance depends on public influence, as all management processes and results are open to public scrutiny and require active solutions. Inviting external stakeholders to have technological commitments as a long-term solution is an alternative for the BMA to create a relationship of trust and mutual accountability. Lessening the technological challenges of MSWM makes the system more sustainable. Neither respondents nor experts feel that achieving sustainable MSWM in Bangkok will happen in short or medium term. However, they think that it is possible in long-term period.

7.1.4 Legislative Viewpoint

Having only effective MSWM is not enough to ensure sustainability of MSWM system of a city. Moreover, it does not ensure that effective services will be provided to all residents. Practical policy is very important to set the direction for the system. The analyses discussed in this study show that an applicable and practical master plan for MSWM is imperative for all residents in all areas at all levels. The plan should be geared towards making all processes of the MSWM system run efficiently.

Budget allocation policy is another essential concern for better MSWM service. Experts state that once there is a technology in use, it is important to optimally utilize it. Moreover, research and development related to MSWM are keys in terms of helping the system run sustainably. Respondents and experts suggest that there be a policy focusing on the public health condition. This policy is for people who work directly with waste and those who are at greater

risk. Another solution is having an education policy. Living in a city without relevant experience or education means residents can inadvertently influence a city's sustainability in a negative way (Chi et al., 2006; Aarras et al., 2014). An education policy will ensure that students in school are educated on how to deal with different types of waste. There should also have projects to promote MSWM methods—for example, promoting waste reduction at the source by encouraging people to separate waste before disposal.

Above all, both respondents and experts express that all stakeholders should be involved in the MSWM system. They would like to be part of setting goals that contribute to the mutual benefit of all related parties. Correspondingly, they think that pilot projects should be implemented, and when these projects are implemented successfully, the methods and procedures of management should be extended to other cities. Additionally, after putting an appropriate waste management infrastructure into place, the government should have a policy to ensure that every process is being appropriately operated and that all people behave correctly. Most of all, there should be enforceable laws applied to all parties and all processes of waste management.

7.2 Potential Knowledge Creation Process

In this section, potential knowledge creation process is introduced. It represents the sequences of how knowledge and values are co-created through three steps of problem solving in different levels of stakeholder involvement.

In the second part, a model of knowledge based service provision for MSWM system is proposed. This model encapsulates the combination of service and KM concepts to represent the co-create knowledge and values for the enhancement of MSWM system by the collaboration of all stakeholders.

According to 'Figure 3.2: Research boundary', the knowledge and value co-creation is exemplified by the collaboration of related multi-stakeholders who have roles and responsibilities to share mutual benefits and risks in the MSWM service system. Regarding the collaboration process, there is KS and KT occurs during the cooperative process of those stakeholders and their resources. In this dissertation, the KS and KT, as the very important factor of KM, are the main knowledge creation elements that lead to KD that all related stakeholders are able use the co-created knowledge and values to enhance the effectiveness of MSWM service provision at community level. Thus, section 7.2.1 shows the step by step process of problem solving in MSWM system that has multisector stakeholders involved.

In section 7.2.2, the knowledge and value co-creation part is explained in details of how solutions are made towards fulfilling the gaps and concerns in MSWM service system. To be able to identify solutions for solving the MSWM related problems, the process includes three layers. After the problem is identified, the first fundamental layer is the collaboration of related stakeholders. These stakeholders exercise their roles by exploiting their knowledge and integrating their resources in order to achieve the same common goal, which is to solve the identified problem.

The second layer is the three kinds of readiness of MSWM system. To solve any problem, stakeholders need to work together to achieve these three readiness. The first readiness is related to the MSWM system itself. It has to be ensured that infrastructure and technology used for each process need to be well maintained and appropriate. The involved staff should be qualified and have suitable capability to handle the task. There should also have the involvement of all sectors to be part of the problem solving or system improving. The second readiness is

related to human resources. Each stakeholder needs to have proper knowledge, skill, and experience towards solving the identified problems. Above all, they need to have good mindset on the mission that they are responsible for. The third readiness is about policies and legislation. In the service system, every process needs to be managed under the practical and enforceable policies and standards.

The third layer illustrates how the stakeholders collaborate towards achieving the three kinds of readiness. At this stage, KS and KT among individuals or groups of stakeholders co-create values leading to KD that can be used as solutions to the MSWM service provision and management processes.

7.2.1 Stepwise Approach

According to the analyzed results of the study in the perspective of MSWM service provision, it is mandatory that all processes be well-planned. By letting all stakeholders perform their roles step by step in MSWM chain, a stepwise research approach is a potential option. This study therefore adopts the approach for the sake of applying KM concept and lessening complexity in understanding the overall processes of MSWM system. Figure 7.1 presents how the stepwise MSWM process should be; the figure is constructed based on the analyzed results of the nine studies comprised in this dissertation.

As presented in the figure, there are three steps in the approach, as shown in the top right corner. The first step is the first four processes in the figure (dark grey boxes). All related stakeholders have roles in these processes. They can share ideas, experience, or knowledge regarding to the identified problem in order to find what potential solutions are. The second step includes three processes (light grey boxes). These processes include roles of extended stakeholders in the way to get their expertise, skill, or knowledge that is suitable to be used as solutions for the problem. The extended stakeholders can be the ones that are not in the problematic MSWM system but have knowledge or know how to deal with the problem. In other words, the extended stakeholders are external actors, who are from other systems. The third step consists of two processes (white boxes). Specific stakeholders have major roles in this step. Krogh et al. (2001) state that not every employee in the organization has to know everything or

do all tasks for the company. In the same way in MSWM system, after getting the direction of management on the basis of the co-creating goal set by all stakeholders; the specific groups of stakeholders are the ones who take actions on solving the problem or managing the situation.

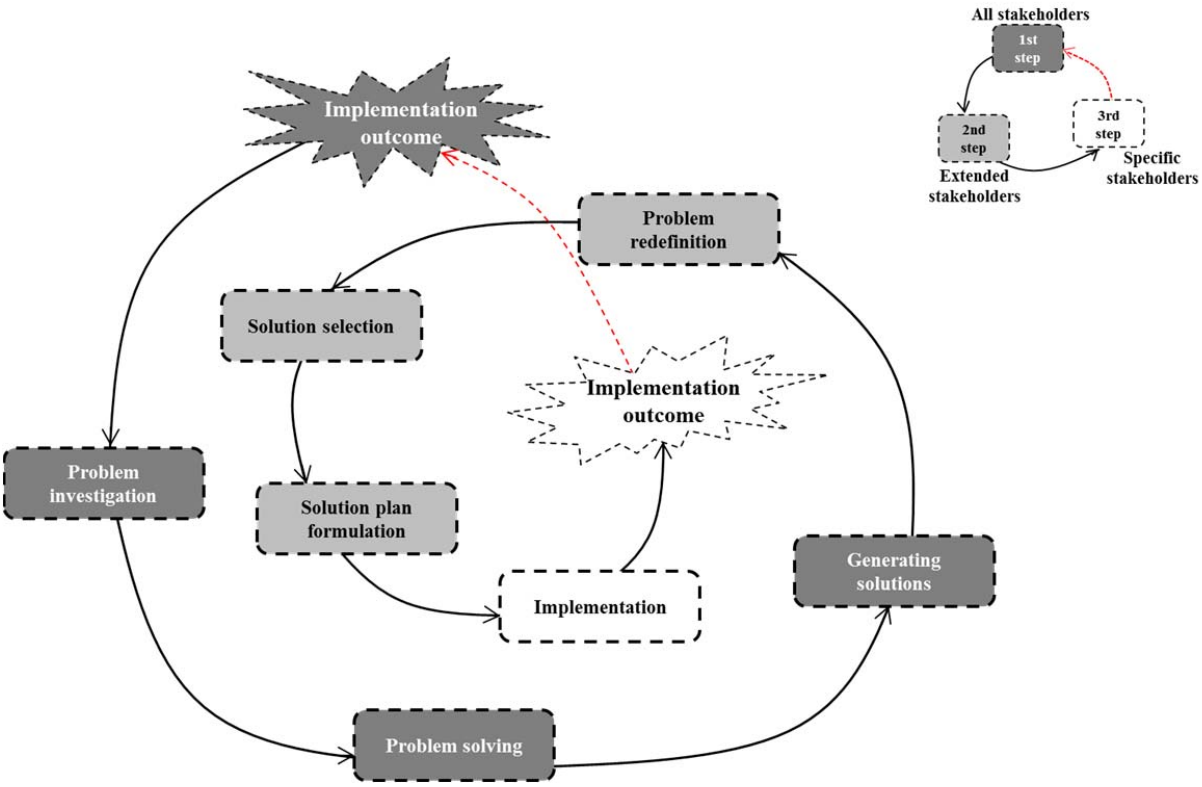

Figure 7.1: Stepwise approach for knowledge creation in MSWM system
(Modified from Lederer, 2012)

The implemented outcome is the result of knowledge creation through the processes that have all stakeholders involved. If the outcome does not turn out in an effective way; the stepwise knowledge creation for MSWM problem solving starts again, shown as the red dotted line. Therefore, the stepwise approach can be applied to enhance the performance of MSWM service provision, as it can generate solutions that come from all related stakeholders in the system. Comparing to other solutions that are successfully implemented elsewhere, the solutions that are generated from the ones who actually get affected are more potential.

7.2.2 Co-Created Values and Knowledge Dissemination

Consolidation of Studies

Based on the results of qualitative and quantitative analyses, this section provides essential factors that lead to practical implications of applying KM on sustainable MSWM service in Bangkok. Integrating analyzed results from Studies A, B, and C, there are three groups of factors that residents and experts concern on in order to have the effective MSWM system. Those three factors are considered as the three readiness of waste management system, including readiness of the system, readiness of policies and legislation, and readiness of human resource.

Readiness of MSWM system means that the city needs to have all required infrastructures which are important factors that support the management of the increased amount of waste. The city has to ensure that all infrastructures are in function and do not generate pollution to the environment. KS and KT among MSWM staff and residents are imperative. For the staff, they have to correctly know what and how to effectively manage MSW as a whole system and especially specialize on their responsible tasks. For Bangkok residents, it is imperative to make them understand the importance of sustainable MSWM. All interviewed stakeholders agree that collaboration based on mutual agreement leads to better MSWM system.

After having suitable infrastructure and appropriate technologies for waste management system, it is highly important that the city be provided with long-term strategic planning and policies on MSWM. In addition, enforceable laws should be in place. The analysis shows that involvement of public and private sectors is vital, for example, in waste management planning or policy setting creates mutual benefits. When all related sectors agree with how the management processes should be, problems on public appealing will no longer occur. This is a big challenge of KS, as it needs to make all parties understand the same knowledge, create the same direction of mindset, and have the same perception of the importance of having sustainable MSWM system with rigid punishment.

This challenging issue of KS among related parties can be solved by adapting the concept of social exchange theory (Homans, 1958). Benefits that are socially exchanged such as information, knowledge, advice, assistance, or commitment have unique significance of their own depending on each individual's preference. In case of Bangkok MSWM system, to get

people have the same direction of mindset, it is easier to exploit interpersonal relations among residents. People tend to believe or consult with ones whose have friendly relations or are trustable. Socially exchange of MSWM knowledge among those who have good relations may result in better quality of KS.

The most important factor that drives MSWM system is human resource. The city needs to ensure that staff at all levels have correct knowledge and practice their work activities properly. KM plays a very important role here. According to the knowledge based theory (Grant, 1996) that focuses on the efficiency of economizing on knowledge exchange, instead of that, this study focuses on the efficiency of MSWM activities based on KS and KT perspectives. Knowledge is a key productive resource that contributes to value co-creation of all staff. Therefore, knowledge should be embedded at every process of MSWM starting from waste generation to final waste disposal. This is also applicable to MSWM that KM can be applied to a simple process to a very complicated activity, for example, using equipment correctly, sorting correct types of waste, or planning waste collection routes. In addition, well-being of front line staff should be more focused. For sustainable waste management and better provision of service, Bangkok is highly recommended to have KM in MSWM master plan to ensure that all staff conduct all activities correctly based on the same knowledge and norm.

When MSWM system and staff are ready, readiness of waste generators to be part of the system is also important. It is again a huge task to build up good mindset of waste generators. At the very start of waste generation chain, suggested by experts, manufacturers should produce goods with less amount of packaging in a more environmentally friendly way. This business practice has started implementing in the past few years, manufacturers launched campaigns of using less raw materials to reduce amount of waste. Residents also have to minimize amount of waste. Reduction of waste at source is the most powerful way to reduce waste generation. Education and public relation to promote correct waste management practices should be consistently available. Knowledge on importance of having effective MSWM should be given. The socio-economic and environmental impacts of having and not having sustainable MSWM system should be explained. People have concerned more on the environment. The residents would like to live in a clean city. They have willingness to join in MSWM collaboration for a better and more effective management system. Thus, it is a task of the BMA to mutually work

with the residents, encourage and draw participation of the public to join MSWM schemes on the basis of consistently promotion and KD on sustainable waste management.

Knowledge Based Service Provision of MSWM System Model

According to the aforementioned details of the Studies A, B, and C, this dissertation presents a conceptual model for knowledge based service provision of MSWM system.

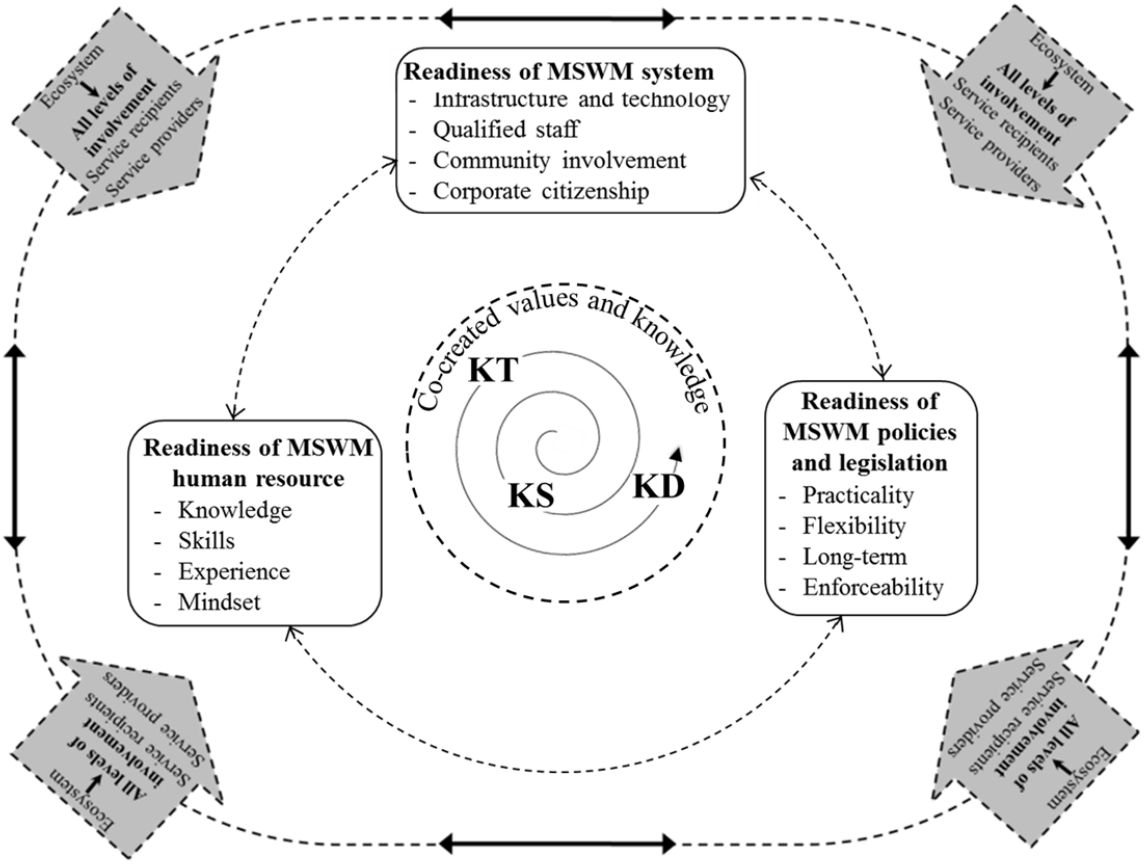

Figure 7.2: Conceptual model for knowledge based service provision of MSWM system

The model includes the essence of partnership, tripartite service, and KM concepts that can enhance the effectiveness of MSWM service provision. As presented in the outermost layer in the model, the fundamental need for successful MSWM is collaboration among stakeholders, which represents by the three elements of the tripartite service concept (grey arrows), namely

service recipients, service providers, and natural capital or the ecosystem. This layer incorporates analyzed results of Studies A1, A3, and B1, which emphasize on the importance of collaboration of all related stakeholders in MSWM system.

The second layer of the model is the three substantial kinds of readiness of MSWM system based on KM concept (white boxes). Getting these three kinds of readiness, the results of Studies A2, A4, B2, and C3 are integrated. To achieve the third layer which is the innermost part of the model; the third layer represents the flow of knowledge that are shared and transferred among stakeholders in the knowledge creation aspect in order to get the final outcome, which in this case is co-created values. This layer includes the results of Studies C1 and C2, together with the stepwise knowledge creation approach, which is explained in section 7.2.1. For a detailed explanation, the third layer adopts the concept of stepwise approach as shown in 'Figure 7.1'. During the processes in the approach stakeholders work together to solve the problem which means they share and transfer their knowledge, skills, and experience. Solving the problem through KS and KT is a way to achieve one of the three kinds of readiness.

In other words, all potential stakeholders get involved in the collaboration (the outermost layer). They work together to achieve the three kinds of readiness, as shown in the middle layer. And for the innermost layer, the stakeholders work together to meet the three readiness through KS and KT to have KD. KD in this case means that the stakeholders are able to turn the knowledge that they have co-created through MSWM chain into actions that improve the performance of MSWM service provision. Eventually, the ultimate outcomes, including solved problems, fulfilled MSWM gaps, or effective MSWM system are considered as the co-created values of the collaborative MSWM system.

7.2.3 Evaluation

In terms of moving towards sustainable MSWM service provision for the city of Bangkok, it is important that all related stakeholders, especially the BMA put more effort to improve the MSWM infrastructure, ensure the qualification of staff, and apply effective and practical management strategies. The procedure has to be implemented in all areas with effectively enforceable laws to manage, control, and mitigate the system. This is to ensure that

the provided services meet the needs of both service providers and service recipients in an environmentally friendly condition.

In spite of the collaboration of stakeholders, KM cannot be effective unless successful KS and KT are not applied. Both residents and experts insist that all related stakeholders have the same mindset in implementing every waste management process. Thus, having an effective KM, it has to be ensured that knowledge gaps are minimized, which can be done by applying KS and KT strategies. Moreover, it is essential to bring out personal hidden knowledge and utmost make use of this knowledge. From the results, every process from simple to complex inevitably needs KM. Thirteen needed types of knowledge are identified in this study, which the knowledge needs sharing and transferring to all related stakeholders. It is unnecessary that each person know all knowledge but at least every person needs to have the same mindset or organizational norm.

All in all, the analyzed results in the nine sub-studies and various discussed perspectives of implications show the process of how to achieve the effective MSWM system on the basis of applying service and KM concepts. Although this dissertation represents the MSWM situation of the city of Bangkok as representative of a city that has faced with adverse impacts caused by ineffective MSWM system in aspects of lack of readiness of infrastructure, lack of ineffective policies, lack of skilled human resource, lack of appropriate use of technology, and lack of involvement from related stakeholders. According to these lacks of readiness which are the fundamental factors for MSWM system, incorporating the research methodologies and research methods used in this dissertation can be a guide to overcome the unreadiness by having inclusive collaboration of stakeholders in a value and knowledge co-creation way.

From the studies, gaps, concerns, challenges and opportunities are identified and explained. The solutions of how to fulfill those gaps are discussed. Possible outcomes are listed out. Moreover, implications of how to adopt the discussed research methods and verified results are provided in a perspective of service and KM concepts to increase the capability MSWM service system. As a result, this dissertation points out contributions that are beneficial to individuals (i.e. better MSWM service at household level, more understanding towards MSWM and related knowledge, less disparity for waste pickers, and less health concerns), communities (i.e. more hygienic society, job creation, improved MSWM system, and effective collaboration) and the environment (i.e. more effective and environmentally friendly MSWM processes, less emitted pollution, less risks of contamination, and more natural resources preserved.

We are living in service and knowledge economy, based on the analyzed results; it suffices to say that sustainable environmental service and KM concepts can perfectly blend together. This dissertation shows human aspects on the current waste management service provided and the importance of KM, together with multisector collaboration. The results show that KM is an important factor for sustainable MSWM.

7.3 Summary

This chapter explains potential implementations in different viewpoints that can be applied in providing MSWM service. The viewpoints are socio-economic, environmental, technological and legislative. Besides, the knowledge creation process approaches are also discussed. The first approach is stepwise, which entails the steps of MSWM problem solving that involve different stakeholders along the processes. Along the process chain, knowledge is shared and transferred. At the end, a solution is achieved as the ultimate outcome that can be used for later implementation. The other approach is the knowledge creation process through all levels of involvement of stakeholders in the tripartite service perspective. Three successful factors of having effective MSWM system are identified. On the basis of these three factors and the involvement of stakeholders, knowledge creation is presented in an innovative adoption of KS and KT. The optimal objective of this approach is to achieve the co-created knowledge and values that can enhance the effectiveness of MSWM system. All in all, a conceptual knowledge based model that embraces all essential elements of the service concepts, KM concept, and MSWM system is presented in this chapter.

Chapter 8
Conclusion and Recommendations

8.1 Concluding Remarks

This chapter explains the summarized details of all analyses in a sequence that answers each of the research questions. All analyzed results are then explained in the academic and practical perspectives. In addition, the results are explained in the view of other applicable research areas. Limitations of the study are also identified. With the aim of enhancing the societal well-being, overcoming these limitations or gaps of research can broaden the applications of service and knowledge concepts for other fields of study other than MSWM.

8.1.1 Answer for Research Questions

The thorough primary and secondary analyses in this study demonstrate that service and knowledge concepts can be applied as ways to create solutions for a better MSWM system in Bangkok. Details of the achieved results that meet each research question are following explained.

SRQ 1: What are the imperative factors effecting MSWM system in three perspectives namely waste generation factors, technological challenges, and policy design for inclusive informal sector?

As explained in 'Chapter 4', this section discusses results that answer this SRQ by identifying stakeholder attitudes on current MSWM situation, MSW generation factors, and technological challenges; which all of these can affect the performance of MSWM system. The results are explained in four parts.

The first part includes aspects on current performance of MSWM service and concerns on the provided services. The results show that the current provided MSWM service was at moderate level. Odor and leftover waste during collection process are the most two occurring problems that needed to be solved. The residents and experts agree that everyone from all sectors should have roles and be part of the MSWM system. The majority of them would like to join in MSWM activities for better management process. However based on their perspectives, they think that waste generation should be reduced with positive attitudes towards waste minimization as it is a sound MSWM method and is more essential than landfills.

The second part consists of analyzed results relating to waste separation at source and waste minimization. As the respondents would like to get involved in MSWM activities, they would like to take part in source separation and minimize waste generation through 3Rs. Yet, there are some concerns that would refrain them from participating; the concerns are separating waste is complicated; do not have time; and no proper trash bins. Upon incentive recycling waste program, half of the respondents had knowledge about this. And in a case that recycling program is formally implemented with supports of government and private sectors and is provided in Bangkok communities, most of the respondents show their interest in participating in the program. The respondents believe that the program can solve MSWM problems in long-term and can be adopted in other communities. They also believe that people who participate in recyclable waste separation with the program will get benefits and the MSWM system will be better. From the results, about one-third of the generated waste is recyclable waste that can later be sold or fruitfully utilized.

Apart from willingness to be involved in MSWM process and make the environment clean and lively, the respondents state that municipalities should be the middleman by putting

more efforts on involving the residents in the management chain. Conversely, waste collectors and waste pickers worry about loss of income from selling recyclable waste if the recycling programs are implemented in their areas. University professors and BMA officers share that providing incentives is a marketing tool that can draw people's attention in joining MSWM activity. Additionally, a concrete plan should be provided to prevent all possible consequences that might happen if the recycling program is applied, for example, problems from waste pickers who collect recyclable waste from households and monitoring system in long-term.

The third part entails root causes of waste generation and waste generation factors for the city of Bangkok. In terms of general MSW generation factors, 14 factors are potential root causes for MSW generation. Out of these factors, there are seven influencing MSW generation factors for the city of Bangkok. The seven factors are population size, number of households, household size, average income per capita, GDP per capita, CIP, and number of tourists. It can be summarized that economic and demographic factors have contributed to MSW generation the most.

The last part is about technological challenges. In this section, ten factors that can increase MSWM service effectiveness and MSWM system sustainability are identified. Most of the respondents respond that waste management infrastructure, practical policies, and enforceable laws are three groups of essential factors for the effectiveness of MSWM system. When the required infrastructure is in place, there should be practical policies and strategies to manage the system. To make a system run smoothly, effective laws need to be enforced. Since people themselves are the main MSW generators, public participation is a crucial key for successful MSWM systems. In terms of attitudes towards level of technology applied to the current waste management system, about half of the respondents think that technology is applied at a moderate level. This implies that Bangkok residents feel that technology should be applied a lot more to increase the effectiveness of the current system. Potential technologies that should be appropriately applied to MSWM system are listed based on the respondents' knowledge and attitudes. The respondents state that applying technologies in the management system would reduce operation and management cost, improve society well-being, and lead the system towards sustainability.

Regarding all presented analyzed results which are the four aspects of effecting factors on MSWM system; it is explicable to conclude that the 'SRQ 1' has been achieved.

SRQ 2: How to broaden the service based approach by analyzing stakeholder attitudes in forming a coherent and structured manner in MSWM through partnerships?

The results that answer this SRQ are explained in 'Chapter 5'. The study comprises of two parts. The first part relates to aspects on having multisector partnership in Bangkok MSWM. The second part identifies essential MSWM policies that are needed for the operation of partnerships, especially the ones at community level.

Regarding the perspective of collaboration through partnership, the majority of respondents think that collaboration among communities, government authorities, private companies, and NGOs are important for effective service provision and sustainable MSWM system. They also express their willingness to join the collaborative system. They share that to have sustainable and successful MSWM system, not only the government or private companies have to manage all waste appropriately but also everyone related to waste. Residents and experts think that PPCP is vital for MSWM in Bangkok and they would like to be part of the sustainable management system. Therefore, PPCP has high possibility to be implemented as a MSWM mechanism. Explaining in the view of tripartite service concept elements, roles of service actors are identified. Value-in-use of each actor is integrated aiming to improve the MSWM system. Actors from public, private, and community sectors mutually co-create values by integrating all resources that each sector has for a better and more effective MSWM, which eventually enhances societal well-being, for example, better health, more happiness, and less disparity. These results are considered as co-created values among all sectors in the system.

Apart from the PPCP aspect, the study also presents the possibility of implementing CBOs as a collaborative stakeholder MSWM solution at the community level, in which waste pickers are the main service provider. The results show very high possibility of implementing CBOs in Bangkok communities. Yet, there are issues that waste pickers concern which relate to the reliability of the system, roles and responsibilities, transparency, and opportunities in career growth. Accordingly, the potential roles and responsibilities of being a CBO member are analyzed. In the partnerships, it is indispensable to neglect the involvement of multisector collaboration. Therefore, the study identifies essential stakeholders that should be involved in the CBOs.

In terms of service policies, the study lists out 27 policies in three important MSWM processes, which are laterally grouped into four categories. The four categories of MSWM policies that should be adopted while providing MSWM service are policies for collaboration and needed infrastructure, policies for MSWM at household level, policies on KM, and policies for MSW collection and transportation.

By applying the partnership and tripartite service concepts to MSWM system, this study provides stakeholder attitudes on collaboration in MSWM. Based on their attitudes, possibility of implementing MSWM partnerships that have multisector of stakeholders involved, roles and responsibilities of stakeholders, and essential policies that are needed for the effective running of partnerships are evaluated. Therefore, it is suffice to conclude that the 'SRQ 2' has been satisfied in terms of analyzing stakeholder attitudes in forming a coherent and structured manner in MSWM through partnerships.

SRQ 3: Based on knowledge management and sustainable service concepts, what are the co-created values of the knowledge based service provision for MSWM system and the needed knowledge and strategic MSW management options?

The third SRQ of this dissertation is related to KM and service concepts in the way to identify co-created values that enhance the overall performance of MSWM service provision. Accordingly, the answers are available in 'Chapter 6', which encompasses three parts in total.

The first part relates to essential knowledge and roles of KM for MSWM. From the analyzed results, respondents think that knowledge on waste management should be consistently promoted to all residents, to be incorporated in lessons for students, and to waste management providers. The study presents 13 needed types of knowledge for having sustainable waste management. Besides, the results show that KS and KT are needed at each step of MSWM for effective KM. KT can be done internally among service recipients or service providers, or externally between service recipients and providers or other indirect actors. All processes of MSWM need KT to lessen knowledge gaps. Some residents can transfer their knowledge on how to minimize waste generation by using reduce and reuse strategies. Staff in the same or different levels can train or suggest each other in order to have the same knowledge that creates norm of MSWM practice.

In terms of value co-creation, applying KM as an alternative solution to increase the effectiveness of the MSWM system, a big concern for practically successful KM is the transparent MSWM process. In service provider side, if each MSWM process along waste management chain is transparently managed based on well-planned policies complying with all stakeholders requirements, provided MSWM service performance will be improved. On service recipients perspective, if residents who are the main waste generators and any other generators are informed, educated, or learn how to correctly manage their waste, waste generation rate will be decreased. Furthermore, respondents and experts agree that if they know what or how to reduce waste, not only waste generation will reduce, but also consumption of natural resources will decrease.

Values that are co-created by related stakeholders for each MSWM process are identified. If KM is successfully applied, respondents state that collaboration among key related actors is formed to create mutual benefits, which results in reduction of waste generation, better MSWM service, transparent and effective MSWM system as a whole, and less socio-economic and environmental impacts. In terms of value co-creation, there will be better understanding of how sustainable MSWM should be among all sectors. Consequently, awareness of impacts caused by waste will increase, so will awareness of the importance of ecosystem. Therefore, the better MSWM system will eventually lead to the better well-being of the society as a whole.

In terms of value co-creation in the implementation of partnership at community level, the inclusive CBOs allow a number of opportunities, such as recyclable waste will be correctly sorted and properly managed; waste pickers will be more recognized and have a formal role in MSWM system without losing their source of income; and waste collection staff spend less time in collection process as they do not have to sort out the recyclables. Therefore, all these benefits can be considered as co-created values that are beneficial to all involved actors. The study also proposes a conceptual service policy framework for MSWM system, which provides a better understanding of how inclusive CBOs will enhance the effectiveness of MSWM service at community level.

The last part consists of the analyzed strategic MSWM options. By employing the stakeholder analysis and TOWS analysis techniques, stakeholders from different levels state both common and diverse opinions on MSW generation concerns. From the given issues, solutions are formed as ways to solve the concerns to make the MSWM system more effective. The

solutions are categorized into the four aspects of TOWS analysis. The analysis eventually reveals the possible conflicts of interest and expectation among stakeholders. Consequently, seven strategic MSWM options that the BMA can adopt as a useful guideline for MSWM planning are identified in order to make the MSWM system more effective and reliable.

With the integrated essence of KM and service concepts, co-created values, needed knowledge, and strategic MSWM options are identified and discussed. Incorporating all of these outcomes, the obtained results are constructive for the enhancement of MSWM service provision which fulfills the third SRQ.

MRQ: How to enhance the effectiveness of MSWM service provision by applying the service and KM concepts?

By combining all results that answer the SRQs, the study explains important factors, processes, and techniques that can be applied to enhance the effectiveness of MSWM service provision. To achieve the main objective of this study, the following results were analyzed and explained:

- Factors that are influential to the effectiveness of MSWM system, which are human attitudes on current MSWM, waste generation factors, and technological challenges
- Service concept approaches on MSWM partnerships, which are human attitudes on implementing partnerships; possibility of having partnerships, and essential policies for implementing partnerships
- Co-created values for MSWM service provision, which include important knowledge for MSWM system, co-created values, and strategic management options

With an elaborate comprising of all factors of each perspective, this study proposes a conceptual model that covers the core concepts of KM and service approaches in MSWM perspective. Consequently, all results explicably confirm that the research question of how to enhance the effectiveness of MSWM service provision by applying the service and KM concepts has been entirely achieved.

8. 2 Academic Implications

It has been revealed that organizational transformation is in a vital need to be viewed in the new paradigm that is shifted from G-D Logic to S-D Logic perspectives. In any service systems, it consists of dynamic and multisector stakeholders that have different resources and expertise to be contributed in the service chain. Taking this as an opportunity, managing those resources to be exploited at the right time by the right people, towards specific targets is a potential strategy to increase the level of effectiveness and competitiveness.

In the context of providing effective and reliable MSWM service, resources of each stakeholder should be optimally utilized on the basis that satisfies all sectors in the system. In the sense that knowledge is the most valuable resource and should be shared and transferred to all sectors in the interactions along the processes, MSWM knowledge should also be well managed in order to provide the effective service without deteriorating the quality of life and the well-being of the society. Thereby, applying the service and KM concepts to MSWM system is an approach that enhances the performance of service provision that answers the optimal goal of both service providers and service recipients.

The conceptions of service research, knowledge management research, and sustainably environmental research have been realized by both public and private sectors. This also applies to the academic arena, providing sustainably environmental related service is complex and dynamic. Scholars have tried to find out solutions that can lessen the complication and overcome the difficulty among related sectors that increase the effectiveness of the provided service.

Though this study relates to MSWM system, as a kind of fundamental public service, it can be used as an applicable example of how the enhancement of service provision can be achieved. Broadening the service and knowledge concepts by applying the analyzed results or techniques used in this study, it can be more or less useful for other studies in the means of lessen the research limitations or extend the body of knowledge that is helpful for the contributions of other studies.

8.3 Practical Implications

The ever increasing amount of waste and the dynamic changes of socio-economic factors have strengthened the level of complexity in MSWM system. Correspondingly, providing effective and reliable MSWM service is a problematic concern that gives challenges to responsible parties in all cities worldwide. This study plays an essential role in overcoming the challenges by providing practical solutions in a number of perspectives. In the service perspective, service concepts are applied to identify potential approaches to involve stakeholders to have active roles in the system and improve the management process. In the KM perspective, needed types of knowledge are identified which can be used as profound elements in setting management plans. In terms of policy, essential policies and practices for each management process are listed out, which help lessen management gaps throughout the whole system. In terms of technology, potential technologies that should be adopted for the MSWM system are pointed out, which can lessen and prevent possible adverse impacts.

With the proposed conceptual model, framework, and management approach, the study builds a value-added MSWM system that is encompassed all related factors from all involved sectors. In other words, this study provides necessary management procedures as a well-prepared step for achieving an enhanced performance service outcome.

This study offers a broad and detailed explanation of how the enhancement of MSWM service provision should be when adopting the concepts of service and KM. In details, the study provides results of influential factors on MSWM system that are attitudes of stakeholders towards current situation of MSWM and technological challenges. The study also comprises the information of opportunities and challenges of implementing partnership approaches and possible MSWM policies as ways to solve ineffective management problems. In addition, the essential knowledge, co-created values, and strategic MSWM options are also detailed in this study.

Adopting such factors as management practices in a MSWM system will give a chance for any community to lessen the seriousness of related problems and increase the level of effectiveness of the system. The analyzed results of this study is verified and validated quantitatively and qualitatively. To specifically confirm the practicality of the methods or techniques suggested in this study, a pilot project or a thorough reinvestigation done by experts is

needed. This is because the nature of MSWM system depends on various factors that vary over time and different from place to place.

This study provides comprehensive practicalities for researchers and practitioners to apply the knowledge based service provision approach through implementing the proposed knowledge based service provision model. Accordingly, the provision of MSWM service will be enhanced in a sustainable value co-creation way.

8.4 Limitations and Recommendations for Further Study

The ultimate values of having better MSWM service are sustainable MSWM system and improved societal well-being. Nevertheless, there are challenges in this study that need more investigation.

For the study of MSW generation factors (Study A3), there are three groups of factors that this study did not analyze. Those groups are technology, consumer behavior, and legislative and administration. For example, it is essential to have data about consumption pattern, waste disposal pattern, or people lifestyle. Knowing such data would be helpful for researchers to estimate possible composition and amount of MSW that would be generated, which eventually leads to a more efficient MSWM system. In this point, further study can touch upon identifying key success factors that have successfully been applied. Analyzing these factors in terms of feasibility for MSWM implementation is also imperative. Regarding negative correlation coefficient values and possible multicollinearity problems, it is suggested to figure out these two points by applying broader population frame and more potential MSW generation factors from other groups.

For the case of implementing partnerships through PPCP or CBO (Studies B1), a clear and practical set of policies is the most important factor for effective MSWM process. The municipal authority needs to ensure that basic infrastructure and equipment are available and meet standards. Another point of concern is that how to manage with waste collection staff who might lose their source of income from collecting and selling recyclable waste. If the CBO staff do not sell collected recyclable waste to junk shops, the authority needs a plan in place to answer what and how to deal with those amount of collected waste.

In addition, this study conducts the research in the city of Bangkok, which is a case example that represents a situation of ineffective MSWM system that is influenced by a large number of dynamic and interrelated of factors. Cities have different influential factors, stakeholders, and policies. Therefore, the results presented in this study should be adjusted according to the norms, characteristics, or standards of such cities.

Analyzed results presented in this study can facilitate a thorough evaluation on the basis of human attitudes as inputs of future research in knowledge based MSWM service provision. It is especially beneficial for policymakers, strategic planners, local government authorities,

scholars, and practitioners to strive towards an effective MSWM system. There is no single solution that is suitable for all circumstances. The most possible way to start improving MSWM service provision can be done by launching small-scale pilot projects, which are required for further analyses in terms of economies of scale, operating performance, and system efficiency. In the same way, there is no perfect policy that is suitable for all areas. The trial-and-error implementation will allow each community adjusts the policies, implementation processes, and roles of stakeholders to suit with local norm, befit with residents, and harmonize with community characteristics. In other words, it is to see how the methods and techniques are when they come into actions and to see what to improve.

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Appendices

This chapter provides sets of questionnaire survey that were used in different studies in this dissertation. There are four sets of questionnaire in total. The first set of questionnaire, 'Appendix A: Questionnaire Set 1' was applied to a number of studies, including Studies A1, A3, A4, B1, C1, and C3. This set of questionnaire was used to obtain MSWM data in various perspectives, such as attitudes of respondents towards current Bangkok MSWM service provision and waste minimization, technological challenges, essential types of needed knowledge for MSWM system, and strategic management options.

The second set of questionnaire, 'Appendix B: Questionnaire Set 2', was used to obtain primary data to validate and verify that the respondents' attitudes on current MSWM system. The obtained data were substantially used in Study A2, which principally focused on the attitudes on waste minimization and recycling, possibility of implementing incentive recycling program, and the possible amount of collected recyclable waste.

The third set of questionnaire, 'Appendix C: Questionnaire Set 3', relates to essential policies and practices that should be applied in the Bangkok MSWM service provision, especially on the perspective of providing collaborative and inclusive partnership MSWM service, which details are explained in Studies B1 and B2. The data obtained from this set of questionnaire was also analyzed for Study C2, as the aim was to identify the co-created values in MSWM system when the combination of important service and KM concepts are adopted to enhance the effectiveness of MSWM system.

The last set of questionnaire, 'Appendix D: Questionnaire Set 4', was launched to waste pickers, who have potential to be the waste collection staff in the CBOs. The results explained in Studies B1, B2 and C2, are the analyses of possibility and concern of the implementation of

collaboration of stakeholders at a community level, which is CBOs. In addition, possible values that are co-created through the involvement of all relating parties are identified and explained.

Appendix A: Questionnaire Set 1

Influential Factors for Bangkok Municipal Solid Waste Management

Part 1: General information of respondents

1. Sex

   ☐ Male ☐ Female

2. Age

   ☐ 16 – 20 years old ☐ 21 – 25 years old ☐ 26 – 30 years old

   ☐ 31 – 35 years old ☐ 36 – 40 years old ☐ 41 – 45 years old

   ☐ 46 – 50 years old ☐ 51 – 60 years old ☐ > 60 years old

3. Education

   ☐ Primary school ☐ Secondary school ☐ High school

   ☐ Vocational school ☐ Bachelor's degree ☐ Master's degree

   ☐ Doctoral degree

4. Occupation

   ☐ Student ☐ Business owner ☐ Company officer

   ☐ Housewife ☐ Government officer/state enterprise

   ☐ Retired ☐ Unemployed ☐ Freelance

   ☐ Others (please specify)_____

5. Monthly income

   ☐ < 5,000 baht ☐ 5,001 – 10,000 baht ☐ 10,001 – 20,000 baht

   ☐ 20,001 – 30,000 baht ☐ 30,001 – 50,000 baht ☐ > 50,000 baht

6. How many people live in your house? _____ persons

   Member(s) whose age less than 16 years old: _____ persons

Part 2: Municipal Solid Waste (MSW) sorting and disposal behavior of respondents

7. Do you sort waste into different types before disposing?

☐ Yes, ☐ No *(go to question 10)*

8. How often do you sort waste before disposing?

☐ Every time ☐ Once a week ☐ Twice a week

☐ Three times a week ☐ Four times a week ☐ Five times a week

☐ Others (please specify)_____

9. What types of waste that you sort before disposing? *(more than 1 answer is possible)*

☐ Paper ☐ Plastic ☐ Food waste

☐ Glass ☐ Metal ☐ Beverage/food cans

☐ Mixed waste ☐ Toxic waste (light bulbs, batteries, used oil)

10. How do you dispose of waste at home?

☐ Put garbage bags in front of the house, to be collected

☐ Put garbage bags at a community dumpster, to be collected

☐ Burn

☐ Others (please specify)_____

11. How often do you dispose of waste per week?

☐ Everyday ☐ Twice a week ☐ Three times a week

☐ Four times a week ☐ Five times a week

☐ Others (please specify)_____

12. How much waste is generated each time of disposal?

Approximate volume: 1 kg. is equal to the weight of two 500 ml. bottles of water.

☐ < 1 kilogram ☐ 1 – 3 kilogram ☐ 3 – 5 kilogram

☐ 5 – 10 kilogram ☐ > 10 kilogram

☐ Others (please specify)_____

13. Do you have to pay for waste collection service?

☐ Yes, _____ baht ☐ No

Part 3: Municipal Solid Waste (MSW) situation and attitudes of respondents

14. How is current performance of provided MSWM service?

☐ Very good ☐ Good ☐ Okay ☐ Bad ☐ Very bad

15. What problems do you usually experience with MSWM service? *(more than 1 answer is possible)*

☐ Waste is not collected on time ☐ Waste is left over

☐ Falling waste during transportation ☐ Bad smell from leachate

☐ No waste collection service in your area ☐ No problems

16. How or what MSWM service should be provided to have a sustainable MSWM system?

(1 = least important, 5 = most important)	**1**	**2**	**3**	**4**	**5**
- Qualified staff					
- Effective trucks and equipment					
- Use of effective technology in MSWM service					
- Strong enforcement on waste collection service					
- Strong enforcement on waste transport service					
- Strong enforcement on waste treatment standard control					
- Practical policy used in all area of the City					
- Stringent regulations on ways of disposing					
- Stringent regulations on waste sorting					
- Strong enforcement on waste collection payment					
- Others _____					

17. Do you agree with the following sentences or not?

(1 = absolutely disagree, 5 = absolutely agree)	**1**	**2**	**3**	**4**	**5**
- Waste is a great source of environmental impacts					
- Waste is a great source of social impacts					
- Waste is a great source of economic impacts					
- Waste generation should be minimized					
- Waste should be managed in a more effective and efficient way					
- Waste can be a great source of energy					
- Waste management should be done in an effective way					
- Others _____					

Part 4: Technological challenges and attitudes of respondents

18. Is technology applied to MSWM?

☐ Yes ☐ No (Go to question 21)

19. At what level is technology applied to MSWM?

☐Very high ☐ High ☐ Moderate ☐ Low ☐ Very low

20. What technologies are being used in MSWM system?

(Please answer for every sector, more than 1 answer is possible for each factor)

Collection	**Transportation**	**Treatment**
☐ GPS/routing	☐ GPS/routing	☐ Recycle
☐ Material sorting	☐ RFID	☐ Composting
☐ Rear loading truck	☐ Energy efficiency	☐ Open burning
☐ Semi-automated truck	☐ Others:_____	☐ Landfill
☐ Automated		☐ Incineration
☐ Bin: RFID tag		☐ Gasification
☐ Bin: built in compactor		☐ Waste to energy
☐ Others:_____		☐ Energy efficiency
		☐ Others:_____

21. Do you agree to the following sentences or not?

(1 = absolutely disagree, 5 = absolutely agree)	**1**	**2**	**3**	**4**	**5**
If technology is applied with management of MSW processes and service, the City would					
- save cost for waste collection					
- save cost for waste transportation					
- save cost for waste treatment and disposal					
- be less left over waste related problems					
- be less concerns on smell/falling waste/ rodents caused by waste					
- require less staff					
- have less economic waste related problems					
- have less social waste related problems					
- have less environmental waste related problems					
- implement MSWM more efficiently					
- have a sustainable MSWM					
- not give any change to the MSWM					
- Others _____					

Part 5: Collaboration and attitudes of respondents on MSWM

22. For an effective sustainable MSWM, who should be responsible for managing waste?

☐ Everyone ☐ Residents ☐ Governments ☐ NGOs ☐ Private companies

23. Do you think waste management system should be improved?

☐ Yes ☐ No

24. Do you think collaboration among communities, NGOs, and government for sustainable MSWM is important?

☐ Yes ☐ No

25. If there is a reorganization of MSWM from current system to a new sustainable collaborative system, would you like to join?

☐ Yes ☐ No *(go to question 27)*

26. What roles each party should do or be involved in MSWM system based on your knowledge?

(Please answer for every sector, more than 1 answer is possible for each factor)

Residents/Communities	**NGOs**	**Government**
☐ Minimize waste	☐ Promote sustainable MSWM	☐ Provide effective and efficient MSWM service
☐ Sort waste	☐ Be an intermediary between communities and government	☐ Use advancement of technology to improve MSWM performance
☐ Dispose waste correctly	☐ Check effectiveness of MSW system	☐ Traceable management process
☐ Work with Government to promote sustainable MSWM	☐ Others:_____	☐ Service oriented MSWM system
☐ Pay waste collection fee		☐ Others:_____
☐ Others:_____		

27. Do you agree to the following sentences or not?

(1 = absolutely disagree, 5 = absolutely agree)	**1**	**2**	**3**	**4**	**5**
If there is an integration of waste management collaboration and use of technological advancement, MSWM would					
- be able to solve MSW related problems in long-term					
- be a sustainable waste management system					
- be able to apply in other cities					
- benefit the society, economy, and the environment					
- Others _____					

Part 6: Needed knowledge and attitudes of respondents for sustainable management system

28. What MSWM knowledge should be provide to have a sustainable waste management system?

(1 = least important, 5 = most important)	**1**	**2**	**3**	**4**	**5**
- Waste sorting					
- Types of waste					
- Waste minimization					
- 3Rs (Reduce, Reuse, Recycle)					
- Education in schools					
- Laws and enforcement					
- Public involvement					
- Training or demonstration of waste management					
- Consistent support and promotion					
- Basic waste management in household					
- Risks and impacts of MSW					
- Service mindset of staff					
- Mindset of waste and the environment of residents					
- Others					

29. How should waste management system be when applying knowledge management concept? *(Please put a number according to what waste management process that will be impacted, 1=Generation, 2=Storage, 3=Collection, 4=Transfer, 5=Processing, 6=Disposal)*

☐ Less waste generation

☐ Less raw material consumption

☐ Less concerns on odor

☐ Less concerns on uncollected waste

☐ Less concerns on leftover waste

☐ Less concerns on falling waste

☐ Less social, economic, and environmental concerns and impacts to the society

☐ Less environmental concerns (soil, water, air)

☐ Less health risks and impacts to staff and residents

☐ Less risks to staff who expose directly to waste

☐Save collecting cost and time

☐ Risks to frontline staff or workers are minimized

☐ Better waste management

☐More recyclable waste to be used as raw materials

☐Transportation cost and time reduction

☐Effective waste collection service

☐ Effective waste transfer service

☐Effective waste processing

☐Effective waste disposal

☐Optimal utilization of machines and trucks

☐Waste is correctly managed and meets management standards

☐Others _____

Appendix B: Questionnaire Set 2

Waste Sorting and Interest in Participation in Incentive Based Recycling Program

Part 1: General information of respondents

1. Sex

☐ Male ☐ Female

2. Age

☐ 16 -18 years old ☐ 19 - 25 years old ☐ 26 - 30 years old

☐ 31 - 35 years old ☐ 36 - 40 years old ☐ 41 - 45 years old

☐ 46 - 50 years old ☐ 51 - 55 years old ☐ 56 - 60 years old

☐ > 60 years old

3. Education

☐ Primary School ☐ Secondary School ☐ High School

☐ Vocational School ☐ Bachelor's degree ☐ Master's degree

☐ Doctoral degree

4. Occupation

☐ Student ☐ Business owner ☐ Government officer/State enterprise

☐ Company officer ☐ Work for money ☐ Housewife

☐ Retired ☐ Unemployed

☐ Others (Please specify) _____

5. Monthly income

☐ < 5,000 baht ☐ 5,001 - 10,000 baht ☐ 10,001 -20,000 baht

☐ 20,001 – 30,000 baht ☐ 30,001 – 50,000 baht ☐ > 50,000 baht

6. How many people live in your house? _____ persons,

Member(s) whose age less than 16 years old _____ persons

Part 2: Waste sorting and waste recycling programs

7. How do you dispose of waste at home?

☐ Put garbage bags in front of the house, to be collected

☐ Put garbage bags at a community dumpster, to be collected

☐ Burn

☐ Throw into a river/a canal/roadside

☐ Others (Please specify) _____

8. How often do you dispose of waste per week?

☐ Everyday ☐ Twice a week ☐ Three times a week

☐ Four times a week ☐ Five times a week ☐ Others (Please specify) _____

9. How much waste is generated each time of disposal? **Approximate volume**

☐ < 1 kilogram ☐ 1 - 3 kilogram ☐ 3 - 5 kilogram

☐ 5 - 10 kilogram ☐ > 10 kilogram ☐ Others (Please specify) _____

10. For each time that you dispose of waste, how much recyclable waste is generated?

Approximate volume _____ percent

11. From the amount of recyclable waste generated in question 10, please put an **approximate volume** of each type of recyclable waste in the table below

Please put an approximate amount of each type recyclable waste	**%**
- Paper	
- Plastic	
- Glass	
- Metal	
- Beverage/food can	
- Others _____	
	100

12. Do you have to pay for waste collection?

☐ Yes, _____ baht per month ☐ No

13. Do you sort recyclable waste before disposal or not?

☐ Yes ☐ No *(go to question 15)*

14. How do you do with sorted recyclable waste?

☐ Put garbage bags in front of the house, to be collected

☐ Put garbage bags at a community dumpster, to be collected

☐ Keep the waste to sell to waste buyers

☐ Others (Please specify) _____

15. Do you know any waste recycling programs?

☐ Yes ☐ No *(go to part 3)*

16. Have you ever participated any waste recycling programs?

☐ Yes ☐ No *(go to part 3)*

17. Have you ever received any incentives from participating in the recycling program?

☐ Yes ☐ No *(go to part 3)*

18. What are the incentives that you received from participating in the recycling program? (More than 1 answer is possible)

☐ Cash ☐ Points ☐ Vouchers

☐ Discount coupons ☐ Tax deduction ☐ Goods

☐ Others (Please specify) _____

<u>Part 3: Interest in participating in the incentive based recycling program</u>

19. Do you know any incentive based recycling program or not?

☐ Yes ☐ No *(go to question 21)*

20. How do you know the program? (More than 1 answer is possible)

☐ Television ☐ Radio ☐ Newspaper

☐ Magazine ☐ Internet ☐ Leaflet

☐ Poster ☐ Exhibition/Conference ☐ Training

☐Others (Please specify) _____

21. If there is an incentive based recycling program, would you like to participate?

☐ Yes ☐ No

22. If there is an incentive based recycling program, which incentives you think the program should reward? (More than 1 answer is possible)

☐ Cash ☐ Goods ☐ Points ☐ Vouchers

☐ Discount coupons ☐ Tax deduction ☐ Others (Please specify) _____

23. If there is an incentive based recycling program, which businesses/organizations you think the program should partner with? (More than 1 answer is possible)

☐ Convenient stores ☐ Supermarkets ☐ Department stores

☐ Charity organizations ☐ Others (Please specify) _____

24. If there is an incentive based recycling program, how much extra would you like to pay on your monthly waste collection bill?

☐ 20 baht ☐ 40 baht ☐ Not willing to pay extra

☐ Others (Please specify) _____

25. For each factor, how does it make you interest or not interest in the program?

(1-Most important, 5-Least important)	**Importance**				
	1	**2**	**3**	**4**	**5**
- Sorting waste is complicated					
- Do not have time to sort waste					
- Do not have bins for each type of recyclable waste					
- Concern about reliability of the program					
- Concern about worthiness of incentives					
- Others (Please specify) _____					

26. Do you agree with the following sentences or not? **BRP = Bangkok Recycling Program*

(1-Completely agree, 5-Absolutely disagree)	**Agreeableness**				
	1	**2**	**3**	**4**	**5**
- Members of the BRP will get benefits from joining the program					
- The BRP can increase the efficiency of waste management system					
- The BRP can alleviate waste management problems in long-term					
- The BRP can be implemented in other communities/cities in Thailand					
- Others (Please specify) _____					

Appendix C: Questionnaire Set 3

A Service Policy Framework for Solid Waste Management

Part 1: General information

1.Gender

☐ Male ☐ Female

2.Age

☐ 16 – 20 years old ☐ 21 – 25 years old ☐ 26 – 30 years old

☐31 – 35 years old ☐ 36 – 40 years old ☐ 46 – 45 years old

☐ 46 – 50 years old ☐ 51 – 60 years old ☐ more than 60 years old

3.Education

☐ None ☐ Primary school ☐ Secondary school

☐ High school ☐ Bachelor's degree ☐ Master's degree

☐ Doctoral degree

4.Occupation

☐ Student ☐ Company officer ☐ Government/state enterprise officer

☐ Freelance ☐ Housewife ☐ Retired

☐ Unemployed ☐ NGO/NPO officer

☐ Business owner – please specify _____

☐ Others (please specify) _____

5.Monthly income

☐ < 5,000 Baht ☐ 5,000 – 10,000 Baht ☐ 10,001 – 20,000 Baht

☐ 20,001 – 30,000 Baht ☐ 30,001 – 50,000 Baht ☐ > 50,000 Baht

6.How many people do they live in your house? _____ persons

Part 2: Municipal solid waste management (MSWM) policy

7.Who should be responsible for MSWM policy setting? (*more than one answer is possible*)

☐ Everyone ☐ Mainly residents ☐ Mainly governments

☐ Mainly NGOs/NPOs ☐ Mainly private companies

8.For each perspective, how essential factors for having effective MSWM policy? (*more than one answer is possible*)

Points of concern	**1= least needed, 5 = most needed**				
	1	2	3	4	5
Social perspective					
- MSWM knowledge dissemination	☐	☐	☐	☐	☐
- Collaboration among related stakeholders	☐	☐	☐	☐	☐
- Public hearing	☐	☐	☐	☐	☐
- Risk/benefit sharing	☐	☐	☐	☐	☐
- Awareness raising	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Technological perspective					
- Appropriate use of suitable technology for each process	☐	☐	☐	☐	☐
- Periodical maintenance and performance monitoring	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Economic/financial perspective					
- Full cost/revenue analysis	☐	☐	☐	☐	☐
- Transparency on investment and operation	☐	☐	☐	☐	☐
- Conflict of interest monitoring	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Legal/institutional perspective					
- Strong enforcement on waste collection and transportation	☐	☐	☐	☐	☐
- Strong enforcement on treatment standard control	☐	☐	☐	☐	☐
- Stringent regulations on ways of disposing waste at source	☐	☐	☐	☐	☐
- Strong enforcement on waste collection fee payment	☐	☐	☐	☐	☐
- Updating outdated laws	☐	☐	☐	☐	☐

- Others_____	☐	☐	☐	☐	☐
Environmental perspective					
- Monitoring system for each process of waste management	☐	☐	☐	☐	☐
- Mitigating system for improving polluted environment	☐	☐	☐	☐	☐
- Ensuring that all management meet standards	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Managerial/administrative perspective					
- Clear roles and responsibility	☐	☐	☐	☐	☐
- Qualified and trained officer/staff for each level	☐	☐	☐	☐	☐
- Ensuring of no overlapping work	☐	☐	☐	☐	☐
- Transparency in all process	☐	☐	☐	☐	☐
- Periodical meetings and management performance report	☐	☐	☐	☐	☐
- Periodical evaluation for improvement	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Political perspective					
- Clear role in MSWM system	☐	☐	☐	☐	☐
- Involvement for improving MSWM system	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
Other perspectives					
- Others_____	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐

9.Do you know any MSWM related policies?

☐ Yes ☐ No (*go to question no. 11*)

10. What are the MSWM related policies you know? Do you think they are effectively implemented? (*Please answer on the effectiveness part, only for the policies that you know*)

Policy	***Effectiveness***	
☐ Promoting waste minimization	☐ Yes	☐ No
☐ Promoting 3Rs	☐ Yes	☐ No
☐ Promoting source separation	☐ Yes	☐ No
☐ Composting	☐ Yes	☐ No
☐ Collecting payment for collection service	☐ Yes	☐ No
☐ Collecting fined on illegal disposal	☐ Yes	☐ No
☐ Scheduling waste collection date and time	☐ Yes	☐ No
☐ Increasing waste collection frequency	☐ Yes	☐ No
☐ Increasing waste collection coverage area	☐ Yes	☐ No
☐ Providing environmentally friendly management service	☐ Yes	☐ No
☐ Adapting appropriate technology for each management process	☐ Yes	☐ No
☐ Collaborating private sector to participate in waste management	☐ Yes	☐ No
☐ Encouraging individuals to participate in waste management	☐ Yes	☐ No
☐ Collaborating with NGOs/NPOs in waste management	☐ Yes	☐ No
☐ Using clean technology in management process	☐ Yes	☐ No
☐ Establishing MSWM network at community level	☐ Yes	☐ No
☐ Promoting community based waste management	☐ Yes	☐ No
☐ Exempting collection for participated community	☐ Yes	☐ No
☐ Providing ‘Street Furniture’ bins	☐ Yes	☐ No
☐ Applying waste to energy plant generating renewable energy	☐ Yes	☐ No
☐ Building incinerators for generating electricity	☐ Yes	☐ No
☐ Building grease treatment for fuel generation	☐ Yes	☐ No
☐ Building infectious waste incinerator	☐ Yes	☐ No
☐ Building compost plant	☐ Yes	☐ No
☐ Providing MSWM knowledge through education	☐ Yes	☐ No
☐ Investment on research and development on MSWM	☐ Yes	☐ No
☐ Having public relation campaigns encouraging MSWM	☐ Yes	☐ No
☐ Establishing waste recycle stations	☐ Yes	☐ No

☐ Establishing incentive based campaigns ☐ Yes ☐ No

☐ Collaboration with private sector ☐ Yes ☐ No

☐ Others (please specify) _____ ☐ Yes ☐ No

11. Do you think knowing what and how MSWM policy is important for city development?

☐ Yes ☐ No (*go to question no. 14*)

12. What are the most effective means of dissemination MSWM policy to the public? (more *than one answer is possible*)

☐ Public hearing ☐ Community meeting ☐ Postal mail

☐ Television ☐ Radio ☐ City's website

☐ Newspaper ☐ Leaflet ☐ Others (please specify) _____

13. Please rate the importance of issues that should be put in MSWM master plan?

Policies	**1= least important, 5 = most important**				
	1	2	3	4	5
- Waste minimization	☐	☐	☐	☐	☐
- Waste separation	☐	☐	☐	☐	☐
- Collection efficiency	☐	☐	☐	☐	☐
- Full stakeholder collaboration	☐	☐	☐	☐	☐
- Reutilization of managed/treated waste	☐	☐	☐	☐	☐
- Working performance of MSWM service provider	☐	☐	☐	☐	☐
- Awareness raising on MSWM	☐	☐	☐	☐	☐
- MSWM knowledge dissemination at household/community level	☐	☐	☐	☐	☐
- Transparency in MSWM process	☐	☐	☐	☐	☐
- MSWM performance report to the public	☐	☐	☐	☐	☐
- Practical enforcement on MSWM	☐	☐	☐	☐	☐
- Updated laws/regulations	☐	☐	☐	☐	☐
- Renewable energy/electricity generation from waste	☐	☐	☐	☐	☐
- Appropriate use of technologies/equipment/tools	☐	☐	☐	☐	☐
- Suitable infrastructure	☐	☐	☐	☐	☐

- Utilization of resources	☐	☐	☐	☐	☐
- Clear roles and responsibilities of all sectors	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐

Part 3: Participation in MSWM policy setting

14. If you can involve in MSWM setting, would you like to participate?

☐ Yes ☐ No (*go to question no. 16*)

15. How do you want to get involved in the MSWM policy setting? (*more than one answer is possible*)

☐ Postal mail ☐ Community meeting ☐ Public hearing

☐ City website ☐ Others (please specify) _____

16. Do you think full stakeholder involvement in MSWM policy setting would increase effectiveness of MSWM service provision in long-term?

☐ Yes, but not significant ☐ Yes, moderate significant

☐ Yes, at significant level ☐ No, same result

17. Please rate the importance of concerns on full stakeholder participation in MSWM policy setting?

Points of Concern	**1= least important, 5 = most important**				
	1	2	3	4	5
- Lack of MSWM knowledge	☐	☐	☐	☐	☐
- Cannot access to learn current MSWM policies	☐	☐	☐	☐	☐
- Reliability of full stakeholder participation	☐	☐	☐	☐	☐
- Worthiness of participating in policy setting	☐	☐	☐	☐	☐
- Possibility of implementing the new policy	☐	☐	☐	☐	☐
- Conflict of interests among stakeholders	☐	☐	☐	☐	☐
- Others (please specify) _____	☐	☐	☐	☐	☐

18. Do you agree to the following sentences?

If there is a full stakeholder participation in MSWM policy setting, MSW service provision would:					
1 = absolutely disagree, 5 = absolutely agree	1	2	3	4	5
- improve in terms of performance	☐	☐	☐	☐	☐
- lessen managerial impacts	☐	☐	☐	☐	☐
- lessen social impacts caused by MSW (health, untidy atmosphere)	☐	☐	☐	☐	☐
- lessen economic impacts caused by MSW (expense)	☐	☐	☐	☐	☐
- lessen environmental impacts caused by MSW	☐	☐	☐	☐	☐
- revitalize the community to be more livable	☐	☐	☐	☐	☐
- increase public awareness on MSWM	☐	☐	☐	☐	☐
- be able to solve MSW problems in long-term	☐	☐	☐	☐	☐
- be able to implement anywhere	☐	☐	☐	☐	☐
- benefit the society as a whole	☐	☐	☐	☐	☐
- lead the city towards sustainable MSWM system	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐

Appendix D: Questionnaire Set 4

Inclusive Community Based Organization – Insights from Solid Waste Management Service Provision

Part 1: General information of respondents

1. Gender

   ☐ Male ☐ Female

2. Age

   ☐ 16 – 20 years old ☐ 21 – 25 years old ☐ 26 – 30 years old

   ☐ 31 – 35 years old ☐ 36 – 40 years old ☐ 46 – 45 years old

   ☐ 46 – 50 years old ☐ 51 – 60 years old ☐ more than 60 years old

3. Education

   ☐ None ☐ Primary school ☐ Secondary school

   ☐ High school ☐ Bachelor's degree ☐ Others (please specify) _____

4. Occupation

   ☐ Waste collection only (*go to question no. 6*)

   ☐ Waste collection and other jobs – please specify what kind of job _____

5. Daily income

   ☐ Less than 100 Baht ☐ 101 - 200 Baht ☐ 201 - 300 Baht

   ☐ 401 - 500 Baht ☐ 501 - 600 Baht ☐ 601 - 700 Baht

   ☐ 701 - 800 Baht ☐ 801 - 900 Baht ☐ 901 – 1,000 Baht

   ☐ More than 1,000 Baht – please specify approximate amount _____ Baht

6. Are you the main source of household income?

   ☐ Yes ☐ No

7. How many people do they live in your house? _____ persons

   Do any member (s) have age less than 16 years old? _____ persons

Part 2: Municipal solid waste (MSW) collection

8. How often do you collect waste per week?

☐ Everyday ☐ Once a week ☐ Twice a week

☐ Thrice a week ☐ 4 times a week ☐ 5 times a week

☐ Others (please specify) _____

9. What means of transportation do you use to collect waste?

☐ Walk ☐ Bicycle ☐ Tricycle

☐ Motorcycle ☐ Motor-tricycle ☐ Pickup truck

☐ 6-wheel truck ☐ Others (please specify) _____

10. How much time do you spend on collecting waste per time?

☐ Less than 6 hours ☐ 6 – 8 hours ☐ 8 – 10 hours

☐ 10 – 12 hours ☐ More than 12 hours

11. Do you have or use any self-protection kit during collecting waste?

☐ None ☐ Gloves ☐ Long sleeve shirt

☐ Safety shoes ☐ Safety face mask ☐ Safety hat

☐ Others (please specify) _____

12. In which area do you conduct waste collection?

☐ Within community ☐ Within and nearby community

☐ Within 5 km distance ☐ Within 10 km distance

☐ Within 15 km distance ☐ Within 20 km distance

☐ More than 20 km distance – please specify _____ km

13. Where do you conduct waste collection?

☐ In front of household ☐ Public waste bin ☐ Along the road

☐ Waste transfer station ☐ Others (please specify) _____

14. What types of waste do you collect? (*Please check on types of collected waste. More than one answer on each type is possible*)

Paper

☐ Black and white
☐ Mixed
☐ Carton
☐ Newspaper
☐ Book
☐ Others _____

Plastic

☐ PET bottle
☐ Plastic bag
☐ Mixed
☐ PVC
☐ Others _____

Ferrous and non-ferrous

☐ Steel
☐ Aluminum
☐ Brass
☐ Copper
☐ Aluminum can
☐ Tin can
☐ Others _____

Others

☐ Electric wire and cable
☐ CD
☐ Battery
☐ Sponge
☐ Others (please specify) _____
☐ Cooking oil
☐ Tire
☐ Cotton
☐ WEEE (please specify) _____

15. How much waste is collected for each time of collection? (Approximate volume)

	Weight in kilogram											
Types	1 – 3	3 – 5	5 – 10	10 – 20	20 – 30	40 – 50	50 – 60	60 – 70	70 – 80	80 – 90	90 – 100	> 100
Paper	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Plastic	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ferrous	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Non-ferrous	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

16. Where do you sell collected waste?

☐ Sell to the nearest recyclable shops in your community (regardless of lower price)

☐ Sell to small recyclable shops in your community (farther but give higher buying price)

☐ Sell to medium to large recyclable shops (regardless of distance but higher price)

☐ Others (please specify) _____

17. Do you have or use any self-protection kit during collecting waste?

(*More than one answer is possible*)

☐ None ☐ Gloves ☐ Long sleeve shirt

☐ Safety shoes ☐ Safety face mask ☐ Safety hat

☐ Others (please specify) _____

18. How many waste collectors are there in your community?

☐ < 10 persons ☐ 10 – 30 persons ☐ 31 – 40 persons

☐ 41 – 50 persons ☐ 51– 60 persons ☐ 61 – 70 persons

☐ 71 – 80 persons ☐ 81– 90 persons ☐ 91 – 100 persons

☐ > 100 persons - please specify _____ persons

Part 3: Situation of MSW collection service provision

19. Do you agree with the following sentences or not?

Points of concern	**1= least needed, 5 = most needed**				
	1	2	3	4	5
Waste causes social impacts.	☐	☐	☐	☐	☐
Waste causes economic impacts.	☐	☐	☐	☐	☐
Waste causes environmental impacts.	☐	☐	☐	☐	☐
Waste generation should be minimized.	☐	☐	☐	☐	☐
Source separation is important for waste management.	☐	☐	☐	☐	☐
Waste has economic value.	☐	☐	☐	☐	☐
Waste should be effectively managed in a practical, economical, and environmentally friendly way	☐	☐	☐	☐	☐
Practical and enforceable waste management policy/law should be in place.	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐

20. How is current performance of waste collection service?

Points of concern	**1= very bad, 5 = very good**				
	1	2	3	4	5
Example: waste is collected on time everyday	☐	☐	☐	☐	☑
- On time waste collection	☐	☐	☐	☐	☐
- Left over waste	☐	☐	☐	☐	☐
- Falling waste during transportation	☐	☐	☐	☐	☐
- Bad smell from leachate	☐	☐	☐	☐	☐
- Available of waste collection service	☐	☐	☐	☐	☐
- Overall performance of collection service	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐

21. What factors are essential for effectiveness of waste collection?

Points of concern	**1= least needed, 5 = most needed**				
	1	2	3	4	5
- Qualified staff	☐	☐	☐	☐	☐
- Effective trucks and equipment	☐	☐	☐	☐	☐
- Use of appropriate technology	☐	☐	☐	☐	☐
- Strong enforcement on waste collection service	☐	☐	☐	☐	☐
- Practical policy	☐	☐	☐	☐	☐
- Stringent enforcement on waste separation (residents)	☐	☐	☐	☐	☐
- Stringent enforcement on waste disposal (residents)	☐	☐	☐	☐	☐
- Stringent enforcement on waste collection fee payment (residents)	☐	☐	☐	☐	☐
- Others_____	☐	☐	☐	☐	☐

Part 4: Situation of MSW collection situation, challenges, and opportunities for inclusive participation

22. What factors are essential for your waste collection in current situation?
(*More than one answer is possible*)

☐ Amount of waste generated ☐ Recyclable buying price
☐ Competition in collecting waste ☐ Disposed waste are mixed
☐ Health concern ☐ Collected waste by municipality staff
☐ Competition in collecting waste ☐ Disposed waste are mixed
☐ Number of waste collectors in the same community
☐ Stringent enforcement on waste collection fee payment (residents)

23. Do you collect work on individual or community level?

☐ Individual level (*go to question no. 26*) ☐ Community level

24. Are you satisfied with the current performance of community based waste collection?

☐ Yes ☐ No

25. What activities are there in the community based waste collection?

☐ Periodical meeting/discussion to share problems or experiences
☐ Accumulating waste and sharing benefits
☐ Raising community fund
☐ Creating incentive based projects (*ex. exchange of waste for money or goods*)
☐ Working with NPO for better management
☐ Working with municipalities (ex. source separation)
☐ Periodical meeting/discussion to share problems or experiences
☐ Working together to improve the collection
☐ Others (please specify) _____

Part 5: Inclusive participation on waste management

26. For effective waste management, who should be responsible for managing waste?

☐ Everyone ☐ Residents ☐ Governments ☐ NPOs ☐ Private companies

27. Do you think that collaboration among residents, communities, NPOs, companies, and governments is important?

☐ Yes ☐ No

28. If there is community based organization (CBO) giving you a formal role in waste management system, would you like to join?

☐ Yes ☐ No

29. What are factors that you expect to get from joining the CBO?

☐ Specified clear role and responsibility in community waste management

☐ Reliable and practical management process that correlate with municipality's policy

☐ Suitable and applicable knowledge and know how on waste management

☐ No overlapped work with other stakeholders

☐ Transparent process and policy

☐ Recyclable waste buying center that is reliable in terms of buying price

☐ Being empowered to manage and control the system with supports of the municipality

☐ Chances for training or having site visits to the successful CBOs

☐ Chances of getting rewards or promotion in waste management chain

☐ Others (please specify) _____

30. What should be the roles and responsibilities of being a member of CBO?

☐ Being community waste management center

☐ Sharing MSW knowledge to residents

☐ Raising awareness on waste management

☐ Promoting waste separation at source

☐ Composting organic waste

☐ Being a recyclable waste collection center for the community

☐ Working with the municipality to improve waste management system (collection process)

☐ Monitoring effectiveness of the system

☐ Selling collected recyclable/compost to the municipality

☐ Being able to manage and control waste management in the community

☐ Working with other communities (strengthening CBOs network)

☐ Having periodical meeting/discussion with the municipality and related stakeholders

☐ Sharing and updating waste management performance to the public

☐ Others (please specify) _____

31. Do you agree to the following sentences?

If there is a community based organization responsible for MSW, waste management service would be:					
1 = absolutely disagree, 5 = absolutely agree	1	2	3	4	5
- improved in terms of performance	☐	☐	☐	☐	☐
- lessened problems of informal waste collector	☐	☐	☐	☐	☐
- lessened social impacts caused by MSW (health, untidy atmosphere)	☐	☐	☐	☐	☐
- lessened economic impacts caused by MSW	☐	☐	☐	☐	☐
- lessened environmental impacts caused by MSW	☐	☐	☐	☐	☐
- revitalized the community to be more livable	☐	☐	☐	☐	☐
- given opportunities for waste collector to legally work	☐	☐	☐	☐	☐
- able to solve MSW problems in long-term	☐	☐	☐	☐	☐
- able to implement anywhere	☐	☐	☐	☐	☐
- benefit the society as a whole	☐	☐	☐	☐	☐
- be a tool for having inclusive community towards sustainable city	☐	☐	☐	☐	☐
Others_____	☐	☐	☐	☐	☐