ASSESSMENT OF MUNICIPAL SOLID WASTE MANAGEMENT CAPACITY OF LOCAL GOVERNMENT AUTHORITIES AND CONTRACTED WASTE COLLECTION SERVICE: A CASE STUDY OF PHNOM PENH CAPITAL, CAMBODIA

地方自治体の都市ごみ管理能力と委託収集サービスのアセスメント：カンボジア・首都プノンペンのケーススタディ

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Abstract

Private sector participation in municipal services has witnessed increased interest in recent years primarily to reform the weak performance of public sector, reduce cost, improve efficiency, and ensure environmental protection. The public sectors including government bodies should be involved in policy making, introducing local legal instruments and supporting the public interests. In Phnom Penh Capital, CINTIRI Waste Collection Company (a single private company) Phnom Penh City Hall (PPCH) has been contracted by Phnom Penh City Hall since 2002 for providing the waste collection service (supply-side) to the whole Phnom Penh city. The provision of service provider is not efficiently performed according to terms and specifications in the contractual agreement while the regulation provision is not enforced by PPCH as required.

This study describes and assesses the factors determining the performance of local government authorities and contracted waste collection service and also identifies sets of possible improving measures for sustainable solid waste management in Phnom Penh city. The results of Focus Group Discussions (FGDs), both all districts of Phnom Penh and related organizations at national and sub-national levels, and interview of key informants are analyzed by qualitative and quantitative methods. The study is using sustainability assessment by success and efficiency factors methods which have been developed by Zurbrugg et al., (2014) for supporting solid waste management in Developing countries. In addition, the six performance indicators were used to evaluate the LGA management and private operator performance including technical, environmental, institutional and organizational, financial and economic, social and cultural, and policy and legal aspects.

The results of this study are important to pertain and deal with the performance of supply side—from CINTRI and LGAs. Waste collection in Phnom Penh city has been an authority of several different contractors since 1994 due to financial difficulties. The main challenges for municipal waste management revealed as institutional capacity of LGAs, operational and service quality of CINTRI. The service provider and PPCH have not expended sufficient effort to improve the situation and the quality of service. Lack of clear operational framework for this long-term contract, CINTRI rendered the difficulties to

widen the service coverage and ensuring the involvement from stakeholders, despite the MSWM decentralization to the LGAs. In addition, the operation systems depend on the service quality and reliability based on technology inputs. The low quality and low service level are caused by a lack of performance control and capability to enforce regulation. It was derived from lack of monitoring and evaluation of the PPP process. Unclear delineation of responsibilities and obligations among relevant organizations often result in poor management. The lack of cooperation and coordination between LGAs, PPCH and service provider lead to low willingness to participate or manage in waste service. It is suggested that revisiting the legal framework, establishing facilitating agency for designing and nurturing partnerships, competitive tendering; transparency and financial accountability are essential elements for PPP on provision of waste services in Phnom Penh capital. From the socio-cultural perspective, it can be seen that the public perception on PPP is important for explaining reliability of services.

Overall, the evidence thus suggests measures and actions for improving the waste services. Firstly, the service provider should provide and expand the collection service to un-serviced areas through enhancing PPP and social acceptability. Providing platform for stakeholder participation could prevent public interest and economic interest. Strengthening collection capacity will increase service level, quality of service, reliability and productivity. Secondly, establishing proper monitoring, controlling procedures and enforcing waste management regulation (e. sub-decree no.113 on MSWM) are needed to reduce the illegal dumping. Thirdly, modernizing fee collection system is soundly financial viability. Lastly, requirements of management services, quality assessment, and priorities for cooperation between the contractor and the LGAs should be studied, so that the options for collection system are based on sound data. For long-term run, LGA needs to be self-sustaining waste management program and strategy to reduce reliance on private sector and national government funding.

Keywords: *Local government authorities, Public-private partnership, collection service, performance measures, quality assessment, solid waste management, capacity, Phnom Penh*

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	RGC	Royal Government of Cambodia	
	RSIII	Rectangular Strategy III	
	SWM	Solid Waste Management	
	SEPDII	Social Economic Development Plan II	
	TRI	Toxic Release Inventory	
	TSS	total suspended solids	
	TSP	total suspended Particulate	
	SDGs	Sustainable Development Goals	
	Sangkat	Urban commune	
	UNCHS	United Nation Center for Human Settlement	
	UNIDO	United Nations Industrial Development Organization	
	USD	United State Dollar	
	USEPA	United States Environmental Protection Agency	
	VDC	Village Development Committee	
	VOC	volatile organic compounds	
	WHO	World Heal Organization	
	WMP	Waste Management Program	
	WTP	Willingness To Pay	

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Abstract

Private sector participation in municipal services has witnessed increased interest in recent years primarily to reform the weak performance of the public sector, reduce cost, improve efficiency, and ensure environmental protection. The public sectors including government bodies should be involved in policy making, introducing local legal instruments and supporting public interests. In Phnom Penh Capital, CINTIRI Waste Collection Company (a single private company) Phnom Penh City Hall (PPCH) has been contracted by Phnom Penh City Hall since 2002 for providing the waste collection service (supply-side) to the whole Phnom Penh city. The provision of a service provider is not efficiently performed according to terms and specifications in the contractual agreement while the regulation provision is not enforced by PPCH as required. The amount of total waste generation in Phnom Penh has increased annually and waste disposal has remarkably grown in PPC, from 0.409 million tons in 2010 to 0.680 million tons in 2015 and it is projected to be 0.792 million tons in 2020. The gross waste generation per capita was 0.762 Kg day^{-1} $capita^{-1}$ in 2013 and estimated to increase to 1.240 Kg day^{-1} $capita^{-1}$ in 2030. However, in the recent data indicated that waste generation in Phnom Penh in Mid-2019 is about 3000 tons/day or about 1.09 million tons/year. Hence, the amount of generated waste would grow larger than the estimate.

This study describes and assesses the factors determining the performance of local government authorities and contracted waste collection service and also identifies sets of possible improving measures for sustainable solid waste management in Phnom Penh city. The results of Focus Group Discussions (FGDs), both all districts of Phnom Penh and related organizations at national and sub-national levels and interview of key informants are analyzed by qualitative and quantitative methods. The study is using sustainability assessment by success and efficiency factors methods which have been developed by Zurbrugg et al., (2014) for supporting solid waste management in Developing Countries. In addition, the six performance indicators were used to evaluate the LGA management and private operator performance including technical, environmental, institutional and organizational, financial and economic, social and cultural, and policy and legal aspects.

The results of this study are important to pertain and deal with the performance of supply-side—from CINTRI and LGAs. Waste collection in Phnom Penh city has been an

authority of several different contractors since 1994 due to financial difficulties. The main challenges for municipal waste management revealed as institutional capacity of LGAs, operational and service quality of CINTRI. About 40% of household have not accessed to CINTRI waste collection service, since the total territory of PPC has increased from 367.47 km^2 to 678.47km^2 in year 2010. With these geographical and technical in nature, the municipal waste management situation in Phnom Penh capital is deficiency in terms of institutional management capacity and operational performance constraints. The service provider and PPCH have not expended sufficient effort to improve the situation and the quality of service. Lack of a clear operational framework for this long-term contract, CINTRI rendered the difficulties to widen the service coverage and ensuring the involvement from stakeholders, despite the MSWM decentralization to the LGAs. In addition, the operating systems depend on the service quality and reliability based on technology inputs. The low quality and low service level are caused by a lack of performance control and capability to enforce the regulation. It was derived from the lack of monitoring and evaluation of the PPP process. Unclear delineation of responsibilities and obligations among relevant organizations often result in poor management. The lack of cooperation and coordination between LGAs, PPCH and service provider lead to low willingness to participate or manage in waste service. It is suggested that revisiting the legal framework, establishing a facilitating agency for designing and nurturing partnerships, competitive tendering; transparency and financial accountability are essential elements for PPP on the provision of waste services in Phnom Penh capital. From the socio-cultural perspective, it can be seen that the public perception of PPP is important for explaining the reliability of services.

Another case study mainly aimed to assess public-private partnership's operational performance by using sustainability aspects of SWM. The aspect analysis was employed for evaluating the six domains for sustainable waste management adapted from Zurbrugg et al., (2014). The result shows that public and private sector is a major concern and need to elucidate the behaviour of involved institutions in waste sector for Phnom Penh Capital. The main challenges of solid waste collecting are service quality, institutional arrangement, stakeholder involvement, legitimacy issues, and labour and employment conditions issues. The on-going efforts to build the LGAs' capacity are of great concern to governmental agencies in the transition period of SWM functional transfer to LGAs. Achieving sustainable management requires an integrated approach. The causes of the

institutional arrangement's shortfalls for PPP are clear indications of the inefficient and ineffective service. It was derived from a lack of monitoring and evaluation of the PPP process. Lack of a clear operational framework for this long-term contract, CINTRI rendered the difficulties to widen the service coverage and ensuring the involvement from stakeholders, despite the MSWM decentralization to the LGAs. A legal framework, no anti-competitive behaviour, allowing the widening of ownership, preventing public interests, must be advised and adopted to municipal and local government. In this transition and local specific context, obligated responsibility, competitive tendering, complete transparency considerably with regards to financial accountability are essentials for enhancing system viability. This study might, differences of cities notwithstanding, be very useful the role of PPP in urban waste governance in a circular economy.

The last case study was to particularly address to the barrier of the synergy of legal framework, regulations and institutional framework to practical implementation. It firmly agreed that the legal, regulatory and institutional framework is the backbone for reforms as it assigns the rules, roles and rights for operating solid waste management at provincial, and municipal/ khan administration level. The challenges for decentralization on solid waste management are legitimacy issues, organizational role, right and responsibility towards the provision of waste service. The decentralized solid waste management policy has not preserved financial estimate which inclined to reduce the capacity for monitoring and legal remedies. The legal framework is likely not to overthrow anti-competitive behavior and preventing political interest. Capacity of organizations and on-going efforts to enhance local governments' capacity are of big concern to national government bodies in the transition period of functional transfer to provincial and municipal/khan administration. Structural analysis determine the forcing, relay, result and autonomous variables suggest that the country as well as the Phnom Penh city administration are progressing toward developing sound institution and proactive policy, especially decentralization policy on solid waste management. This study contributes to a arising research stream documenting the public policy reform in solid waste sector challenges in emerging country like Cambodia, using Phnom Penh city as a case study. The illustration of six aspects and identification drivers and indicators as the function of supporting and enabling factors for sustainable solid waste management are the key findings for this study and of which can be extended to studies in other major cities of Cambodia in similar local context.

Overall, the evidence thus suggests measures and actions for improving the waste services and LGA administration's capacity. The service provider should provide and expand the collection service to un-serviced areas by enhancing PPP and social acceptability. Providing a platform for stakeholder participation could prevent public interest and economic interest. Strengthening collection capacity will increase service level, quality of service, reliability, and productivity. Secondly, establishing proper monitoring, controlling procedures and enforcing waste management regulation (e. sub-decree no.113 on MSWM) are needed to reduce the illegal dumping. Thirdly, modernizing fee collection system is soundly financial viability. Fourthly, requirements of management services, quality assessment, and priorities for cooperation between the contractor and the LGAs should be studied, so that the options for the collection system are based on sound data. Fifthly, Phnom Penh Capital should merge *Khan* and *Sangkat* administrations' structure, function, and governance of SWM system with its strategies and priority action plans. Hence, the synergies between local development strategies and Phnom Penh SWM strategies and action plans for 2018-2035 are the key trigger for achieving the strategy's goals. For the long-term run, LGA needs to be self-sustaining waste management program and strategy to reduce reliance on private sector and national government funding. In turn, LGAs of PPC shall strike for right balance between policy, governance, institutional arrangement and resource provision as the mean to prevent the affection of role of party politics to the system.

Keywords: *Local government authorities, decentralization, public-private partnership, collection service, performance measures, quality assessment, legal and institutional framework, municipal solid waste management, , Phnom Penh*

Chapter 1

Introduction

1.1 Overview of Cambodia

1.1.1 Geography of Cambodia

The kingdom of Cambodia is located in mainland Southeast Asia in between latitudes 10^{o} and 15° N and longitudes 102° and 108° E. Cambodia occupies a total area of 181,035 km^{2}. The borders of this country share with Thailand to west and northwest, Laos to the northeast, Vietnam to the east, and the Gulf of Thailand to the southwest. The country's topography consists of the central plains surrounded by Cardamom mountain and highland regions. The coastline is 435km along four provinces in the south. Phnom Penh is the capital of country locates in south-central Cambodia (Figure 1) (MOE,2015).

Figure 1.1. Map of Cambodia
Source:https://www.drivingdirectionsandmaps.com/cambodia-google-map/

Cambodia situates in the tropical monsoon climate which is characterized by a rainy season and a dry season. The rainy season, which lasts from May to early October, accounts for 90% of annual precipitation whereas the dry season, from November to April, brings drier and cooler air from November to March, and hotter air in April to May. The mean variation of temperature ranged from 6-8 ^{o}C, which is maximum mean temperature is about 28^{o}C and the minimum mean temperature is about 22 ^{o}C. On average, the annual rainfall varied between 1400 mm and 1970mm (MOE, 2015).

1.1.2 History

Cambodia continues to emerge gradually and steadily from a long history of war and economic deprivation (MOE, 2009)1 [1] . Historically, Cambodia was under French colonization from 1863 to 1953. Cambodia took backed the full independence from France on 9th November 1953, led by Prince Norodom Sihanouk. In March 1970, a military coup led by General Lon Nol overthrew Prince Norodom Sihanouk. On 17 April 1975, the Khmer Rouge ousted the Lon Nol regime and took control of the country. Under the new regime, Democratic Kampuchea, called the Khmer Rouge's radical and genocidal regime (1975-1979) which caused nearly 2 million Cambodian people dead because of starvation and burden of workload. On 7 January 1979, the revolutionary army of the National Front for Solidarity and Liberation of Cambodia defeated the Khmer Rouge regime and proclaimed the country the People's Republic of Kampuchea and later, in 1989, the State of Cambodia. The country's most important political event was the free elections held in May 1993 under the close supervision of the United Nations Transitional Authority in Cambodia (UNTAC). At that time Cambodia was proclaimed the Kingdom of Cambodia, and is a constitutional monarchy (https://en.wikipedia.org/wiki/Cambodia, retrieved January, 2019).

After the peace building accords in 1993, the government institutions and ministries are re-establishing; the demobilization of arm-force has begun. At the moment the overall standard of living and economic health are gradually increasing. The infrastructure was maintained and re-built to service the public interests. In other words, the country has fully integrated into the regional and international communities. Over three decades, Cambodia has reformed different sector aiming at raising productivity and living standard, to ultimately alleviate poverty (MOE, 2009).

[1] MOE(2009). Cambodia Outlook, Ministry of Environment, Phnom Penh

1.1.3 Economy

Cambodia's economy has grown steadily since the liberalization of its market; the annual GDP growth rate from 1993 to 2004 averaged 9.7% while the per capita GPD averaged 6.5% (MOE,2015). In the recent years, Cambodia has recorded sustained economic growth. The economy grew by 10% per annum between 2004 and 2007 (ADB,2012).

National gross domestic product (GDP) increased by over 170% between 2000 and 2014 (Figure 1.2). Growth has moderated since the global financial crisis in 2009 (averaging 7.45% between 2010 and 2014, compared to 8.63% between 2000 and 2008), although the long-term prospects for growth remain strong (see below). GDP per capita has increased rapidly as a consequence of this rapid economic growth, up from USD 295 in 2000 to USD 1,136 in 2014. Cambodia was expected to cross the GDP per capita threshold for middle-income country status in 2015 (World Bank, 2015).[2]

Four main economic sectors have been important contributors to Cambodia's rapid growth: rice, garment, construction and tourism. High industrial growth rates have been driven largely by manufacturing, and the garment sector has constituted 75% of manufacturing output in 2010. Foreign investment in the garment, textiles and footwear sector has been attracted to Cambodia due to low labor costs and preferential access to European and US markets. The construction sub-sector has also emerged as an important contributor to industrial growth (World bank, 2015). Tourism has also been a key component of growth in this sector, accounting for around 13% of GDP in 2013, a more than six-fold between 1995 and 2014. Investment in tourism has also dwarfed that in other sectors (ADB, 2014).

It can be seen that differential sectoral growth rates are reflected in the changing structure of the county's economy, with a relative decline in the share of value-added attributable to agriculture and expansion of the shares attributable to the industrial and service sectors (changing agricultural sector share at 47.7% in 1994 to 30.4% in 2014) . This pattern of structural change is typical of rapidly growing low-income countries as they develop (GGGI, 2016). This is recognized in recent RGC policy documents, including

[2] World Bank 2015a. According to the World Bank definition, middle-income economies are those with a per capita gross national income of more than USD 1,045 but less than USD 12,736. Cambodia's per capita gross national income was USD 1,020 in 2014, but more recent statistics are currently unavailable.

Cambodia Industrial Development Policy 2015 – 2025 to promote the industrialization and industrial sector in the country. With this connection, the industrial waste generation and waste composition are expecting to increase respectively.

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National gross domestic product (GDP) increased by over 170% between 2000 and 2014 (Figure 3). Growth has moderated since the global financial crisis in 2009 (averaging 7.45% between 2010 and 2014, compared to 8.63% between 2000 and 2008), although the long-term prospects for growth remain strong (see below). GDP per capita has increased rapidly as a consequence of this rapid economic growth, up from USD 295 in 2000 to USD 1,136 in 2014. Cambodia was expected to cross the GDP per capita threshold for middle-income country status in 2015 (World Bank, 2015).[3]

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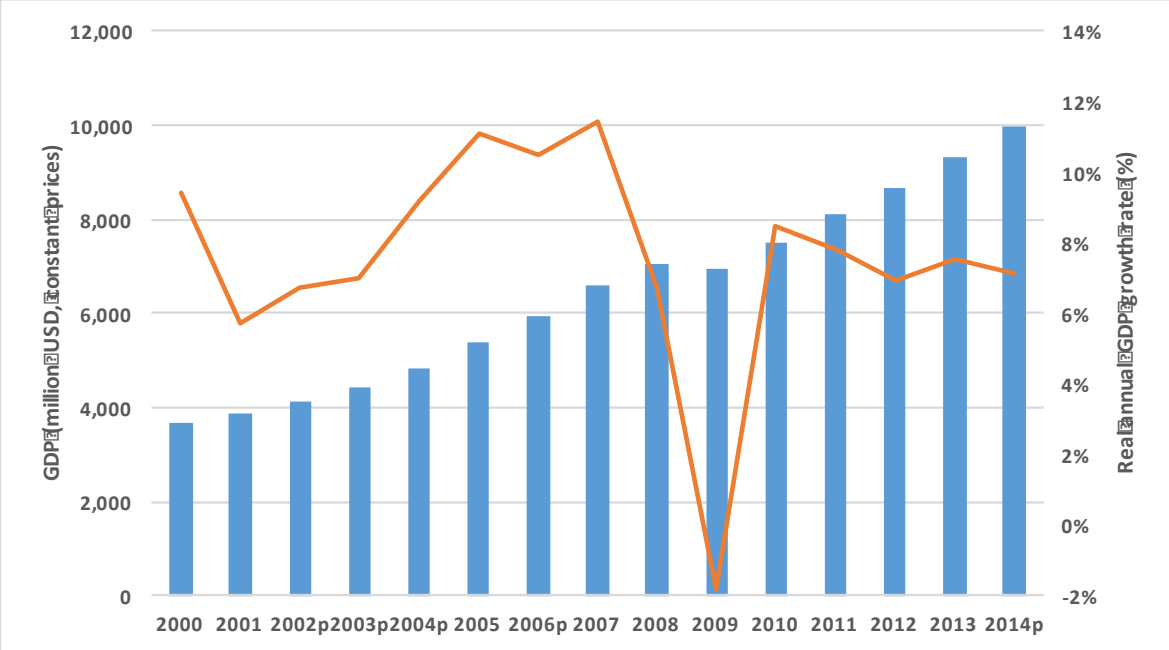
Figure 1.2 Trend of National Gross Domestic Product (GDP): 2002-2014



Source: GGGI, 2016

1.1.4 Population of Cambodia

a. Current population

Cambodia is currently undergoing a period of rapid demographic change associated with rapid growth and structural change in the economy. This is characterized by falling fertility levels, lower natural population growth rates (in urban and rural areas) and rapid urban population growth driven by high levels of rural-urban migration.

[i]During the 1990s and following the end of decades of destructive civil conflict, Cambodia had a very high population growth rates in both urban and rural areas. Since the turn of the century, however, population growth has fallen dramatically, reflecting falling fertility levels and lower natural population growth (NIS, 2014). Nevertheless, total population grew by approximately 46% (over 5 million) between 1995 and 2015 (Table 1).

This trend is expected to continue as the country moves towards middle-income status (UNDSEA, 2014).

Table 1.1. Population growth, Cambodia, 1990-2015

Population	**1995**	**2000**	**2005**	**2010**	**2015e**
Phnom Penh	-	1,198,080	1,376,391	1,663,341	2,065,321
Urban	1,864,281	2,271,793	2,560,946	2,845,724	3,248,723
Rural	8,904,917	9,951,078	10,795,478	11,519,207	12,428,336
Total	10,769,198	12,222,871	13,356,424	14,364,931	15,677,059

Growth rate	**1990-1995**	**1995-2000**	**2000-2005**	**2005-2010**	**2010-2015**
Urban	5.61	3.95	2.40	2.11	2.65
Rural	3.04	2.22	1.63	1.30	1.52
Total	3.46	2.53	1.77	1.46	1.75

Source: GGGI, 2016 (modified from UNDSEA 2014; JICA 2014)

Cambodia remains predominantly rural, with official figures suggesting that currently approximately four-fifths of its population reside in rural areas. Long-term population growth projections foresee continued rural population growth until the 2040s. At the same time, Cambodia has been experiencing rapid urban population growth, with much of it concentrated in Phnom Penh. Cambodia's urbanization rate has increased from 17% in 1995 to an estimated 22% in 2015 (NIS, 2015). As urban areas have lower fertility rates than rural areas, the difference in population growth rate is explained by rural-urban migration. While the motivation for migration tends to be complex, the lack of economic opportunity and rural poverty are important push factors. Conversely, the economic opportunities offered by growth in services, construction and manufacturing industries concentrated in and around urban centers are an important pull factor for migrants (MoP, 2012 and GGGI, 2016).

b. *Population Projection*

Cambodia's rapid urbanization is expected to continue for the foreseeable future as urban population growth continues to accelerate and rural population growth decline (Table 2). This points to accelerating rural-urban migration as fertility rates and overall population

growth rates fall, and differentials between urban and rural fertility rates persist (UNDSEA, 2014). Projections for Phnom Penh foresee urban growth continuing to outstrip other urban areas in the country, and an increase in its already high share of Cambodia's urban population (Table 1.2). This trend is expected to continue until after 2020, by which time growth in other urban areas is expected to exceed that of Phnom Penh and, as a consequence, its share of the national urban population is expected to fall (GGGI, 2016). In this view, waste generation quantity has positive relation with both population and GDP growth rates over times.

Table1. 2. Current and projected population growth in Cambodia by urban-rural areas, 2010 – 2025

Population	**2010**	**2015e**	**2020p**	**2025p**
Phnom Penh	1,663,341	2,065,321	2,405,500	2,549,736
(proportion of total urban population)	*(59%)*	*(64%)*	*(65%)*	*(60%)*
Urban	2,845,724	3,248,723	3,723,400	4,273,673
Rural	11,519,207	12,428,336	13,223,429	13,846,034
Total	14,364,931	15,677,059	16,946,829	18,119,707
Growth rate	**2005 - 2010**	**2010-2015e**	**2015-2020p**	**2020-2025p**
Phnom Penh	3.79	4.33	3.05	1.16
Urban	2.11	2.65	2.73	2.76
Rural	1.30	1.52	1.24	0.92
Total	1.46	1.75	1.56	1.34

Source: GGGI (2016)

1.2 Background

The population growth and rapid urbanization generate many problems concerned with the environmental management of urban areas. The rapid pace of socio-economic development, urbanization and growth of population in most cities of the developing countries have caused and increased in amount of waste. The quantity of solid waste generated in developing countries is increasing and may double by the end of decade (UNCHS, 1994). These caused by growing of urban population and, economic growth and consumption patterns. The major problem of urban environment also includes inadequate

waste management, low service quality and pose to living condition due to improper waste disposal.

The overall responsibility of waste management in cities primarily and traditionally has been with the municipal authorities and contracted waste collection company (Guerrerio et al., 2013). The waste management problem has already become so severe in most cities that municipal or a contractor service is no more appropriate or improper of solid waste management system like collection system and services (Massoud et al., 2003). This problem is usually in the developing countries like Phnom Penh Capital (Spoann, 2010).

The common problems include institutional deficiencies, lack of resource, facilities collection system, lack of environmental awareness, and willingness to participate and cooperate in solid waste management (Spoann, 2006).

The waste management situations have been observed among various low-income countries. Many Asian urban cities face serious environmental degradation and health risks caused by uncollected household waste and domestic refuse in street and opened space areas, urban drainage system, and pollution of water resource near the uncontrolled dumping site. It is estimated that the typify existing services in many urban areas in developing counties for overall population coverage, particularly the poor, is low-only about 60 to 70% of refuse is collected, and in some cities less than half the population is served; publicly service tend to be inefficient. It is noted that there are still lacking official policies— most notable contestable market, while the private sector tries to make a valuable contribution to solid waste management (Bartone et al, 1991). Similarly, most major cities have waste collection systems, and willingness to participate of people for better collection system as standards, coverage and efficiency are very low, the disposal are generally uncontrolled, with dumping as the norm. Therefore, inappropriate management of solid waste causes environmental pollution degradation of the level of sanitation and sanitary living condition in urban areas. Managing solid waste is one of the costliest services. It requires one per cent of GNP and about 20% to 40% of municipal revenue in developing countries (Habitat, 1991, cited by Spoann, et al. 2010). The immediate challenge for waste collection in low-income countries is insufficient budget and capacities of service provision and also these most services often do not meet or fulfill

the needs of all peoples due to different factors such as: geographical, location, condition of socio-economic characteristic and people's behaviors and their disposal practices.

1.3 Statement of the Research Problem

Phnom Penh is a famous tourism site in Cambodia as well as in Asia. It comprises of commercial, physical and political and cultural feature which is the most valuable symbol of the country and the aging city since the year of 1865.Geographically, Phnom Penh is located in the south-central region of Cambodia, at the confluence of the Tonlé Sap, Mekong, and Bassac rivers. This confluence of the three rivers provide potential freshwater and river ecosystems as important resources for sustainable environment conditions, nature's beauty and a prosperous culture for the people of Phnom Penh City from the past to the present (PPC, 2016). Its population at the present is 1,501,725 people , with the total land cover of 678.46 Km^2 (0.37% of country's total area) (PPCH, 2016). The rapid urban growth and economic growth in this town causes the imbalance of income distribution, different opportunity to participation and inadequate urban services. Thus urban authorities, especially the municipality has to confront urban environmental problems such as inadequate drainage and sewerage system, storm water, flooding, waste water treatment, solid/municipal waste management (waste collection system and disposal), indoor air pollution, public health, etc, and also the issue of efficiency, quality of life, equity and poverty. For many cities of the developing world, the top environmental priority remains improving access to clean water & sanitation, waste management, affordability and safety. Similar to many other cities the main environmental problems rise from low quality of waste service, treatment and recovery of waste materials in Phnom Penh Capital. The capital city of Cambodia, likewise other cities and township, are facing similar challenges on municipal solid waste management due to population growth, and increasing consumption levels and urbanization (IGES, 2018).

Fortunately, during a last decade, the population and economic activities of this town is growing very fast. The number of guesthouses, hotels, restaurants and other kind of service and economic activities are increasing dramatically. The expansion of city boundary aims at providing opportunities to industry development and new special economic zone development led to increasing real estates, settlements and urban sprawl. However, solid waste management is considered as one of inadequate waste management and serious environmental problems in this Capital.

Before 1994, the entire of Phnom Penh city had no waste collection service at all. In 1994, after quickly grew in economic activities and the increase of urban population, the city has face problem of waste collection and transportation. The Phnom Penh Department of Public and Transport was responsible for waste collection, transport and disposal at dumpsite located about 16 km from the city center. In July, 1995, the solid waste management in Phnom Penh city had delivered the responsibility to private operator namely Pacific Asian Development in the form of franchise agreement. However, the contract was cancelled and handed over the task to individual districts or Khan to operate waste collection and transport until 1997. From the year 1997, the PSBK Ltd, is the sub-contractor was asked to continue the service for waste collection. It is a monopolistic service provider in Phnom Penh that operated its service until 2002 before delivering the contract to CINTRI. From 2002, the CINTRI bought the contractual right from PSBK Ltd and signed the new contract with Phnom Penh Municipality in the form of public-private partnership. The contract period was 49 years term for Phnom Penh waste collection service, transport and cleansing works. The performance of CINTRI, at the meanwhile, has been considered as the champion by comparing with the previous waste contracted services. However, the burdens of CINTRI on waste collection service were critically inadequate as the city has expanded from 7 Khans to 9 Khan by 2010. Solid waste management (SWM) in Phnom Penh faces enormous difficulties in both the collection and disposal of solid waste with the total population in 2008 of around 1.3 million people (Hul, et al. 2014). Beside municipal solid waste other waste streams such as industrial waste and demolition waste are also increasing due to the rapid industrialization and urbanization process (IGES, 2018). About 80.2 % of municipal waste has collected every day by CINTRI while about 200 tons of wastes have not been swept out from the city (Denny, 2016). The remaining uncollected waste of is disposed by residents in various ways such as burning, burying, dumped on the roads, open spaces, into open canal and/or throw into rivers, thus leading to serous health risks and degradation of living environment. It is an indicative of deficiency waste collection system, even though public-private partnership management system exists in Cambodia. The local government needs to monitor and control with the private company and also improve the people's behaviors in SWM practice.

The problems of without waste collection services are usually in the low-income community or unsatisfactory areas. One of the main reasons is inadequate financial

resource to cope with the increasing waste generation and rapid growth of urban population in the town. Often inadequate collection fees, unwillingness to participate with urban services, insufficient funds and coordination, contractor cannot access the efficiency and coverage of solid waste services. In other words, the facilities for collection system are still insufficient and inappropriate technologies. Thus the operation system is more available for the selected areas in the town (higher income community) and also, most areas have been collected only for secondary storage points such as on the main road and specific sources. Due to low frequency of waste collection and inefficient collection schemes which caused the waste is piled for longtime and scattered along road which created hygienic unsatisfactory condition and have become clogged the drainage system. The inefficient urban infrastructure and road network much as roads is still the obstacles of waste collection in urban poor areas.

In addition, there is another associated problem related to the people's behaviors and their practice with waste disposal at household level many communities due to the lack of users' involvement and affecting factor relationship with their socio-economic characteristics. The level of household participation for better environment in solving solid waste collection and proper disposal are low due to the unsatisfactory service and low collection frequency. This has led the households to consider the options of waste illegal dumping or throw their waste to vacant land areas. Although PPCH reported that almost communities were paid for collection services, but some of peri-urban communities/ households in the newly expanded territories dispose the waste into the community roads, waterway, burning or discarding in the open land behind their houses. The recent study indicated that about 20-60% of the new peri-urban areas have not accessed to waste services (PPDOE, 2016). The compatibleness of collection services and household behavior/practice of waste disposal not only polluted environment and human being but also lose the esthetic of city as capital of the country and tourism attracting place.

1.4. Rationale of the Study

The current state of solid waste collection system and disposal practice in Phnom Penh Capital is environmentally ineffective, inefficient and hazardous to the health of the public and biodiversity. It is reality that CINTRI services cannot keep pace of with the rapid growth of the city and generation of municipal solid waste (Seng, et al., 2013, and COMPED, 2014). The waste generation produces around 4.09 million tonnes per year

(IGES, 2008). For instance, one fifth of total waste generation is not collected yet. The institutional gap and political factors and technical managerial solution to the problem are the rooted of the problems rather than socio-economics and socio-cultural decisions.

Traditionally, the provision of contracted waste collection service has been the most vital function of solid waste management system and environmental cleanliness. At the same time, the finance required and appropriate service levels and standard installation is to be used of these services. Therefore, today, there is an emphasis on using more affordable technology and standards. The technical inputs are the most challenging factor both public and private sector, especially for waste collection system and disposal at landfill. The study is important as it can provide insights to develop the collection systems and policy to ensure that the collection service is compatible with demand and attitude of household.

The importance of people's involvement in collection service and environmental awareness in urban waste management is not only due to the fact that the local government faces shortages of resources (financial, human, technical and institutional), but also because the great proportion of health implications deriving from improper waste disposal and collection system are basically the outcome of their own behavior itself. Accordingly, low awareness of household means waste collection practice and willingness to pay or participate for better waste collection system does not work well. Therefore, the study will examine the people's behaviors and their practices of waste disposal at the household level and the relationships with their socio-economics characteristics and private contractor service itself. It will be interesting to find out the possible missing access of waste collection system between high income and low income areas, and also to assess the determinant factors affecting their willingness to participate of this service.

1.5 Research Questions

To achieve the overall objective of the study, the following research questions are raised:

1. What is the existing solid waste management system and provision of solid waste service in Phnom Penh Capital?

2. What are the challenges and constraints that influence to the performance of the public and private sectors in municipal solid waste management? Are the local government authorities capable to manage MSW?
3. What are the factors that determine the performance of the provision of contracted solid waste collection service in Phnom Penh?
4. To which extend should related-SWM government organizations be encountered versus their roles, responsibilities and resources due to adoption to the decentralization of urban solid waste management policy?
5. How and to what extents of solid waste contributed to pollution load from industry sector?
6. What are effective ways for improving municipal solid waste management and solid waste collection scheme? and what may be the appropriate alternative recommendation to cope with waste management in Phnom Penh and incorporate with the decentralized waste management policy?

1.6 Research Objectives

The main purpose of this research is to examine the status and constraints of solid waste management in Phnom Penh and discuss the performance of local government authorities and contracted waste collection service (CINTRI waste collection Company) to propose possible mechanisms and strategies to improve the SWM system.

To realize the above main objective, the specific research objectives set for the study are as follows:

1. To provide the overview and describe existing municipal solid waste management in Phnom Penh Capital in the transition of decentralized municipal waste management policy.

2. To identify the challenges and opportunities to improve capacity of local government authorities (LGAs) on municipal solid waste management in Phnom Penh;

3. To identify and evaluate the factors that determine the performance of contracted waste collection service (CINTRI) and local government administrations in Phnom Penh;

4. Examine the progress of reforming institutional and legal frameworks towards sustainable waste management in Phnom Penh;

5. To review and examine waste pollution load of industry sector into water and land;

6. To recommend an appropriate set of management measures/actions to improve capacity of local government authorities and waste collection scheme by ensuring stakeholder involvement for incorporating environmental friendly waste disposal practices and sustainable waste management system for Phnom Penh Capital.

1.7. Scope and Limitation of the Study

The study covers following tasks in order to answer study objectives:

Municipal solid waste management policy in Cambodia needs to fulfill the number of regulations (e. g. sub-decree 113, on urban solid waste management). The progressive stringency of policy requirements seek for number of aspects that supporting the variable system. It is obviously impossible to cover all indicative aspects of the municipal solid waste management system with in the resource available for this research: This study focus on agent-based implementation of local government authorities and based activities of private contractor conducting with solid management and collection service, especially, focus on the institutional arrangements and management landscape, quality of service and operational performance. The sustainability domains and indicators used in assessing the above objectives included: technical, environmental and health, institutional and organizational, economic and financial, socio-cultural and legal and policy aspects.

The study has purposively selected Phnom Penh Capital which represented a sole Cambodia's capital. There are three groups of key informants which selected as the sample size including:

i. local government authorities (municipal and Khan Authorities);
ii. representatives from relevant ministries, environmental protection agencies; and
iii. Non-government organization, international organization and project technical assistance experts, and waste collection operators.

1.8. Assumptions

The following assumptions underline this study:

1) The Phnom Penh capital's cleanliness and safeguards for urban life will be improved if there are stronger public sector capacity and privatization procedures in urban service such as solid waste collection services.

2) The quality of waste management service for both public and private operator will be improved if there is effective and efficient operational system towards sustainability domains of SWM.

3) The waste management capacity and existing collection system will be sustainably and enhanced and efficient if there are good governance, proper institutional and legislative framework ;

4) The practical implications for urban SWM in Phnom Penh will be inevitably promoted if capital, municipal and *sangkat* administration and specialized department/agencies promptly change their behavior in communication and work closely with stakeholders as addressed in the reforms policy documents on SWM.

1.9 Dissertation outline and organization

The organization of the chapters for this dissertation is derived from the goal of the study as the topic of dissertation itself covers to five main aspects as indicating in research question formulation. There are seven chapters in this dissertation. The first three chapters present the introduction of research idea formulation, theoretical framework and methodology for the study. The last five chapters cover the results of the study with respect to specific objectives and conclusion of the findings. The outline of each chapter is highlighted as the following:

Chapter 1, "Introduction"

This chapter presents the overview of Cambodia—geographical feature, history, economy for Cambodia. In this part provide also briefly about the socio-economics and demographic information of Phnom Penh city which are essential to have better understanding in relation to the following section and chapters. It essentially also presents the background, problem statement, research questions, research objective, and scope of the study and assumption for the study.

Chapter 2, "Literature review"

Typically, the related literature is reviewed to this study is in this chapter. Chapter 2 presents the reviews of SWM theories and conceptualization in relation to the research

questions. This chapter provides the situation of municipal solid waste management system in Developing countries and in Cambodia. The solid waste management elements also presents including waste generation, treatment, collection, transport and disposal. The institutional, technical, environmental economic, social and legal aspects are included as well. The chapter also provides the case which already studied for municipal solid waste management in Cambodia and particularly in Phnom Penh.

Chapter 3, "Methodology"

Chapter 3 illustrates the process of methodology and materials employed for the entire study. The chapter also presents the research designs for the study including description of study area, data collection method and materials, and data analysis in detail. The assessment methods and indicators are presented respectively.

Chapter 4, "Municipal solid waste management in Phnom Penh: Constraints and opportunities to improve capacity of local government authorities "

Chapter 4 presents the results and discussions of the study. The report describes and analyzes the constraints and opportunities for improving local government authorities on solid waste management. The chapter focuses on the institutional capacity of local authorities due to the decentralization policy on urban waste management.

Chapter 5, "Assessment of Public-Private Partnership in Municipal Solid Waste Management in Phnom Penh Capital, Cambodia"

Chapter 5 also presents the performance of public-private partnership (PPP) on municipal solid waste management in Phnom Penh. This chapter is coherent chapter with Chapter which anticipating to discuss the role of private sector and public government agencies in enhancing waste management in Phnom Penh. Quality of service assessment is the keyword for evaluating the performance of PPP. In addition, the successes and failures in MSW in Phnom Penh are discussed in this Chapter

Chapter 6, " Reforming Institutional and Legal Framework Towards Sustainable Municipal Solid Waste Management in Phnom Penh.

This chapter aims to review the progress of decentralized MSWM system in the Phnom Penh and examine the institutional and legal aspects after the reform of urban solid waste management policy established in late 2015. It presents reform policy and regulations on solid waste management and institutional framework from 1999 to 2017. The legislative gaps for moving from policy to practice and technique are also presented.

At last, the chapter presents the recommendations for strengthening law enforcement and enhancing institutional capacity towards sustainable solid waste management.

Chapter 7, "Estimating Industrial Waste Load Assessment in Phnom Penh City: Using an Industrial Pollution Projection System

The chapter provide the result and discussion on pollution load of industrial solid waste. Projection of pollution load also presented. The finding from the previous case study conducted by author is crucial to present for this chapter.

Chapter 8, "Conclusions and Recommendations for Improving the Municipal Solid Waste Management"

Chapter 8 provides the discussion on improvement measure and recommendations for municipal solid waste management in Phnom Penh. The recommendations for improving MSWM for Local Government Authorities and Waste collection Company in terms of institutional management, legislative aspect, and quality of services, economic and social aspects are provided. Last but not least, this Chapter also summarizes the findings and concluding remarks for the dissertation. The suggestions of future possible researches also introduced.

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Chapter 2

Literature Review

This chapter was formulated to review some of the relevant literature on topic under study. The part of those will provide an understanding of urban service delivery particularly reference to solid waste management and collection system and conceptual theories. The chapter provides the situation of municipal solid waste management system in Developing countries and in Cambodia. The solid waste management elements also presents including waste generation, treatment, collection, transport and disposal. The institutional, technical, environmental economic, social and legal aspects are included as well. The chapter also provides the case which already studied for municipal solid waste management in Cambodia and particularly in Phnom Penh.

2.1 Solid Waste Management in Developing Countries: Challenges and Issues

For the last few decades, population and economic growth have increased the rate of municipal solid waste generation and rapid urbanization have also resulted in substantial improvement in well-being for large fractions of the world population (Singh et al, 2014 and Arbulứ et al, 2016). At the same time, in the industrialization world, we have found out increased materially intensive resource consumption and consequently large amount of waste to the environment (Sign, et al, 2014). Annual waste collection globally accounted for 1.3 million Gg/year in 2012 and increase to 3 million Gg/year in 2025. It is predicted that waste production is increased by 51% between 2005 and 2025 (Charles et al., 2009). Following this trends, Figure 2.1 illustrates the classification of different countries group with their urban population projection and waste generation per capita. Singh et al, (2014) noted that urban SWM amount in low-middle and high-income countries are identical as regulated by amount of GDP per capita of these countries.

This increase has been putting pressure on public authorities to develop accurate municipal solid waste management policies and systems to deal with the impacts ecosystem service related to waste generation (Bartone, 1990; Shekdar, 2009; Al-Khatib et al, 2010 and Arbulứ, et al., 2016). In appropriate management has led to global efforts in order to reorient MSWM systems towards sustainable and acceptable waste management system in a given available resources (Arbulứ, et al., 2016). Sakai et al, (1996) emphasized

that waste management can considerably vary and there also difference in other factors which impinge upon the selected strategies, such as transportation infrastructures, population densities, resource bases, land availability, energy requirements and environmental regulations.

Table 2.1. Classification of the countries by urban population and per-capita waste generation

	Low-income countries		Low-middle Income countries		Upper-midde Income countries		High-Income countries	
	2010	**2025**	**2010**	**2025**	**2010**	**2025**	**2010**	**2025**
Urban population (millions)	343	676	1296	2080	572	619	774	912
Waste (kg/capita/day)	0.6	0.86	0.78	1.3	1.16	1.6	2.13	2.1

Source: Sigh et al., (2014)

2.2 Urban Services Delivery System in Developing Countries

It has been noticed that many countries in Asia are undergoing reforms to bring improvement in environmental governance (Memon, et al. 2006) and enhance the operational performance of the urban environmental service (Amin, 2005).There are different forms of urban services in developed countries, because of the difference in geographic, location, and the condition of socio-economic and cultural environment. Usually, in very small countries, a government authority is responsible for all urban service. In large countries, the central government decentralizes the responsibility to the local government. In market economics either the central government and the private sector or local government and the private sector collaborate in the provision of urban services (Cointreau-Levine, S. 1994). On the other hand, for achieving the targets of Millennium Development Goals, the national and international priorities to provide solid waste management, safe water and sanitation and clean air and require prompt and appropriate investment to improve the coverage and quality of environment infrastructure and services (Memon et al., 2006).

Until recently, urban services in many countries have been provided by central government agencies. However, urban services, like waste collection service, most often did not meet or fulfill the needs of all people due to lack of funds and capacity (Post and

Obirih-Opareh, 2003). In addition it has been nearly impossible that the central government agencies reach all urban settlement especially when the cities are in the process of rapid urbanization. In order to tackle this inefficient waste management system in Cambodia, the central governments have decentralized the power and transferred some responsibilities to the regional or local authorities (Vong, 2016). The improvement of the efficacy and efficiency of urban environmental management, most Asian countries have started implementing reforms to promote decentralization, private-sector participation, and community participation (Memon, et al., 2006). It is evident that local authorities themselves also cannot fulfill the need urban services such solid waste collection service, to all settlement because of the continuing shortage of budgets and capacity (technical knowledge and experience of implementation). With the realization of failure in decentralization, both national and local governments have turned their attention to private sector since 1980s with the high trend for privatization. It was soon realized that the public and private sector collaborations could provide more and better urban services even at increased costs to the consumer. On the other hand, the private enters into collaboration or undertakes sole responsibility of service provision only where the ventures are significantly profitable (Cointreau-Levine, S. 1994).

2.2.1. Public-Private Sector Partnership and Operational Procedure

"A public-private sector partnership is *a contractual relationship between a public and a private partner that commits both to providing a municipal service".* The main reason for a municipality to enter into a partnership with a private company is to achieve more efficient and cost effective services. Other reasons may be: (i) access to more sophisticated management, technical competence and financing; (ii) cost effective designs, construction and operation facilities; (iii) delegation of responsibility and risks; and (iv) guaranteed costs (Cointreau-Levine, S. 1994).

The public-private partnership (PPP) approach means a sharing of responsibilities and tasks for providing services, financing the service using a blend of public and/or private funds, design and construction of facilities, and operation and maintenance of the service facilities. Therefore, the division of responsibility and roles needs to be clearly established (ibid.).

SWM services are considered a public responsibility (public good), but this does not require the government to perform these services with its own facilities, equipment and personnel. The government is responsible for ensuring that adequate services are being provided, but it may choose to contract out to the private sector the actual delivery or supply of services. In such as schemes the government establishes the services regulations, defines the work to be done and the terms of agreement, overseeing the work and enforcing compliance with the government regulations and the terms of the agreement. They may also be involved in arranging financing and payment to the private sector. The responsibility of the private sector is to deliver the specified services according to the agreed contractual terms, standards and costs. In other words: *The public (municipality) is the service regulator, enforcer and facilitator and the private sector is the service supplier* (Cointreau-Levine, S. 1994). Arbulú et al., (2016) suggested that for a successful PPP implementation there is the need for a strategic vision of public authorities. He found out that institutional capacity and possibility for clarity of tasks and enabling working environment would be built and ensured in order to reduce risk from public side.

The premise is that a private contractor can provide more efficient arid cost effective services than a local government agency because when there is competition for winning contracts, the contractor must operate under *marker forces*. However, in many developing countries this may not be the case, because there will not be enough qualified private companies to compete for the services, or contracts for various reasons are awarded without *fair competition* or under rigged or skewed competitive conditions (favoritism, nepotism, rent seeking, hidden subsidies, etc.). Other important constrains are that the procurement arrangements and the contractual terms for providing the services often lack the necessary *transparency*, and *accountability*. It is therefore necessary that clear and transparent bidding and procurement conditions be established. Bidding should be open to all qualified firms and the conditions, terms and service standards must be clearly specified. Payment should be based on performance outputs that can be verified and/or measured, that the method of performance monitoring and enforcement are specified. Penalty clauses for violation not complying with service standards should also be clearly specified (Cointreau-Levine, S. 1994 cited in Spoann, 2010).

Another and equally important factor for good waste management services is that contracts are awarded and implemented under *transparent* conditions. The private firms must be allowed to compete on a "level playing field", and particularly the decision-

making and financial dealings must be transparent, if not crippling corruption and favoritism be the result (Cointreau-Levine, S. 1994). In some developing countries there may be too few private companies to ensure adequate competition; existing companies may have hidden family or friendship relationships with other competing companies or political authorities. These factors can inhibit real competition, and the regulatory and judicial systems may be inadequate in assuring ethical business practices, resulting in collusion and cartels. In such cases, competition may be enhanced if the government provides *contestability.* It can do this by letting a government agency supplying competing services on a limited scale using government equipment and personnel. The private contractor will then know that the government agency is in a position to assess his performance, operating efficiency and costs. Without this knowledge and competence the government agency will be in a disadvantaged condition when negotiating the contractual conditions, particularly the financial terms. In cases of abuse, defaults, strikes, etc. the government agency will be in a better position to take over services from the private contractor, and therefore less vulnerable to service disruptions (Ibid).

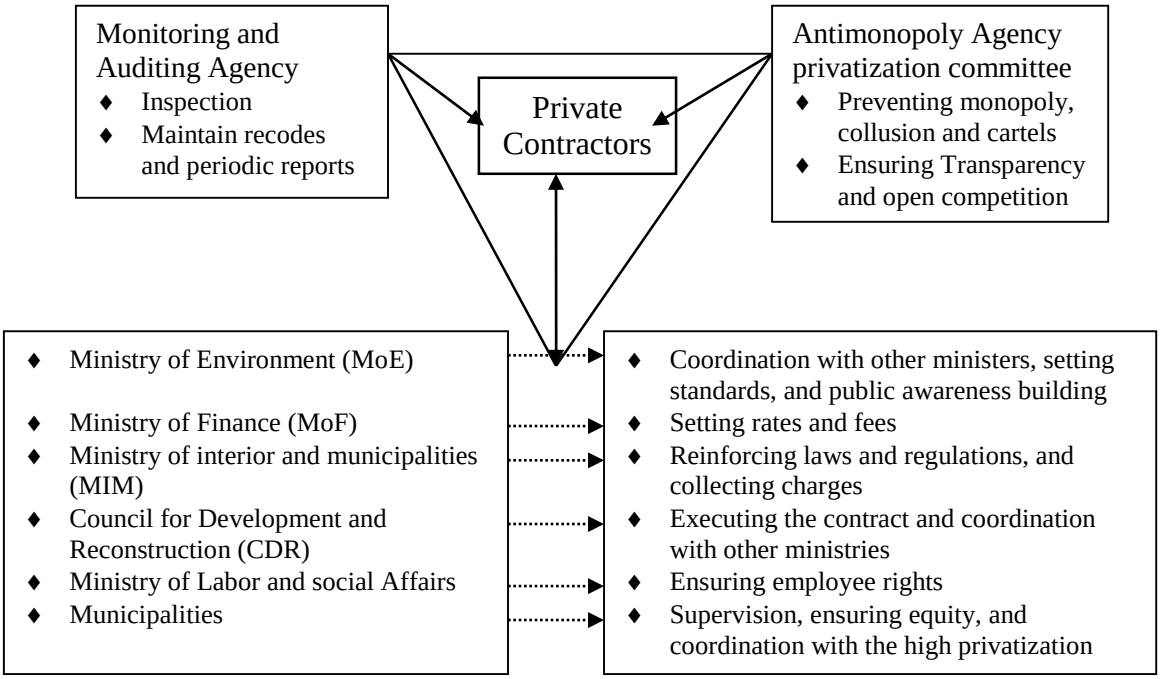
2.2.2 Role of Private and Public Sector in Municipal Solid Waste Services

In developing counties, both public and private sectors are active in management of solid waste as the recent trend has emerged the private sector to enter into solid waste management operation and heading to link as public-private operator. Consequently, the public sector, as a city corporation, operates under certain inherent limitations (Ahmed and Ali, 2004). While the private sector can make a valuable contribution to solid waste management, there are few instances of adequate official policies to promote private sector participation and to create necessary conditions for success_ most notably contestable market (Schertenleib& Triche 1989, Baumol& Lee 1999) *cited by* (Barton, *et al*. 1991). This has been typified that existing services in many urban area of developing countries are dominated of poor people, and the frequency of collection is low as less than half of population is served in some cities (Barton, et al. 1991).

Bartone, et al. (1991) responded to the question on "*could an expanded role for private sector help to alleviate the solid waste problem by improving the efficiency and coverage of solid waste service*?" by his study, that private sector performs more efficiently. The most important step to get effective private sector involvement is to strengthen the technical capacity of public sector so that it is better able to exercise proper

contract control, inspection and supervision. It was similar findings from Massuod et al, (2003) and Denny (2016). In other worlds, the local authorities should establish operational and environmental regulations and standards to guide private contractors and have the capacity to oversee these activities (Bartone, et al, 1991), and introduce local ordinance and carryout legislative obligation (Massoud et al, 2003). Joseph (2006) suggested that identification of the stakeholders and their interests is important in coordinating their involvement and participation in various waste management activities.

Figure2.1: Institutions Involved in MSW Management with their Respective Roles (Massoud, 2003)



Thapa (1999) found that appropriate policies and laws private sector involvement in waste management and degree of involvement varies from one city to another. In the majority cases, privately manage systems have provided services more efficiently than publicly managed systems due to a disciplined working system, personal supervision and regular monitoring of a management system aimed at maximizing the profit margin. As the people pay for waste collection and disposal services, this serves as an economic incentives for entrepreneurs. In their pursuit of security the contract, entrepreneurs will provide the service at the lowest possible price, thereby reducing the public cost of waste management. Private sector involvement in waste management would enable the municipal government to concentrate on other development activities (Thapa, 1999). In addition, Visvanathan et al., (2004) suggests considering an integrated approach for

achieving sustainability in waste management by the involvement and participation of all the stakeholders—waste processer (formal and informal sector), waste generator and government institutions.

2.2.3 Criteria for Assessment of Public and Private Participation in Waste Services

As the argument is valid that in developing countries the government's SWM services often are not as efficient as they could, or perhaps, should be. The criteria for choice of the public or private service delivery are to be deeply considered. According to question, How does government resolve the question of whether to privatize a specific aspect or portion of its service?

Cointreau-Levine (1994) has identified some criteria that need to be examined in deciding whether to involve the private solid waste management services: (i) the ease of defining outputs, (ii) efficiency, (iii) capability, (iv) competition, (v) duplication, (vi) risk, (vii) accountability, and (viii) costs. These criteria deal with many complex factors that affect the ability of the private and public sector to perform efficiently and effectively. Massoud, M. A. et al.(2003) claimed that private sector involvement implies a shift in the role of government institutions from service provision to regulation. Essential conditions for successful private sector involvement include competitive bidding, technical and organizational capacity, regulatory instruments, and monitoring and control systems. Development of evaluation criteria to be used as a guide for selecting successful applicants and executing contracts is the first step. Zurbrügg et al. (2014) have developed the assessment methods for supporting solid waste management in developing countries. The assessment methods and tools are varied and are currently available to support decision making in solid waste management. The assessments explore the weaknesses or strengths of existing systems in a structured way and hereby highlight factors successes and failures. Sustainability domain consists of technical, environmental and health, economic and financial, social and institutional, organizational aspects are the key specific indicators attempt to provide a more holistic picture by integrating different sustainability domain into the same tool (Zurbrügg et al. 2014).

2.3 Solid Waste Management in Cambodia

2.3.1 Definition of Solid Waste Management

Solid waste management defined as the discipline associated with the waste generation, storage, collection, transfer and transport and disposal in the manner that is in particular reference to principles of public health, economics, engineering, conservation, aesthetics and other environmental consideration and that also is responsive to public attitudes Tchobanoglous *et al.* (1993). Another definition by Bhide (1983) cited in Spoann (2010) defined solid waste management involves management of activities associated with generation, storage, collection, transfer and transport, processing and disposal of SW which is environmentally compatible adoption principle of economy, aesthetic, energy and conservation. It compasses planning, administration, financial, legal and engineering aspects involving interdisciplinary relationships.

According to UNEP (2012), solid waste defined waste as 'substance or object that is disposed of, intended to be disposed of, or required to be disposed of by provisions of national law'. Solid waste is categorized into different types based on sources including residential, industrial, commercial, medical and agricultural sectors (see Table 2.1). Solid waste generation in Phnom Penh Capita is typically from the three sources defined by the ministry of environment. They are: i) municipal solid waste (residential and commercial and market waste); ii) hazardous waste (typical waste from factory and industry waste; and iii) medical waste (from hospital and clinical site).

The term of solid waste defined in the Sub-Decree on Solid Waste Management of Cambodia (1999) ascribed there to (RGC, 1999):

> a). solid waste refers to hard objects, hard substances, products or refuse which are useless, disposed of;
>
> b). Household wste is the part of solid waste which does not contain toxin or hazardous substance, and is discarded from dwellings, public buildings, factory, market, hotel, business building, restaurant, transport, recreation site, …etc;

Table 2.2 Sources, typical waste generators and types of waste

Sources	**Typical Waste Generators**	**Types of waste**
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metal, ashes, special

		wastes and household hazardous wastes, e-wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes, e-wastes
Institutional	Schools, hospital (non-medical waste), prisons, government buildings, airports	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes, e-wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes, e-wastes
Construction/Demolition	Construction/renovation sites, road repair, demolition of buildings	Wood, steel, concrete, dirt, bricks, tiles
Medical waste	Hospitals, nursing homes, clinics	Infectious wastes, hazardous wastes, radioactive waste from cancer therapies, pharmaceutical waste

Source: The World Bank, 2012

2.3.2. Solid Waste Generation and Compositions

a). Waste Generation

The quantity of solid waste generation rate varies form country and city to city due to different factors such as, geographic location, seasonal variation, the extent of salvaging and recycling, economic condition of the people, characteristics of services, frequency of collection, public attitude and legislation (Tchobanoglous *et al.* 1993).

Factors affecting waste generation rate as following

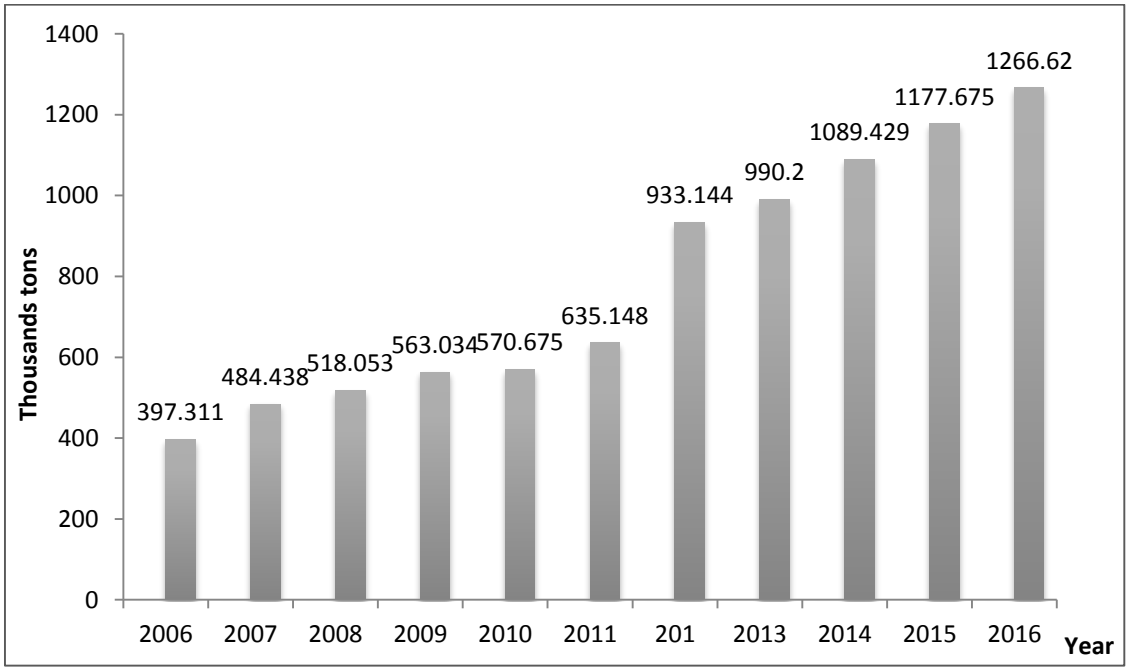
a) Source reduction and recycling activities
b) Public attitude and legislation
c) Geographic and physical factors

d) Income and affluence

Effect of income and affluence on waste generation, according to Vesilind *et al*. (2002) stated that "income and affluence tend to have a positive effect on refused generation with the logic that the more expandable income a household has, the more they tend to throw away. On other worlds, in the low-income settlements the quantity of solid waste per capita is generally smaller than in the high and middle areas (Jindal, *et al*., 1997). Nevertheless, the low-income area is remaining without waste collection services.

In Cambodia, with a rapid economic development together with urban and industrial development with nearly three decades has been giving rise to the concerns of how to manage municipal solid waste in the urbanized cities. The annual total MSW in Cambodia generate around 2.80 million tonnes per annum and the waste generation rate is estimated to be around 0.50 kg/cap/day in Cambodia based on the population of 15, 391,058 in 2014 (MoE, 2017). The recent reports from Phnom Penh Department of Planning estimated that, waste generation rate in Phnom Penh is a bit higher than other cities, it accounts for 1.59 kg/cap/day. This increase is because of the rise of standard of living and economic activities (ibid).

Figure 2.2. Solid Waste Generation in Cambodia



Source: Department of solid waste management (MoE, 2016)

Most Cambodia waste collection system, transportation and final disposal in major cities provided by private contracted company under the supervision of local authorities and related government technical departments (Sethy, et al., 2014). Some small town and urban center are also absent of private operators as the waste collection schemes is not feasible and the waste disposal practice are uncontrollable. In these areas, each household manages its own waste by their own ways. Traditionally, the wastes are disposed in the vacant lands or private lands, burying and burning openly and through wastes into water body and waterways (ibid, and Spoann, 2010). Most of the cities in Cambodia, the final disposal of municipal solid waste are disposed at dumpsites which are not environmental soundly designed to comply with minimum standards and requirement of environmental quality. The dumpsite with a large open space area, no soil cover and uncontrolled leachate treatment system are used for landfilling (MOE, 2017).

Table 2.3. Solid waste compositions (%)

	Phnom Penh city					Siem Reap		Battambang		Kampong Chhnang	Kampong Cham
	1992[a]	2002[b]	2003[c]	2009[d]	2011[e]	2008[f]	2009[d]	2008[f]	2009[d]	2008[f]	2009[d]
Organics	87	65.0	70.1	76	50.5	65.2	65	71.9	77	80.5	76
Plastic	6	13.2	15.5	6	17.8	8.9	11	8.6	10	3.3	12
Paper	3	3.8	6.4	5	12.7	0.9	6	2.7	2	2.1	5
Textile	-	-	2.5	3	11.1	4.3	1	2.9	2	1.3	1
Glass	1	4.9	1.2	2	4.0	7.8	2	5.4	4	0.7	2
Rubber & leather	-	0.6	0.1	-	-	-	-	-	-	-	-
Metal	1	1.0	0.6	2	0.3	5.3	1	1.1	3	7.7	1
Stone&ceramic	-	-	1.5	-	-	-	-	-	-	-	-
Others	2	11.5	2.1	6	3.5	7.6	11	7.4	2	4.4	16

Source: [a]MoE, 2004; [b]Kum et al., 2005; [c]JICA, 2005; [d]Sang-Arun et al., 2011; [e]Heng et al., 2011; [f]Sethy et al., 2014

2.3.3 Solid Waste, Storage, Collection and Transport

a). Storage of Solid Waste

Thanh and Muttamara (1978) summarize that there are tow types of refuse storage which are commonly used in Asia, namely: the communal storage and household storage:

Communal Storage: in the communal storage method, the residents themselves deliver their waste to container provided, normally, by government officials, To avoid the

refuse careless disposed on the pavement of residents, the container should not be located very far from the house.

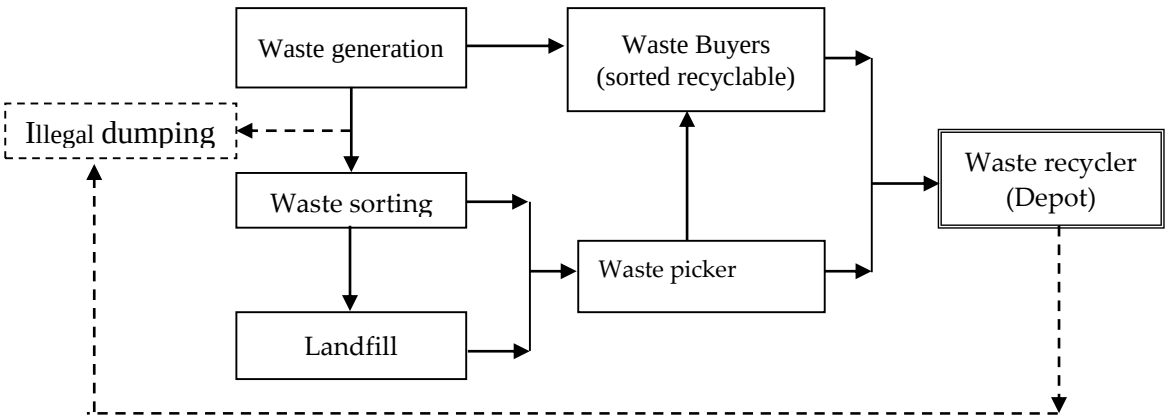
Household storage: household storage is used to supplement the function of communal storage bins. Each family is request to use containers to store their daily waste and these waste are dumped at the nearest communal storage facility or brought directly to the disposal site.

Betts (1978) reviews the main operational factors to be taken into account when deciding to arrange the most suitable form of solid waste storage; these factors are, such as: (i) climate, (ii) nature and quantity of the waste, (iii) condition at the premises generating the waste. (iv) method and frequency of collection.

b). Solid Waste Collection and Transport

The data of Provincial Department of Planning showed that about 10% of families among of 3.056 million households in Cambodia have accessed to waste services in year 2015 and majority of them resided in the cities and capital. Out of them, Phnom Penh Capital represents the largest service users and accounted for 81% of households of the total residences. Some new growing cities in Coastal zone province contribute 20.9% for Sihanoukville and Siem Reap city represents 6.3%. For other provinces, the numbers of waste service users are relatively low, ranging from 1.5% to 10%. The report also showed the waste collection and disposal in province, except Phnom Penh Capital, are not soundly environmentally practice as the facilities and the dumping sites are still poor and underserved (Sethy, et al.,2014).

Figure 2.3 Flow chart of waste management in Cambodia



Source: Cam Consultant (nd).

In Phnom Penh, solid waste is generated from three waste sources: municipal solid waste (residential and commercial waste), hazardous waste (factory and industrial waste) and medical waste (hospital, clinic, etc.). And those collection services are conducted by three agencies: Municipality of Phnom Penh (MPP) is responsible for municipal solid waste (MSW), SAROM trading Co. Ltd, is responsible for hazardous waste and Phnom Penh Waste Management Authority (PPWMA) is responsible for medical waste, respectively. Due to lacking of financial resources for waste collection and disposal system, in 2002 MPP had franchised out municipal solid waste collection service to a private waste hauler, CINTRI, and was completely provided in 2009 for the whole city (urban and peri-urban) under monitoring/supervising of MPP. Since then storage and discharge practices of the waste have changed from burning, burying, dumping in back yard, disposing in water body, etc., to collection and disposal due to vacant space scarce caused by fast population growth and urbanization. However, municipal solid waste management (MSWM) has still poor performed in both sanitation and environment because of minor illegal dumping and individual disposal are existing. Improper operations are caused by a couple of factors including technical, economic, political, regulations and human resources. It seems that legal system arrangements and resources are the major challenges for improving MSWM in Phnom Penh(Kum et al, 2004). In addition, operation and maintenance (O&M) of machinery is also a plus because CINTRI's machinery for waste collection, transport, and road cleansing, being in use for 8 to 25 years which break down frequently. CINTRI is somehow able to keep the machinery in working condition. However, the collection schedule has not been punctual resulting in improper disposal for householders. And PPWM itself does not have the human resources, equipment or facilities to operate and maintain its machinery. When machinery breaks down, the repair work is entrusted to a private service shop. All facilities/machinery operated at landfill are rental, and the rental company carries out the repair work at a small shop set up on-site (Yim, et al., 2015).

c). Solid Waste Collection Method

Collection includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be materials processing facility, a transfer

station, or a landfill disposal site. Final disposal sites are nearly in small cities, the hauling waste is not a serious problem, however, and the haul may have significant economic implications in large cities (Han, 1999).

Flintoff (1984) stated that waste collection and disposal systems are in continuous changes in almost all countries as a result of increased regulations and public pressures. In the future, city administrations will constantly resist relating problems to the number, capacities and locations of waste disposal facilities, routing of collection vehicles, crew etc., In every city many trucks are used to collect and transport waste form different part of cities to landfill, incinerators and transfer stations. However, According to Schertenleib (1988) found that most of community primary collection is limited in term of participation. A commune collection scheme is seen in areas where conventional collection systems cannot reach households due to poor accessibility, and/or low-income areas, where the population cannot afford door to door collection by trucks.

There are various methods of waste collection employed in Asia, these are house to house, communal, curbside and block collection:

- House to house collection, the collector enters the garden or courtyard, carries the bin to the vehicle, empties and return it to its original place
- Communal collection, the collectors just collect the waste form communal site;
- Curbside collection, residents are urged to place their bins on the pavement in advance of the collection and removes them after they have been empty; and
- Blocked collection, the collection vehicle stops at very street intersection where a well is rung to inform the residents around there to bring their waste containers to the crew to empty them.

The waste collection in Phnom Penh has been contracted out to a private company. As the franchise contract with PSBK does not specify the required services level or standard, the contractor provides whatever service level the think is appropriate. The waste collection practice seemed to be less suitable to daily waste generation, result from :(1) poor condition of collection vehicles, facilities, and roads; (2) inadequate collection services such transportation and time of collection. The service cannot cover the whole

city, especially, the areas with narrow roads where the truck cannot go to collect (Vibol, 2002).

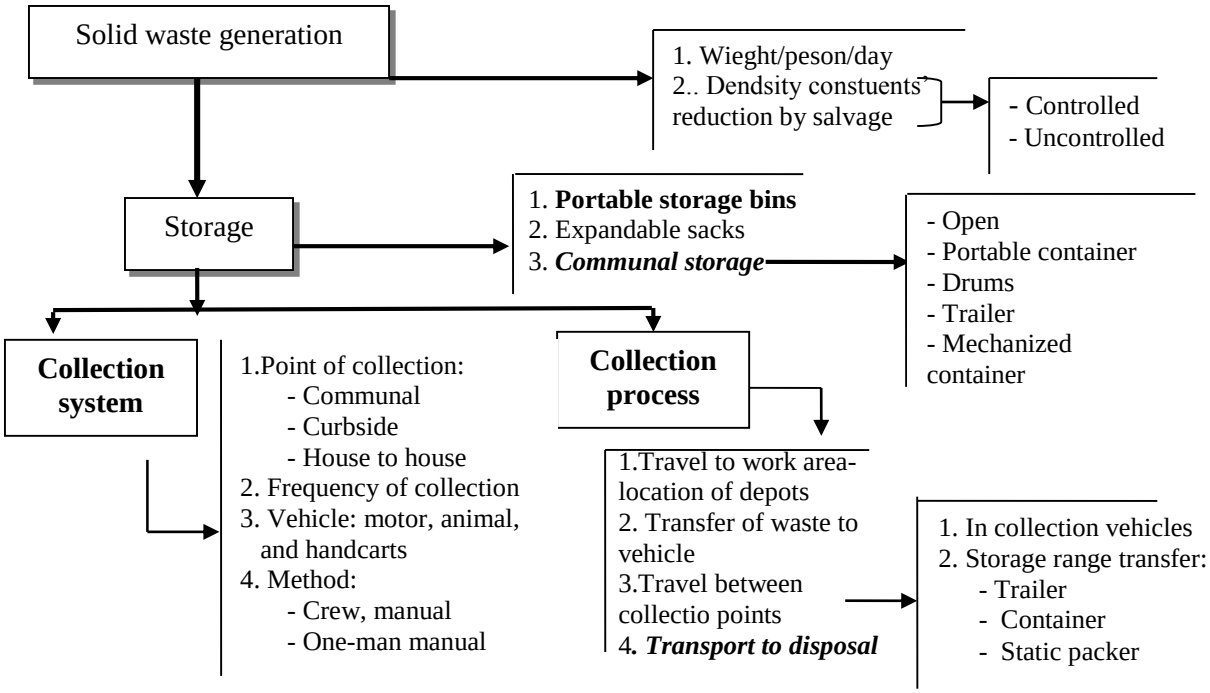


Figure 2.4: Flow chart and Decision area for Waste Storage and Collection (Flintoff, 1984 in Spoann, 2010)

2.3.4 Factors Affecting Waste Collection System

The problem of urban service delivery in developing countries as well as in developed countries are that the government cannot provide all services to all urban settlements due to insufficient budgets and capacities. The other reasons are the rapid growth of population and urbanization, which create the high demand for services. This is clearly seen form the publication by Romos and Ma (1986). The fast growth of population, the urban settlements also increase as well as urban poor but the government cannot provide all services to all settlements. Therefore, a lot of communities are living in a poor condition such as overcrowding, lack of solid waste collection, drainage system and insufficient infrastructure services (Nengxay, 2002).

Solid waste collection refers is very costly service and traditionally has been the most expensive phase of waste management. Every jurisdiction should carefully evaluate types of vehicles and collection methods in order to select the system, which is the most appropriate to local condition in terms of quality and efficiency of service and cost of operation. The consequent problems such as a road congestion and exhaust gas emission,

and storage of collection personnel will become a new problem. The collection transfers cost normally takes from 70 to 80% if total budget of SWM (Bhat, 1996). Therefore, even a small improvement in refuse collection operation can lead to a significant reduction in cost. Elements to be taken into consideration are:

- Waste categories, characteristics and generation rate
- Climate, topography and population density
- Roads and traffic, conditions and accessibility
- Waste storage
- Facilities at the waste disposal site
- Vehicle availability, spare part, maintenance cost, etc.
- Final treatment, type and distance form collection area
- Labor impact
- Labor cost
- Willingness or ability to pay and
- Service coverage and efficiency

The collection is the largest cost element in most municipal solid waste management systems, accounting for 60%-70% of costs in developing countries. In cities of industrialized countries, collection rates are at about 90%, however, the poor countries, collection rates can be lower than 50% (Han, 1999).

a). Service Level and Standards of Waste Collection

Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low-income population living in peri-urban areas. One of the main reasons is the lack of financial resources to cope with the increasing amount of generated waste produced by the rapid growing cities. Often inadequate fees charged and insufficient funds from a central municipal budget cannot finance adequate levels of service. However, not only financial problems affect the availability or sustainability of a waste collection service. Operational inefficiencies of SW services operated by municipalities can be due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved as well as the use of inappropriate technologies. With regard to the technical system, often the

"conventional" collection approach, as developed and used in the industrialized countries, is applied in developing countries. The used vehicles are sophisticated, expensive and difficult to operate and maintain, thereby often inadequate for the conditions in developing countries. After a short time of operation usually only a small part of the vehicle fleet remains in operation.

In many countries there is currently great interest in involving private companies in solid waste management. Sometimes this is driven by the failures of municipal systems to provide adequate services, and sometimes by pressure from national governments and international agencies. Arrangements with private companies have not all been successful, and as a result some opposition to private sector involvement is now in evidence. An important factor in the success of private sector participation is the ability of the client or grantor - usually a municipal administration - to write and enforce an effective contract. Many municipalities do not know what it has been costing them to provide a service, so they cannot judge if bids from the private sector are reasonable. The contract document must be well written to describe in quantitative terms what services are required and to specify penalties and other sanctions that will be applied in case of shortcomings. Monitoring and enforcement should be effective. It is also important that the rights of both parties are upheld by the courts. Three key components of successful arrangements are competition, transparency and accountability (http://www.sandec.ch/SolidWaste/).

b). Inadequate Fee Collection in Some Developing Countries

Fee collection for solid waste services appears to be influenced by willingness to pay, by the way of payment, by the availability of sanctions and by the persons collecting fees. If willingness to pay is low; fee collection will be low too. Lack of sanctions and a lack of legal obligations to pay are often the cause of fee collection problems. In Mali, fees are collected as part of taxes by the government which in turn pays the micro-enterprise. The disadvantage of this system is the dependence on the efficiency of tax collection by the government that determines the payment of the micro-enterprise. The micro-enterprise itself cannot influence it and government officials may not have enough incentive to carry out fee collection effectively.

Inadequate fee collection can have negative consequences for the motivation of garbage collectors and thus for the reliability of the service, if they depend directly on

these fees for their income. Low reliability of the service can lead to low willingness to pay of households. It thus may become a vicious circle. One way to improve fee collection is to change the way of payment. In La Paz, Bolivia, the municipality tried to collect garbage fees with electricity bills. This was not successful, because the people were not informed properly. It even came to boycott actions. Garbage fee collection together with water bills was tried in Ujung Pandang, Indonesia also in Cambodia in the recent year. Results are still unknown. In Surabaya, Indonesia, a minimum fee was set during a meeting with residents. This fee covers all social welfare activities in the neighborhood, and it is collected during monthly social meetings. This system is rather effective because people prefer to pay one lump sum instead of many small amounts. Because success of a certain way of payment usually depends on the local context, community preferences have to be assessed. Another way to improve fee collection is to give fee collectors more personal benefit. A subject that is often neglected by community-based solid waste management projects is the possibility of sanctions for non-payment to increase fee collection. In Padang, Indonesia, it is practice to pay the solid waste fee directly to the garbage collectors in the beginning of the month. Otherwise one's garbage is not collected. As was made clear above, the persons collecting fees may influence the rate of fee collection. Fee collection by operators rather than government officials appears to be more effective (Anschutz, 1996).

2.4 Management Aspects

As the number and complexity of MSW management alternatives increase, the selection of the best waste management becomes a more difficult task. There are three main components of SWM including institutional, legal system and financial aspects to be taken in order to achieve the goal of sustainability of waste management.

2.3.1 Institutional Aspects

An integrated strategic planning framework should be adopted at the national and local levels and institutional arrangements as well as efficient management and finance should be considered in the sector. Therefore, the strategic plan for SWM provides a basis for putting the defined role of government authorities and other actors into effect. A clear definition of jurisdiction and roles is essential to the political sustainability of SWM systems (Massoud, et al. 2003). As the institutional arrangements in Cambodia, the government has clearly defined the need for improving of public sector services and

suggests a reform of the civil services and public enterprise. Plan for development of SWM services will take the following alternative objectives such as government provides services, informal service provision and public-private partnerships (Inter-consult, 2002).

The local government authorities have been responsible for solid waste management service. However, over the years, various weakness in the institution financial and technical aspects, have led to inefficiency in the provision of services at various level. These contrast with the increasing waste generation rate and environmental awareness among the general public. To reduce the burden faced by the local governments, the privatization process was initiated with the aim of attaining an efficient management system to enhance environmental quality through resource, re-use and waste minimization. However, there are uncertainties in consumer's attitude towards a number of solid waste management options. A critical issue relates to consumer demand or willingness to pay with the types of services characteristics and disposal options that private contractor can offer (Othman, 2002). As these results, many studies have found and recommended that the public sector involvement implies a shift in the role of government institutions from the service provision to regulation. Essential conditions for successful private sector involvement include competitive bidding, technical and organization capacity, regulatory instruments and monitoring and control systems (Massoud, et al. 2003).

2.3.2 Sub-national Institutional Reform and Decentralization of SWM in Cambodia

In recent years, Government of Cambodia has entered a new phase of the reform for institutional management and its functions. Decentralization reform has been putting effort after general election in 2013. Districts and municipalities have embarked upon administrative renewal and various functions and decision roles has been transferring from line ministries. The statement of Minister of Ministry of Interior stated that the goal of functional transfer is to move service delivery closer to the people in order to promote local initiatives and shorten the accountability route (Vong, 2016). In the light of new phase of government policy, decentralization reform of solid waste management was also proceeded, while cooperative and coordinating functions between sub-national governments and line ministry agencies via provincial or municipal departments were delineated (IGES, 2018) and outstanding as technical department agencies. Under the new structure, the Provincial Department of Environment's role in SWM were being technical support and control (Vong, 2016). As stated by government, waste management has been

gaining increased attention in municipalities and districts (M/D) across Cambodia as a priority issue. The Sub-decree no. 113 on Urban Solid Waste Management issued in November 2015 clarifying municipal and district's mandate and delineating role and right on solid waste management at municipal/district level with the support and coordination from provincial administrations (IGES, 2018). However, the recent study by the National League of Local Councils (2016) shows that lacking personnel resource and institutionalized arrangement for M/D are the critical movement, while the financial allocation from national government are still inadequate. This study concluded that municipal and district administrations are still being guided by its Provincial administration in some tasks, although the reforming functions have been delegated to district level (NLLC,2016). In this sense, the instructional capacity of local government authorities are underserved to enable to enhance the waste management system efficiently at this moment.

The coordination and cooperation of related institution in solid waste sector are not well defined and unclear in most of the cases in Cambodia. Spoann *et al.* (2006) found from his case study in Siem Reap town that weaknesses in institutional arrangement have arisen from the three sources. First of all, the absence of accountability and transparency in ensuring competition was the cause of unreliable service and ineffective management. Secondly, the roles of the involved organizations were not clearly delineated and Thirdly, poor enforcement and low commitment of regulatory agencies led to uncontrollable practices of illegal disposal and inefficient performance of service provider. Similarly, the study by COMPED (2014) report that related organizations have blamed each other on arising solid waste issues and not were not getting along well in coordination and cooperation, especially relationship between line ministries and the Municipality of Phnom Penh. The limited institution capacity is the gap in leading implementation and control to CINTRI's service performance.

2.3.3 Legislative Aspects

With the concerns for governance issues in SWM the government realized that it would be necessary to separate the government's responsibilities as a regulator from that of supplier of services. It proved politically and practically difficult for the regulatory branch of the government to enforce compliance with regulations, which were violated or ignored by other government branches or departments- For example, the Ministry of Environment

would find it difficult to monitor SWM services provided by the municipal government and to enforce compliance with the environmental regulations. Also, it made little practical sense for the central government to subsidize local SWM services, and then for MOE to collect fines from the local governments for violations of regulations. Thus, the dual government role as regulator and service supplier impaired or jeopardized effective environmental protection. This is basically the situation in Phnom Penh today (Inter-consult, 2002).

The strategic plan for MSW management provides a basis for putting the defined roles of government authority and other actor into effect. The clear definition of jurisdiction and role is essential to the political sustainability of municipal SWM system (Massoud, et al. 2003, pp. 21). However, the lack of transparency in the decision-making process has resulted in residents being unsure of their own roles, of what to expect from the authorities, and of what the authorities expect form them. This has been a major contributory factor in the failure of previous solid waste management schemes as the case in Accra. In order to enhance household's patronage of solid waste management's schemes, residents should be involve in decision relating to type of collection arrangement and fee charged. They should also be informed about what they can do to ensure the scheme's success. Such measures would help to strengthen relationships between authorities and residents, one of the main characteristic of any democratic society (Yobo-Addo and Ali, M. 2003:387).

2.3.3.1 Legal instruments and Regulations in Cambodia

The Ministry of Environment (MoE) established in 1993, and it has the main mandate for environmental protection in the country. Based on Article 59 of Cambodia's constitution, the state shall protect the environment and the balance of natural resources and establish a precise plan for the management of land, water, airspace, wind, geology, ecological system, mines, oil, and gas, rocks and sand, gems, forests, and forestry product, wildlife, fish and aquatic resource. In response to this statement, MoE acts as a competent agency in the protection, prevention and control (of) all activities which potentially and eventually affect the quality of the environment (GMS Environment Operations Center, 2016). The General Directorate of Environmental Protection comprise of eight Departments including Department of Solid Waste Management and Department of Hazardous Waste Management. The Department of Solid Waste Management has mandate

to oversight the planning, policy, action plan and other related regulations on solid waste management. The Sub-decree on solid waste management (1999) established the legal basis for management of solid waste in the country together including municipal and hazardous wastes. The main purpose of the sub-decree is to regulate the solid waste management in order to protect human health and the conservation of biodiversity (Article 1). This sub-decree applies to all activities related to disposal, storage, collection, transport, recycling, dumping of garbage and hazardous waste (Article 2). However, the collection, transport, recycling, minimizing and dumping of waste in the provinces and cities is the responsibility of the authorities of province and cities (Article 5) (RGC, 1999). It was noted that sub-decree of solid waste management also supported by the inter-ministerial declaration between Ministry of Interior and the Ministry of Environment on the implementation of solid waste management at sub-national levels. This declaration aims at support and facilitate local government authorities and related organizations or agencies for effective implementation of solid waste management in their province or cities. The declaration is also to ensure human health and improve environmental quality, aesthetics and protection of biodiversity. In term of enforcement and penalty, it introduced the penalties of between US$2.5 to US$25 for those are illegally dumping of waste (Sethy, et al., 2014).

Although number of legal instruments were adopted and introduced by the government of Cambodia, the implementation and enforcement were not certainly acted effectively. There were some weakness due to limited functional role and responsibilities for sub-national level such as for municipal, cities and commune level (COMPED, 2014).To promote the implementation of decentralization and de-concentration program effectively, the RGC of the fourth legislation developed, approved, and implemented the law on administrative management, capital, province, municipality, district and khan in 2008. This represents a commitment to the political, administrative and development reform at sub-national levels (RGC, 2014). In addition, Ministry of Environment approved and implemented on some legislations and regulations related to solid waste management and inter-ministerial declarations (Prakas) and circulations in the past decades. These have addressed to tackle the challenges of implementation of solid waste management a national and sub-national level as well

Policy and regulations for management of solid waste in Cambodia and Phnom Penh city are shown in Table 2.4. The list of legislation and related policies indicated the

reforms of waste management over time while the decentralization policy has been introduced to Cambodia since 2012.

Table 2.4 Policy and legislation related to solid waste management

General laws, policies and regulations
National • Law on Environmental Protection and Natural Resources Management, 1996
Municipal Solid Waste Management
National • Sub-decree on Urban Solid Waste and garbage Management, No.113(2015) • Sub-decree on solid waste management, No.36 (1999) • Inter-ministerial Declaration of Ministry of Interior and Ministry of Environment on Solid waste management in province/municipalities of Cambodia, No.80 (2003) • Inter-ministerial Declaration of Ministry of Interior and Ministry of Environment on the implementation of sub-decree 113 on urban solid waste and garbage management, 2015
City: Phnom Penh • Draft Strategy and Methodology for Improving Solid Waste Management and Cleansing, Collection and Transport of Solid waste in Phnom Penh Capital • Sechkdey Chun Damnoeung (Notification) on Waste storage, Cleansing, Waste Discharge and Penalties on Improper Waste Disposal in Phnom Penh Municipality, No.13 (2013) • Instruction Plan on the Application of Penalties to Promote Environmental Sanitation in Phnom Penh Municipality, No.09 (2010) • Instruction Plan on Waste Separation Promotion in Phnom Penh Municipality, No.08(2010) • Sechkdey Naenoam (Instruction) on Penalties on waste Disposal in Public Areas, No.16(2010)
Industrial Solid Waste
National • Guideline on Solid waste management at factories, enterprise and companies, No. 11(2003) • Guideline on Sludge waste management at factories-enterprise (2000) • Directive on Industrial hazardous waste management, No. 87 (2000) • Sub-decree No. 446 on the organization and function of the Department of Hazardous

Substance Management (2015) • Declaration No. 387 on enforcement to standard level the amount of toxic or hazardous substance that allow to abandon (2015)
City: Phnom Penh • Declaration on Industrial solid waste collection and transport in Phnom Penh and Kandal province, No.148(2002) • Declaration on the permission for Sarom Trading to collect and transport industrial wastes from Phnom Penh and Kandal province, No.156 (2001)
E-Waste
National • Sub-decree of E-Waste and Electronic Equipment (2016)
Plastic bag Management
National • Sub-decree on plastic bag management, (2017)

Source: IGES, 2018; COMPED, 2014, RCG, 2015, RCG, 2017

2.3.4 Financial Aspects

In the form of PPP, the public sector may also take part in financial arrangement for private sector. Payments of the private sector may also be arranged by contracting out fee collection services to the private sector to commissioned fee collectors, or to another public utility, such as the water supply or electricity utilities (Cointreau-Levine, S. 1994).

One of the most crucial factors in determining the success of privatization is to ensure that an acceptable profit margin remains after all the costs incurred have been recovered. Cost-effectiveness of privatized solid waste collection is one of determining factors that rendered the service quality, income level of service area, technology used and a plausible fee collection (Post, 1999). However, literature review regarding the cost of municipal solid waste management shows that the question of the cost of solid waste management is very complex (Jacobsen, et al., 2013). In most cities of developing countries, SWM cost consume between 20% and 50%. However, the waste collection service levels remain low with only between 50% and 70% of the residents receiving services and most of the disposal being unsafe (Anjum and Deshazo, 1996).

Only 40 percent of urban households are currently served by some form of garbage collection (ESCAP, 1993). In Phnom Penh city, for some area with high level of income are the inner-city districts have more waste services, but on the other hand, the low-income areas in the outskirt districts are poor waste service (between 20%-60%) (Seng et al., 2018). According to UNCHS (1996), one way of estimating the scale of non-income poverty in urban centres is to base it on the number of people who live in poor quality houses or neighborhoods that lack the basic infrastructure services. Kayaka, S. et al (2003) estimated the household income that given the same level of satisfaction, households with a higher disposable income are more likely to respond faster to water (waste) bills than households with lower income levels. This because of households in former category has higher ability to pay for utility services, than those in the latter category.

According to Hassan (1985) in Mani, D. (1993), the criticisms of institutional concerned with urban service delivery, which have been made, form both equality and efficiency point of view. It has been found that the formal bureaucratic structure exclude low income groups and the poor service delivery even though it is one of their primary goal to ensure delivery to all income group. It is has been argued that the low income groups and the poor function form marginal areas, have no legal status ad are unable to pay for the services. However, in most cities in the developing world, services are provided at highly subsidized rate to the higher income group who can afford to pay the price at their costs.

For instance, the municipal solid waste management system (MSWM) system cost per capita are expressed as a percentage of the national income per capita for 11 municipalities, A general finding is that the total MSWM cost are lower in developing counties than in developed countries, which of course is due to the large different in income per capita. Thus, when assessing MSWM policy approach, it is important to take into consideration not only the financial capacity of municipal administration, but also perhaps as a still more important factor, the economic capacity of the community in general (Jorgensen and Jakoben, 1994).

Policy directed at waste diversion in the consumption and disposal stages such as a waste collection charge on the household can lead the household to demand products with less content, thereby affecting production decisions as well (Fullerton and Wu, 1998). While such a waste collection charge can give the household incentive to reduce waste, it

may also lead the household to consider to option of illegal dumping to avoid the charge. In short, a satisfactory analysis of household waste management policy warrants a comprehensive framework that includes policy instruments directed at production, consumption, and disposal stages. Without explicit incentives, neither the firm nor the household will necessarily undertake costly actions to reduce the amount of waste, but explicit incentives such as waste charges might induce households to choose the option of illegal disposal (Choe and Fraser, 1999).

2.5 Environmental and Social Aspects for Solid Waste Management

Most solid waste management studies claim that there is a direct relationship between solid waste management, behaviors and some socio-economic factors. Common among them are studies relate to environmental awareness of collection and disposal with the level of income, level of education and occupation. Several approaches have been suggested in order to improve SWM in developing countries. Chan (1998) observes environmental awareness campaigns through mass media and advertisements to be one of the methods that can be used to promote public awareness on SWM and other environmental issues Public awareness and attitudes to waste can affect the whole solid waste management sys-tem. All steps in solid waste management starting from household waste storage, to waste segregation, recycling, collection frequency, the amount of littering, the willingness to pay for waste management services, the opposition to the sitting of waste treatment and disposal facilities, all depend on public awareness and participation. Thus this is also a crucial issue which determines the success or failure of a solid waste management system (http://www.sandec.)

Most attempts to improve solid waste management studies in developing countries have focused on the technical aspects of different means of collection and disposal. By comparison, much less effort has been directed at investigating the demand-side aspects related to solid waste management (Anjum and Deshazo, 1996). The study showed the different disposal patterns of high-income, middle and low income households in Accra, Ghana. For the household in high-income areas use the standards refuse storages material and receive favor weekly house to house collection services. In middle-incomes areas, the collection crew picks up refuse twice a week (Yobo, and Ali, 2003). Inadequate service coverage could also be attributed to improper planning, operational deficiencies, lack of skills trainings for those involved and the use of inappropriate technologies which causes

inefficient use of time and resources. To make matters worse, authorities usually allocate resources to service richer and more accessible area where the residents can exert stronger political pressure. This leaves many low-income areas, including slums and squatter settlements, under-served or completely un-served (Gozun and Palomata, 2000:124).

The general belief that waste disposal is a menial job with a low social status is exemplified by the people who carry out such activities, even at the household level. They are rarely motivated to carry out the duties properly (Anand, 1999). According to Anschutz (1996) noted that households often behave contrary to schedules and rules of effective solid waste management. Sometimes this is caused by a lack of facilities; education and lack of participation in services form household level.

2.5.1 Environmental and Health Aspects

Urban planning in Phnom Penh is now at a crossroads. The recent approval by the Council Minister in 2015 on the Urban Development Master Plan of Phnom Penh Capital City over the period of 20 years has not specifically addressing each sectorial development. The environmental issues in urban areas in still focused on a field of solid waste as one of the eight priorities sector Phnom Penh Green City Strategic Plan in 2017-2016 (GGGI, 2016). The state of environment indicated that unsound waste management has already begun to cause serious impacts on public health, the ecosystem and contributed to air pollution, waste pollution and soil pollution, and threatening the sustainability of natural resource and economic development. From international agreement— the Paris Agreement and Sustainable Development Goals (SDGs), which provide a framework for local, national, and global policy making—building a low-carbon, resource-efficient sustainable society is an imperative for all cities and countries. Phnom Penh city now strike to develop the green city strategy and action plan and its sectoral strategy on solid waste management from 2018-2035 in order to attain sustainable prosperity for its residents ((PPCA, IGES, Nexus, UN Environment, CCCA, 2018).

The solid waste has increasingly contributed pollution to environment (WHO, 1982) and greenhouse emission. Based on the recent study resulting that Green House Gases emissions from waste sector will increase around 1,556 $KtCO_2eq./year$ in 2010 to 5,731 and 15,216 $KtCO_2eq./year$ in 2030BaU and 2050 BaU, respectively. This amount will contribute total country GHG emissions 5% in 2010 and 8% in 2030 (GSSD, 2015). With

the alignment of Climate Change Strategic Plan, Phnom Penh city has developed its strategic plan coping the various environmental issues— solid waste, energy, wastewater/sewerage system improvement, transportation, environmental conservation and green production. This strategic plan also proposed measures to take action in each field in order to address climate-induced environmental challenges of PPC (PPCA, IGES, Nexus, UN Environment, CCCA, 2018).

2.5.2 Willingness to Cooperation of Stakeholders in Waste Management

It is not uncommon that low-income neighborhoods often face considerable problems. Inadequate solid waste management is just one of them and its improvement may not have priority for a community. If solid waste management is not a felt need, this will have consequences for their participation in the service and their willingness to pay. A possible solution to the problem of lack of community priority for solid waste management education. This solution was tried in Katmandu, Nepal. To be achieved a change of behaviors through the provision of buckets and a competition among households for the cleanest environment. So the provision of appropriate incentives appears to be important. Other examples proved also that education alone is not enough to make people change their minds and priorities. Another solution involves consultation with the community on its problems and priorities. Ivory Coast is an example: a local sanitation committee discussed the main problems of solid waste collection and decided on solutions. But no attention was paid to willingness and capability to pay, so this project ran into financial difficulties. Households often behave contrary to schedules and rules of effective solid waste management. Sometimes this is caused by a lack of facilities. More often, however, it is due to households lacking knowledge and incentives to keep to the rules of the collection system, and operators lacking sanctions and authority. .Low willingness of households to participate in collection and recycling also depends on the perceived benefits and costs of the system. According to their experience, education accounted only for 10 to 30% of change in user habits. In Curitiba, Brazil, some interesting solutions are tried to encourage low-income households to participate in solid waste collection. First a massive education campaign, involving all media, promoted the separation of garbage at source (the "Garbage that isn't garbage" program). This program obtained a participation rate of 70% of all households, which can be qualified as quite successful (Anschutz, 1996). For the case in Phnom Penh, the recent study found out that the determinants of willingness to pay

and cooperate for waste collection service are positively influenced by education level, perceived health risk. The residents seem dissatisfied with the inefficient waste collection performance and led to improper waste management and dispose of waste illegally. Higher willingness to pay and cooperate is associated with the better services and numbers of collection frequency and income is the economic factor of knowledge and attitude toward waste management (Seng, et al., 2018).

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Chapter 3
Research Methodology

Chapter 3 illustrates the process of methodology and materials employed for the entire study. The chapter also presents the research designs for the study including description of study area, data collection method and materials, and data analysis in detail. The assessment methods and indicators are presented respectively.

3.1 Type of the Research

Part of this study of solid waste management system focuses on operational capacity of LGAs and private operating performance information, and evaluates the processes and services quality of solid waste collection system. The performance indicators for sustainable waste management were evaluated, therefore, both qualitative and quantitative information were employed for the assessments.

The study was descriptive and evaluative research using sustainability domains for assessing the performances of LGAs and the contracted collection service. The evaluative will examine the correlation between the existing solid waste management service and the institutional capacity of local government bodies, private operator and stakeholders during the reform of MSWM in Cambodia. The study was also focusing on assessment of supply-side of waste management system t associated with LGAs and CINTRI by problems and opportunities for improving the system. The study tries to come up with primary data analysis form focus group discussion and semi-structured interview with key informants. However secondary data were also collected according the data needs. Actually, the secondary data of study are very limited due to the few study on institutional capacity of public and private sector on SWM in Cambodia. The key questions are to be asked in the FGDs and semi-structured interviews are necessarily related to answer the research questions (see Figure 4.1 below).

3.2 Research Analytical Framework

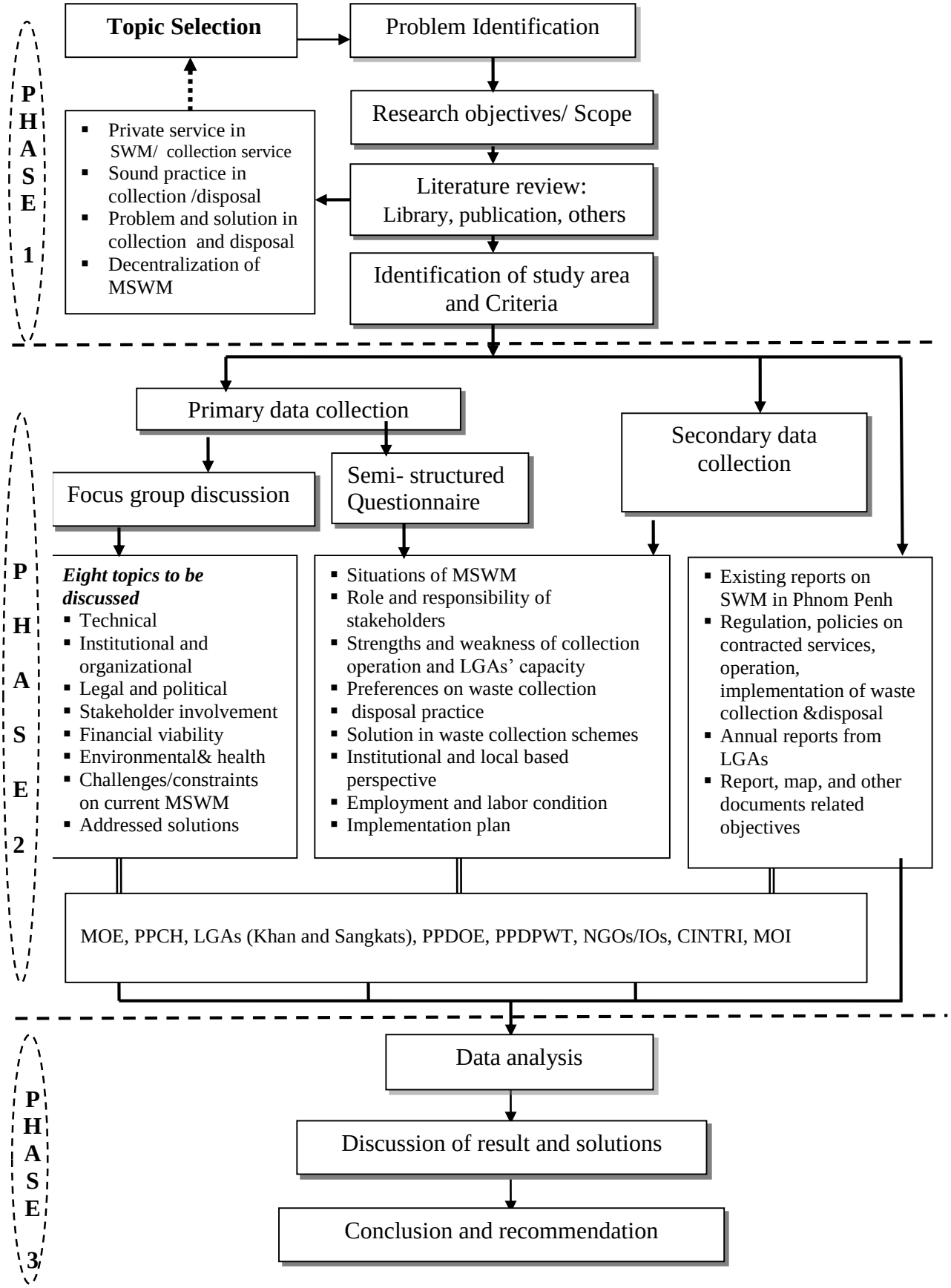
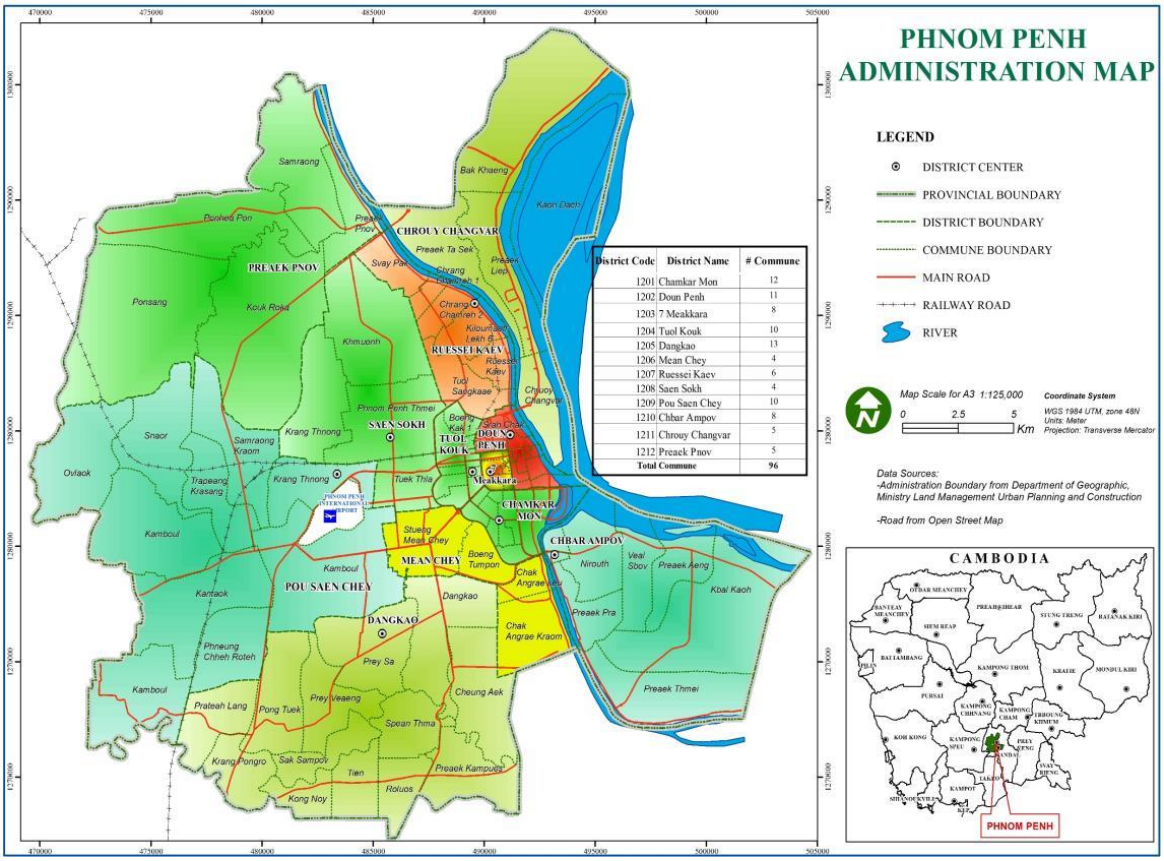


Figure 3.1 Research Design of the study

3.3. Study Area

The study took place in Phnom Penh city. The total population was 2.06 million in 2015 (JICA 2014). The city expanded its administrative boundaries in the past decade associated with economic growth and structural changes covering 678 km^2, including 12 districts and 96 communes. The average population density is about 2,213 persons km^{-1} (Hul et al. 2015) and the area of city will expand up to a 100 km radius around its city centre (PPCH, 2015). PPCH is the centre of business and commercial hub, government administration and agglomeration of economy which urban sector share accounts for 50% of country's GDP (GGGI, 2016). In the light of rapid growth of urban population due to urbanization and industrialization, the city has also increased in waste production and other waste streams beside municipal solid waste such as hazardous waste, industrial waste and construction and demolition waste (IGES, 2018).

Figure 3.2 Map of the study area



Source: GGGI (2016)

3.4 Data Collection Methods and Materials

The collection of data is derived by the goal of the study; the evaluative assessment of p the public and private sectors' performance is conducted. Joseph (2006) and Visvanathan et al., (2004) indicated that achieving sustainability in waste management requires an integrated approach including the combined solid waste elements, stakeholders' involvement (waste processors) and the interactions between waste system and other relevant systems in urban context. For this study, the current context of solid waste management in Phnom Penh municipality is established and private operator namely CINTRI waste Collection Company and government actors are addressed. Key issues on quality of service, operational quality and legal and institutional landscape between municipality and private contractors are examined. The case study approach allows the evaluation of both quantitative and qualitative variables and offers the opportunity to develop the causal link between the action and outcome in real life situation. With is approach were used by Massuod et al. (2003) for his study for assessing public vs private SWM management. Governmental documents, reports, scientific papers, and academic literature were also reviewed. Besides reviewing literature, the data used in this study were drawn from the combination of primary source using the focus group discussion (FGDs) during the 8-month project study from November 2016 to June 2017 based in Phnom Penh. A total of 60 key informants, including representatives from PPCH, MOE, Phnom Penh Department of Environment (PPDOE), CINTRI waste collection Company and LGAs officers of the twelve districts were conducted. The FGDs focused on the waste collection service performance, quality of services and system improvement, legal enforcement; stakeholder involvement, and challenges and limitation to LGAs and private sector for SWM. Thus, all data can obtain through the following:

3.4.1 Primary Data

The primary data direct interview of key stakeholders and waste collection Company and related line departments officers. In order to get information from targeted key informants' perception, experiences, possible solutions and the practices of SWM, the researcher conducted both focus-group discussion and semi-structured questionnaire survey. There are three mainly methods of primary data collection:

3.4.1.1 Focus Group Discussion

The focus group discussion sessions were merged the participants from different organizations which are purposively invited to discuss on the urban solid waste management issues in Phnom Penh particularly. In specific discussion topics, research proposed the discussion themes on waste collection performance and system improvement, recycling, final disposal, capacity building, awareness raising, public participation, policy engagement, legal enforcement, challenges and limitations. In addition, group discussions with LGAs offer the generic results for determining the causal link between challenges and opportunities. Again, the results from focus group discussion were asked to present to audience in the following sessions. The participants are allowed to have questions or ask for clarification on identified problems and the priority actions. Participant's interactions were considered as the justification of the information and bring more insight of the waste management aspects in the Phnom Penh as specific.

3.4.1.2 Semi-structured Interview

The respondents for the questionnaire interview were selected from the purposive areas. During the field data gathering, the study also conducted semi-structured interview with LGAs' representatives, representative from department of solid waste management, MOE, representative of Division of waste management at Phnom Penh Capital, Phnom Penh Department of Environment, Phnom Penh Department of Public Work and Transport, representative from non-government organizations such as COMPED, SCARO and EURO champ etc. About 20 representatives were interviewed and the questionnaire instrument is designed with open questions with the focuses four sections included: role and responsibility of organization related to waste management, perceptions on current solid waste management in practices, challenges and constraints on urban solid waste management due to decentralization policy, recommendations for improving and enhancing the capacity of organizations.

The protocol of the survey was divided into two steps. Firstly, research developed the questionnaire instruments with consolidation from the literature review and purpose of the study. Secondly, research prepared and sent the appointment requests to key informants with the questionnaire or electronic file for their review and preparation. However, during the interview time, the interviewees were introduced the purpose of the study and asked

with leading questions. The researcher was able to discuss on with answers along the session in order to have more elaboration and explanations where are attempted by research objectives. Following the assessment methods for qualitative information, the study adapted with existing techniques (see in below section) through applying assessing indicators/criteria as shown in table 3.1 below.

Table 3.1 Indicators/criteria and questions to be considered for the assessment

Assessment indicator/Criteria to be assessed the sustainable SWM	**Questions to be covered**
1. Technical aspects	
- Collection rate - Collection coverage - Collection efficiency - Disposal practices	- Is the technology appropriate to existing local infrastructure conditions? - Can the collection facilities cope with and adapt to possible changing conditions (e.g. quantity or nature of waste)? - Has the most cost-effective technology been selected for CINTRI services? - In relation to the total amount of waste generated, what % of waste is collected? - Relative to the total population, what % of people are served? - Quantity and physical property of waste bins in commercial areas
▪ ***2. Health and environmental aspects***	
- Collection efficiency - Cleanliness - Environmental safeguard at landfill - Illegal dumping	- Illegal disposal practices and areas as % of waste generated - Is collection performance adequate and sufficiently clean? - Do the crew and cleansing workers' well-being and health? - Is community wellbeing and health safeguarded? - Does the study support a modernized and sustainable system?
3. Institutional and organisational aspects	

- Personnel capacity and employment - Role and Responsibility of stakeholders - Institutional framework - Labour tenure - Coordination and Cooperation	- How are tasks performed? - Are MSW systems were being delegated effectively? - How do LGAs monitor and control waste collection service? - Are there sufficiently skilled staffs; is there a legitimate workforce for MSWM? - What are the management gaps for LGAs and CINTRI? - Is the management framework workable and feasible? - How well is MSWM functioning? Is there effective cooperation with other stakeholders in the system that will allow for the structuring and maintenance of successful interaction?
4. Financial viability and economic aspects	
- financial and fiscal viability - Willingness to cooperate/pay for waste service - Fund for waste management - Accountability	- Level of fee collection efficiency and payment vehicles - Budget allocation for waste management as % of the total budget - Operation and maintenance cost under LGAs' responsibility - Level of cost-sharing amount shared holders
5. Social aspects	
- MSWM activities/Campaign - Stakeholders' participation - Communication mechanisms/complaints	- Do residents and local authorities believe that waste services are socially beneficial; are they supportive of the services? - Has consideration been given to community participation/ involvement in the waste services providing by CNTRI? - How do they communicate (private-public and community) with each other?
6. Policy and legislative aspects	
- Relevant legislation, strategies on MSWM	- Are the policies and legalisation sufficient; are they implemented in such a manner as to facilitate the

- Legal frameworks for LGAs - Incentives or barriers to waste management practices	work of current SWM? - Do the decentralized SWM receive support from the private operator and local government authorities? If not, what are the limitations or gaps? - Do the waste services comply with quality standards of service as define in the contractual agreement? - How does the public sector enforce the policy and legal frameworks?

Source: Zurbrügg C, et al. (2014), van de Klundert et al. (2001); Massoud et al. (2003); Wilson and Tormin (2000); COMPED (2014); Spoann (2010)

3.4.2 Secondary Data

The secondary data are collected through the available reports from governmental documents, reports, scientific papers, and academic literature, unbound documents and publications. Some important documents are imperative to discuss and analysis such as sub-decree on municipal SWM, government declarations, *prakas*, guidelines, solid waste strategy and action plan for Phnom Penh and other existing legal documents for Phnom Penh Capital. These set of information are collected from Ministry of Environment, JICA research team, Provincial Department of environment (PDOE), project and the study on waste management in Phnom Penh by COMPED, IGES and the Asian Foundation are the main contributions to the review and discussion. For the private sector side, especially, Collection Company (CINTRI) and Sarom trading industrial waste collection are also considered as the control partner for providing inputs for this study.

3.5 Data Analysis

Given the goal of the study, an assessment of SWM collection services in Phnom Penh city is private sector conducted. The current context of solid waste management in the town is established. Key issues and constraints with the type operation and participation between private contractor and service users are addressed. The problems and opportunities associated with the private sector and public institutions are scrutinized. The case approach allows the evaluation of both qualitative and quantitative variable and offers opportunity to assess or develop the casual link between the action and the outcome in the real life situations. Due to data limitation, qualitative approaches were predominantly

undertaken for the analysis. Two qualitative analysis methods—aspect analysis and structural analysis, were described in the following sections.

3.5.1 Aspect Analysis

The study employed aspect analysis for examining as sustainability aspects of waste management as described in below section:

The technique was used primarily to assess the determinant factors which influencing the both local government units and private sector performance. To do so, the assessing criteria is used for evaluate the performance measures and monitoring of waste quality and system viability. Those typical criteria to be used for assessment are: efficiency, reliable inputs, effectiveness for assessing quality and technical system of collection system. The fairness, clarity, accountability, enforceability, concordance within institutional framework for assessing institutional arrangement and management of public-private partnerships and the willingness to cooperate, participate from related stakeholders for improved waste services and institutional capacities. The challenges and constraints that are influenced to the process of waste management system are to be analyzed based on the information and finding for related chapters (Chapters 4 and 5).

The aspect analysis gives a rich and full set of idea about the problem, challenges of solid waste management and it can be used to support research in any area (Anschütz, et al. 2004). The existing solid waste system can be assessed through distinguished six aspects based on the ISWM concept (the third dimension). The ISWM aspects create measures to give the desired results (de van Klundert, 2001). Anschütz, et al. (2004) has described the six sustainability aspects of the system are as the following as illustrating of in Table 3.1 (performance indicators for assessment of waste management system).

For this study, the qualitative data and information were recorded and deeply exploring during the focus group discussions (FGDs). There are two steps of data exploration are: 1) identification of key issues and problems from all respected aspects above; and 2) examine and propose the set of opportunities and improvement measures for improving municipal solid waste management in Phnom Penh Capital. The detail technique is provided in *Appendix C*. of Aspects, Techniques and Data Sources for the aspect Analysis.

3.5.2 Structural Analysis:

The study employed structural analysis for analyzing a way to see through the complexity of the impacts of sustainability dimensions on integrated solid waste management. It identifies the key elements of waste system, outline the relationships between the elements, and highlight the ranking structure with in the system (Ancelin, 1983). By following with Ancelin (1983), the structural analysis proceeds in four steps. First, we identify the relevant variables, e.g indicators of the five aspects in waste management adapted from Zurbbrügg et al, (2014), Second, an interaction matrix of all identified indicators are constructed to see the strength of driving power versus dependency of the constructs. Third, we summed the score (dummy score are 1 and blank, otherwise) of each row and each column. Finally, we analyzed the relationship based on four assuming four categories of variables.

The interaction matrix, *A*, is built (Table XX: solid waste variables), letting X_i and X_j to be variables and $a_{i,j}$, a measure of their interaction such that

$$a_{i,j} = \begin{cases} 1 & \text{If } X_i \text{ exerts a direct influence on } X_j; \\ a\ blank\ space, & \text{Otherwise.} \end{cases} \quad \text{(A1}$$

The sum, P_i, of a given row, I, measures the ' *arıvıng power* ' of variable X_i:

$$P_i = \sum_j a_{i,j} \quad \text{(A2}$$

Conversely, the sum, D_j, of a given column, *j*, measures the ' *dependency*' of variable X_j :

$$D_j = \sum_i a_{i,j} \quad \text{(A3}$$

The solid waste operational system, we define variable are: let variable X_1 refer to 'Quality of Service', X_2 to 'technological appropriate for collection system', X_3 to 'collection efficiency in terms of collection frequency and scheduling', X_4 to 'cleanliness of the city', X_5 to 'stakeholder's involvement in SWM', X_6 to 'personnel resources (skills and manpower', X_7 to 'labor tenure and employment condition', X_8 to 'role &responsibility of LGAs', X_9 to 'institutional framework for related agencies', X_{10} to 'coordination &cooperation', X_{11} to 'willingness-to-pay for improved collection service', X_{12} to 'accountability', X_{13} to 'monitoring &control (of) activities of CINTRI' , X_{14} to 'regulation instruments for SWM' and X_{15} to 'enforceability performance of government bodies to the

public'. The sum of rows, P_i , and of the columns, D_i , are given on the left and the top of borders of the matrix respectively (See Matrix in Appendic C.). The information and scoring in this matrix are used to draw a *'dependency' versus 'driving* power' graph in graph builder of SPSS package.

According to Holling, 1978 cited in Martin and Lefebvre (1993) indicated that the structural analysis here can be presenting a special case of cross impacts analysis. It is emphasizing on interaction term instead of indicating the presence or absence of an interaction and this interaction term can be chosen to represents its strength between identified variables.

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Chapter 4:

Municipal Solid Waste Management in Phnom Penh: Constraints and Opportunities to Improve Capacity of Local Government Authorities

Chapter 4 presents the results and discussions of the study. The report describes and analyzes the constraints and opportunities for improving local government authorities on solid waste management. The chapter focuses on the institutional capacity of local authorities due to the decentralization policy on urban waste management.

4.1 Solid Waste Management in Cambodia

Solid waste management involves management of activities associated with generation, storage, collection, transfer and transport, processing and disposal of SW which is environmentally compatible adoption principle of economy, aesthetic, energy and conservation. It compasses planning, administration, financial, legal and engineering aspects involving interdisciplinary relationships Bhide (1983) cited in Spoann (2010).

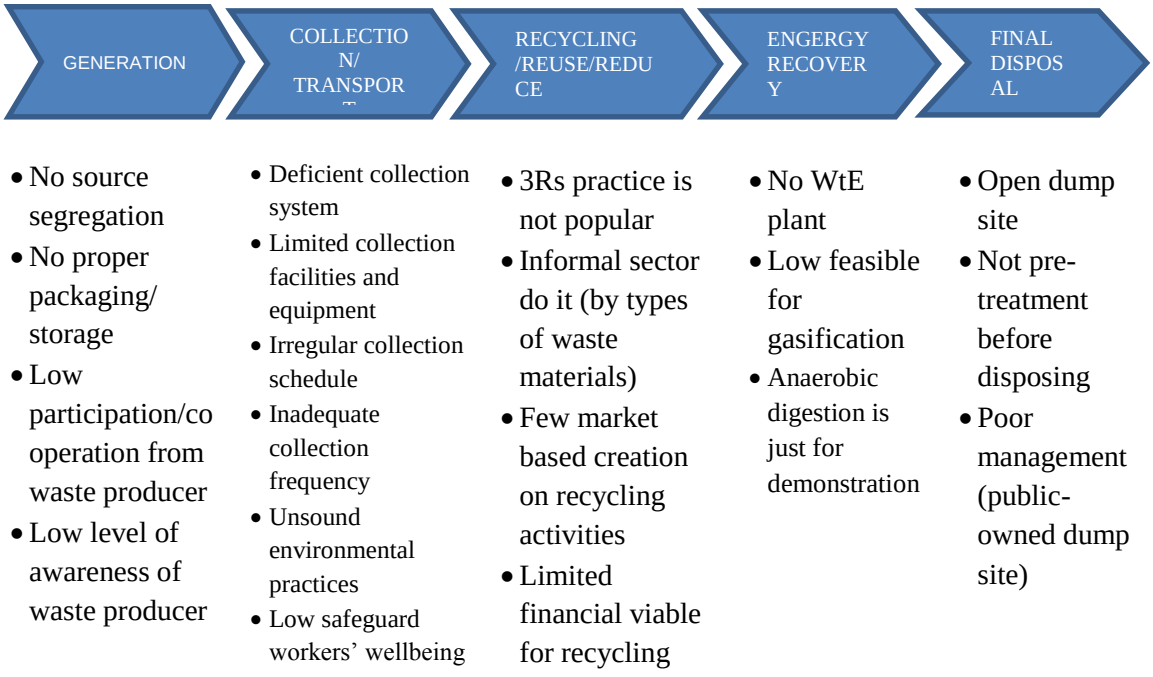
Phnom Penh is the capital of Cambodia, has outstanding economic growth for two decades. Growing of economic activities, increasing industries, rapid urbanization generate prosperity and contribute to improve livelihood of its peoples. With these trends of urban development coupled with economic development have brought to change the lifestyle and increasing consumption as well as, at the same time, increase in waste generation in the city from 0.136 million tons in 1995 to 0.681 million tons in 2015 (Seng et al, 2013). Nowday, the city faces with two main challenges for the trends of increase of waste generation are: 1) volume of generated wastes, and 2) nature of waste collection operated by CINTRI. These would pose to environmental pollution, health risk and resource challenges.

Figure 4.1 depicts the waste flow chain ant its attributes from generation at sources to the final disposal. Most of the cities in Cambodia, like Phnom Penh Capital, household wastes are mixed together and storing in different type of bins. Collection and transportation are mostly responsible by CINTRI. Many recent studies indicated that waste collection system did not fulfill the resident's demands and satisfaction level. Many peri-urban communities are still lacking of services due to limited collection capacity (Spoann, et al, 2018, Seng, et al, 2018). Recycling activities have not been popular for Cambodia as

recycling activities are done by informal sectors (Seng, et al., 2010). Technically, there have some feasible project implementation for energy recovery; however, the city has not been approved on the proposal due to financial and technological constraints. MSW disposal in Phnom Penh is totally relied on a single landfill with rudimentary practices. The landfill life span is even shorter than what it would be due to bulky mixed waste loading from daily increasing of wastes from this urbanized city. Waste loading in this landfill caused to environmental pollution and threaten to neighbor communities.

Solid waste generation in Phnom Penh Capita is typically from the three sources defined by the ministry of environment. They are: i) municipal solid waste (residential and commercial and market waste); ii) hazardous waste (typical waste from factory and industry waste; and iii) medical waste (from hospital and clinical site).

Figure 4.1 Solid Waste Value Chain in Cambodia (Author modified from Seng, et al., 2018).



4.1 .1. Waste generation, compositions and disposal

In Cambodia, with a rapid economic development together with urban and industrial development with nearly three decade has been giving rise to the concerns of how to manage municipal solid waste in the urbanized cities. According to Figure 4.1, the annual

total MSW in Cambodia generate around 2.80 million tonnes per annum and the waste generation rate is estimated to be around 0.50 kg/cap/day in Cambodia based on the population of 15, 391,058 in 2014 (MoE, 2017). The recent reports from Phnom Penh Department of Planning estimated that, waste generation rate in Phnom Penh is a bit higher than other cities, it accounts for 1.59 kg/cap/day. This increase is because of the rise of standard of living and economic activities (ibid).

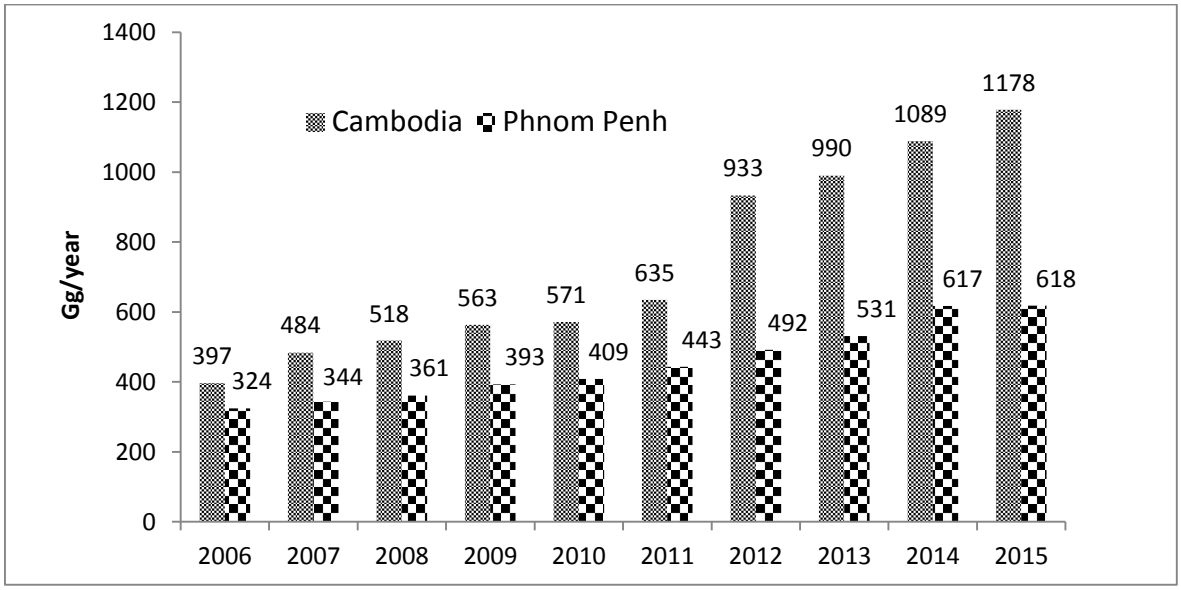


Figure 4.2 The total amount of solid waste disposed in dumpsites for Cambodia and Phnom Penh (Gg/year) (DoPC, 2014 and MoE, 2016)

Most Cambodia waste collection system, transportation and final disposal in major cities provided by private contracted company under the supervision of local authorities and related government technical departments (Sethy, et al., 2014). Some small town and urban center are also absent of private operators as the waste collection schemes is not feasible and the waste disposal practice are uncontrollable. In these areas, each household manages its own waste by their own ways. Traditionally, the wastes are disposed in the vacant lands or private lands, burying and burning openly and through wastes into water body and waterways (ibid, and Spoann, 2010). Most of the cities in Cambodia, the final disposal of municipal solid waste are disposed at dumpsites which are not environmental soundly designed to comply with minimum standards and requirement of environmental quality. The dumpsite with a large open space area, no soil cover and uncontrolled leachate treatment system are used for landfilling (MOE, 2017).

MSW generation in Phnom Penh has increased rapidly from 0.136 million tons in 1995 to 0.409 million tons in 2010 (Seng et al. 2013), and 0.681 million tons in 2015 (PPDoE 2016). Table 2 shows the quantity of waste disposed at the final disposal site in 2004-2015. About 20% of total waste generated in the city has not been collected. The gross generation rate per capita was about 0.74 kg day^{-1} in 2003 (Seng et al. 2010) and 0.762 kg day^{-1} in 2013 and would be 1.24 kg day^{-1} in 2030 (Hul et al. 2015). A household generates about 0.34 kg $capita^{-1}$ day^{-1} (Fujiwara et al. 2013). The major composition is kitchen waste (63.3%), followed by plastic (15.5%), grass/wood (6.8%), and paper/cardboard (6.4%). The remaining waste includes metals, glass, rubber/leather, textiles, and ceramic/stone, which accounted for less than 3% (Seng et al. 2013).

Table 4.1. Population, GDP and amount of waste generated from 1994-2015

Year	Population in million [a]		GDP (USD $Capita^{-1}$) [b]	Waste amount in Phnom Penh (tons $year^{-1}$) [c]
	Cambodia	Phnom Penh		
2004	12.824	1.044	389	227,910
2005	12.963	1.108	454	266,781
2006	13.103	1.177	513	324,159
2007	13.245	1.249	575	343,657
2008	13.868	1.326	739	361,344
2009	14.085	1.438	765	393,141
2010	14.302	1.504	830	409,335
2011	14.521	1.570	853	442,469
2012	14.741	1.637	915	492,380
2013	14.962	1.704	1,036	531,340
2014	15.184	1.770	1,137	617,489
2015	15.405	1.835	1,237	617,905

Modified after Seng et al. (2013); [a] MoP (2008); [b] RGC (2009); RGC (2014) and [c] PPDoE (2016)

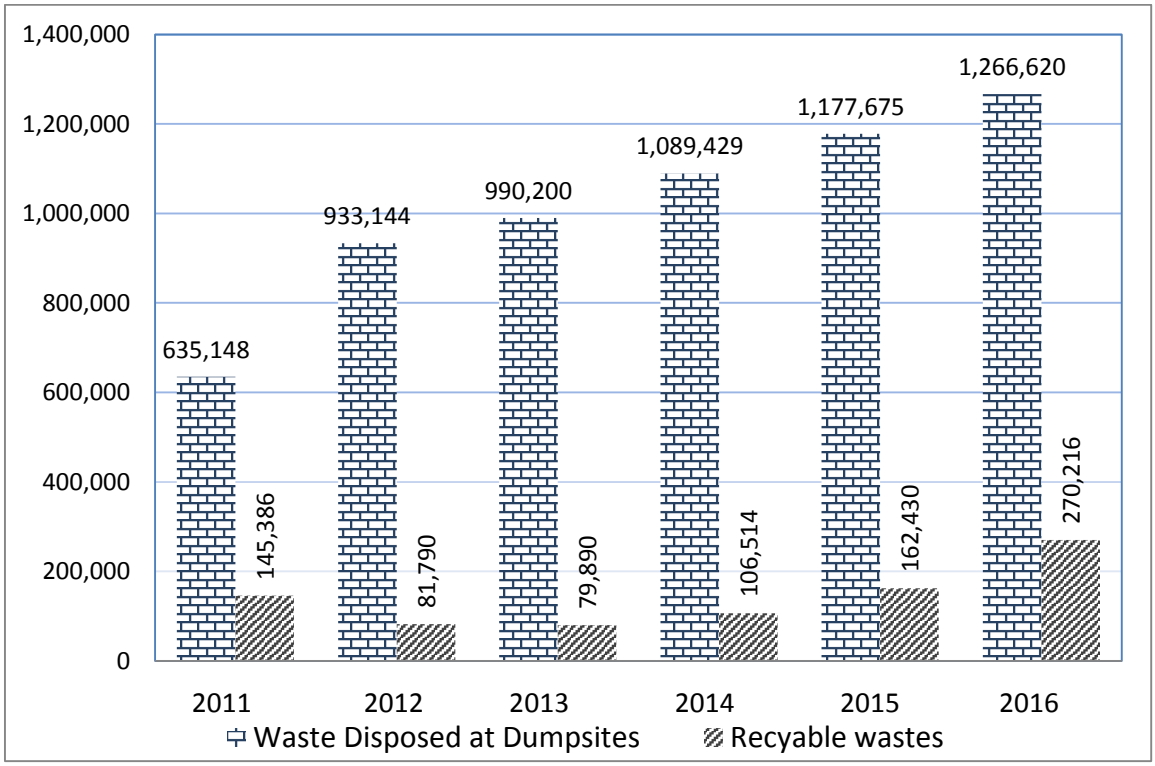
The collected MSW is transported to the landfill site in the Dangkor District, about 16 km from the city centre, which has been under operation since 2009. The landfill, with an area of about 26 ha, was initially designed as the sanitary landfill. However, due to financial difficulties and a lack of technical staff, it is now being operated as a partial sanitary landfill when soil covering is irregularly performed (Seng et al. 2010). Disposal of

mixed waste shortens the site's life-span. It is expected that the amount of daily waste generation will exceed 2,200 tons day^{-1} in 2020. It would increase pressure on MSWM (COMPED 2014). The uncollected waste is another issue where about 100-200 tons remain self-treated (Denny 2016). Most households usually burn, bury, or dump their waste in their gardens or free land (Seng et al. 2010; COMPED 2014; Denny 2016).

4.1.2 Resource recycling and recovery

The informal sectors have informally conducted waste recycling in Phnom Penh. In 2003, about 9.3% of the waste generated was recycled (JICA 2005). The reasons for the low MSW recycling are associated with the low cost of end-product recovery and difficulties of source separation (Seng et al. 2013), and localised market dependency where processing is partially aided by technology.

Figure 4.2 Amount of solid waste disposed at dumpsite and recyclable wastes in Cambodia



Source: MOE (2017)

Figure 4.2 shows the amount of recyclable waste are recycled by informal sectors by year comparing to total solid waste generation. Interestingly, the amount of recyclable wastes have gradually increased from year 2103 to 2016. LGAs have suggested that resource recovery could be used to promote the development of a biogas digester for gas

recovery from existing landfill. Hence, the resource recovery initiative has attracted investors as municipal and government policies were decentralised.

4.1.3 Solid Waste Collection and transport in Phnom Penh Capital

The coverage, efficiency and frequency of collection vary substantially from one area to another, or even form one street to another street. As the single contract waste collection company (CINTRI) does not specify the required service level or standard, the contractor provide whatever service collection system in Phnom Penh. The reality of the collection service seems to be deteriorating in Phnom Penh. In many areas, the collection frequency has dropped from once a day to one per two or three days. In addition, the collection times are quite flexible. Residents must wait for the trucks to honk their horns to signal that they are on the street. However, with irregular collection times, people are not always home or always home or ready to deliver the waste. Consequently, more and more households place their waste outside their house along the curb or roadside, where it is exposed to the itinerant waste pickers and animal scavengers. The collection job is also made more difficult for the labors, as they will have to shove the loose waste from the ground. This system leads to unacceptably low collection efficiency (10-20%) and too much waste is left on the streets of Phnom Penh. The challenge for the municipality is to replace the existing collection system with systems that are more efficient, yet not more expensive, and to expend the service coverage to those areas that are without service today.

In Phnom Penh, collection service is adequate only in some places such as at shopping centers, restaurants, and hotels (see Figure 4.4). The collection is mainly done with motorized-vehicle and very few areas pushcarts are used. Truck go from one place to other have four to six workers and one driver, the residents in this area are supposed to come and dumped their waste into the truck. When the truck is filled up with wastes it is transported to the only dumping site called Dangkor landfill. At the present waste collection area have been identified as:

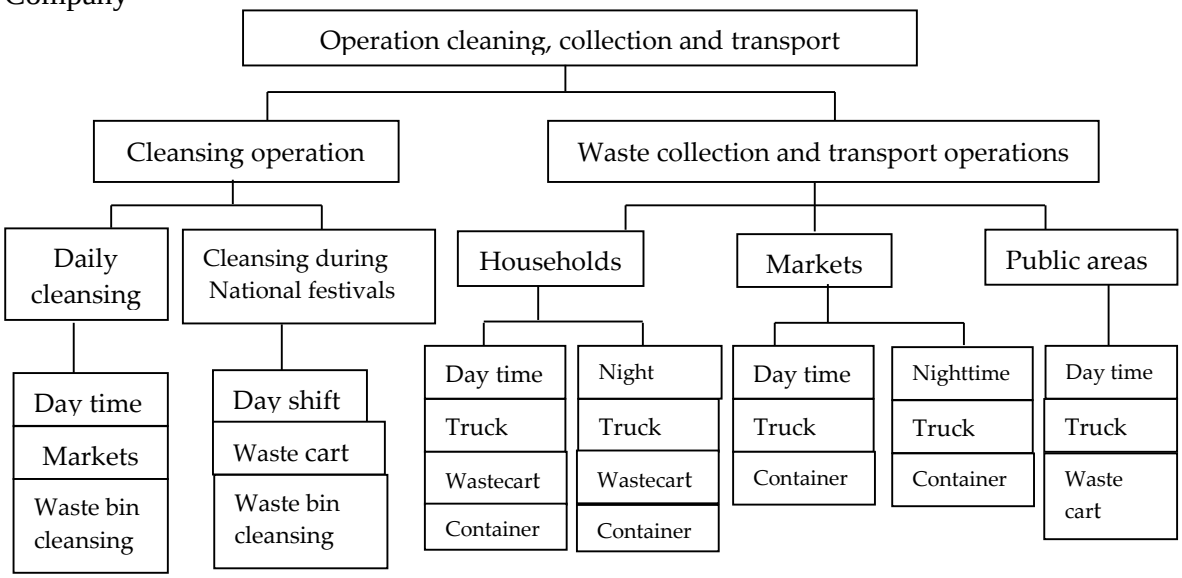
- ***Service Coverage*** **:** the service coverage of collection system is about 80% in the urban and 24%-40%. This variation is not only due to the differences in service coverage, which is much less in rural area and in the poorer residential areas, but also due to variations in the waste generation.

- ***Collection Efficiency*:** Not all the waste generated in the area actually collection duet to many reasons. These include the lack of storage bins, irregular collection frequency and the types of collection systems used.

- ***Collection Frequency*:** The collection frequency will depend on storage facilities at the household level and the collection system. However, in Phnom Penh the waste collection is known as unreliable and irregular collection service.

- ***Standard of Service:*** it refers mainly to reliability of the service, but also to characteristics such as noise, smell and littering in connection with collection equipment operations.

Figure 4.4: Operational collection, cleansing and transport by CINTRI waste collection Company



Source: COMPED, 2014

Although getting recommendations and restrictions from the local authority and MoE, commonly, SWM is still limited in Phnom Penh municipality. Waste collection process reasonably seemed to be less suitable to daily waste generation, resulted from: (1) poor conditions of collection vehicle, facilities and roads, (2) inadequacy of vehicles and equipment for waste collection and transportation. This is why waste piles still existed at market areas or on the streets or sidewalks with mess condition, although a proper schedule of waste collection was set up. In some case, collection process is not sufficient in areas where waste collection vehicles cannot access (Inter-consult, 2002).

4.2 Performance evaluation

Effectiveness, efficiency, accountability and service quality were used to assess the MSWM performance. LGAs' management and organisational capacity are evaluated using six measures such as technical, environmental, institutional and organisational, financial and economic, social and cultural, and policy and legal performance measures. Table 1 presents 21 indicators/criteria and 28 questions to be considered for the assessment.

Table4. 2 Performance measures and assessing indicators/criteria

Assessing indicators/criteria to be assessed	**Questions to be covered**
1. Technical performance measures	
- Collection rate - Collection coverage - Collection efficiency - Disposal practice	- How much waste is collected as % of total amount generated? - How many people are served as % of the total population? - Quantity and physical property of waste bins at commercial areas - How well is a waste being disposed of?
2. Environmental performance measures	
- Collection efficiency - Cleanliness and Environmental activities - Fund environmental awareness	- Illegal disposal practices and areas as % of waste generated - Is collection performance adequate and clean enough? - Environmental and clean-up campaigns - Policy, annual development plan for environmental awareness - Are collection points /waste storage points clean?
▪ 3. Institutional and organisational performance measures	
- Personnel capacity and employment - Role and Responsibility of stakeholders	- How are tasks performed? - Are MSW systems were being delegated? - How do PPCH monitor and control waste collection service? - Is there sufficient skilled staff and workforce for

- Institutional framework - Labour tenure - Coordination and Cooperation	MSWM? - What are the management gaps for LGAs? - Is the management framework workable and feasible? - How well is MSWM functioning?
4. Financial viability and economic performance measures	
- Efficiency of fee collection - Budget allocation - Accountability	- Level of fee collection efficiency and payment vehicles - Budget allocation for waste management as % of total budget - Operation and maintenance cost under LGAs' responsibility - - Level of cost-sharing amount shared holders
5. Social and cultural performance measures	
- MSWM activities/Campaign - Stakeholders' participation - Communication mechanisms	- What types of activities do LGAs carry out? - Are the stakeholders/ service users willing to participate/pay in MSWM activities? - How do they communicate with each other?
6. Policy and legal performance measures	
- Relevant legislation, strategies on MSWM - Legal frameworks for LGAs - Incentives or barriers	- Are the policy and legal frameworks sufficient? - Do the strategic plans reflect the policy and legal frameworks? - How do LGAs enforce the policy and legal frameworks? - What are the obstacles to attaining the management plan?

van de Klundert et al. (2001); Massoud et al. (2003); Wilson and Tormin (2000); COMPED (2014); Spoann (2010)

4.3 Institutional Arrangement

MSWM in Phnom Penh has been an authority of several different contractors since 1994. As seen in Figure 4.5, collection, transportation, and cleaning were historically the responsibility of the Department of Public Work and Transport (DPWT). After 1994, PPCH franchised the service to private companies due to the limited capacity of the DPWT

(COMPED 2014; Kum et al. 2005). The service providers had changed several times because of the financial difficulties. PPCH finally has contracted a private company, CINTRI, to provide collection service.

Table 4.3: Roles and Responsibility of Institutions Involved in SWM

Institutions	Role and Responsibility
➢ **Ministry of Environment (MOE)**	▪ MOE is the main responsible body at the national level for the administration of SWM. The MOE is responsible for established proper guidelines for SWM, approving and issuing operating and discharge permits for the necessary facilities, new or old, such as storage and transfer station, recycling and treatment plants and final disposal sites. The MOE is also responsible for monitoring, control and enforcing compliance with environment with the environmental law and the operating and discharge permits.
➢ **Phnom Penh Department of Environment (PPDOE):**	▪ In term of decentralization of its responsibility, the Phnom Penh Department of Environment (PDOE) play role quite similar to MOE. It like at branch office of MOE in Phnom Penh as show in appendix B. There are more than 30 personnel in total in PDOE and the pollution control and education office which has 5 staff members, is responsible for SWM.
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  -
- **Department of Public Work and Transport (DPWT)**
  - A MSWM facilitator and the responsible body for waste cleansing and city parks through the supervisor form Phnom Penh Capital. The organization of DPWT is shown that one of the four deputy offices is responsible for the Drainage and Sewerage office as well as the city cleansing unit. The unit, however, has a few staff members and carries out very limited administration work.

Division of Waste Management of Phnom Penh Capital

- There is the planning and management body who deliver the urban service to private sectors. The Board of Director (BOD) is the legislative organization consists of Phnom Penh governor and municipal council who play the key role in making decision. Then, The CINTRI waste collection company was contracted by Phnom Penh Capital Authority under the supervision from Division of Waste Management as a public sector partnership. So the roles and responsibilities of Division of waste management towards SWM service are:
  - Develop sector strategies and development activities, and determining the service contracting and investment.
  - Carry out research and development activities, such as planning and implementation the project
  - Development technical and financial sector plans according to government priorities (SEDPII),
  - Preparing annual investment and operating budgets, setting collection fee tariff and charge.

	▪ Carry out public relations, planning and awareness information campaigns. ▪ Carry out delegation the role and duty to Khan and Sangkat and coordination of urban waste management based on sub-decree 113 adopted in 2105. ▪ Preparing the legal instruments and local ordinance related to urban solid waste management
Local Government Authority District Authority (LGAs) (Local Authority involved in service delivery in SWM as partnership to contractor company)	▪ Is the main executing SWM service (public sector partner) under control by PPCH. Key player (regulating agency) in solid waste management service. ▪ It is at the local government level have been authorized from the provincial governor to deliver the SWM service. Municipal and Khan authorizes have very wide mandates, it may delivery and co-operate with hand in hand to SWM services with the contractor, such as collection and disposal, or to contract out these services and control/monitor the performance of private service providers. The district authority mandates are addressed in sub-decree 113 (in year 2015) (see figure 5.2: Organization chart of SWM arrangement)

The contractor could recover the operation and disposal costs through a monthly fee collection (Seng et al. 2010). However, service was still not efficiently provided (Spoann 2010). The management, therefore, was transferred to LGAs in 2015 by decentralisation (MoE, MoI & MEF (2015). The interview results indicated that the LGAs faced to handle their assigned responsibilities due to controllable constraints and limitations in their administration area.

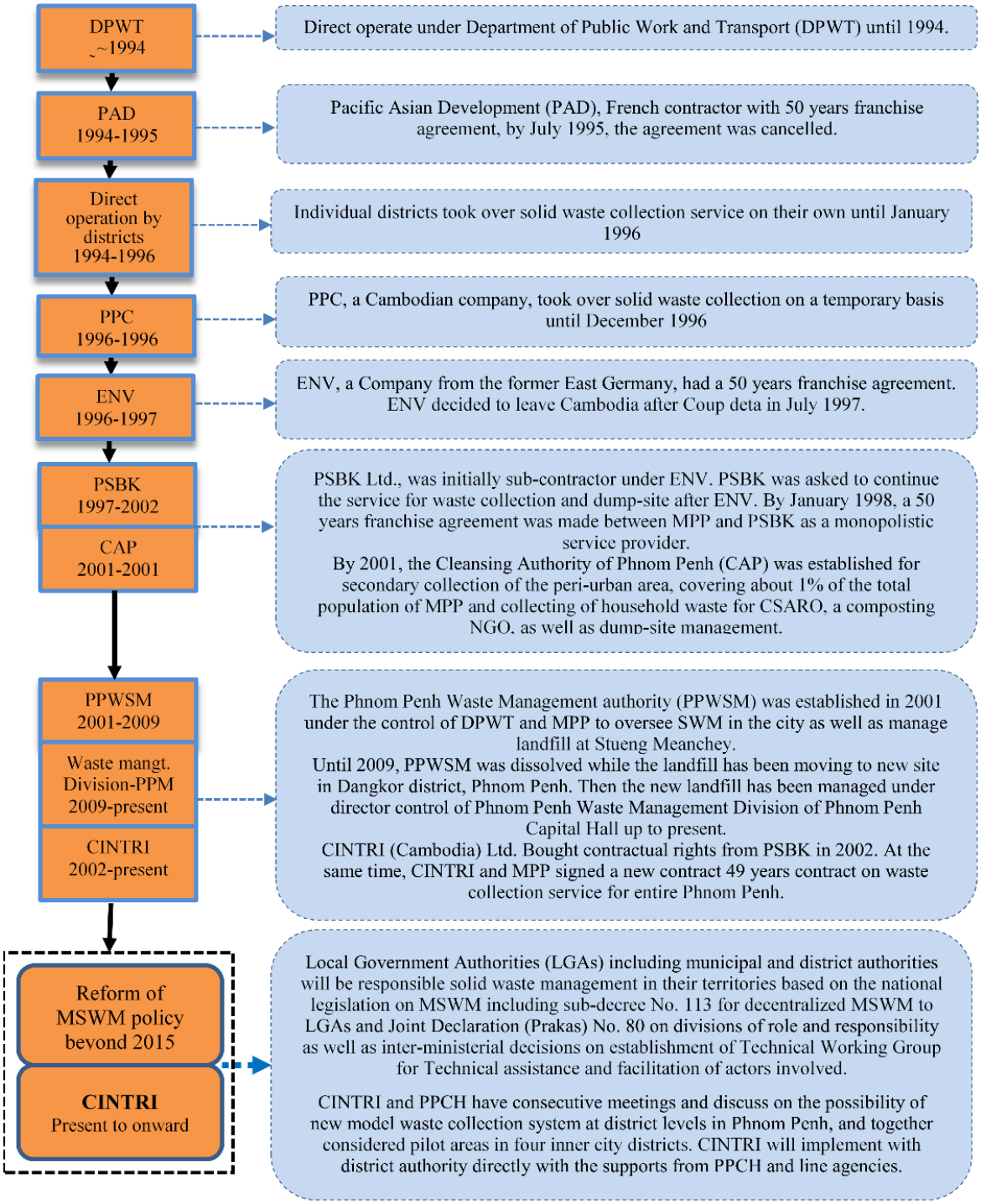

Figure 4.5. MSWM service delivery in PPCH (Author modified after JICA 2005; Seng et al. 2010; COMPED 2014)

Positive development, however, varies from place to another, depending on its level (World Bank 1999; Amin 2006). In fact, according to PPCH waste management division, MSWM in Phnom Penh has improved in terms of landfill management and collection service. From viewpoints of the LGAs, the service provision, however, seems to be

inefficient, and not to satisfy the contractual terms. There are limits of incentivisation that result in irregular monitoring and evaluation.

4.4 Technical performance

The professional capacity of LGAs is limited as they are not prepared to take responsibility for the management service in their area. The quality of the service is still low and inadequately hygienic. The collection frequencies and schedule were also inadequate and affected the collection time. Collection frequency was the most important factor affecting the users' satisfaction with the service, especially in the peri-urban areas. A study by the Asian Foundation suggested that the problems can be split into two issues: i) the volume and composition of waste and capacity of the landfill site, and ii) the nature of collection (Denney 2016). These issues were also raised by the LGAs and PPCH, as the current landfills will reach the full capacity by 2020. Another issue was that insufficient service provision causes waste to accumulate in containers and community storage sites, or become scattered in the unused land. Operational performance depends on the quality of the service provided and its reliability based on technical inputs. The evidence from a pilot Khan indicated that the lack of collection facilities and personnel are the main reasons why the services provided by LGAs are inadequate. Most of the statements from the LGAs during the discussion can be summarised as follows: the lack of crew and vehicles are the main issues of using a private operator. The CINTRI attempted to collect daily waste during three to four trips as the collection crews were receiving a low wage. Figure 4.X shows the routine of waste collection proposed by CINTRI. Operations of this company are: collection from three main generation sources, cleansing public areas and transport waste to landfill. There are two shifts of collection system. The focus discussion also raised the concerns of irregular collection, in spite of the existing schedule of collection and time of waste collection. There is likely lacking of collection facilities (waste carts, containers and bins) to some areas as well as collection crews.

Waste was not source-separated, and about 0.15% of organic matter was composted by Community Sanitation and Recycling Organization (CSARO) and Cambodian Education and Waste Management Organisation (COMPED) (Seng et al. 2013), despite the MoE pushing the National 3Rs Strategy since 2009 (MoE 2009). The 3Rs policy and its implementation are still limited at LGA and community levels due to limited capacity and participation from households.

4.5 Environmental Performance

The result of FGD revealed that the lack of standard waste bins and certain public areas reduce the desirability of the local environment, especially in six peri-urban *Khans*. It not only leads to health hazards but also negatively affects service productivity. The existing landfill site is causing environmental pollution and poses risks during the rainy season due to leaching. The study on Dangkor's landfill management by COMPED forecasted that the landfill could not load the volume of waste generated more than 25 years as it was initially expected due to the increase of waste generation to 2,200 tons day^{-1} (COMPED 2014). The PPCH eventually failed to prevent hazards and manage pollution, so it requires more resources and technical solutions.

4.6 Institutional and organisational performance

All levels of the government, including multi-national agencies and transnational corporations, must play a role in long-term development programs (World Bank, 1999). The RGC has identified the need to improve the public services and suggests that the civil services and public enterprises should be reformed through the alternative provisions included: a) government-provided service, b) informal service, and c) public-private sector partnership (Spoann 2010).

Weaknesses in the institutional organisation have been elucidated based on the results of discussions, meetings, and reviews of previous work (JICA 2005; Spoann 2010; COMPED 2014). First, the lack of accountability and transparency in ensuring competition has rendered the service unreliable and ineffective. Second, the roles of the involved institutions and associated departments are not delineated or politically established. The overlapping of responsibilities between municipal authorities slows the work, and bureaucratic administration is not conducive to the provision of efficient services. Third, weak enforcement and a lack of commitment to enforce regulatory measures have led to uncontrollable and illegal disposal.

The result noticed that there are no competitors to CINTRI regarding facilities, financial viability, and resources, although district authorities can provide contracts to any waste collection company. It may cause some challenges to remain, although the agreements between some districts and CINTRI have been modified. Each district has recently established a waste management division that monitors and controls

CINTRI's performance and promotes waste management to the public. However, there are some limitations and constraints for this initiative due to the allocation of a small budget, limited capacity of officers and workforce. This finding suggests that another challenge to enhancing institutional capacity is the lack of cooperation and coordination between the responsible authorities, and their limited power and experience in MSWM, despite the government delegating responsibility to the district and commune levels. However, political manipulation reduces the ability of authorities to effectively enforce the regulations and monitor the operation, which was also found by this study.

4.7 Financial viability and economic performance

Providing the collection service is usually the responsibility of the municipal government. Other services are provided by contracted public and/or private autonomous enterprise (Wilson and Tormin 2000). In Phnom Penh, MSW collection and transportation service is provided by a franchised private contractor. CINTRI recover operation and disposal costs through a monthly charge (Seng et al. 2010). The PPCH charges CINTRI a disposal fee of 0.75 USD ton^{-1}, generating about 33,190 USD $month^{-1}$, while the estimated operational expenditure cost is about 11.5% greater than the landfill income (COMPED 2014). The collected fee covers the costs of landfill operation and personnel. However, the fee is insufficient to cover the total expenses, and PPCH were urged to increase the disposal fee so that CINTRI could pay more. However, CINTRI did not agree with this proposal unless households would pay a higher price than that current set. Consequently, the limited financial resources provided by the government and their insufficient monitoring of CINTRI meant that a legal remedy to incentivise CINTRI to improve their performance was not established. It can be noted that these flaws also found in Asian Foundation study.

To ensure that the collection is efficient, CINTRI have supported two members of the commune staff to conduct daily inspections and report insufficient waste disposal and collection to LGAs. By doing this, LGAs and the collection company can manage uncollected waste and prevent illegal dumping within their area. However, this has not been implemented in all districts as support from CINTRI is limited. Obirith-Opareth & Post (2002) also stated that this was the most significant flaw of the lack of financial sustainability, as it led to the provision of low-quality services and numerous drawbacks. The budget allocation to LGAs for MSWM seems sufficient and limited to specific activities, e.g for environmental campaigns and clean-up activity. LGAs have not

generated income from resource recovery, even though PPCH have recently piloted composting activities at the landfill site.

4.8 Social and cultural performance

Achieving sustainable waste management requires an integrated approach (Visvanathan et al. 2004; Joseph 2006) that involves all stakeholders. Klundert and Lardinois (1995) included social and cultural aspects as an instrument for planning and assessment a management system. Therefore, they play an important role in the assessment of their relationships. The LGAs are aware of the health risks and environmental problems caused by inadequate management. In response to these consequences, The LGAs, including PPCH, has issued nine local regulations on waste management, and more decisions have been made to improve MSWM. It includes the clean city assessment and strategic plans to educate the locals. These factors allowed the stakeholders, including non-governmental organisations (NGOs), private firms, banks, students, and the public to participate in monthly community cleaning and awareness raising, and other related campaigns. Post and Obirih-Opareh (2003) stated that criteria that reflect major public concerns could assess the strengths and weaknesses of the partnership. In this regard, the results from the FGDs indicated that the public participation is still limited in some districts and communes in the peri-urban area due to service limitations and low willingness to pay. In some central districts, more clean-up activities are being undertaken, and the involvement of stakeholders was increased, particularly financial support from NGOs. The promotion of new governmental policies on clean city competition has encouraged the LGAs to perform their tasks actively. According to the meeting with LGA officials, the locals are willing to pay an extra fee for the improved services. The involvement of stakeholders increased after introducing Clean City Policy. Therefore, identifying stakeholders and their interests is essential in the coordination of their participation and involvement in sharing the cost of various activities.

4.9 Policy and legal performance

The government, especially the MoE, introduced policies and regulations regarding MSWM. However, the capacity and competence seem to be limited to achieve fruitful enforcement (COMPED 2014). The previous failure to provide the collection services prompted the recent decentralisation of MSWM, as enforced by the RGC's sub-decree 113 (RGC 2015). The sub-decree aims to sustainably improve MSWM in a transparent and

accountable manner to ensure environmental stability. It states that MSWM will be addressed by the decentralisation system to the LGAs, and the responsibility has been shifted to provincial, municipal, and district levels. The MoE and MoI also established a joint declaration to facilitate, coordinate, and support the sub-national level, especially the LGAs to implement the decentralisation of MSWM effectively (MOI 2016). It is a critical movement, as Rushbrook and Finnecy (1988) suggested that proper management would only exist on the legal foundation. Therefore, the law enforcement is one of the most important roles of public authorities.

The RGC (2015) has issued several laws on solid waste management, including sub-decree 36 in 1999, inter-ministerial declaration 80 in 2003, and other regulations at both national and sub-national levels. Challenges have remained, however, and the performances of the LGAs and responsible departments are affected by inadequate financial resources and facilities. The PPCH also formulated ten local regulatory documents, including local orders, instruction, notification, decision, and strategic planning (COMPED 2014) to improve the MSWM exercise of storage, cleansing, and collection and transportation. The FGDs found that the law enforcement and implementation are still weak and receive less attention from relevant agencies. The function transfer to LGAs did not include reassignment personnel, so it has disproportionally affected the LGAs' administration. The LGAs play a key role in coordinating with other stakeholders, and to respond to the local complaints, if any. All district governors and CINTRI have revised their agreement to ensure a high quality of services and enable the LGAs to involve in MSWM.

4.10 Measures and recommendations for improving LGA's capacity

The main challenges of MSWM are technical, financial and legal, and institutional arrangement issues. The on-going efforts to build the LGAs' capacity is of great concern to governmental agencies. Achieving sustainable management requires an integrated approach. The causes of the institutional arrangement's shortfalls are the inefficient and ineffective service that was derived from lack of monitoring and evaluation. The unaccountable responsibilities rendered the difficulties to widen the service coverage and long-term performance, despite the MSWM decentralisation to the LGAs. There are recommendations for future improvement.

- The requirements of management services, quality assessment, and priorities for cooperation between the contractor and the LGAs should be studied. Management alternatives should respond to LGA's capacity and local demands.
- Technical assistance, expertise, and budget support should be provided. An expansion of collection coverage should cooperate with the private contractors and LGAs in the forms of public-private partnership.
- Strengthening cooperation and coordination between governing institutions and LGAs involved, and in order to achieving target goals for decentralized urban SWM.
- Management facilities should be decentralised to LGAs for monitoring and evaluation. The role of organizations and responsibilities should be delineated. Functions transferring should effectively adopt with legal foundation and local ordinances.
- The stakeholders should work closely with the LGAs, and to provide technical support and capacity building. Also, the LGAs should provide a platform for stakeholders to participate in the community-based collection system.
- Willingness to pay should be assessed to gain a clearer understanding of local preferences. The LGAs should be integrated into tipping fee determination. PPCH and CINTRI should re-visit the waste collection fee list and re-determine based on users' preferences.
- The proposed method of paying the service charges with the LGAs waste division offices will increase the revenue recovery and maximizing fee collection ratio.
- District-level waste management division offices should directly have received the budget allocation. The allocation would incentivise and reflect the performance.
- Collection trucks should be equipped distance-monitoring devices and regularly reported to LGAs. Clean-up activities, initiated by LGAs in alignment with existing clean city policies, should be promoted.

4.11 Conclusion of the chapter

The study reveals the main problems of MSWM in Phnom Penh. The institutional capacity and operational performance are deficient. The service provider and PPCH have not expended sufficient effort to improve the situation and the quality of services. Operation systems depend on the service quality and reliability based on technical inputs. It has been revealed that waste storage, discharge, collection, transport, and

disposal are neither environmentally sustainable. The factors influencing the institutional arrangement shortfalls include lack of monitoring and evaluation, unclear roles and responsibilities, and limited technical capacity, as reform policy is still in its early stages. Limited financial resources and budget allocation reduce the capacity for monitoring and legal remedies. Political interest and manipulation weaken enforcement and control. Public participation and awareness raising would have gradually increased due to the policy interventions on the clean city competition. Promoting resource recovery, recycling, and composting through stakeholder involvement is essential to reduce the management cost and increase the cost recovery for LGAs. The LGAs should frequently assess its operational procedures to ensure that the service is operated reliably. The financing of collection services should regularly be evaluated. A feasibility study should be conducted on contracts and payment schemes, leading to successful and efficient service delivery by private contractors.

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Chapter 5:
Assessment of Public-Private Partnership in Municipal Solid Waste Management in Phnom Penh Capital

6.1 Introduction

Recently, there has an increase in interest in addressing the weak performance of the public sector, including reducing costs, improving efficiency and ensuring environmental protection (Massoud et al., 2003). Public-private partnership (PPP) is a significant approach that can support strong future development of the country's economy and society. Some studies show that the public-private partnership (PPP) model of waste management in cities such as Nigeria (Lasisi, 2007); and other developing economies (Massoud et al., 2002; Aliu et al.,2014). Public-private partnerships are often a suggested response to reduce the cost of waste management, improve service quality and make a formal link between public and private sector operations to improve the efficiency of the entire sector. Nevertheless, the process of PPP is often complex and has limitations (Stoker, 1997; Massoud et al., 2003; Spoann et al., 2006). Several findings illustrate similar constraints that face the public sector, including: financial challenges, low quality personnel, outdated equipment, laborious procurement procedures, rigid working schedules, constraints on management changes, poor supervision and corruption (Ahmed et al., 1999; Massoud et al., 2003; Spoann et al., 2006). Post (1999) found that the determining factors for cost-effectiveness in privatized solid waste collection are: quality of service operation, income level in the service area; technology used and success of fee collection. Since waste collection services in Phnom Penh have been awarded to a single company via a long-term, confidential contract as part of PPP, collection service provision has been difficult to monitor; the fee structure has not improved household waste collection systems; collector employment conditions do not incentivize performance (Denney, 2016); citizens living in peri-urban communities often throw out waste in open spaces or illegal dumpsites due to the lack of the access to collection services. Like other fast-growing cities in the region, Phnom Penh has struggled for years with inefficient household waste collection. The waste management in this city is labor-intensive. It is a low-margin business and the collection service provision has been delivered by different six organizations since 1994 (see Figure1).

This paper will assess the performance of public and private institutional arrangement in municipal waste collection in Phnom Penh. Consideration will be given to both regulating agencies and service providers. The analysis pays attention to decentralization and privatization policies that have been implemented in Cambodia since 2009. These have changed institutional arrangement and administrative functions. The operational performance of contracted waste collection services will be assessed using an amended version of the multiple sustainability assessment developed by Zurbrügg et al. (2014).

6.2 Public and private sector actors in MSWM

Both public and private sectors are active in addressing MSWM in countries that are developing (Ahmed et al., 1999). Actors involved in solid waste management are introduced below, noting their particular role, responsibilities, benefits and constraints. Public sector agencies have an overall responsibility for urban waste management. Leitmann (1999) noted in most Asian cities there has no single institution is responsible for urban environmental management issues. The prioritized sectors in urban environmental management issues are solid waste, water supply and sanitation and air quality (Memon et al., 2006). Hence the criteria for choice of the public or private service delivery are to be deeply considered. The questions were often asked "*could an assigned role to local governments and expanded role of private sector help to alleviate the solid waste problem by improving the efficiency and coverage of waste services?*" (Bartone et al., 1991; Memon et al., 2006).

The Government of Cambodia has clearly identified the need for the improvement of public sector services and suggests a reform of civil services and public enterprises. With this view, the plan for the development of SWM service will take three principles into consideration, including a) government endorsed services; b) informal sector service provision; and c) partnerships established with the public-private sector (Spoann et al., 2010; Spoann et al., 2018). In light of these principles, the reforms to improve the solid waste management were introduced and role, right, and legislative obligations were clearly defined in sub-decree 113, inter-ministerial declaration and Phnom Penh' directive on urban solid waste management. The decentralization of institutional function and responsibility is specifically targeted the quality and the coverage of service and level of environmental protection (RGC, 2015). However, the questions need to answer after

reforming policy is "what *challenges and constraints have public sector bodies faced in exercising those right and responsibility?*". Evidently, the report from the National League of Local Councils reported that only 17% of municipal authorities have been integrated solid waste management issues into the 5-years development plan even though the reform policy has been already introduced (NLLC, (2016). Vong (2016) has studied the challenges of decentralization on urban waste management in Cambodia; however, few studies provide the little insights to the assessment of rights and responsibilities of public-private partnership for solid waste management.

6.3 Solid waste management and the public sector

6.3.1 National Level

In a recent sub-decree, No. 113 enacted on 27 August 2015, urban solid waste management was decentralized, and responsibility was given to provincial, municipal and district levels (RGC, 2016). This transformation allowed district/municipal administrations to deliver local services to the private sector. The Ministry of Environment still maintains responsibility for setting regulations, monitoring and evaluation, and levying penalties for waste management non-compliance. The Ministry of Interior has the mandate to support the Ministry of Environment through coordination with other relevant agencies in capacity-building and experience sharing. The Ministry of Economics and Finance coordinates with the Ministry of Environment and the Ministry of Interior in establishing tariff rates for urban solid waste management services. Fig.1 shows the basic components of the MSWM system in Phnom Penh, with CINTRI bearing responsibility for waste collection services. Evidently, these components are the basic requirements for Phnom Penh City Hall (PPCH) in private sector waste services (COMPED, 2014).

6.3.2 Local Government Units

Figure 1: represents the municipal solid waste situation over the last 30 years in Phnom Penh. The evolution of MSWM in Phnom Penh has seen responsibility shift several times to different parties from a public waste management to a public-private partnership model. After the civil war ended in 1993, MSWM functioned under the responsibility for municipal cleansing of Department of Public Work and Transport (DPWT) of PPCH, providing MSWM services until 1994. Due to rapid growth and limited capacity (Kum et

al., 2005; COMPED, 2014), PPCH entrusted its MSWM services to private contractors with franchise agreements to collect, transport and dispose of municipal waste. Nevertheless, services were not efficiently provided, according to the terms of specifications in the contractual agreement (Spoann et al., 2006). This was due to the fact that service providers often faced financial difficulties, such as unclear tipping fee criteria, and service quality on waste collection, fee collection efficiency, and unwillingness to pay for services (COMPED, 2014).

6.3.3 Private Operator on Solid Waste Service

In Cambodia, after nearly three decades of unrest in civil society, the public sector's performance deteriorated, due to a lack of an organizational framework, physical losses, spiritual suffering, inadequate government services and lack of resources. After the re-establishing of Kingdom of Cambodia in 1993, the new coalition government attempted to introduce a private sector participation policy under the rectangle government strategy II (Kum et al., 2005). The strategy aimed at promoting private sector involvement in infrastructure and service management to reduce poverty in the country.

There was an exclusive agreement between PPCH and CINTRI for 49 years to deliver the major responsibilities of MSWM to CINTRI on the provisions of garbage collection services from 2002 until the present. Additionally, there also was also an agreement between CINTRI and Electricity of Cambodia Authority (EDC) on waste fee collection. The fee collection was included in the electricity bill to ensure the effectiveness of cost-recovery. However, the long-term single-service provider contract between CINTRI and the government was confidential, and even PPCH rarely received annual reports from CINTRI from the time when the contract began in 2002. It was observed that PPCH had limited ability in monitoring CINTRI and lacked legal avenues to incentivize improvements to its performance (Denney, 2016). Responding to the above-mentioned problems, PPCH adopted a local regulation, No. 593, to enforce punishment and allocation of fines to local authority funds of up to 60% of the total fines (COMPED, 2014).

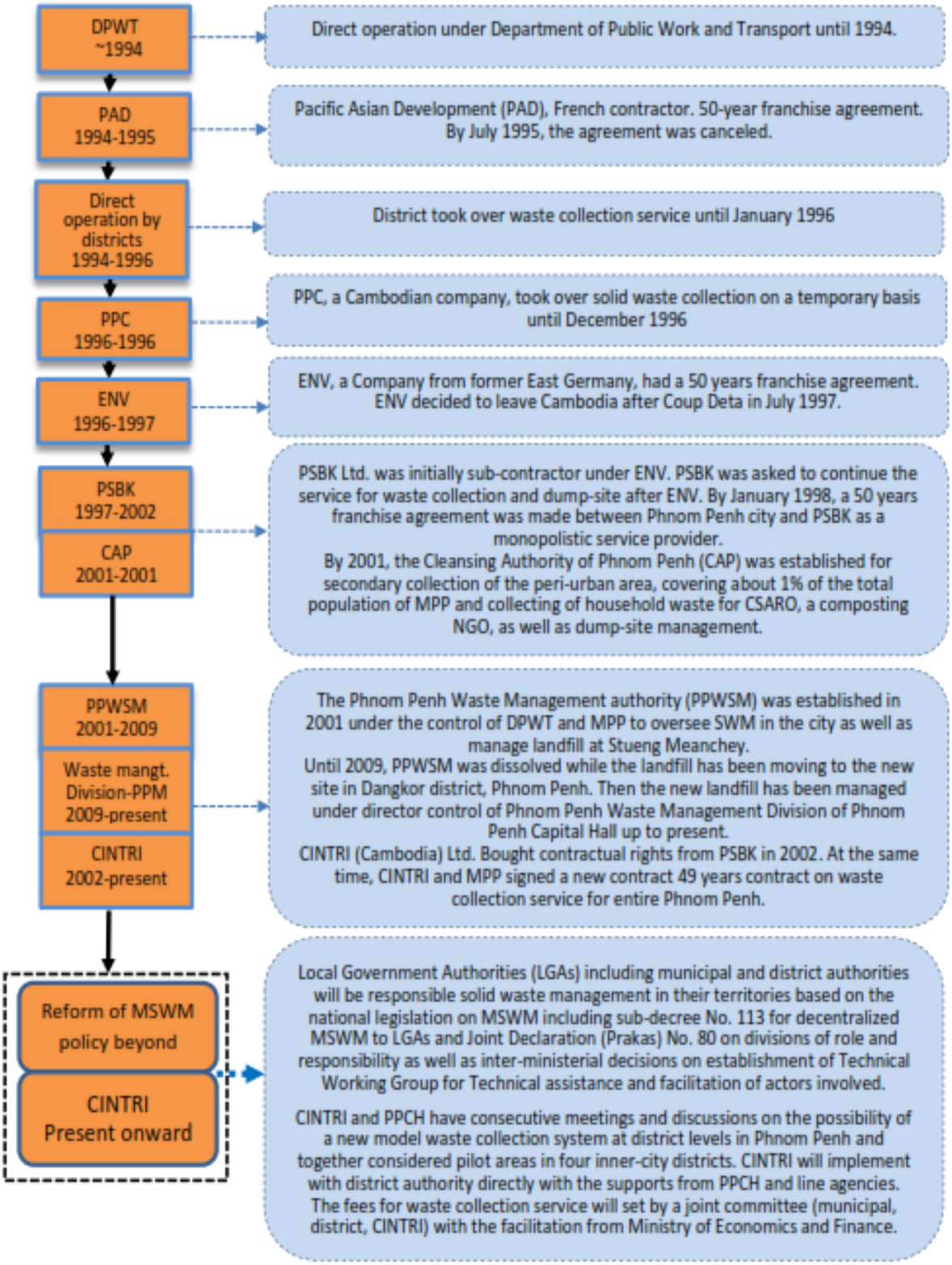


Figure 5.1. The flow of MSWM service providers in PPCH [Author modified after COMPED, 2014 and Spoann et al., 2018]

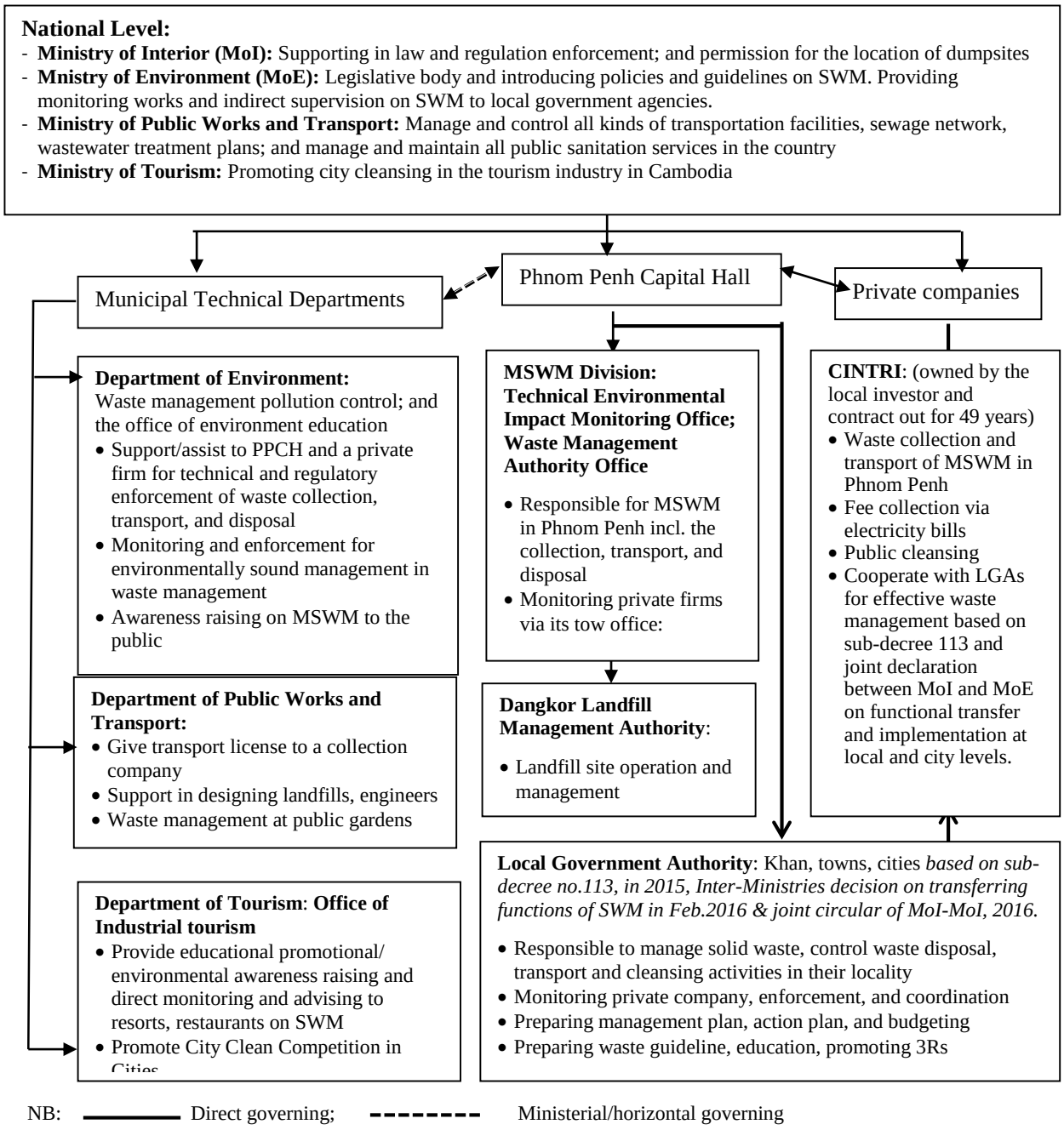


Figure 5. 2: Current Institutional Arrangement of MSWM in Phnom Penh Capital (author modified after (COMPED, 2014)).

6.4 The Study Area: Phnom Penh Capital

Phnom Penh Capital was selected as a study area where the MSWM public-private partnership was implemented within considerable contextual complexity. In 2015, the total population of the city was 2.06 million (RGC, 2014). In the 10 years, the city has expanded the boundaries of its administration in association with economic growth and structural

changes. These cover 678 km^2, and include 12 districts and 96 communes (Figure 3). The population density averages about 2213 people km-^{1} (JICA, 2014) and the area of the city has expanded up to a 100 km radius around the city centre (Hul et al., 2015). PPC is the centre of the business and commercial hub, government administration and agglomeration of the economy; the urban sector share accounts for 50% of the country's GDP (PPCH, 2015).

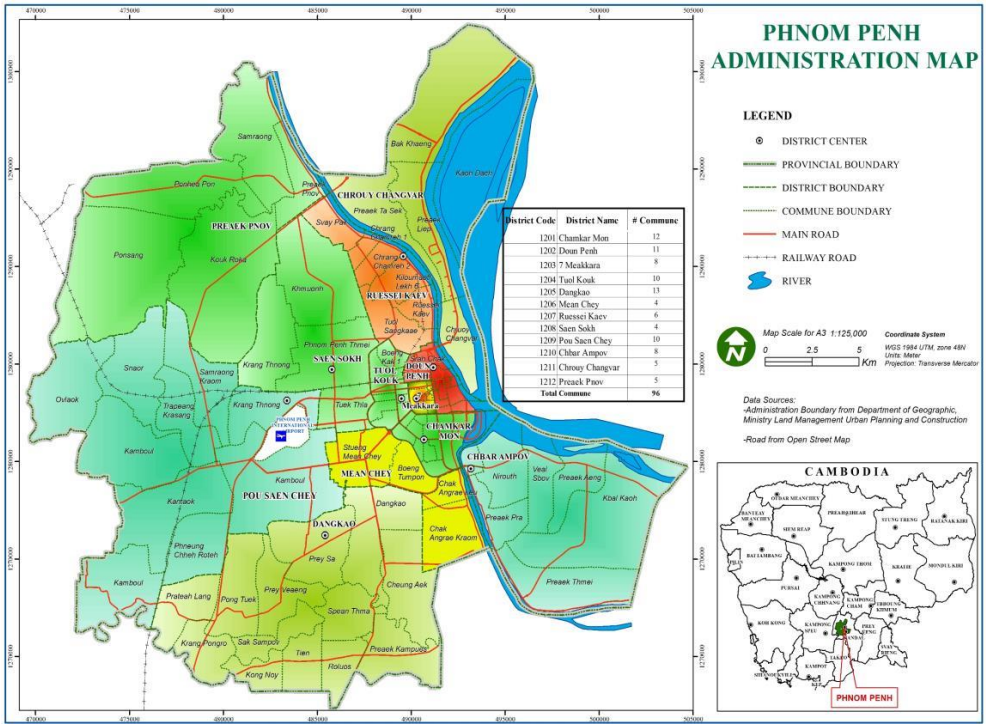


Figure 5. 3: Map of Phnom Penh Capital Cambodia, (PPCH, 2015) (GGGI, 2016)

6.5 Methods and Materials

The data collection was derived from the goal of the study; an evaluative assessment of the public and private sectors' performance was conducted. Joseph (2016) and Visvanathan et al., (2006) indicate that that achievement of a sustainable model of waste management requires an integrated approach, including combined solid waste management elements (e.g. waste generation, collection, treatment and final disposal, etc.), stakeholder involvement (waste processors) and cooperation between waste management and other related urban systems. For this study, the current context of SWM in Phnom Penh capital is established and the private operator, namely CINTRI, as well as government actors, is addressed. Key issues related to quality of service, operational quality, legal and institutional landscape between the municipality and a private contractor, are examined. The case study approach allows for both quantitative and qualitative

evaluation variables to be considered. Further, it offers the opportunity to assess the causal link between actions and outcomes in a real-life situation. An approach used by Massoud et al., (2003) in his study has been applied in assessing public vs private SWM management. Published documents from government offices, project reports, scientific papers and academic literature have also been reviewed; moreover, the data in this study has been drawn from a combination of primary sources via focus group discussion (FGDs) during an 8-month project study from November 2016 to June 2017 in Phnom Penh. Sixty key informants, including representatives from PPCH, Ministry of Environment, Department of Environment in Phnom Penh (PPDOE), CINTRI waste collection Company and LGAs officers of the twelve districts participated in the FGD's sessions. The FGDs focused on waste collection service performance, quality of services, system improvement, legal enforcement, stakeholder involvement, as well as challenges and limitations to PPPs for SWM.

a. Performance indicators for assessing sustainable waste management

In Phnom Penh, the method of evaluating operational components has repeatedly been a source of imprecision. The study did not estimate costs of private waste operators and public sector agency due to limited information on costs. The study uses sustainability assessment by a success and efficiency factor method. This was developed by Zurbrügg et al., (2014) to support solid waste management in countries that are developing. To assess "critical aspects" that influence success or failure, a set of guiding questions has been developed. The guiding questions are listed in Table 1:

Table 5. 1: Key questions to be considered for assessment domains

Sustainability domain and indicator	**Questions to be covered**
1. Technical aspects	
- Collection rate - Collection coverage - Collection efficiency	- Is the technology appropriate to existing local infrastructure conditions? - Can the collection facilities cope with and adapt to possible changing conditions (e.g. quantity or nature of waste)? - Has the most cost-effective technology been selected for CINTRI services?

	- In relation to the total amount of waste generated, what % of waste is collected? - Relative to the total population, what % of people are served? - Quantity and physical property of waste bins in commercial areas
2. Health and environmental aspects	
- Collection efficiency - Cleanliness - Illegal dumping	- Illegal disposal practices and areas as % of waste generated - Is collection performance adequate and sufficiently clean? - Do the crew and cleansing workers' well-being and health? - Is community wellbeing and health safeguarded? - Does the study support a modernized and sustainable system?
3. Institutional and organisational aspects	
- Personnel capacity and employment - Role and Responsibility of stakeholders - Institutional framework - Labour tenure - Coordination and Cooperation	- How are tasks performed? - Are MSW systems were being delegated effectively? - How do LGAs monitor and control waste collection service? - Are there sufficiently skilled staffs; is there a legitimate workforce for MSWM? - What are the management gaps for LGAs and CINTRI? - Is the management framework workable and feasible? - How well is MSWM functioning? Is there effective cooperation with other stakeholders in the system that will allow for the structuring and maintenance of successful interaction?
4. Financial viability and economic aspects	
- financial and fiscal viability - Willingness to cooperate - Accountability	- Level of fee collection efficiency and payment vehicles - Budget allocation for waste management as % of the total budget

	- Operation and maintenance cost under LGAs' responsibility - Level of cost-sharing amount shared holders
5. Social aspects	
- MSWM activities/Campaign - Stakeholders' participation - Communication mechanisms	- Do residents and local authorities believe that waste services are socially beneficial; are they supportive of the services? - Has consideration been given to community participation/ involvement in the waste services providing by CNTRI? - How do they communicate (private-public and community) with each other?
6. Policy and legislative aspects	
- Relevant legislation, strategies on MSWM - Legal frameworks for LGAs - Incentives or barriers	- Are the policies and legalisation sufficient; are they implemented in such a manner as to facilitate the work of current SWM? - Do the decentralized SWM receive support from the private operator and local government authorities? If not, what are the limitations or gaps? - Do the waste services comply with quality standards of service as define in the contractual agreement? - How does the public sector enforce the policy and legal frameworks?

Sources: Author adopted from (Zurbrügg et al., 2014; Massoud et al., 2003; Spoann et al., 2018; van de Kludert et al., 2001 Wilson and Tormin, 2000)

6.6 Results and Discussion

5.6.1 Waste generation and composition

From 1995 to 2010 to 2015, MSW generation in Phnom Penh increased rapidly from 0.136 million tons in 1995 to 0.409 million tons (Seng et al., 2013) to 0.681 million tons (Spoann et al., 2018; Seng et al., 2013) respectively. Waste generation rates are affected by socio-economic development, level of industrialization, urbanization, excessive consumption of modern life and climate. In brief, the conjunction of economic prosperity and rate of urbanization has greatly increased solid waste volume. Table 2 shows the

quantity of municipal solid waste disposed at the landfill in 2004-2015. In relation to the total waste generated in the city, about 20% was not collected. In 2003, gross generation rate per capita was about 0.74 kg day^{-1} (PPDoE, 2016) and 0.762 kg day^{-1} in 2013. It is projected that it will be 1.24 kg day^{-1} by 2030 (Seng et al., 2013]. The major components of the refuse are kitchen waste (63.3%), plastic (15.5%), grass/wood (6.8%) and paper/cardboard (6.4%). Beyond this, the other waste collected includes metal, glass, rubber/leather, textiles and ceramic/stone. These things account for less than 3% of the total. All waste sources contain high moisture content, ranging from 45% to 69% (Seng et al., 2013).

Table 5.2. Population, GDP and amount of waste generated from 1994-2015 (Spoann et al., 2018)

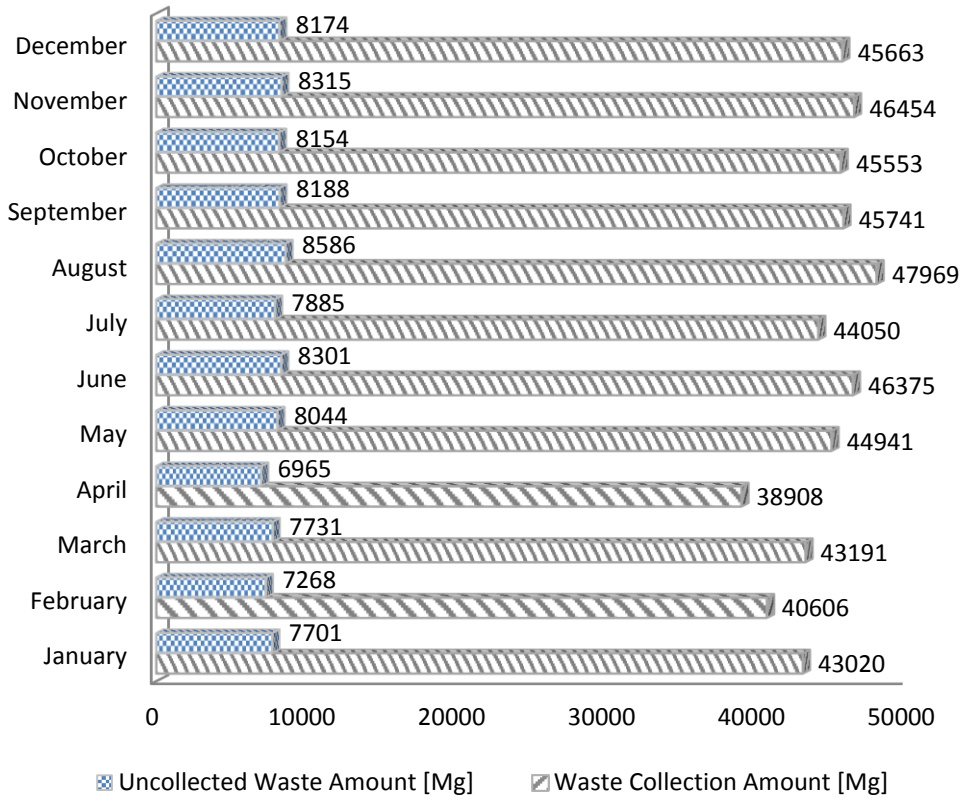
Year	Population in million		GDP (USD $Capita^{-1}$)	Waste amount in Phnom Penh ($tons\ year^{-1}$)
	Cambodia	Phnom Penh		
2004	12.824	1.044	389	227,910
2005	12.963	1.108	454	266,781
2006	13.103	1.177	513	324,159
2007	13.245	1.249	575	343,657
2008	13.868	1.326	739	361,344
2009	14.085	1.438	765	393,141
2010	14.302	1.504	830	409,335
2011	14.521	1.570	853	442,469
2012	14.741	1.637	915	492,380
2013	14.962	1.704	1,036	531,340
2014	15.184	1.770	1,137	617,489
2015	15.405	1.835	1,237	617,905

b. Waste Collection, Transportation and Disposal

Waste collection and transportation in Phnom Penh city has improved significantly. The collection rate was 80% in 2010 (Seng et al., 2010) and increased to 82.1% in 2015. Figure 4 presents the amount of collected and uncollected solid waste in Phnom Penh. The total amount of uncollected waste calculated was about 7,943 Mg per month on average or 264 Mg daily. The private operator has put more efforts into collecting waste from some

suburb communities, over others. In fact, service is often provided to the beneficiary's locations rather than low income communities. The recent study noted that of 41 Sangkats in the outskirts, 20 had no households that registered as receiving collection services (MOE, 2014). According to the results from consultation meeting with LGAs, the waste collection frequency area is relatively low in that peri-urban communities and accounted to once or twice per week, even though CINTRI has claimed high service coverage rate. Based on CINTRI data six districts have received the collection services at rates ranging from 20 to 60 percent (e.g. Khan Po Sen Chey, Khan Chroy Changva, Khan Prek Phnov, Khan Sen Sok, Khan Chbar Ampov and Khan Mean Chey).

Figure 5.4: Amounts of collected and uncollected MSWM in Phnom Penh , 2015 (Author calculated after (COMPED, 2014))

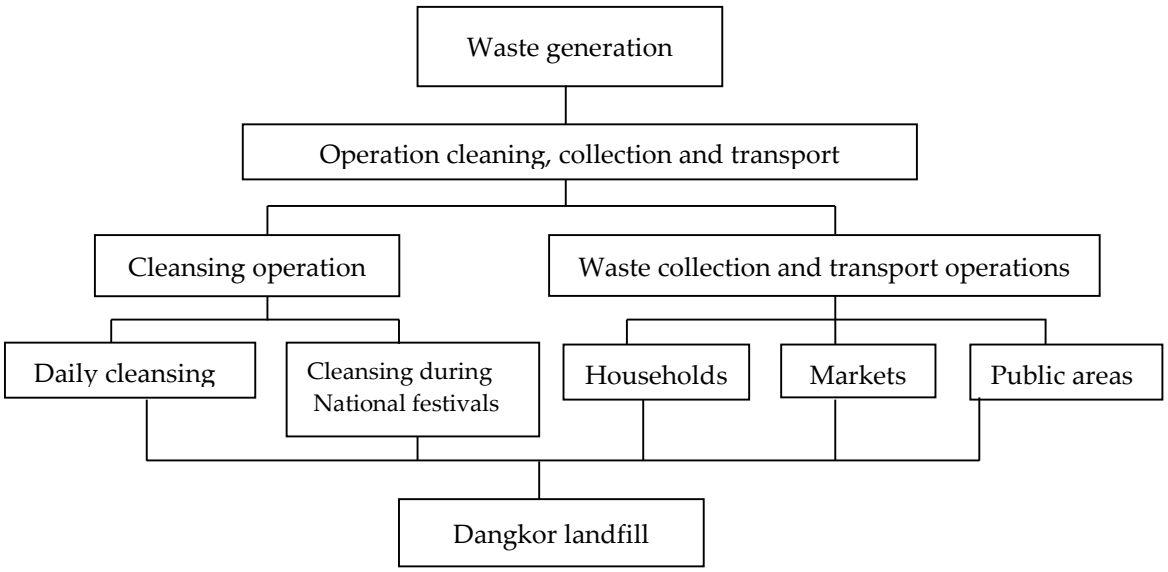


The transportation efficiency of municipal waste collection service depends on technical input and crew personnel. The inadequate transportation facilities of CINTRI have necessitated a shift in the collection time and transportation routine from day to night time for some inner-city districts and commercial areas. Spoann et al., (2018) indicate that the collection capacity of CINRTI is limited not only in terms of facilities but also lacks

personnel resources. In other words, the main constraint on waste collection is the lack of personnel due to low compensation rates.

MSW is transported to Dangkor District landfill site, 16km from the city centre. The site has been under operation since 2009. Initially, the 26-ha landfill was designed to serve as a sanitary landfill. CINTRI is obligated to operate daily cleansing, collection and transportation to the landfill (Figure 5). The city does not have a pre-treatment facility and does not treat waste before transferring it to the landfill site, thus the major limitation site's lifespan shortened. The amount of waste generated daily is anticipated to exceed 2,200 tons day^{-1} by 2020. This will significantly increase burden on MSWM (COMPED, 2014). The uncollected waste is an additional problem - about 100-200 tons of waste is not being collected and is instead self-treated (Denney, 2016) [9]. Most households burn, bury or dump their waste in their land pots and open spaces in the community (COMPED, 2014; Denney, 2016; PPDoE, 2016). This is illegal dumping, which has been prohibited by regulations and city orders. However, waste disposal practices became a topic of critical discussion among stakeholders. Evidently, many complaints against CINTRI's performance from residents have reached the local authorities. The results of FGD indicate that the complaints have reduced noticeably, and some heaps of uncollected waste have been replaced by large containers. This essentially resulted from the responsibilities of SWM being delegated to LGA units and the adoption of sub-decree 113 on urban waste management to local government levels.

Figure 5. 5: Basic components of SWM illustrated by CINTRI Waste Collection Company, Phnom Penh Capital



5.6.2 Public and Private Sector Role

It is the case in many cities of developing countries, like Phnom Penh in Cambodia that the private sector is regarded to be strong at design and operation and the government is deemed to be weak in regard to management and operation. Massoud et al., (2003) have also noted this flaw is known when there are changes to the politicians in power. Accordingly, government bodies should be involved in policy-making, introducing the local ordinance and carrying out legislative obligations, supporting and protecting the public interest and allocating funds for LGAs as public-partners. The private sector, CINTRI waste collection company, has significant strengths in management and control of cost recovery, the extension of services in new urban development areas, design and use of technology (Figure 4). More importantly, CINTRI is the sole service provider partnering with LGAs, which has a high profile and resources to meet specific performance criteria in the future. However, the gap between demand and supply side of infrastructure and service still exist and prolong significantly as their focus are varied. This case study of Phnom Penh waste management, based on the fact that reform is new, and a contract agreement is a long-term business, one of the practical options is to strengthen the role of the public with respect to decentralization and private sector with respect to private sector participation. The delegation of functions to local government units is more useful because may help to improve the level of service and are targeted to improve accountability and effectiveness of LGAs.

5.6.3 Monitoring and Regulations

Policy and regulations that regulated national and Phnom Penh Capital on solid waste management are sequent established since 1999, however, the local legal instruments are recently being addressed to concern of waste issue due to city's challenges. A number of regulations are ratified after establishing the Ministry of Environment (MOE). The previous failure in providing collection services promoted the recent decentralization of MSWM. This was enforced by RGC sub-decree No. 113 (RGC, 2015) and the joint-declaration between MOI and MOE on establishing the implementation of urban waste management at local government levels. This regulation aims to improve the sustainability of MSWM, in a manner that is both transparent and accountable, in order to preserve environmental safeguards and stability. The new regulations have shifted the responsibility to sub-national government including provincial, municipal and district

authorities, to control and monitor the performance of private operators. Massoud et al., (2003) argue that the success of PPP depends on the competence of the government in developing good monitoring practices and regulations. In contrast, the capacity and competence of regulatory agencies seems to be limited to the achievement of fruitful enforcement due to certain reasons (e.g. political manipulation and politician interest). Denney (2016) has noted case studies in which the reforming solid waste management in Phnom Penh led to problems of waste collection, especially for the existing waste collection system within a difficult wider political context, and the reform of the SWM system in a limited space, and the lack of a political will to deal with the problem of solid waste. Similarly, the information from the focus group discussion reported that LGAs are encouraged to try to continuously work with CINTRI, rather than to work against them in an effort to revise the term of the contract. Asian Foundation's report cited by Denny (2016) described:

CINTRI's political protected…control of guarantee revenues irrespective of performance is the root cause of the poor performance of solid waste collection in Phnom Penh.

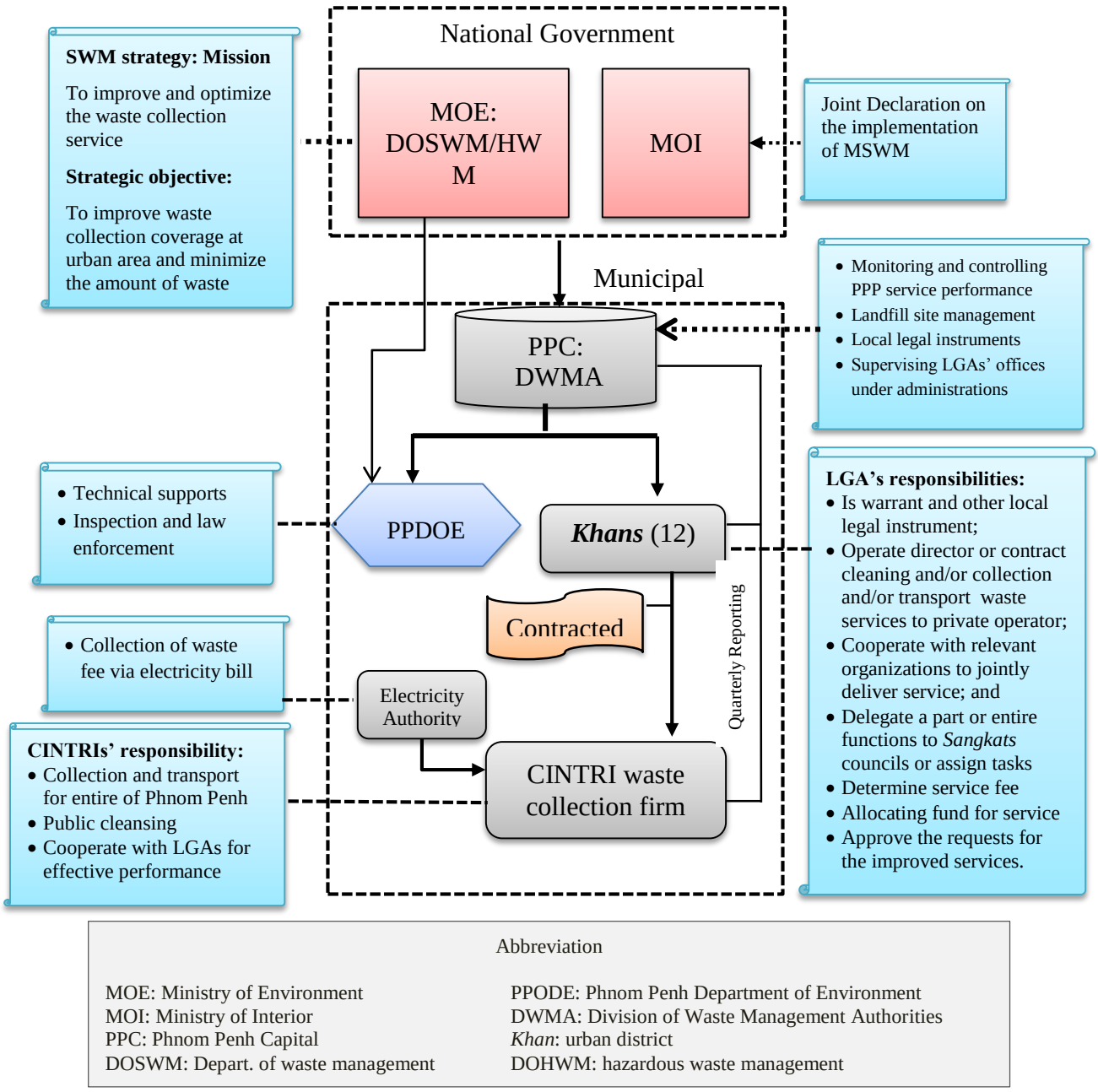
The finding on the challenges of LGAs in waste management is a critical movement; Spoann et al. (2018) argue that proper management needs only a solid legal foundation. They deem law enforcement to be one of the most important duties of the public authorities. In addition, limits in relation to incentivizes resulted in irregular monitoring and evaluation (Spoann, et al., 2018). The result of the focus group discussion (FGD) indicated that regulatory agencies, such as Department of Environment and LGAs, are affected by inadequate financial resources and facilities, resulting in weak enforcement and less attention to assigned tasks. However, Kum et al. (2005) have shown that it is politically and practically challenging for government regulatory units to enforce compliance with regulations where regulatory agencies are ignored and worked out with less commitment. Therefore, policy support and a localized legal framework need to be developed to ensure the effectiveness of law enforcement, monitoring of the private operator and controlling illegal dumping.

5.6.4 Institutional Management and Operational Framework

Multi-national government agencies and transnational corporations play a vital role in the long-term development program (Hoornweg and Thomas, 1999). RGC has highlighted the need to develop public services and has suggested alternative service provision through public-private sector partnership (Spoann, 2010; Spoann et al., 2018). COMPED; JICA (2005) and Spoann, et al. (2018) conclude that weaknesses in institutional organization have been elucidated as four encounter problems: lack of accountability and transparency, unclear delineation of roles, political manipulation and limited commitment in relation to regulatory measures enforcement.

It has been generally proven that developmental strategies must go beyond mere technical considerations and address the aforementioned set of the issues in order to achieve sustainable and effective waste management (Massoud, et al., 2003). As such, a national waste management strategy and action plan for Cambodia (Seng et al., 2010) should reflect the local context and institutional arrangement landscape. The responsibilities of LGAs have come with the resources and obligated duties. There are at least seven of responsibilities supporting to the function executions local government units addressed in Sub-decree 113. In the light of new reform of solid waste management regulations, LGAs are seemingly realized to improve the operational performance due to the exclusive agreement with CINTRI will be made directly with individual Khan. However, the municipal and Khan also have understood that private operator alone cannot fulfill its tasks without supports and interventions from LGAs and stakeholder involvements (Figure 5.6). The results from focus group discussions suggesting that CINTRI has to prepare a proper waste collection schedule and the proposed schedule needs to be reviewed by LGAs and it then informs to the citizens in Khan and Sangkat before implementation. The reforms of a solid waste management system in Phnom Penh are meant to lead about institutional and organization change and fund reallocation from the national government to local government units. In addition, Phnom Penh Capital administration is currently establishing the local legal instrument (e.g. local ordinance on solid waste management in Phnom Penh) for enhancing instructional capacity, responsibility, right and resources on the implementation of urban waste management at LGAs context. In some places, decentralization brings to improve the level of environmental cleanliness and it is also possible for promoting clean municipal or Khan through Clean City Competition.

Figure 5.6. Overview of Decentralized Municipal Solid Waste Management in Phnom Penh



5.6.5 Stakeholder Involvement

Identification of the stakeholders and their interests is important in order to gain their participation and involvement in various waste management activities (Joseph, 2006). In Cambodia, cooperation with private service providers has reportedly been problematic - less than one-third of the service providers in Cambodia have been reporting to government units regularly (NLLC, 2016). The municipal and district administration has faced constraints and limitations in involving private operators in the expanding of the service areas to suburban communities where there are fewer beneficiaries and they are

underserved by the road infrastructure. Joseph (2006) noted that it's not an easy task to plan and implement an action plan to achieve efficient waste management without the active involvement of relevant stakeholders. Joseph (2006) and Wilson and Tormin (2000) suggest that efforts ought to be made at all levels to minimize the volume of generated waste and manage municipal solid waste in a safeguard manner. Hence, reforming waste management in Phnom Penh will help to promote participation and provide a platform for a sound working environment. Despite years of promoting decentralization reforms, the level of participation is still limited. This is because solid waste has fewer entrenched political interests than some other sectors (Denney, 2016). According to the focus group discussions, the issues of lacking accountability and transparency in competition have likely rendered less involvement from other private operators. This has led to unreliable and ineffective performance during the period of CINTRI carrying out its a 49 year-long contract for waste collection services in Phnom Penh.

5.6.6 Quality of Services

Quality testing considers the actual frequency of collection and the cleanliness of the service (Obirih-Opareh and Post, 2002). According to Spoann et al., (2018) service quality is still low and lacks sufficient hygiene. The collection frequency and schedule are also inadequate and affect collection time. Collection frequency was the most important factor affecting user satisfaction, especially in peri-urban areas. The recent study on knowledge, attitude, and practices of household waste management in suburbs of Phnom Penh indicated the situation of SWM is not satisfactory owing to the responses of 78.68% from within service using households and the collection frequency accounts for 46.19% for twice times a week and 22.34% once a week (Seng et al., 2018). Likewise, the study also indicated that the technical capacity and skills of LGAs is limited - they are not actually accepting their duty for management services in their respective areas. Inadequate service provision causes waste to accumulate in bins and community temporary storage points or become littered on vacant land. There are onther significant issues. It is understood that operational performance depends on the quality of services provided and reliability technically based on technical input. It is identified that the problem of waste management in Phnom Penh can be split into three areas: i) the volume and composition of waste and the capacity of the landfill site, ii) the nature of collection provision by CINTRI, (Denney, 2016) and iii) institutional and LGA capacity in coping with waste management at their

respective territories. Evidently, the main reasons why service provision is inadequate are because of lacking collection facilities and limited numbers of personnel. This is the evidence from the polit implementation in Khan Daun Phenh of Phnom Penh (Hul, et al., 2015). In additions, the statements from the LGAs during the group discussion can be summarised as follows: lack of waste collection crew and compact trucks are the main issues for CINTRI. It is reported that low salaries for collection crews is considered as a constraint on improvement of regular waste collection, even though CINTRI strives to collect household waste three to four times daily. In addition, CINTRI is also responsible for public areas, street cleansing and waste clean-up actions during festivals. These tasks place an additional burden upon the collection company. Another shortfall of service quality is the cleansing of anomalous illegal dumping sites; LGAs request that CINTRI collect from the communities. According to Denney (2016) there is about 100-200 tons of uncollected waste which remains self-treated- households dump, burn, and discard in their waste in empty land and illegal dumping plots. Thus, the new reform policy to transfer duties and responsibilities to LGA (e.g Khan/municipal authorities) are likely to face delays in reinforcement and will require revisions to the separate contract between LGA and CINTRI. The limited resources and capacity of the public-sector to cope with uncontrollable dumping sites leads the decision-makers to choosing this existing waste operator as the long-term running business firm in waste service. However, Phnom Penh City Hall remains reluctant to pass over this task to CINTRI for all Khans, unless the terms of the contractual agreement are responsibly rendered to reflect the public interest and unless there is efficient performance.

5.6.7 Personnel Resources and Labour Conditions

The retrenchment of public workers and personnel officers in the 1994-2001 periods seriously affected the performance of Phnom Penh Solid Waste Management Authority (PPSWA). Lacking personnel resources and contracted workers in the public sector like municipal and Khan authorities, privatisation was the only available avenue to increase labour input in solid waste collection system (Amin, 2005). CINTRI created the labour-intensive employment; it has been the champion of solid waste collection since 2002. Workers are mostly migrant workers; some previously worked as waste pickers at the landfill. Another problem that the CINTRI waste collection company faces relates to uncertainty about the availability of crew and street sweepers. Many of these workers only

work seasonally and they return to agricultural work during the farming season. Working conditions for those working in waste collection are unattractive and unhygienic; this is coupled with low wages.

The government has understood that the solid waste collection system run by the public sector was deficient due to low financial availability (Wilson and Tormin, 2000; Kum et al., 2005; Spoann et al., 2018). The low government salary, for instance ranging from US$75-US$150 in 1998-2002, was the biggest constraint to public sector performance as government job regulations were not effectively enforced. Therefore, the Phnom Penh municipality waste division had to provide a subsidy to those who were working at the landfill and incentivize inspection works. CINTRI was provided US$300 for 2 inspectors of each Khan office for the monitoring and daily reporting assignment. This direct incentive from CINTRI was an attempt to address the monitoring process and the effectiveness of enforcement. Results from focus group discussions with LGAs indicated that the human capital of LGAs on waste management was limited as personnel resources were lacking and there was low capacity to handle newly assigned tasks. It can be concluded that waste collection drivers are included in human resources, security and employment.

Figure 5.3: Equipment and Labor of CINTRI Waste Collection Company for Phnom Penh

No.	Year/ Equipment and Labor	2010	2011	2012	2013	Number change (2010-2013)	Δ rate (2010-2013) (%)
1	Staff and worker	1227	1282	1345	1449	222	**15.3**
2	Trucks for operation collection	113	126	152	161	48	**29.8**
3	Mobile repair car	3	4	4	7	4	**57.1**
4	Lifting tractor/whell loaders	3	4	3	5	2	**40.0**
5	Cleansing trucks	3	3	3	3	0	**0.0**
6	Waste carts	224	2288	232	347	123	**35.4**
7	Dumpster bins	65	79	89	121	56	**46.3**
8	Waste bins for cleaner (140liter)	300	327	343	348	48	**13.8**
9	Waste bins for garden and public areas	286	295	378	419	133	**31.7**

Source: COMPED (2014).

5.6.8 Public Perception

The public (urban residents) are the largest and critical category of stakeholders in waste management. They have a two-way relationship with waste services: the waste generator, sorting and managing curb-side storage, waste service clients, and information receivers and participants in community cleansing activities. The findings from recent studies show that the SWM situation has not been soundly addressed as the responses owing to 78.68% of service-connected households. The level of satisfaction is significantly associated with quality of services, frequency of collection and tipping fees; all coefficients are positive (Seng et al., 2018). The service users are willing to pay more for improved collection services and reliability of service depending on the perception of PPP operational procedures (COMPED, 2014). The perception of PPP is based on the reliability of services which is measured with six reliability variables (Aliu et al., 2014). The form of participation and cooperation for an improved living environment and waste services, in both connected and unconnected households, is positive, but some constraints and difficulties in accessing collection services and low collection frequency have not yet been solved. Most local residents in suburbs areas complained to CINTRI for not providing services adequately, except for those areas with high beneficiaries. Evidently, similar findings have been indicated by (Kum, et al., 2005; Seng et al., 2013 and Seng et al., 2018). It can be seen that the public perception of PPP is important for explaining the reliability of services.

5.6.9 System Viability in SWM

The viability of the entire institutional arrangement in Phnom Penh capital waste collection depends on financial sustainability. The collection of solid waste carried out by CINTRI under its 49-years term requires clear municipal and local government unit planning and regulation (Spoann, et al., 2018), because collection systems and disposal have large externalities and economies of scale that make competitive provision less viable (Amin, 2005). The GS Engineering & Construction Corp. projected that the service coverage will increase to cover 100% of city areas by 2020 and income rose relatively. However, CINTRI has suggested increasing the fee, especially for those peri-urban district areas as the cost of transport will also simultaneously rise. It was raised by CINTRI during the meeting with Phnom Penh Governor that the income losses of almost US$20 million

for service users was not paid to CINTRI from 2003-2016. Another problem facing PPCH is the construction of a new landfill as the current landfill will be full by 2020. The construction cost for a new landfill is estimated by the GS Engineering & Construction Corp. as US$120.1 million (COMPED, 2014). PPCH cannot afford this huge investment. Although there are financial shortfalls for the new construction of the landfill, PPCH is inclined not to allow CINTRI to increase the fees. Political interest would make the public sector decision weaker. There would be less commitment, and weaker enforcement and control for operators and users.

5.7 Priority Actions and Recommendations for Improving Public-Private Partnership On SWM

Decentralization reform on SWM in Cambodia has entered in 2015. The reform is carried out to improve the situation of waste management and overall governance by transferring solid waste management functions to municipal and district administrations established by Sub-decree No.113 on "*Urban Solid Waste Management"* (RGC, 2015). With a new phase of decentralization, this case study found that reforms can be challenged to institutional, regulatory, technical and financial aspects or a combination of all. Private sector participation varies in its focus as it joins hand with the public sector to share the responsibilities. However, CINTRI cannot bridge the gap due to the limited quality of services and unsatisfactory from service users. Based on the findings and critical review, the following recommendations can be made:

- *Enhancing PPP and social acceptability.* To reduce the deficiency of the waste collection system in Phnom Penh, the key measure for successful development of stakeholder participation is giving consideration to public interest, economic interest, preventing political manipulation and the will of municipal, Khan and Sangkat councils. The operational framework and procedure in PPP should be adjusted toward the system goals.
- *Resource management of the public sector.* LGA needs to be self-sustaining in its waste management program and strategy to reduce reliance on the private sector and also national government funding (subsidies).
- *Continue monitoring and enforcing solid waste disposal regulations:* implementing proper monitoring, controlling procedures and enforcing urban solid waste management regulations (e.g. sub-decree no.113 on MSWM). These measures are

necessary to reduce illegal dumping and should be enshrined in new urban waste management policies.

- *Economic burden to LGAs and CINTRI*. To reduce the fiscal and financial burden, operational processes for cost-recovery can be made through implementing an applicable fee that will adequately fund the LGAs and provide viable financing to CINTRI for a modern, sustainable system.
- *Consideration of waste collection options.* The requirements of management services, quality assessment, and priorities for cooperation between the contractor and the LGAs should be studied so that the options for the collection system are based on sound data.
- *Building on strengths and working politically and flexible.* Each *Khan* and municipal authorities should be paid attention to establish an effective mechanism to resolve constraints and obstacles by having regular technical working group meetings and discussions. The technical working groups established by joint ministries could provide the platform for involved parties to identify common ground and make discussion. In addition, the study suggests that LGAs should be working politically and flexible based on their own approaches and strengths for re-allocation of resources and funds from national governments and multinational corporations.
- *Capacity Building:* Either professionals or paraprofessionals normally are in local government units are not trained in many aspects of waste management, so that the future planning based on sound resource management performance. To provide the proper training of LGAs' personnel dealing with waste management and service management is needed and critical in this transition, as this also suggested by Seng et al. (Seng et al. (2018); Spoann et al. (2018) and NLLC (2016) in their case studies of Cambodia.

5.8. Conclusion

The main challenges of solid waste collecting are service quality, institutional arrangement, stakeholder involvement, legitimacy issues, and labour and employment condition issues. The continued efforts to build the LGAs' capacity are of vital interest to governmental agencies in the transition period of SWM functional transfer to LGAs. Achieving urban waste management that will be effective in the long-term requires an

integrated approach. The shortfalls of the institutional arrangement for PPP are clear indications of a service that lacks efficiency and effectiveness. This is the result of a lack of monitoring and evaluation of the PPP process. Due to the lack of a clear operational framework for this long-term contract, CINTRI rendered difficulties widening service coverage and ensuring involvement from stakeholders, despite the MSWM decentralization to the LGAs. Consequently, inadequate waste collection frequency and tipping fee are the major public concerns and affect to users' satisfactory with service. Meanwhile, the incidence of retrenchment of government officials and hiring low wages for crews led lo unreliable service and unsound sustainable financing. A legal framework, no anti-competitive behaviour, allowing the widening of ownership, preventing public interests, must be advised and adopted by municipal and local government. In this transition and specific local context, obligated responsibility, competitive tendering, complete transparency with regards to financial accountability are essential for enhancing system viability. At the end, particularly in this period of decentralization we could discover the reform is not meant to an end; however, the results differed because of difference in the political will and commitment of stakeholders including national, local government, the private sector and communities. This study might, differences of cities notwithstanding, assist PPP in urban waste governance in a circular economy.

Summary of the Chapter 6

The overall responsibility for waste management in Phnom Penh Capital (PPC) has rested with the municipal authorities and contracted waste collection companies. Providing waste collection services is a major challenge for Phnom Penh due to the increasing waste volume and the deficiency of the system under public-private partnership. In response to continuing population growth and urbanization, sustainable management is necessary. This paper will review the details of the processes and examine the performance of the private sector and local government authorities (LGAs). The study uses sustainability assessment, according to a success and efficiency factor method. This assessment method has been developed to support solid waste management in countries that are developing. Multiple sustainability domains will be evaluated, including: institutional, legislative, technical, environmental and health aspects; as well as social, economic, financial; and critical aspects. The results indicate that the long-term contract design attempts for partnership may result in a worsening of the situation by facilitating new ways of concentration, inefficiency and

political interest. The limited institutional capacity of the public sectors is a consequence of the inefficient decentralization of municipal solid waste management (MSWM) policies. Public-private partnerships can be neither effective nor sustainable if LGAs and CINTRI waste collection company do not build proper incentives into their management of the two sectors. Revisiting the legal framework, establishing a facilitating agency that will assist in the design of, and the nurturing of, partnerships, competitive tendering; transparency and financial accountability are essential elements for PPP on the provision of waste services in Phnom Penh capital.

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Chapter 6:

Solid Waste Management Politics: Reforming Institutional and Legal Frameworks for Sustainable Waste Management in Phnom Penh Capital

6.1 Solid Waste Management Issues in Phnom Penh

Phnom Penh is the capital of Cambodia, has outstanding economic growth for two decades. Growing of economic activities, increasing industries, rapid urbanization generate prosperity and contribute to improve livelihood of its peoples. With these trends of urban development coupled with economic development have brought to change the lifestyle and increasing consumption as well as, at the same time, increase in waste generation in the city from 0.136 million tons in 1995 to 0.681 million tons in 2015 (Seng et al, 2013). Nowadays, the city faces with two main challenges for the trends of increase of waste generation are: 1) volume of generated wastes, and 2) nature of waste collection operated by CINTRI. These would pose to environmental pollution, health risk and resource challenges.

Most of the cities in Cambodia, like Phnom Penh Capital, household wastes are mixed together and storing in different type of bins. Collection and transportation are mostly responsible by CINTRI. Many recent studies indicated that waste collection system did not fulfill the resident's demands and satisfaction level. Many peri-urban communities are still lacking of services due to limited collection capacity (Spoann, et al, 2018, Seng, et al, 2018). Recycling activities have not been popular for Cambodia as recycling activities are done by informal sectors (Seng, et al., 2010). MSW disposal in Phnom Penh is totally relied on a single landfill with rudimentary practices. The landfill life span is even shorter than what it would be due to bulky mixed waste loading from daily increasing of wastes from this urbanized city. Waste loading in this landfill caused to environmental pollution and threaten to neighbor communities.

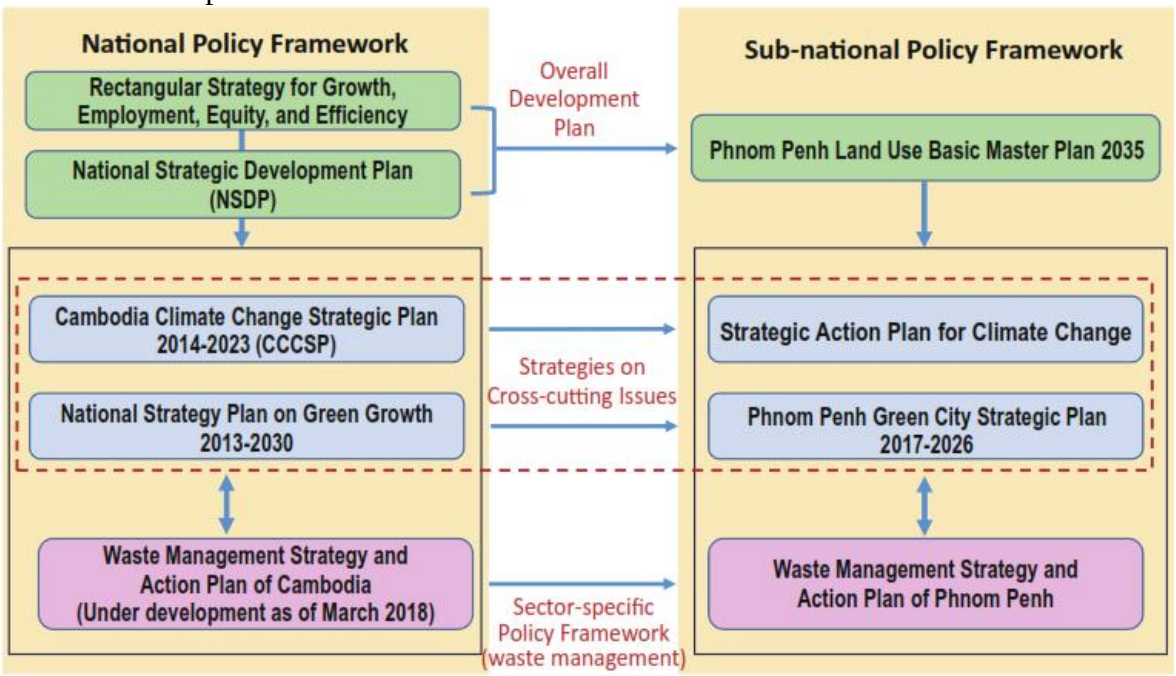
Solid waste management problems in Phnom Penh are likely from supply side (waste collection services by CINTRI). The major challenges are inefficient service quality and operational performances of private operators. Operation systems depends technical inputs while the institutionalization of government bodies become more complexity due to the reform of SWM policy— transferring functions to local government administration (municipal/khan) levels. Historically, a waste management system of this city has been

evolving and delivered by several waste contracted companies since 1995. The reform aims to improve waste management systems and enhancing local government authorities' capacity for better management, monitoring and control (of) private's sector performance.

6.2 National Policy and Sub-National Policy Framework: Why needs policy alignment?

Royal Government of Cambodia (RGC) has developed numbers of national policies in order to navigate the ministries and subnational government administration to formulate and prioritize their development strategy and plan in individual ministry or sub-national administration. Rectangular strategy attempts to ensure the growth, employment, equity and efficiency of the implementation and expanding policy priorities. National Strategy Development Plan 2014-2018 has been formulated for implementation of the Rectangular Strategy Phase III (RSIII) (RGC, 2014). In light of these national priorities on strengthening urban planning and management (RSIII, priority No.4), Ministry of Environment (MOE) is currently developing waste management strategy based on the needs and priorities. With this alignment, Phnom Penh Capital Administration (PPCA) has currently developed the Phnom Penh Solid Waste Strategy and Action Plan: 2018-2035. This new strategy and action plan constitutes as integral part of the city's development policies and offers a visionary document and strategic guide to address key issues, needs and challenges associated with the management of solid waste (PPCA, IGES, Nexus, UN Environment, CCCA, 2018). The position of the waste management strategy and action plan attempts to address the national waste management strategy and Phnom Pen Green City Strategic Plan (see Figure 6.1). However, it is seen that the efforts were likely divergent as the national waste management strategy and action plan are currently still under developing by MOE. Technically, the waste management policies are devoted to be an interdependent (Vesilind et al., 2002). In 2016, the MOE, with support from UN Environment and the IGES Center collaborating with UNEP on Environmental Technology (CCET), has initiated a project to develop the national waste management strategy and action plan. Until now, this strategy has been drafted and provided the multi-stakeholders for feedback and discussion. Even though, the national strategy on SW strategy has not officially formulated, the framework document has currently been drafted and provided guidance for the direction to sub-national government for adaption to their local waste management strategy.

Figure 6.1: Positioning of the Waste Management Strategy and Action Plan of Phnom Penh Capital



Source: PPCA, IGES, Nexus, UN Environment, CCCA (2018)

From a country perspective, the policy framework should align with local, regional and global context. Building low-carbon, resource efficient sustainable society is an imperative for all cities and countries, including Phnom Penh, in order to attain sustainable prosperity for its citizens. In this context, the role of the waste management sectors—regulatory agencies, can play is substantial (PPCA, IGES, Nexus, UN Environment, CCCA , 2018). For legal framework, policy and its interpretation can or hinder any solid waste strategy and projects. Joseph (2006) denoted that sustainable waste management laws necessarily need the support form legislators and politicians. They would play a significant role in shoring up the waste management strategy. Singh (2014) pointed out that there many cases often happened as policy interventions face failures during their implementation stages, for example owing economic reasons or competition with existing approaches. To address to the barrier and to practical implementation and performance of existing approaches to Phnom Penh waste management, we would need to answer the question as follow: *Are the Phnom Penh Waste Management Strategy and Action Plan are closed with the need to work towards integrated, sustainable SWM systems that are locally appropriate to specific city's context?*

6.3 Key Concept Decentralization Policy

There is no doubt that solid waste management (SWM) in Cambodia is a very complex issues, particularly when the institutional and legal aspects are part of the reform where the country needs to enhance the institutional capacity of SWM institution and other responsible organizations from a weak enforcement and performance. The Asian Development Bank pointed out that the legal and regulatory framework is the backbone for reforms as it provides the rules of operation for different levels of government—administrative, political, and financial (Naizi, 2011). The rule of operations varies from countries to country, cities to city and local governments to others, depending on levels of operations and viability of the system. In this point of view, Vesilind *et al*. (2002) urged that the methods of SWM are interdepends and interlocking. For decentralized approach of SWM, it has criticized that the approach is not always successful in developing countries. This has proved by the case study in Addis Ababa, Ethiopia, that the city administration is not willing to cooperate and wiped-out informal sectors from waste collection services (Teshager, 2017). These can be derived from very complex issues of waste management system, especially for the cities in developing countries like Phnom Penh. Like most complex issues, it has to be tackled from many different points of view, with all the actors playing their roles towards attaining a common objective (Grosso, 2016). Rodić, L., & Wilson, D. (2017) concluded from her study in developing countries that the countries actually have relevant regulations on SWM, yet the implementation in practice does not have the qualities and the abilities necessary to do in many places and with the result that waste collection services are not simply available to all urban habitants. In this Cambodia context, the better understanding on how we could move from waste politics to practice in the way of equitable, accountable and transparent manners.

6.4 Decentralized solid waste management regulations

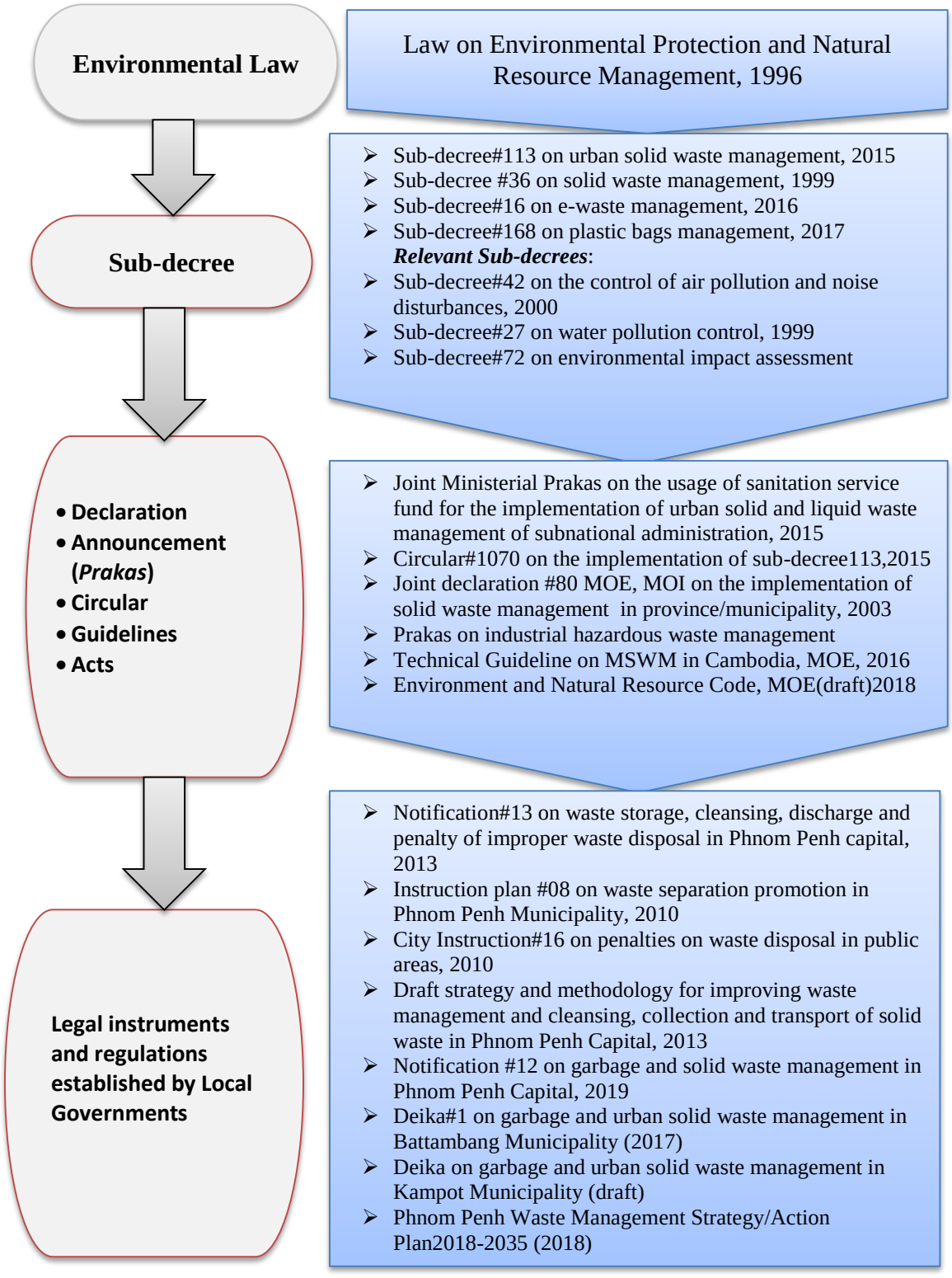
To which extent should related solid waste management organizations be encountered versus roles and responsibilities? This is an important question that has confronted municipal planner, waste manager and waste collection operators since 1994. In Cambodia, pollution control mandate is under the Ministry of Environment which has the main authority for environmental protection in the country (GMS Environment Operations Center, 2016). The Ministry comprises five general directorate departments; including Directorate of Environment Protection, which itself comprises eight departments including department of solid waste management, and department of inspection. The department of

solid waste management plays the vital roles in preparing solid waste legal instruments and monitoring and control (of) all activities in relation to solid waste sector. The department of inspection is another department providing the enforcement work, environmental quality standard assessment and compliance inspection throughout the country; and issue licenses or giving certificates of discharge that complied with national effluent standards. According to the Law on Environmental Protection and Natural Resource Management was adopted in 1996, said law indicate (Article 15);

"*...during the inspection, when found out that there is any criminal offence, the inspector shall report immediately to the competent institution to take action according to the law*".

As mandated in Article 13 of the Law, particular in solid waste sector, subsequent sub-decrees were adopted in various years to govern SWM including sub decree on solid waste management (1999), E-waste management (2016) garbage and urban solid waste management (2015), and plastic bag management (2017). Beside, government sub-decree(s), the responsible Ministries, Ministry of Environment (MOE) and Ministry of Interiors (MOI), have consecutively issued the joint ministerial declarations, *Prakas*, circulars, guideline and environmental code and other specific legal instruments related on solid wad waste management (see Figure 6.2). These are an indicative of growth efforts and commitments of Ministry of Environments and other related department on promoting sustainable solid waste management in Cambodia. In the light of new sub-decree #113 on urban solid waste management and joint declaration of MOE and MOI, a tier under national levels is known as provincial, municipal and Sangat authorities have established *Deika* (Notification) on garbage and solid waste in their provinces and in the reflection to their local appropriately context (Figure 6.2). This pool of legislations and regulations has been elucidated based on the performance of the previous works and effectiveness of the certain enforceability. It can be seen that the existence legal foundation on solid waste management would lead to proper management (Rushbrook and Finnecy (1988). Therefore, the law enforcement is one of the most important roles of government authorities (Spoann, et al. 2018).

Figure 6.2. Legal Framework related to solid waste management



In general, sub-decree and implementation of sub-decree aim to sustainably improve the solid waste management in the transparent and accountable manner. To achieve this, enhancement of institutional capacities in order to both enforce the law and closely work

with various service providers (both formal and informal) are the enabling and supporting factors (Rodić, L., & Wilson, D. 2017). According the recent studies by COMPED (2014), Spoann et al. (2018), and Vong (2016) noticed that the competence of regulatory agencies seems to be limited to achieve fruitful enforcement and disproportionally effective by complying with the said legislations. The decentralized reform of solid waste sector, with legislation framework, appear in place and it is generally—and openly and delegated—admitted that its effective implementation has been challenging and has suffered from political affiliation's role and lacking of manpower and national budget allocation.

6.5. Institutional and Organizational Framework on SWM

In the recent years, many concerns about inappropriate management has led to global efforts in order to reorient municipal solid waste management systems towards sustainability given the limited resources (manpower and funding) and needs for social acceptability and preventing public interest aligning the incentives for the waste processors and waste generator (Arbulứ, et al.2016; Shekdar, 2009; Spoann, et al.,2018). Likewise, Sub-national governance of Cambodia has reformed and transformed to decentralization and de-concentralization policy since 2008. This reform has transferred the administrative functions to sub-national government levels (the provincial and municipal local authority administrative layer) (IGES, 2018) based on law adopted in 2008 (Naizi, 2011). This organic law was passed and requires the establishment of new sub-national structure and systems to ensure its provisional goals (Naizi, 2011). When a function is deconcentrated, the central ministry retains policy and fiscal directions while sub-national government administrations are responsible for implementing the function and control the personnel transferred from the ministry (Vong, 2016). There are some complaints from local government authorities on the allocation of budgeting and public financial management for solid waste management activities as this was subsumed in sanitation component. It is clear that solid waste management fund for municipal/Khan Authority is not sufficient and sustained for enhancing capacity of organization. ADB report noticed that the National program established in 2010 for supporting the reform is not strong enough due to financial estimate and variety of stakeholders' interest. Evidently, a senior MOE official emphasized that challenge needs to pay serious attention was the renovation of governance structure for solid waste management (Vong, 2016). There were some indicative cases in Kampong Chhnang municipality on mandate of local government administration and operational framework on solid waste management as delegated functions (assignments) are not only

about the assigned role and obligation, but there are big barriers and limitations of technical and financial resources. Similarly, a study conducted by National League of Local Councils (NLLC) provided the substantial investigation on the causes of municipal/khan authorities encountered and had small numbers of sub-national government level integrated solid waste program into their development and investment plans. With its new assignments, it is needed to instructions and clear guidelines from above/supervised institution before they could take action and to avoid mistakes (NLLC, 2016; Vong, 2016). It is generally proved that development of solid waste strategies/plan at municipal/khan administration must go beyond institutional and legislative considerations to better address the technical and financial challenges.

Another shortfall on institutional arrangement is the link between political party, state, and civil services also contribute to institutional complexities. Like most complex issues, it has to be well-understood and tackled from different points of view. Vong (2016) pointed out that the reform has interacted with political reality over time, whereas Spoann et al. (2018) concluded that the results of insufficient decentralization power and allocation of fund and workforce for promoting technological and environmentally sustainable practice in SWM are derived from limited institutional capacity and its performance toward the assigned functions. However, in some cases, e.g solid waste collection in Phnom Penh has proved that politically and practically difficult for a regulatory government unit to enforce compliance with regulations, where regulatory agencies ignored and worked out with less commitment (Kum et al, 2004 and Spoann, et al. 2019). It has understood that the right balance must be struck between the interests of the stakeholders and actual reform implementation.

6.6 Methodology

The information collection is derived from the goal of the study and; national and sub-national government bodies both are regulatory agencies and implementing institutions were conducted. The key issues on legal and institutional landscape of sub-national government units are the areas of focuses for this study and systematically examined. The case study approach allows the evaluation of qualitative indicators of legal, policy and institutional aspects and offers the chance to unfold the causal link between actions and outcome in existing SWM system situation in Phnom Penh Capital as a case study. The

data/information are drawn from a combination of reviewing literature and key information interviews and discussion during the project implementation.

For a confirmatory results, the study employed structural analysis for analyzing a way to see through the complexity of the impacts of sustainability dimensions on integrated solid waste management. It identifies the key elements of waste system, outline the relationships between the elements, and highlight the ranking structure with in the system (Ancelin, 1983). By following with Ancelin (1983), the structural analysis proceeds in four steps. First, we identify the relevant variables; e.g indicators of the five aspects in waste management adapted from Zurbbrügg (2014). Second, an interaction matrix of all identified indicators is constructed to see the strength of driving power versus dependency of the constructs. Third, we summed the score (dummy score is 1 and blank, otherwise) of each row and each column. Finally, we analyzed the relationship based on four assuming four categories of variables (the detail of interaction matrix in Appendix C.).

The interaction matrix, *A*, is built (Table 3.1: solid waste variables), letting x_i and X_j to be variables and $a_{i,j}$, a measure of their interaction such that

$$a_{i,j} = \begin{cases} 1 & \text{If } X_i \text{ exerts a direct influence on } X_j; \\ a\ blank\ space, & \text{Otherwise.} \end{cases} \quad \text{(A1}$$

The sum, P_i, of a given row, I, measures the ' driving power' of variable X_i:

$$P_i = \sum_j a_{i,j} \quad \text{(A2}$$

Conversely, the sum, D_j, of a given column, *j*, measures the ' dependency' of variable X_j :

$$D_j = \sum_i a_{i,j} \quad \text{(A3}$$

The solid waste operational system, we define variable are: let variable X_1 refer to 'Quality of Service', X_2 to 'technological appropriate for collection system', X_3 to 'collection efficiency in terms of collection frequency and scheduling', X_4 to 'cleanliness of the city', X_5 to 'stakeholder's involvement in SWM', X_6 to 'personnel resources (skills and manpower', X_7 to 'labor tenure and employment condition', X_8 to 'role &responsibility of LGAs', X_9 to 'institutional framework for related agencies', X_{10} to 'coordination &cooperation', X_{11} to 'willingness-to-pay for improved collection service', X_{12} to 'accountability', X_{13} to 'monitoring &control (of) activities of CINTRI' , X_{14} to 'regulation instruments for SWM' and X_{15} to 'enforceability performance of government bodies to the

public'. The sum of rows, P_i , and of the columns, D_i , are given on the left and the top of borders of the matrix respectively (See Matrix in Appendix C.). The information and scoring in this matrix are used to draw a *'dependency' versus 'driving* power' graph in graph builder of SPSS package.

6.7. Results and Discussion

6.7.1 Evaluating the Factors Influencing to SWM System

The study employed structural analysis to which it can offer a way to see through complexity of supporting and enabling factors on waste collection services in Phnom Penh. Fifteen assessing indicators were elicited from the six sustainability domains are underlined as the key elements in the sustainable waste system, highlight the relationship between these elements, and outline the hierarchical structure with the waste system. The impact of operational performance is considered as waste service quality is used to illustrate the method. The pertinent variables are Quality of Service itself, technological appropriate, collection efficiency, cleanliness, stakeholder's involvement, personnel resource, labor tenure, role &responsibility, institutional framework, coordination &cooperation, willingness-to-pay, accountability, monitoring &control, regulation instruments and enforceability. We used this list of variables to construct an interaction matrix to see the relationship between the different variables (for more information about the matrix, please see Appendix C). Then, we analyzed the role of each variable in terms of *driving power*—a measure of its ability to influence the whole system, and in terms of *dependency*—a measure of its ability to be influenced by other variables. As the result, a driving power/dependency graph is plotted (Figure 6.3).

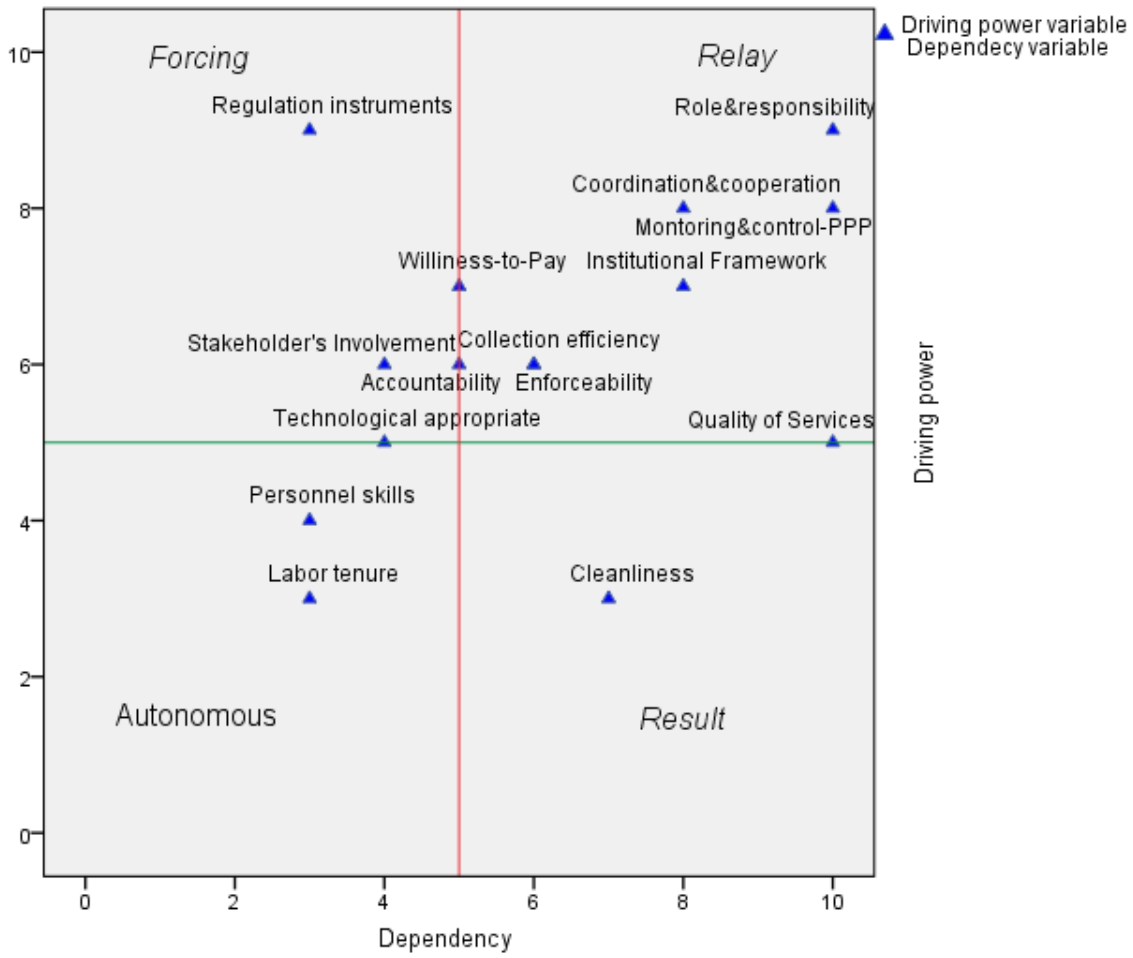


Figure 6.3 Structural Analysis Visualization.

The graph illustrated the position of the plot that represents to each variable where it would fall to any of the four classified categories of variables (relay, forcing, result and autonomous). According to graph, it can be clearly classified into four variable types and this visualized graph also contrasts all four variable types. Autonomous variable are labor tenure, personnel skills and technology appropriate, which are weakly driving and weakly dependent; result variables (e.g. cleanliness, quality of service) are weakly driving and strongly; relay variables (e.g role and responsibility, monitoring and control, coordination and cooperation, institutional framework and ability to enforceability) are strongly driving and strongly dependent; and forcing variables (e.g regulation instrument, stakeholder involvement, willingness-top-pay, collection efficiency and accountabilities) are strongly driving and weakly dependent.

It could be concluded from Figure 6.3 that 'regulation instrument' appears to be stronger forcing variable than 'service quality' from the stand point of the operational performance by CINTRI. The ' Quality of Service' of waste management (Spoann et al.,

2018) and Rushbrook and Finnecy (1988) would only exist legal foundation. Other contradicts variables, 'role and responsibility', 'monitoring and control (of)' activities/performance of CINTRI, and 'enforceability' should constitute good indicators for improving service quality of waste collection system and could be supportive and enabling factors for promoting sustainable waste management. Likewise, Guerrero et al., (2013) analyzed the Principle Component Analysis (PCA) for the waste management system in 26 cities across the world, and the results indicated that the support (component) from government administration, interest of politician and policy maker on MSWM, coordination &cooperation between service providers and service users, stakeholder's involvement and willingness-to-pay for waste service represented to 45.5% of explained variance of the construct by comparing to 15.5% for infrastructure component. In addition, for the case of Phnom Penh, the effective solid waste services require the support of LGA's institutions; even though the legislative exist. In this point of view, Guerrero et al., (2013) and Konteh (2009) pointed out that the weak institutional structure and arrangement are easily overwhelmed by increasing demands for waste management and service quality, even after the decentralized SWM regulation is introduced.

6.7.2 Challenges in Institutional Arrangement

Consequently, two dimensions of waste management are: the volume of waste and the nature of collection (Denney, 2016). It is no doubt that rules of operation were bulked to private operators rather than to public sector. In response to workload and concessions as a single long-term contract firm, waste contractor was making advantages and difficult to push for contract revocation in order to prevent the public interests and social acceptability. Despite increase of attention reforming waste policy, there are some constraints to remove the anti-competitive behavior which rendering unaccountable responsibilities in some cities.

The result from group discussion showed that the challenges for municipal urban solid waste management consist of institutional arrangement, legitimacy issues and stakeholder involvement. The shortfalls of institutional arrangement are clear indications of lacking efficiency and effectiveness. Regarding these issues, we have to deal with situations where the critical challenge and limitation are to effectively enhance capacity of institution and ensure it up to more reliable and sustainable waste management system. Similarly, Spoann *et al*. (2019) also concluded to his recent study that institutional

landscape of local government administration in the period of transformation is quite complex while problems arise from the limitation of operational experience and resources.

6.7.3 Legislative Gap

SWM is considered as the crosscutting issues that affect an impact various areas of sustainable development in each of three sustainability domains: ecology, economy, and society. At least 12 Sustainable Development Goals (SDGs) and their pertinent targets have a direct link to SWM (Rodić, L., & Wilson, D., 2017). RGC and MOE has developed numbers national policies and legislations in the sense of response to SDGs, as well as navigating the ministries and sub-national government administration to formulate and prioritize their development strategy such as sub-national solid waste management strategy and action plan 2018-2035. In relation to SWM strategy, it is seen that the efforts were likely divergent as the national waste management strategy and action plan are currently still under developing by MOE. Only Phnom Penh City has been firstly released this SWM strategy in late 2018, nevertheless, the once sub-national strategy and position would align with national SWM strategy. Rather than above mention, Vesilind (2002) suggested that the waste management policies would be an interdependent to national program. In addition, Joseph (2006) denoted that sustainable waste management laws necessarily need the support form legislators and politicians. They would play a significant role in shoring up the waste management strategy. In that sense, the study found out that lacking of specific local by-laws are the flaws of ineffective implementation of decentralized SWM policy in many provinces.

6.7.4 Moving from Politics to Practices and Technique

The urban solid waste service in most of the cities in Cambodia has been operated by private contracted companies. The waste private operators/contractors take up almost overall responsibilities for waste management including collection, transport, disposal of waste and even fee collection, municipal administration are mainly responsible for monitoring and control (of) waste collection program of waste contractor. After 2015, the implementation of new reform on urban SWM has a critical movement as some municipalities has been revoked and revisited the contractual agreement in response to locally appropriated approach and institutional capacity, example Phnom Penh municipality called for meeting and negotiating with CINTRI to find possible solutions for tackling the current waste management constraints and limitations.. The reform has

gradually promoted the municipal/ districts administration on internalization of waste management program in development plan and waste fee-based setting mechanisms. Evidently, locally fee-setting approach has been implementing to some cities, likewise, the provision of contract made by Khan/districts authorities have already adopted respectively.

Based on the procedure instructions from Ministry of Economic and Finance, an appropriated form of waste fee is the function of affordability and willingness to pay for service users. With different local contexts, every municipal/district administration is always setting the same fee or charging criterion. However, this has not been employed with many cases for public-private partnership waste service in Cambodia, except, a few Khans in Phnom Penh capital.

In practice, for win-win solution, promoting stakeholder involvement might be working politically rather than directly influencing with legitimacy. This indicated that the moving from policy and legislation to practice is best to understand and find the right balance. As the waste management has become "*a matter of State*", which periodically influences the local peoples' perception and participation, the holistic approach on waste management in response to locally appropriated. Enabling and supporting factors for provincial and municipal/district administration and specialized departments to promptly change their behaviors in communication and exchange with stakeholder are necessary for the require new reform of decentralized SWM.

6.8 Conclusion and Policy Implications

6.8.1 Concluding Remark

The legal, regulatory and institutional framework is the backbone for reforms as it assigns the rules, roles and rights for operating solid waste management at provincial, and municipal/ khan administration level. The challenges for decentralization on solid waste management are legitimacy issues, institutional arrangement and service quality. Shortfalls in financial, manpower, and political commitment, and on-going efforts to enhance local governments' capacity are of big concern to national government bodies in the transition period of functional transfer to provincial and municipal/khan administration. The decentralized solid waste management policy has not preserved financial estimate which inclined to reduce the capacity for monitoring and legal remedies. The legal framework is likely not to overthrow anti-competitive behavior and preventing political interest.

Institutional support through enhancing skilled personnel, providing appropriate operational facilities in parallel to the regulations may help to reduce the burden on local government administration. Financial arrangement for waste management, as the part of institutional resources, requires the proper administration of optional fund mobilization and efficient cost-recovery through collection of applicable fees with a modern sustainable system.

The findings from structural analysis determine the forcing, relay, result and autonomous variables suggest that the country as well as the Phnom Penh city administration are progressing toward developing sound institution and proactive policy, especially decentralization policy on solid waste management. This study contributes to a arising research stream documenting the public policy reform in solid waste sector challenges in emerging country like Cambodia, using Phnom Penh city as a case study. The illustration of six aspects and identification drivers and indicators as the function of supporting and enabling factors for sustainable solid waste management are the key findings for this study and of which can be extended to studies in other major cities of Cambodia in similar local context.

6.8.2 Policy Implication

For promoting sustainable institutional and effective legislative framework, Phnom Penh Capital Administration should take account into some policy implications towards sound institutions and proactive policies as the following:

- It is necessary to establish the legal framework for inclusion of both public and private, and both formal and informal providers for waste services and enhance institutional capacity to both enforce law and to work closely with service providers and local tire under municipal authorities. Reinforcing of LGA's performance, there should establish proper monitoring, controlling procedures and enforcing waste management regulation (e.g sub-decree 113 on MSWM) by enshrining in new local legal instrument such as *Deika* on MSWM.
- Since the Politics inevitably play a large role in SWM system, Phnom Penh Capital City should merge Khan and Sangkat administrations' structures, function, and governance of SWM system with its strategic development strategy and priority action plan of Phnom Penh. The synergies between local development strategies

and solid waste management plan in should ensure the successful stakeholder participation in order to achieve the strategy outcome and impact to society.

- The way forwards to overcome the greatest challenges for PPC is to strikes for right balance between policy, governance, institutional mechanisms and resource provision (financial and fiscal allocations). Responsibility, role and right of local government administrations should not be affecting by the role of party politics or political interests.
- Initiatives to improve coordination and communication across the city administrative department, Khan and Sangkat authorities and agencies/ CINNTRI implementing waste management activities.
- The proper waste management would need the legal foundation to respond to local context like Phnom Penh city as the increase of urbanization and quantities of waste generation suggesting that enforcement to illegal dumping and improvement of service soon become imperative.

6.9 Summary of the chapter

Management of municipal solid waste (MSW) is a major challenge in cities of Cambodia. Overall responsibility for waste management has rested with municipality and district authorities and private operators. Providing waste services is a major challenge for both public and private sector due to the increasing waste volume and low service quality. While several strategies, regulations and policy have been introduced for efficient municipal solid waste management (MSWM) in Cambodia, their performance level, practices and motivation level has not been critically investigated. This paper aims to review the progress of decentralized MSWM system in the Phnom Penh and examine the institutional and legal aspects after the reform of solid waste management policy established in late 2015. We used sustainable waste management performance indicators involving qualitative assessment of institutional, legal and political aspect for system evaluation. Information was collected through literature reviews, scientific papers, and published documents from government offices. Since, SWM in Phnom Penh is the most complex issues, the cases study from Phnom Penh city were discussed. Solid waste related regulations and policies established from 1999 to 2017 are the key domains for the evaluation. Shortfalls in financial, manpower, and political

commitment, and on-going-efforts to enhance local government's capacity are great barrier to address to solid waste management (SWM) reform's objective. New reform requires behavioral change on the part of sub-national government administrations and related specialized departments, so that, communication and coordination with stakeholders function as enabling and supporting factors. Political, economic interest and will of municipal/district administration is the function of the levels of public and stakeholder participation and motivation. It suggests that reinforcing of Local Government Authorities' performance, with response to the reform, there should establish proper administration for monitoring; controlling procedure and enforcing waste regulations. This critical review has essentially practical implications for SWM, promotion of synergies between sub-national and others; and creating value via sustainable waste management and circular economy opportunities.

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Chapter 7:
Estimating Industrial Waste Load Assessment in Phnom Penh City: Using an Industrial Pollution Projection System

7.1. Key Concept of Industrial Pollution Projection

Rapid industrial development and urbanization many primate cities throughout the world have led to the admitting and increasing understanding of the linkage between pollution, human health and urban environment. According the Blacksmith Institute and Green Cross Switzerland (2012) reported that about 125 million people living in 49 lows-to middle income countries is at risk from toxic industrial pollution. Primary industry in Cambodia accounted for 26.18% of the total economy in 2015, while the secondary and tertiary industry respectively account for 22% and 38% of the total economy (CDC, 2015). Phnom Penh accounts for the largest share of enterprises of most industrial sectors with the neighbour provinces (for textiles and apparel sector, spinning, weaving and finishing textile and printing). Again, Phnom Penh alone accounts for 61.2% of industries distribution in the whole counties, as in the dataset. The study by GMS Environmental Operation Center (2016) suggests that further study should be focused on hotspot areas where industrial pollution is concentrated (GMS Environmental Operation Center, 2016).

Information regarding industrial pollution necessary to set strategies, priorities, and action plans for environmental protection is lacking in most developing countries. However, effective environmental protection cannot be implemented in the absence of such data (Oketola and Osibanjo, 2007). Many researchers noted that assessing and controlling industrial pollution is time consuming, expensive, resource intensive, and tedious for most developing countries (Oketola and Osibanjo, 2007, 2009a, 2009b). Likewise, for Cambodia situation, plant monitoring of air emission, water, and toxic discharge is at best done in a sporadic fashion, monitoring protocols and methods may not be applied consistently, monitoring equipment is often obsolete, data management and arching procedures may not be strictly followed, and undertake data analysis for setting priority actions (GMS Environmental Operation Center, 2016). Such a situation, it is generally recognized that environmental regulators in Cambodia often lack vital information where the main pollution hotspot, for instance in Phnom Penh, are found. As a response to this insufficiency of information, our study has employed a tool known as the

Industrial Pollution Projection System (IPPS) adopted from Hettige et al. (1994). The study aims to estimate industrial pollution load by employing the Industrial Pollution Project System, a rapid environmental management tool for assessment of pollution load, to produce a scientific rational basis for preparing future policy direction to reduce industrial pollution in Phnom Penh city. The study also presents the characterization of industrial pollution in Phnom Penh using IPPS.

7. 2. Is Non- Hazardous Industrial Material is Municipal Solid Waste?

Industrial waste generation and composition depends upon various factors, such as types of industries set up in the country. Goods manufacturing produce large portion amounts of wastes, often non-hazardous. Basically, industries emit more concentrated pollutants and larger amounts on per-source basis (Sigh et al.,2014; Chalmin and Gallochet, 2009). Non-hazardous or ordinary industrial waste is generated by industrial or commercial activities, but it similar to household waste by its nature and composition. In particular, it includes ordinary waste produced by companies, shopkeepers and trades people (paper, cardboard, wood, textile, packaging, etc.).The majority of the industries types and degree of industries in Cambodia are textile and apparel sector factories. These factories types produce tremendous amounts of wastes which categorized as non-hazardous wastes. For this argument, Chalmin and Gallochet, (2009) conducted the world waste survey and noticed that municipal solid waste in the United States includes a large amount of commercial waste that is normally accounted for as being industrial waste in Europe. Comparatively, the industrial waste in Cambodia discharge in bigger amounts from textile industries where mostly are non-hazardous wastes. The industrial waste estimate were based on the quantity of waste collected by a private industrial waste collection firm called Sarom Trading Co. Ltd.

7.3. Data Sources and Validation

Factory data between 1994 and 2014 obtained from the Ministry of Industry and Handicraft of Cambodia (MoIH) were used in our study. The factory data were defined and limited to all factories located in Phnom Penh city only. Two datasets were required to construct this study. Employment data for industrial sectors in Phnom Penh for 1994 to 2014; and Data and information about industrial pollution levels is necessary. The Policy Research Department of the world Bank collaborated with the Center for Economic Studies of the United States Census Bureau and the US Environmental Protection Agency

(USEPA) to produce a massive United States (US) database using environmental, economic, and geographic information from approximately 200,000 US factories in all regions of the country. This database was used to generate the IPPS and was developed by merging the data from U.S. Manufacturing Census and USEPA data on air, water, and solid waste emission (Hettige et al., 1995). In 2016, the GMS Environmental Operation Center of GMS Core Environmental Program with collaboration the ADB team, has conducted the study on estimating industrial pollution in the Kingdom of Cambodia by using IPPS. Following these, industrial activity data were combined with data on pollution emissions to estimate pollution intensity factors (or coefficients) (usually defined as pollution per unit of output or pollution per unit of employment).

With connection to solid waste, pollution load was also estimated from solid waste emission (WHO, 1982; Hettige et al., 1995, Oketola and Osibanjo, 2011; Oketola and Osibanjo, 2007, 2009; and GMS Environmental Operation Center, 2016). According to the Department of Environmental Pollution Control reported that industrial solid waste in Phnom Penh City significantly increased from approximately 31,325 Mg in 2000 to approximately 40,000 Mg in 2002 (DoEPC, 2005). Regarding industrial solid waste management under the services of Sarom Trading Co., Ltd., The amount of industrial waste disposed at the Sarom's landfill in 2014 was approximately 206,690 Mg (an approximate increase of 23% from 2013) (MoE, 2015).The pollution intensities were used to calculate the pollution load for the 20 industries sectors after merging the intensities of all 79 major categories according to the International Standard Industrial Classification (ISIC) code, to conform to 20 sectors in Phnom Penh. Based on the data from factories registered under the MoIH from 1994 to 2014, the number of industrial firms operating in Phnom Penh city increased from two factories in 1994 to 726 factories in 2014. The Textiles and Apparel sector had the largest number of firms, which accounted for 69.97% of all firms in 2014 followed by the Leather sector (7.99%), and the Paper, Paperboard containers and Boxes sector (3.03%). The result shows geographic distribution of industrial air, water and land pollution. Majority compositions of industrial waste are from Textile and Apparel industries. Textile and Apparel sector had the greatest contribution to environmental pollution and followed by Basic Metal sector (GMS Environmental Operation Center, 2016; Hettige et al., 1995). Toxic Metals released by Textile and Apparel sector into the air, water and land. The type of raw materials used for production

may be an important factor affecting the amount of toxic metals release to the environment, which also strongly agreed by Oketola and Osibanjo, (2007).

The World Health Organization (WHO) indicated that inventories of pollution and waste sources have varied applications in environmental protection program, depending on the governmental level at which they are applied in a given countries. Local and municipal authorities have been effectively adopted the environmental monitoring program in the most economical way. In such program, these inventories further help the assessment of the environmental effects of emissions. Sometimes, the emission inventories are also used as the basis for formulating pollution control laws and regulations, and for the preparation of preliminary environmental impact assessments (WHO, 1982).

To manage industrial pollution, the Ministry of Environment (MoE) has established the law on Environmental Protection and Natural Resource Management in 1996 Said law required MoE to establish an inventory list that will indicate (Article 12):

- The sources, types, and quantities of pollutants and wastes that are imported, generated, recycled, treated, stored, disposed, or released into the airspace, water, land or on land surface; and
- The sources, types, and quantities of all toxic and hazardous substances that are imported, produced, transported, stored, used, generated, treated, recycled, disposed, or released into the airspace, water, land or on land surface.

Solid waste management regulations were also established respectively in order to adapt to the above law such as sub-decree on solid waste management (1999), sub-decree on urban garbage and solid waste management (2015), sub-decree on e-waste management (2016), and *Prakas* (declaration) on industrial hazardous waste management (2009). Sub-decree on solid waste management has implemented associated with Sub-decrees such as Sub-decree on water pollution control (1999), Sub-decree on air pollution control and noise disturbance (2000) and Sub-decree on environmental impact assessment (1999).

The study gathered the required data by looking up pollution and waste factors. The *pollution factor* is the amount of a pollutant or a combination of pollutants released into the environment by an industry (directly, or indirectly through municipal sewers or though the industrial/municipal waste collection and treatment network) per unit of merchandise produced or per unit of raw material consumed, depending upon the type of industry or

method of calculating of the pollution factor. On the case of industrial and municipal wastes, the term *waste factor* refers to the total amount of waste (solid or liquid) released into the environment (directly, or indirectly through municipal sewers or through the industrial/municipal waste collection and treatment network) by a city, or state, etc. during a certain period of time. After having pollution and waste factors, we used them in calculating pollution and waste load respectively. The *pollution load* refers to the total amount of a pollutant or a combination of pollutants released into the environment (directly, or indirectly through municipal sewers or through the industrial/municipal waste collection and treatment network) by an industry or a group or industries in a given area during the certain period of time. In the case of municipal wastes, the term *waste load* refers to the total amount of waste released into the environment (directly, or indirectly through municipal sewers, or though the municipal waste collection and treatment network) by a city or state, etc. during a certain period of time (WHO, 1982). The factors for industrial solid wastes have been categorized into three major sources are:

- solid waste from industrial processes;
- solid wastes from the treatment of liquid effluents; and
- solid wastes from the treatment of air emissions.

Most industries emit to pollutants from both fuel-burning and industrial production processes. The a literature review was therefore conducted and suitable pollution and waste load factors for industrial effluents are identified for most of the industrial processes as listed in WHO list of factors for industrial effluents. The working table for industrial solid waste gives solid waste factors for various industrial processes along with the nature of wastes produced (WHO, 1982).

As response to the validity of using solid waste data for industrial pollution, the study has adapted to the relevant legal regulations and standards defined to solid waste terms as following:

Article #3 of sub-decree #36 on solid waste management (1999) defined the technical term of solid waste, household waste and hazardous waste. The type of hazardous waste is listed in the Annex of the sub-decree consists of metal waste and their compounds as well (RGC, 1999).

Article #3-e of sub-decree #27 on water pollution control (1999) defined the technical term shall have the meaning ascribed here to:

- garbage refers to disable used substance or objects that are disposed of from dwellings, and public buildings;
- pollutants refers to solid or liquid or gaseous substances or all kind of waste that cause any charges of component or characteristic of water such as physical, chemical or biological when it is intentionally or unintentionally released into the water.

The sub-decree on also defines standards for effluent discharge for any source of pollution (Article #4) where the metals and their compounds as the same specified in sub-decree on solid waste management (RCG, 1999) (see in Appendix xx).

7.4. Method and Materials

Manufacturing activities contributed almost two third of the industry sectors, especially for textile and apparel factories. These are the main source of metal and organic waste including hazardous and non-hazardous industrial wastes. These types of solid waste are considered as the industrial pollutants an both harm human health and degrade the environment by contributing to global issues such as enhancing greenhouse effect from open burning, biodiversity losses, water body contamination and city aesthetics. The main sources of solid wastes and toxic metals and other organic solvents are from industry activities. According to the identification of industrial solid wastes the sub-decree #36 on solid waste management has categorized it into three source are: (i) solid waste from industrial processes; (ii) solid waste from the treatment of liquid effluents; and (iii) solid waste from the treatment of air emissions. Due to limitation of study on and lack of total industrial pollution data in Phnom Penh, industrial pollution from industrial solid wastes to air, water and land as well as the sums of emissions to all mediums (air, water and land) are estimated using employment economic variable in IPPS. The estimate and methods were adopted from Hettige et al. (1994) and extensive elaboration and description of result and discussion were based on research's publication which has been published in 2018. Thus formula for estimating industrial pollution load are expressed below:

$$PL_s = \frac{PI_s \times TEM_s}{1000 \times 2204.6}$$

where,

PL_s = Pollution load in ton per sector *s*

TEM_s = Total number of employees per sector *s*

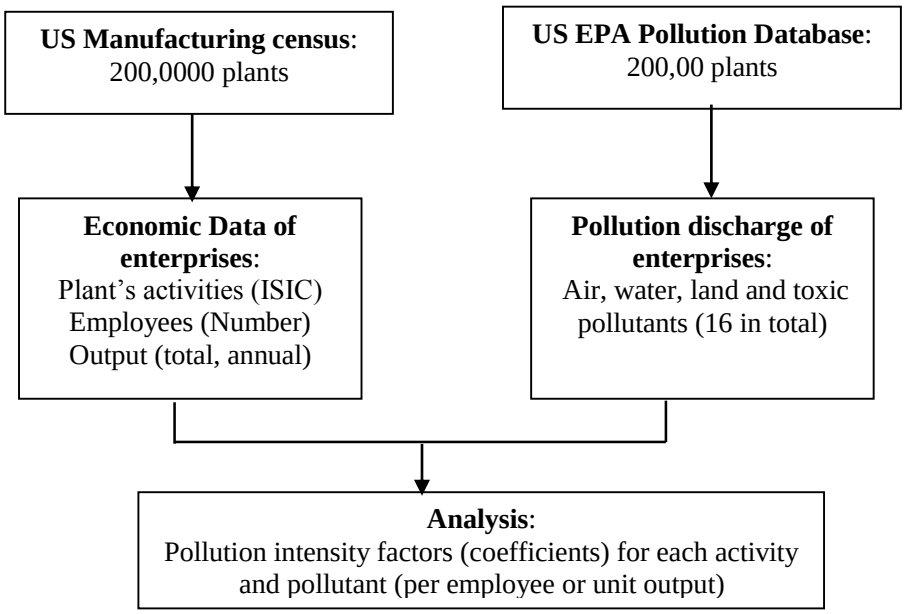
PI_s = Pollution intensity in pounds per thousand employees per year

2204.6 = Conversion factor from pounds to tons

The results of this chapter were mostly derived from the researcher's publication entitle "Industrial pollution load assessment in Phnom Penh, Cambodia using an industrial pollution projection system", published in 2018 (615), of which the researcher is the co-author of this original article. With the elaboration from this paper, researcher extensively analyzed and provided the discussion in particular reference to solid waste load assessment and its elements.

The Industrial Pollution Project System (IPPS) combines data from industrial activities, such as pollution and employment, with data on pollution emissions to calculate pollution intensity factors, thus representing the level of pollution emissions per unit of industrial activity (see Fig.7.1) (Hittege et al., 1995, GMS Environmental Operation Center, 2016).

Figure 7.1 The industrial Pollution Project System (GMS Environment Operation Center, 2016)



Data sources for analysis were from datasets related to industry profile/information, especially employments, firm location and capital stock and industry assets. The data and information from Ministry of Industry and Handicraft (MIH) from year 1994-2014 are used to estimate the pollution load. Cambodian Industrial Standard Classification (CISC) is used to classify the types of firms/factories in Cambodia. Thus, the identification of polluting industry can be identified as most, moderate and least polluting industries.

7. 4.1 Study Area

Phnom Penh city is the most populous areas in Cambodia, which is estimated to be home to approximately 2.06 million or approximately 13.15% of the total population of Cambodia (JICA, 2014) Much of the growth in economic activity in Cambodia occurs in and around Phnom Penh, which has seen a high population growth driven by high levels of in-migration as a consequence (Fig. 8.1). The city accounts for approximately 75% of internal investment in the industrial sector, thus, this is the reason of growing manufacturing and service sector in recent decades. The annual total generation of solid waste is estimated at close to 1 million tonnes a year, of which a about 0.70 million is deposited in the landfill. Industrial wastes were critical movement while a single private contracted service, called Sarom Trading CO. Ltd, privatizing this collection operation and disposal of. Based on the agreement, the Company is subject to collect, transport only non-hazardous industrial waste from the factories and warehouses in Phnom Penh and dispose in its own dumpsite.

7.5. Results and Discussion

7.5.1 Industrial Development in Cambodia

Cambodia's industrial sector has risen significantly in recent decades after establishment of the second Kingdom of Cambodia in year 1993. The share of gross domestic product (GDP) by sector increased from approximately 12.5% to 24.1% in 2103 by comparing with the GDP in year 1993. The growth has been significant remark between the years of 1998 to 2013 which represented to approximately 12.4% on an average annual growth rate. Among the three sectors, industrial sector also represents a large share of employment in Cambodia, as the increase of industrialization processes, especially in Phnom Penh city. This share for Cambodia increased from 5% in 1993 to 24.3% in 2014, (GMS, environmental operational center, 2016) whereas Phnom Penh alone represent to

approximately 70% (GGGI, 2016) of the total share. For Phnom Penh, the share of industry sector increase from 21.2% in 2009 to 28.2% in 2014 of the total share. Even though the increase rate was approximately 7%, this has been experienced significant growth as the land areas of Phnom Penh has been changed double by 2014.

Table7.1: Employed population by industrial sector (%)

Sector	2009		2014	
	Phnom Penh	Cambodia	Phnom Penh	Cambodia
Agriculture	1.9	57.6	25.0	45.3
Industry	21.2	15.9	28.2	24.3
Services	76.9	26.5	69.3	36.4

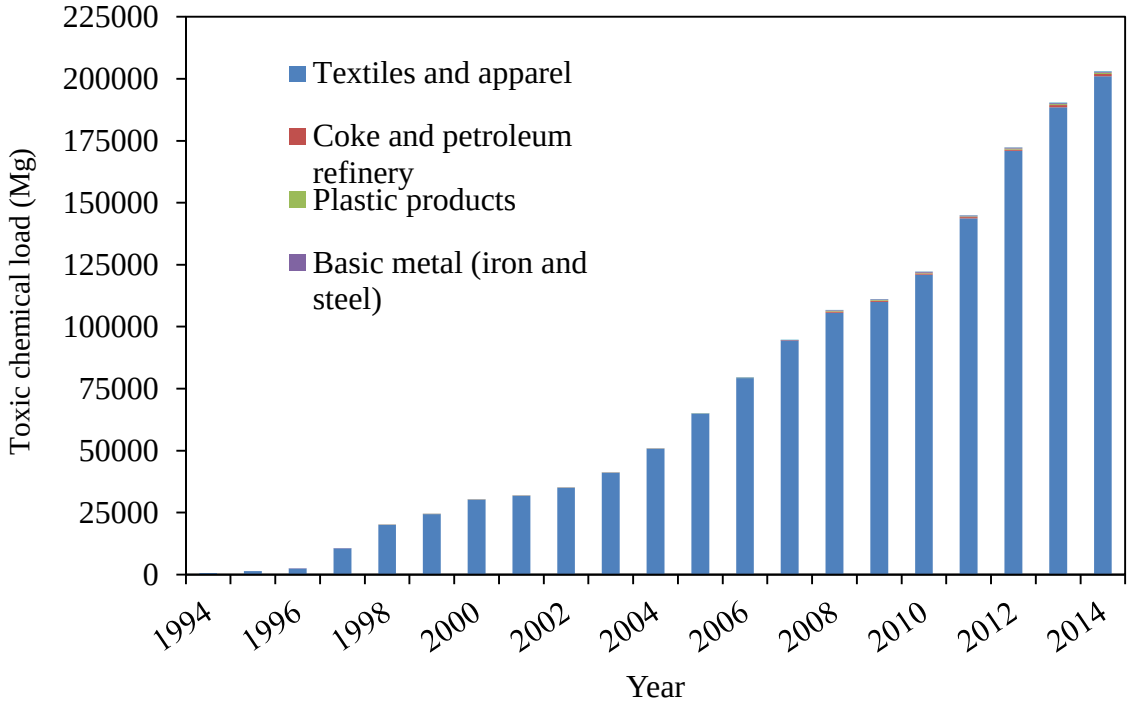
Source: Author adapted from (GMS Environmental Operation Center, 2016)

7.5.2 . Toxic Pollutant Load

7.5.2.1 Toxic Chemicals pollutant load

According to the recent study, San et al., (2018) has grouped toxic pollutants as organic chemical including benzene, toluene, xylence, cholrethene, and chloromethane, and pesticide residues. Figure 7.2 shows the total toxic chemical pollution load of the common-five polluting industrial sector from 1994-2014. The textile and apparel sector generated the greatest amount of total toxic chemical in Phnom Penh city, and followed by Coke and Pertoleum Refinerary sector, plastic products, basic metal (iron and steel), and the electrical apparatus. The estimate of the total toxic chemicals released to the environment were 203,991 Mg comparing to the total toxic chemical released in year 2004, accounted for 50,806.26 Mg. The toxic chemicals from textile and apparel sector are the largest category from 1994 to 2014 and it is accounted for 201,045 Mg (98.56%) comparing with total estimates. Textile and apparel sector were the largest pollutant to land and air. Toxic chemicals are usually dumped on land as part of the solid waste. However, a major part of land pollution is likely to end up in water via direct seepage and runoff. This result was consistent with the estimate conducted by Oketola and Osibanjo (2007).

Figure 7.2 Toxic Chemical Pollution Load from 1994-2014

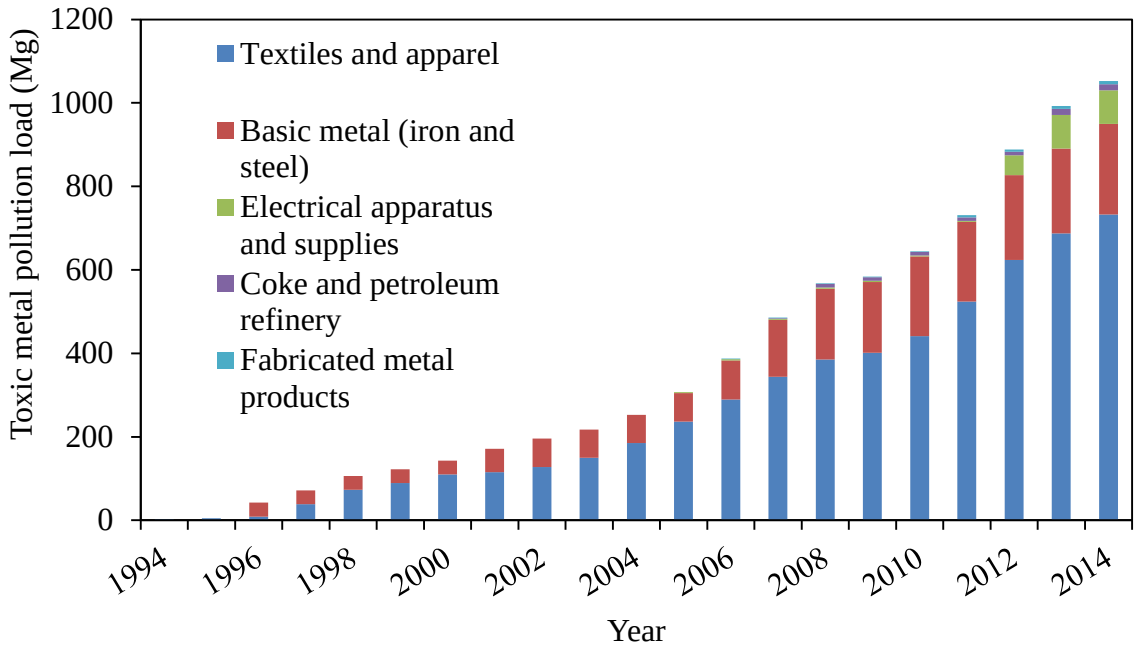


Source: San, V.; Spoann, V.; Schmidt, J. (2018)

7.5.2.2 Toxic Metal pollutant load

Figure 7. 3 shows that the Textiles and Apparel sector had the greatest contribution to environmental pollution in terms of toxic metals of approximately 68.34% (733 Mg) of toxic metals (1,072 Mg) in 2014, while the Basic Metal sector contributed 20.20% (217 Mg). The results also reveal that the Textiles and Apparel sector was the greatest generator of toxic metals to all media. Toxic metals released by the Textiles and Apparel sector into the land in 2014 were greatly estimated as 693 Mg (68.22%). Basically, the toxic metals for textile and apparel sector are largely polluting to land, water and air. In the context of Cambodia, the dumping and disposing of textile and apparel industry wastes were apparently polluting more to land and air as some of these type of wastes were somehow burned for other purposes by local people and dumping improperly. It can be concluded that the direct discharge of toxic metals to the land by all sectors was the highest, while emissions to water were the lowest compared to land and air. Most polluting sector of toxic metals are from garment industry and also were identified by most of the study conducting in development countries, such as in Vietnam.

Figure 7.3 Toxic Metal Pollution Load from 1994-2014

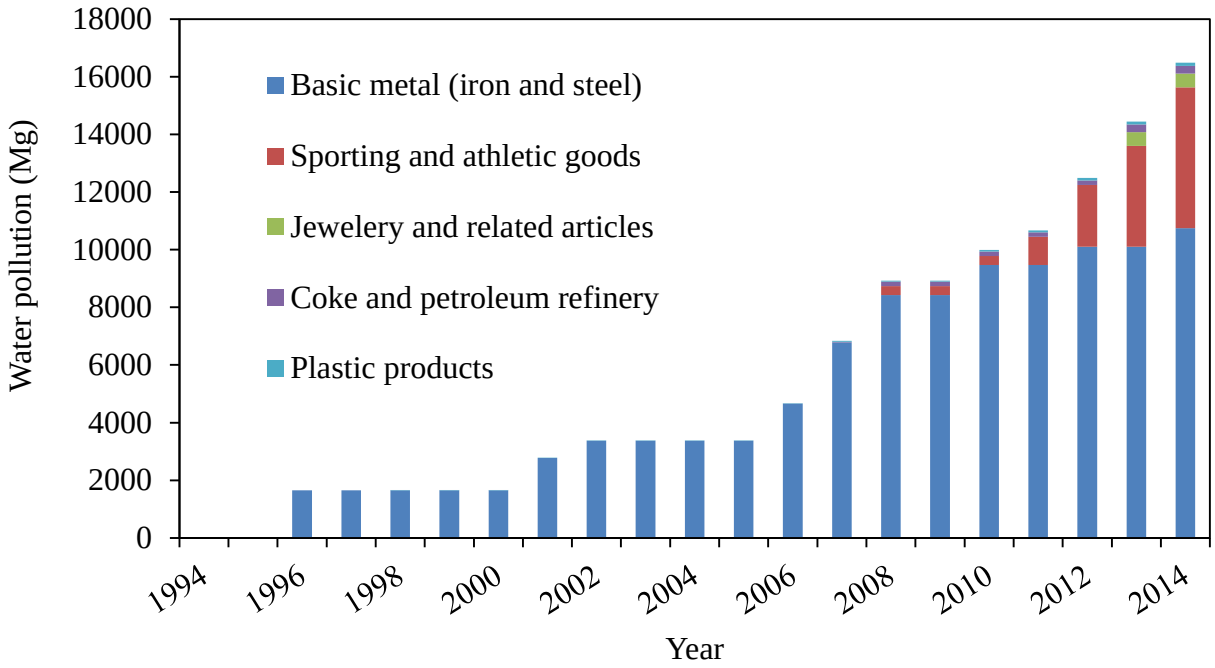


Source: San, V.; Spoann, V.; Schmidt, J. (2018)

7.5.3 Water Pollutants

Water pollution caused by industrial activities in Phnom Penh city are identical. Most of manufacturing firms are produced waste water and discharged polluted water into sewerage system without proper treatment. The disposing of sludge from industries and dumping of wastes are major concern for industrial waste management in Phnom Penh (GMS Environmental Operations Center, 2016, and PPCA, IGES, Nexus, UN Environment, CCCA (2018). According to data from Department of waste management, MOE, the wastes from industries and manufacturing firms are largest category as it present 206, 690 m3 in 2014. Figure 7.4 shows that water pollution in 2014 from basic metal (iron and still) are the largest amounts which represented to 10750.50 Mg, followed by the sporting and athletic goods firms with 4879.88 Mg. By increasing of number of firms from 1996 to 2014, the total volume of water pollution from industries has been increased about six times. The analysis indicated that TSS generated from the industrial sector in 2014 were approximately 16,480 Mg, which represented 98.48% of the total water pollution (San, V.; Spoann, V.; Schmidt, J,. 2018)

Figure 7.4 Water pollution load from different industry types (1994-2014)



Source: San, V.; Spoann, V.; Schmidt, J. (2018)

7.5.4 Land Pollutants

Land pollutions is more complicated and accumulative. There are three media from land pollution load that were interacted between air, soil and underground water. Table 7.2 shows the pollution load to land by toxic chemical and toxic metals. Toxic chemicals to land were increasing respectively from 2006 to 2014. Toxic chemicals and metals generated as waste by-products on land from the industrial sector in 2014 estimated with IPPS were 38,523 Mg and 1,016 Mg, respectively (Table7.2). Another pollution load to land was toxic metal were also relatively increasing from 2006 to 2014. It indicated that the industrialization process of Cambodia after integration to ASEAN community was significant. Alongside with these trends, the economic growth of Cambodia was growing remarkably from the last decade. The land pollution load in Phnom Penh city are considered to increase in the next future, as the increasing city boundary and industry activities.

Table 7. 2. Industrial pollution to land by pollutant type (in Mg)

Pollutants	***1994-2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Land pollution										
Toxic chemicals	58,355	14,754	17,659	20,161	20,983	23,083	27,349	32,494	36,134	38,523
Toxic metals	1,555	368	462	540	555	614	703	854	957	1,016
Total	59,910	15,122	18,121	20,701	21,538	23,697	28,052	33,348	37,091	39,539

Source: San, V.; Spoann, V.; Schmidt (2018)

7.5.5 Projection of Pollution Load

The projection of pollution load was estimated from 1994-2014 by author (s) in his paper published in 2018. In this chapter, the author estimated the pollution project into water and land from different five intervals. In table 7.3, the projection predicted from year 2000 to 2030, of which would provide the substantial outcomes based on the changing of employments and industry activities. However, this approach faced with some limitations due to the data of industry sector was not completely recoded every year by MIH. The assumptions were made. First, it is assumed that the entire industrial sector will continue to grow (or shrink) at a rate similar to that from the base estimation years (1994-2014). And, the pollution intensity was assuming to be remained the same. The conditions of technology applications, trends of agglomeration of economy in urban areas and regulations of Cambodia, the estimate of intensities of pollution would reflect to actual available information. This may not be followed to the approach used in the United State and its result was indicative. The reliability of the result of the estimates depends on how closely Cambodia technology responding to that in the United States (San, et al, 2018). So, the estimate then referred to the registered firms are currently operating in Phnom Penh.

Table 7.3 shows the results of projection of pollution load estimates by types of pollutants. For water pollution, TSS are predicted to increase to 18,089 Mg in year 2030, followed by BOD with amounts of 247 Mg. Based on the estimate in Figure 7.4, Textiles and Apparel sector would increase significantly and accounted for 682,620 Mg in 2030 (San, et al., 2018). For land pollution, It is projected to increase to 60,388 Mg for toxic chemicals and 1,618 Mg for toxic metals. The studies revealed that toxic chemicals and toxic metals are harmful to environment and public health (WHO, 1982).

Table 7. 3. Effluent projection by pollution types (Mg)

Pollution load	2000	2014	2020	2030
Water Pollution				
Toxic chemicals	6	57	69	89
Toxic metals	1	9	11	16
BOD	4	189	210	247
TSS	1,662	16,480	17,083	18,089
Land Pollution				
Toxic chemicals	5,604	38,523	46,722	60,388
Toxic metals	136	1,016	1,242	1,618

Source: San, V.; Spoann, V.; Schmidt (2018)

7.5. 6. Management Measure for Industrial Pollution

The management and protection of environment and natural resources has been addressed in the law on environmental protection and natural resource established in 1996. However, the implementation of those regulations are often challenging due to legitimacy issues and governance (Spoann, et al. 2019). The applications for industrial waste management have varied and depending on the governmental level at which they are applied in a given city and countries (WHO, 1982). The national and sub-national government have been adopted the environmental program by referring to sub-decree #36 on solid waste management and ministry circular on industrial waste management, sub-decree on water pollution control and sub-decree on air pollution; guideline on solid waste management at factories (2003) and sludge management at factories (2000) and declaration on the enforcement to standard level for toxic and hazardous substance (2015); and other local regulations related to waste management. In late 2018, the Phnom Penh Capital has developed the Phnom Penh Waste Strategy and Action Plan for year 2018-2035, as the guiding policy document for its mid-to-long term development. The strategy and action plans have designed and provided the road map for managing solid waste and industrial waste management in Phnom Penh.

Regarding the management of collection, transport and disposal of industrial waste that Ministry of Environment provides the service license to Sarom Trading Co. Ltd. Company, the service quality monitoring and assessment should regularly conduct and enforce effectively. The proper management of industrial wastes need the legal foundation and work closely with factories on waste management processes. Even though the Sarom Trading Company have been operating industrial waste collection, the amount of waste generated from industries have been collected approximately 80% of the total industrial wastes in Phnom Penh. Therefore, measures for improving the waste collection system should be taken into account for long-term management due to then increasing of industrialization and trends of waste production in various industrial activities in the future. Anti-competition behavior on industrial waste services should ensure the participation from capable waste operators and recycling firms. On the other hands, number of possible options on industrial waste management would exist and service quality would improve relatively.

7.6 Conclusion and Recommendation

The industrial pollution and pollution loading status of Phnom Penh city were critical movement as the about half of industry activities and firms were being operated in this city. The study of industrial pollution were limited due to lacking of information on industry sector and pollution inventory. Basically, the results of the study offers a doable management tools and direction for government agencies in taking intervention on environmental protection and mining the cost of externalities. The findings concluded that geographic difficulty and sectoral distribution of industrial pollution are the factors to regulate the pollution load and emission levels. The most polluting industries are textile manufacturing and apparel industries due to highest numbers of firms. Toxic chemicals, metals in water and lands are estimated and contributing to pollutant load from textile and apparel sector were 57,274 Mg of total pollution load. The projection of pollution load by industry and manufacturing types are typically indicative. The water and land pollution are critical for year 2030 as the increase of pollution load were significant and tremendously harm to environment and public health. The management of industrial pollution should focus on holistic approach that could reduce the solid waste generation at industries and promoting resource recovery though recycling and energy plant for non-hazardous wastes. Pollution control regulations for industry sector and types and at landfill should establish

as the current interventions have its limitations due to legal challenges. Cleaner production processes for manufacturing firms would introduce and restrict for polluted potential industries. To protect the environment and human health, and prevent the public and economic interest, the proper monitoring and control of the performance to comply with effluent and emission standards should be regularly implemented and enforced effectively. Development of a sound data management of industrial wastes for future planning, design and monitoring and evaluation is essential and needed.

7.7. How the previous paper contribute to this research study

The study on the solid waste management in Phnom Penh produces a scientific rational basis for better understanding on the waste management system in Phnom Penh Capital, both municipal and industrial waste management. In the Broad meaning of waste management, this study is the complementary research work in the field of industrial pollution projection because solid waste load and industrial waste categorization are part of urban waste management system. By law and regulations, non- hazardous industrial waste are included as household solid waste category and being disposed in the same landfill.

Some reasons that author is eligible for the claims and validate this paper as the achievement of the scientific peer-reviewed publication for PhD degree evaluation are as follow:

i. The nature of waste categorization for industrial solid waste (e.g textile, paper, plastics, cardboard, wood, etc.);
ii. Study area is the same to PhD dissertation (Phnom Penh Capital)
iii. The estimate of solid waste loading and waste factor refer to the total amount of waste (solid or liquid) released into the environment (directly, or indirectly through municipal sewers or through the industrial/municipal waste collection and treatment network) by a city, or state, etc. during a certain period of time.
iv. The synergy studies of municipal solid waste management including industrial waste management are necessary important for municipal management and planner in establishing the Phnom Penh waste management strategy and action plan for year 2018-2035.

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Chapter 8:
Conclusion and Recommendations

8.1 Conclusion

The overall results for the study are divided into three main chapters (chapter 4,5 &6), which corresponding to its research questions. Thus, three conclusions from the above three area of focuses were made as the following.

The amount of total waste generation in Phnom Penh has increased annually and waste disposal has remarkably grown in PPC, from 0.409 million tons in 2010 to 0.680 million tons in 2015 and it is projected to be 0.792 million tons in 2020. The gross waste generation per capita was 0.762 Kg day^{-1} $capita^{-1}$ in 2013 and estimated to increase to 1.240 Kg day^{-1} $capita^{-1}$ in 2030. Waste composition is dominated by kitchen waste at 63.3%, followed by plastics (15.5%), grass and wood (6.8%) and paper and cardboard (6.4%). There has been about 9.3% of waste recycling by informal sector from amount wastes disposed at landfill. About 40% of household have not accessed to CINTRI waste collection service, since the total territory of PPC has increased from 367.47 km^2 to 678.47km^2 in year 2010.With these geographical and technical in nature, the municipal waste management situation in Phnom Penh capital is deficiency in terms of institutional management capacity and operational performance, legal framework synergy constraints.

The conclusion remarks from topic one the challenges and opportunities of improving capacity of local movement authorities reveals that the institutional capacity and operational performance are deficient. The service provider and PPCH have not expended sufficient effort to improve the situation and the quality of service. Operation systems depend on the service quality and reliability based on technical inputs. It has been revealed that waste storage, discharge, collection, transport, and disposal are neither environmentally sustainable. The factors influencing the institutional arrangement shortfalls include lack of monitoring and evaluation, unclear roles and responsibilities, and limited technical capacity, as reform policy is still in its early stages. Limited financial resources and budget allocation reduce the capacity for monitoring and legal remedies. Political interest and manipulation weaken enforcement and control. Public participation and awareness raising would have gradually increased due to the policy interventions on the clean city competition. Promoting resource recovery, recycling, and composting

through stakeholder involvement is essential to reduce the management cost and increase the cost recovery for LGAs. The LGAs should frequently assess its operational procedures to ensure that the service is operated reliably.

The PPP assessment of operational performance of public and private sector is a major concern and need to elucidate the behaviour of involved institutions in waste sector for Phnom Penh Capital. The main challenges of solid waste collecting are service quality, institutional arrangement, stakeholder involvement, legitimacy issues, and labour and employment conditions issues. The on-going efforts to build the LGAs' capacity are of great concern to governmental agencies in the transition period of SWM functional transfer to LGAs. Achieving sustainable management requires an integrated approach. The causes of the institutional arrangement's shortfalls for PPP are clear indications of the inefficient and ineffective service. It was derived from a lack of monitoring and evaluation of the PPP process. Lack of a clear operational framework for this long-term contract, CINTRI rendered the difficulties to widen the service coverage and ensuring the involvement from stakeholders, despite the MSWM decentralization to the LGAs. A legal framework, no anti-competitive behavior, allowing the widening of ownership, preventing public interests, must be advised and adopted to municipal and local government. In this transition and local specific context, obligated responsibility, competitive tendering, complete transparency considerably with regards to financial accountability are essentials for enhancing system viability. This study might, differences of cities notwithstanding, be very useful the role of PPP in urban waste governance in a circular economy.

The third case study was to particularly address to the barrier of the synergy of legal framework, regulations and institutional framework to practical implementation. It firmly agreed that the legal, regulatory and institutional framework is the backbone for reforms as it assigns the rules, roles and rights for operating solid waste management at provincial, and municipal/ khan administration level. The challenges for decentralization on solid waste management are legitimacy issues, organizational role, right and responsibility towards the provision of waste service. The decentralized solid waste management policy has not preserved financial estimate which inclined to reduce the capacity for monitoring and legal remedies. The legal framework is likely not to overthrow anti-competitive behavior and preventing political interest. Institutional support through enhancing skilled personnel, providing appropriate operational facilities in parallel to the regulations may help to reduce the burden on local government administration. Shortfalls

in financial, manpower, and political commitment, and on-going efforts to enhance local governments' capacity are of big concern to national government bodies in the transition period of functional transfer to provincial and municipal/khan administration. Structural analysis determine the forcing, relay, result and autonomous variables suggest that the country as well as the Phnom Penh city administration are progressing toward developing sound institution and proactive policy, especially decentralization policy on solid waste management. This study contributes to a arising research stream documenting the public policy reform in solid waste sector challenges in emerging country like Cambodia, using Phnom Penh city as a case study. The illustration of six aspects and identification drivers and indicators as the function of supporting and enabling factors for sustainable solid waste management are the key findings for this study and of which can be extended to studies in other major cities of Cambodia in similar local context.

Lastly, the fourth case study presents the findings of the estimating industrial pollution load in Phnom Penh, which the results and discussion critic and review based on author's previous studies. However, the findings were particular focus on solid waste from industries and manufacturing activities. The industrial pollution and pollution load in Phnom Penh were in critical movement as the increasing of manufacturing and agglomeration of the urban economy. Investment in nature and geographic distribution, most polluted industries were textile and apparel sectors. The toxic chemical and toxic metals were the main pollutants loading to water and land. The projection of pollution load by industries types are indicative and critical increased by year 2030, at which caused to environment pollution and public health. The contributing to industrial solid waste to pollution are significant amounts and needs for further study. The management of industrial pollution should focus on holistic approach which integrating of cleaner production processes, minimizing waste generated from waste value chains and promoting the energy recovery from non-hazardous wastes. To protect environmental pollution and prevent public interest, the proper monitoring and control to comply with effluent and emission standards are regularly monitored and enforced.

8.2 Recommendations

8.2.1 Recommendation for Policy Implications on SWM

For promoting sustainable operational, institutional and effective legal framework, Phnom Penh Capital Administration should take account into some policy implications towards sound institutions and proactive policies as the following:

- *Enhancing PPP and social acceptability.* To reduce the deficiency of waste collection system in Phnom Penh, the key precondition for successfully developing stakeholder participation is considering the public interest, economic interest, preventing political manipulation and will of municipal, Khan and Sangkat councils. The operational framework and procedure in PPP should be adjusted toward the system goals.
- *Resource management of the public sector*. LGA needs to be self-sustaining waste management program and strategy to reduce reliance on the private sector and also national government funding (subsidies).
- Establishing proper monitoring, and continuing controlling procedures and enforcing waste management regulations (e.g. sub-decree no.113 on MSWM) is needed to reduce the illegal dumping and to enshrine in the new urban waste management policy.
- *Economic burden to LGAs and CINTRI*. To reduce the fiscal and financial burden, operational processes for cost-recovery through the collection of an applicable fee to adequately fund the LGAs and viable financing to CINTRI for a modernized sustainable system.
- *Consideration of waste collection options.* The requirements of management services, quality assessment, and priorities for cooperation between the contractor and the LGAs should be studied so that the options for the collection system are based on sound data.
- Building on strengths, minimizing weaknesses of the current system and developing an improved data management system, so that future planning is based on sound data.
- Each Khan and municipal administration should establish an effective mechanism to resolve constraints and obstacles by having regular technical working group meetings and discussions. The technical working group involved from multi stakeholders and ministries could provide the platform for identifying common ground and make discussion.

- *Capacity building*: professional and paraprofessionals in local government administrations are not often trained in many aspects of waste management, e.g planning, design and technological application. Proper training of LGA's personnel with solid waste and service management is needed and critical in this transition.
- It is necessary to establish the legal framework for inclusion of both public and private, and both formal and informal providers for waste services and enhance institutional capacity to both enforce law and to work closely with service providers and local tire under municipal authorities. Reinforcing of LGA's performance, there should establish proper monitoring, controlling procedures and enforcing waste management regulation (e.g sub-decree 113 on MSWM) by enshrining in new local legal instrument such as *Deika* on MSWM.
- Since the Politics inevitably play a large role in SWM system, Phnom Penh Capital City should merge Khan and Sangkat administrations' structures, function, and governance of SWM system with its strategic development strategy and priority action plan of Phnom Penh. The synergies between local development strategies and solid waste management plan in should ensure the successful stakeholder participation in order to achieve the strategy outcome and impact to society.
- The way forwards to overcome the greatest challenges for PPC is to strikes for right balance between policy, governance, institutional mechanisms and resource provision (financial and fiscal allocations). Responsibility, role and right of local government administrations should not be affecting by the role of party politics or political interests.
- Initiatives to improve coordination and communication across the city administrative department, Khan and Sangkat authorities and agencies/ CINNTRI implementing waste management activities.
- The proper waste management would need the legal foundation to respond to local context like Phnom Penh city as the increase of urbanization and quantities of waste generation suggesting that enforcement to illegal dumping and improvement of service soon become imperative.

8.2.2 Recommendations for Constraints and Limitations of the Study

- The scheme seems to be not running well, so it is difficult to make an assessment as to how crucial each indicator to success to the LGA and service providers. In order

to investigate this, it would be necessary to strongly cooperate with and support for providing needed data or information and spending time to investigate the solid waste management system elements as well as the attitudes of customers on waste services.

- With of time constraints and very few previous research has been conducted in this relevant study especially solid waste management service, the study try to analyzed the information from FGDs and semi-structured interview from key informants interview and the unbound reports form related organization. Accordingly, by using suggested indicators is concentrated on primary data analysis and supported by secondary information (from interview and unpublished information). Because of these information limitations, the study could not be deeply assessed and able to estimate the cost of system and optimum system by using detailed analysis.
- Innovative solid waste management in circular economy is soundly recommended for global action. This research has not been conducted yet in Cambodia, even though the policy agenda strike to focus on inclusive waste management, especially integrated waste management and planning in both national and sub-national levels.

8.2.3 Recommendations for Further Studies

In order for a more extensive assessment of these performance measures for collection operations, it is important to also assess these criteria for choice of public-private partnerships. The further study should be made into the ease and applicability of these methods of measuring the provision of service.

It should be necessary to deeply assess and estimate the cost of SW management system by using the statistical and LCA tools. This would potentially allow more specific performance and recommendations.

This study only made assessment of one case study. In order to get fuller picture of the assessment and applicability of service quality and operational performance both public and private sectors, it is necessary to study a wide variety of waste management schemes and models. It is only through the use of these assessing criteria or indicators in more varied circumstances that more problems will be highlighted and improvements can be made.

Topics recommended for further studies are:

- Resource based solid waste management in Khan and Sangkat administration levels.
- Cost and financing of municipal solid waste collection service in Phnom Penh.
- The mode of contracting, payment schemes, and conditions lead to successful service delivery by the private sector.
- The linkage between willingness to pay and affordability to pay and cost-recovery for provision of waste management services in uncollected waste management peri-urban communities
- Household demand for improved solid waste management: A case study
- Analysis of costing in solid waste illegal dumping in Cambodia

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Appendix A

I. Semi-Questionnaire and Focus group discussions' questions

Questionnaire: Assessment of Local government authorities' performance on Solid Waste Management in Phnom Penh Capital.

Performance measures and indicators/criteria for assessing solid waste management system

Performance measures	**Assessing indicators/ criteria to assessed**	**Description of Questions and Issues to be covered in the assessment**
Technical	▪ Collection rate ▪ Collection coverage ▪ Collection efficiency ▪ Disposal practice ▪ Technological appropriate	▪ How much waste is collected as % of total amount generated …… ▪ How many people are served as % of the total population of in Koh……? …… ▪ How well is waste being disposed? And where they dispose waste? …….. ▪ Is technology appropriate to operate under local infrastructure conditions? …….. ▪ Can the technology easily cope with and adapt to changing conditions (e.g amount or characteristics of waste)? …… ▪ Has the most cost-effective technology been selected for CINTRI services? …….. ▪ Quantity and physical property of waste bins at public areas, commercials and households …… *(other related data and published documents will be requested upon interviews sessions)*
Environmental and health aspect	▪ Collection efficiency at points ▪ Cleanliness and Environmental activities	▪ Illegal disposal practices and areas as % of waste generated …… ▪ Is collection performance adequate and clean enough?

	▪ Fund environmental awareness	…… ▪ What is the concern on waste disposal in Phnom Penh? Any solid waste pollution you have observed? …… ▪ Numbers of environmental and clean –up campaigns by government or other organizations? …… ▪ Policy and budget allocation for environmental education? …… ▪ Does the collecting and disposing waste safeguard worker's well-being and health? …… ▪ Does the waste collection and disposal contribute to utilization of modernized system? …… *(other related data and published documents will be requested upon interviews sessions)*
Institutional and organizational	▪ Personnel capacity and employment ▪ Role and Responsibility of Local government authorities (LGAs) and stakeholders ▪ Institutional framework ▪ Labor tenure ▪ Coordination and Cooperation	▪ Are tasks divided over several departments? How they are performed? …… ▪ Are municipal waste management systems were being delegated? …… ▪ Does the City hall have the authorities to monitor and control to waste collection company ? If yes, at which certain levels?..... ..... ▪ Is there sufficient skilled staff and manpower for SWM? …… ▪ What are the management gaps for LGAs and CINTRI? …… ▪ Are the management framework (based on sub-decree113) are workable and feasible? How well is SWM functioning? …… ▪ Does the organization interact successfully with other stakeholders in the system to structure and maintain successful cooperation? …… *(other related data and published documents will be requested upon interviews sessions)*

Financial viability and economical	▪ Efficiency of fee collection ▪ Accountability (government support Vs outputs) ▪ Willingess-to-pay and cooperate ▪ Financial and fiscal viability	▪ Budget allocation from Governments for solid waste and environmental awareness as % of total budget. …….. ▪ Operational and maintenance cost on waste management under LGAs responsibility? ……. ▪ Level of cost sharing amount shared holders (e.g tax and subsidies?) …….. ▪ Level of fee collection efficiency? ……. ▪ How is your payment vehicle? Any challenges and limitations facing to payment methods? ▪ Operation and maintenance cost under LGAs' or/and CINTRI performance? …… *(other related data and published documents will be requested upon interviews sessions)*
Social and Cultural	▪ SWM activities/ Campaign ▪ Stakeholders' participation ▪ Communication mechanisms	▪ What types of activities do LGAs carry out? …….. ▪ Are others stakeholders willingness to participate and cooperate in SWM activities and services? …….. ▪ Do the beneficiaries (residents, local authorities) regard waste services as socially beneficial and are they supportive of the services? ……. ▪ How do they communicate with each other (LGA- private sector and community? ……. ▪ Is the complaint mechanism functioning well? …….. *(other related data and published documents will be requested upon interviews sessions)*
Policy and Legal performance	▪ Relevant legislation, strategies on SWM ▪ Legal frameworks for LGAs ▪ Incentives or barriers	- Are the policy, legal framework on SWM are sufficient for LGAs during the functional delegation on SWM? ……. - Are the policy, legal instrument implemented to support the operation and existence of current SWM in Phnom Penh? ……. - Any policy gaps and limiataiton are still for LGAs? ……

		- Do the decentralized SWM policy supported by private operator and service users? …… - Do LGAs (Municipal/districts and communes) strategic plan reflect to plastic waste policy? …… - At LGA level, how well does enforcement of these regulation functions? ……. - Is there an action plan for waste management at the city level, if there is, what the main obstacles for attaining the objectives? …….. - Do the waste services comply with quality standard of service as defined in the contractual agreement? ……. *(other related data and published documents will be requested upon interviews sessions)*
Development of critical aspect over time	▪ Evolution of aspects above overtime ▪ Future perspective	- How have aspects above evolved over time? Are they favorable or unfavorable for SWM system? …… - How are the future perspectives in this regards? Will the SWM system improve? ……. - And what are the supportive factors that functioning favorable development of SWM system (both for LGAs and CINTRI)? …….. *(other related data and published documents will be requested upon interviews sessions)*

II. Focus Group Discussion

Leading Questions used for Focus Group Discussion are:

The groups were divided in seven for discussing on the respective questions. The 8-10 members for each group are mixed from different stakeholders.

6.6.3.1 What are the problems of waste collection in your Khans(districts)? And what are the solutions you have been implemented so far?

6.6.3.2 How to improve 3Rs practices in your Khans?

6.6.3.3 How to manage dumping site and landfill site properly?

6.6.3.4 How to promote stakeholders participation in household solid waste management practices (including citizens)

6.6.3.5 What should promote capacity building for Local government authorities after decentralization of SWM?

6.6.3.6 What are the needs and resources you may require for your institution on promoting solid waste management, based on your role and responsibilities?

6.6.3.7 What constraints and possible mechanisms for improving waste management in Phnom Penh?

Appendix B

(Organization charts, figure and sub-decree 113 on MSWM (2015))

Declaimer Note:
" this is an unofficial translation of sub-decree subject to the needs of the data/information for this study only. Only selected Articles are translation, otherwise are not necessary for anlaysis."

SUB-DECREE ON SOLID WASTE MANAGEMENT IN URBAN AREAS

No.: 113 RNKRO/BK

General Description:

Sub-decree has the following elements:

- 9 chapters included:
    1. Chapter1: General Provisions
    2. Chapter2: Responsible Units
    3. Chapter3: Waste Separation, Wraping, storage, and disposal practice in Urban areas
    4. Chapter 4: General Measures for solid waste in Urban areas
    5. Chapter5: Waste Services in Urban areas
    6. Chapter 6: Management measures for final disposal at Landfill
    7. Chapter 7: Penalties
    8. Chapter 8: Transitional Provisions
    9. Chapter 9: Final Provisions
- 55 articles

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CHAPTER1: GENERAL PROVISIONS

ARTICLE1:

This sub-decree has the purpose to improve the solid waste management (SWM) in urban area in the sustainable way, transparent and accountable manner in order to ensure environmental soundness, public health and urban esthetics.

ARTICLE 2:

This sub-decree has the objectives as follows:

- To strengthen the role and responsibility of the sub-national government institute/authorities and stakeholders that involve in solid waste management in the urban areas
- To delegate the duties of solid waste management in urban areas to municipal, city and district authorities and decentralize the urban solid waste management system/function from municipality level to district level
- To determine management measures to ensure the effectiveness and safety in urban solid waste management, and
- To promote the public awareness and participation in managing and implementing of measures for improving the solid waste management in urban areas.

ARTICLE3:

This sub-decree applies to waste separation, storage, treatment, collection, transportation, and recycling and final disposal at landfill at urban areas of Cambodia. This sub-decree does not apply to industrial waste management and hazardous wastes.

Chapter 2: Responsible Units

Article 5:

Ministry of Environment (MoE) is the government body that holds leadership and promotes the implementation of urban solid waste management.

The tasks and responsibilities of MoE are to:

- Establish policy and strategic plans, regulations and technical guidelines for urban solid waste management in collaboration with relevant ministries and other government authorities
- Strengthen capacity building and technical assistance to sub-national government/authorities on urban solid waste management
- Leading a facilitation with development partners, private sector and public institution in order to mobilize financial resources, facilities and materials for supporting sub-national government/authorities on urban solid waste management
- Support and cooperate with relevant ministries, institutions and sub-national government/authorities in promoting informal awareness and dissemination on urban solid waste management in the way environmental safeguard manner including reduction, recycling, and re-use. To promote utilizations of recyclable materials and;
- Monitor and evaluate on environmental impacts caused by urban solid waste management practices.

Article 6:

Ministry of Interior has the mandate to enhance the collaboration provisions for the implementation urban solid waste management, are as follows:

- Support and cooperate with Ministry of Environment and relevant agencies in development of capacity and sharing experiences on urban solid waste management
- Facilitate and mobilize resources to sub-national government/authorities in promoting the effectiveness of urban solid waste management
- Interment the monitoring and evaluation process on urban solid waste management pratices.

Article 7:

Provincial Government has to support and facilitation and enhances the implementation of urban solid waste management, which operated by city/ district authorities. Provincial government has duties as follows:

- Prepare necessary legal documents for guiding and reinforce the related legal instruments and regulations related urban solid waste management
- Provide guidance to city/district authorities on planning and preparing action plan and annual budget plan on urban solid waste management
- Promote and support the establishment of urban solid waste services, including cleansing, collection, transportation and final disposal at landfill.
- Promote and enhance the education, awareness and dissemination to the public in all means in order to improve the waste separation at source, reduction of waste generation, re-use and recycling activities; and promotion of utilizations of recycled products.
- Facilitate municipal/city government[4] and district authority in planning and using urban solid waste services
- Monitor and evaluate the implementation process of municipal/city or district authorities on urban SWM.

Article 8:

Provincial Department of Environment (PDOE) is the secretariat of provincial government, municipal/city on the management of urban solid waste. PDOE has duties as the following:

- Promoting the environmental awareness though education, public hearing on waste storage, cleansing, separation, 3Rs and participation in using urban solid waste services.
- Involve in planning process on urban solid waste management of sub-national government
- Involve in providing technical advice/comments on the proposal or project related to urban solid waste service

[4] Urban area here refers to municipal, city, and district authorities.

- Monitor and evaluate on the implementation process of waste service and recycling activities in the urban area,
- Enforce law and solid waste regulations and involvement in enforcement actions and provide penalties and punishment to illegal activities
- Preparing bi-annual report on the situation and process of urban solid waste management

Article 9:

Municipal/city and district authorities have duties to manage urban solid waste in their administrative boundary. These units undertake their duties the as following:

- Preparing management plan, action plan and annual budget plan for solid waste management in their territory.
- Prepare and take action on urban solid waste management in accordance with the approval permits and ordinances
- Establish, control and manage activities on waste cleansing, collection, transportation and disposal of at landfill in their areas of control
- Provide guidance to local people on environmental awareness and city cleanliness and encourage them to use the waste collection services, on-site waste wrapping, storing and disposal practices in their community
- Educate and disseminate on environmental safeguards, 3Rs practices and promotion of using of recycled products.

Article 10:

Each municipal and city Administration could request for establishment of unit or office under their authority and being responsible for urban solid waste management.

Article 11:

Municipality has to authorities the partial or full task in management of urban solid waste to district (Khan) authority or/an commune (sangkat) authority.

City Authority can also partially delegate a task to commune authority on urban solid waste management.

Article 12:

District (Khan) authority has to be responsible in implementing and providing support and facilitating the tasks on waste cleansing, collection, transportation, storage in the municipality. District has duties as the following:

- Manage and implement the urban SWM
- Involve and jointly implement urban SWM
- Involve in on-going monitoring on cleansing, collection and transportation and final disposal in landfill

Article 13:

Commune (sangkat) is responsible to implementation of urban SWM that delegated by district; and providing support and facilitating the tasks on waste cleansing, collection, transportation, storage in the municipality. Commune (sangkat) has duties as the following:

- Manage and implement the urban SWM
- Educate and broadly disseminate to the public on waste cleansing, collection, transportation of waste in their area of control
- Involve and jointly implement urban SWM
- Participate in planning process and consultation on waste cleansing, collection, transportation of waste
- Involve in on-going monitoring on cleansing, collection and transportation and final disposal in landfill
- Involve conflict resolution on waste cleansing, collection, transportation and final disposal at landfill
- Contribute to enforce the SWM regulations

Article 32:

The provision of waste cleansing service or/and, waste collection service; or/and transpiration of urban solid waste is not allowed to exceed a 10-year term per a contract and this have to follow the appropriate method and procurements required.

Article 33:

Based on the waste fee agreed by inter-ministries (ministry of Environment, ministry of Interior and Ministry of Economic and Finance), Municipality, city and district have to follow based on the below criteria:

- Consult with local people and stakeholder in their area
- Ensure the effectiveness and efficiency of urban waste collection management
- Determine the waste services and fee based on type of business, location, income level, quantity of waste generation
- Need to verify and approve from their councils

Article 34..
Article 35
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.Article 55.

Phnom Phenh, July 27, 2015

Prime Minister

Hun Sen

Copied to

Deputy Prime Minister
and Minister of Interior

Sor Kheng

Minister of Ministry of Environment

Say Sam Al

Appendix C

I. Methods to Identify Key Issues for Aspect Analysis:

According to Anschütz, et al. (2004) defined that "*key issues and problem definition*" document represents the results of a series, problems and bottles and bottlenecks in the waste management system. Having clearly defined the key issues and problem allow municipal planner to design the set of priorities for desired change. The process of filtering and weighing the essence of the issues and problem identified and socialized in baseline. The study employed the brainstorming methods as the foundation technique for defining and prioritizing the key issues and problems.

Figure C1. Aspects, Techniques and Data Sources for the aspect Analysis

Sustainability aspects	**Methods and Techniques**	**Data sources**
Legal, political and policy	- Review official legal, policy, planning documents - Literature review of law and regulations - Review recent on-going project related to waste management - Review plan and strategies of Phnom Penh - Interview with municipal department and officials from related departments and ministries - Focus group discussion with LGAs and relevant agencies	- Phnom Penh City Hall - Phnom Penh Department of Environment - Ministry of Environment - Project implementing units
Institutional and organizational	- Situation analysis of institutional arrangement - Literature review of waste management strategy, action plan and activities at different administration levels; - Review recent on-going project related to solid waste management - Interview with municipal department and officials from related departments and ministries - Focus group discussion with LGAs and relevant agencies	- Phnom Penh City Hall - Phnom Penh Department of Environment - Ministry of Environment - Project implementing units - Development partners
Technical and technological	- Review on technical documents - Check-list on technical,	- Phnom Penh City Hall - Phnom Penh Department

	technological and equipment, skill personnel, and employment conditions - Review recent on-going project related to solid waste management - Literature review on waste management and practices - Interview with municipal department and officials from related departments - Focus group discussion wth LGAs	of Environment - Waste collection company - Project implementing units - Landfill management office
Environmental and public health	- Review state of environment documents - Determine the health risk and environmental pollution (waste collection and disposal) - Review recent project documents on waste management - Consultation with experts, academics, and environmental protection agencies - Determine the public awareness and campaigns	- Phnom Penh City Hall - Phnom Penh Department of Environment - Ministry of Environment - Project implementing units - Local authority administrations
Financial and economic	- Review state budget allocation for waste management/activities - Review recent research studies on willingness-to-pay on waste management - Group discussion with LGAs - Consultation with municipal departments and waste operator	- Phnom Penh City Hall - Ministry of Environment - Project implementing units - Local authority administrations - Waste collection company
Social and cultural	- Determine on public participation activities - Determine the social acceptability and complaints - Review recent on knowledge, attitude and practice toward waste management - Consultation with experts, academics, local authorities	- Development partners - NGOs - Project implementing units - Local authority administrations - Phnom Penh Department of Environment - Citizens

II. Structural Analysis: the Interaction Matrix

Sustainability Domains		TECH			ENV	SOC	INSTI					FINA&Eco		POL&REG			Row sum
	Indicators	Quality of services	Technological appropriate	Collection efficiency	Cleanliness	Stakeholders' Involvement	Personnel Skills	Role&responsibility	Institutional Framework	Labor tenure	Coordination &cooperation	Willing-to-Pay	Accountability	Monitorting/control-PPP	Regulation instrument	Enforceability	Driving power
TECH	Quality of Services				1			1		1	1	1					5
	Technological appropriate	1		1	1		1		1					1			6
	Collection efficiency	1			1			1		1		1		1			6
ENV	Cleanliness					1						1				1	3
SOC	Stakeholder's Involvement	1			1		1				1			1	1		6
INSTI	Personnel skills		1					1	1					1			4
	Role& responsibility	1		1		1			1		1		1	1	1	1	9
	Institutional Framework	1				1	1	1			1				1	1	7
	Labor tenure	1		1				1									3
	Coordination &cooperation			1	1	1		1	1			1		1		1	8
FINA &Eco	Williness-to-Pay	1		1	1						1		1	1			6
	Accountability					1		1	1		1	1		1			6
POL &REG	Montoring &control-PPP	1	1	1				1	1		1		1			1	8
	Regulation instruments	1				1		1	1	1	1		1	1		1	9
	Enforceability	1			1			1	1					1	1		6
(Column sum) Dependency		**10**	**2**	**6**	**7**	**6**	**3**	**10**	**8**	**3**	**8**	**5**	**4**	**10**	**4**	**6**	

III. Organization Structure of Phnom Penh Capital Administration

Figure C2, illustrates the reform of administration structure of Cambodia for local government units before and after 2008. (IGES, 2018).

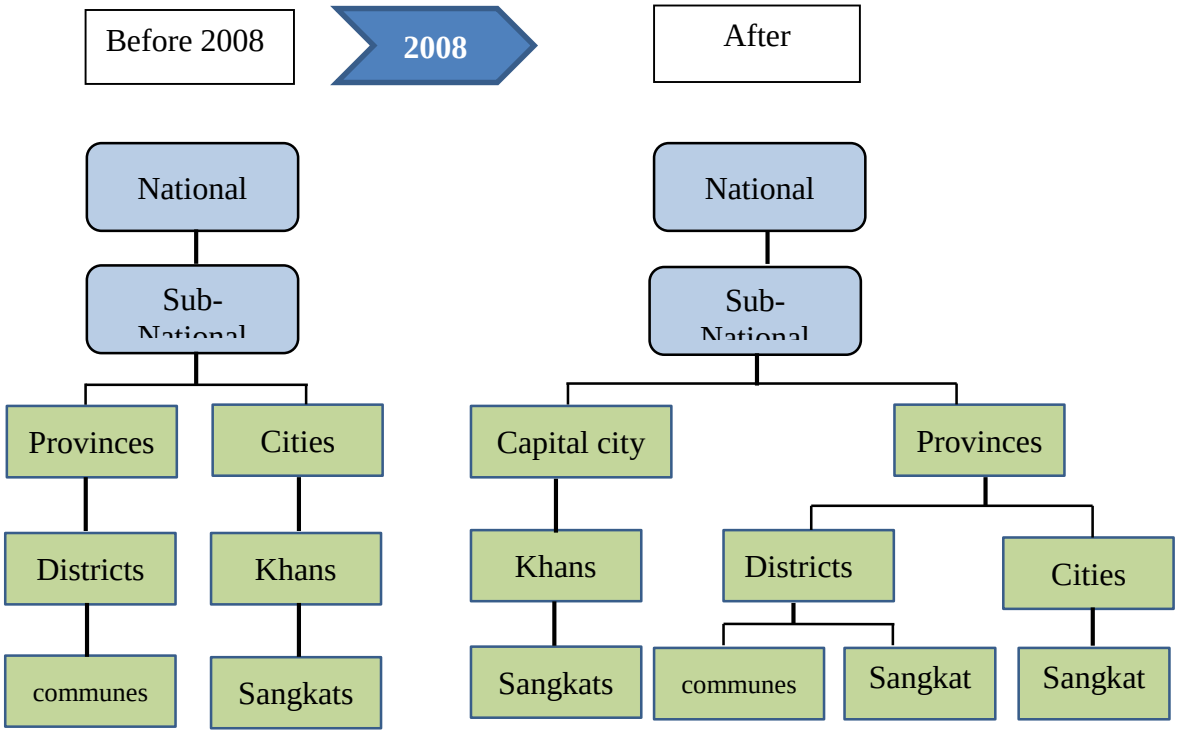
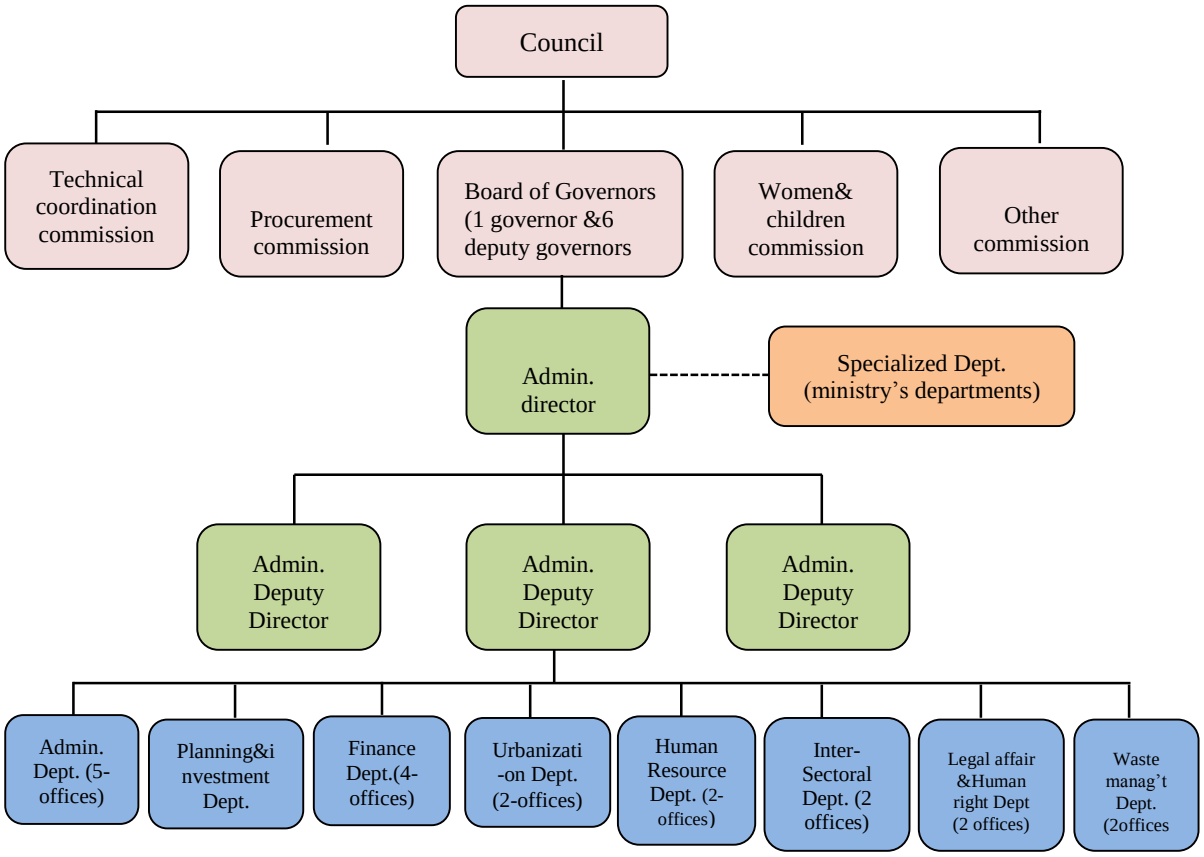


Figure C3: Administrative structure of PPCH (source: MPP, 2011 cited in IGES, 2018)



IV Role and Responsibility of Solid Waste Management in Phnom Penh Capital

According to the Phnom Penh Waste Management Strategy and Action Plan for 2018-2035 pointed out the role and responsibility of Phnom Penh Capital Administration and CINTRI waste collection Company[5]. The role and responsibility has addressed in Sechkdey Nenam (Instruction) on the Implementation of Improving Task for Solid Waste Management in Phnom Penh Capital. However, this Sechdey Nemam is currently being drafted to provide clarity of roles between key stakeholders in waste management governance. The purpose of this instruction aims to improve waste management service in the city.

The draft instruction contains 10 objectives:

1. Enhance participation of the public and other stakeholders cooperation on the improvement of city beauty and environment
2. Enforce the city solid waste cleaning, collection and transportation service in Phnom Penh
3. Set up the schedule for the city solid waste cleaning, collection and transportation service for smooth waste discharge, collection and transportation
4. Change habit of the citizen of illegal disposal and turn to properly store their waste and on schedule waste discharge
5. Educate citizen to sort their waste properly for reuse and recycling as well as to reduce waste to landfill sustantially
6. Reduce plastic waste consumption
7. Strengthen the expansion of the city solid waste cleaning, collection and transportation service to the area where it is not yet having the service, esp. the new 20 Sangkats from Kandal province
8. Seek for investment partnership to recycle wastes at landfill for energy recovery, biogas treatment or composting activities, etc.

[5] Phnom Penh Waste Management Strategy and Action Plan 2018-2035 has prepared by working group consisted of PPCH, IGES, Nexus and UN Environment, CCCA for documenting and providing road map on solid waste management. This is the first strategy document after JICA's study since 2005.

9. Enforce the regulation effectively on solid waste management in Phnom Penh
10. Join concerns, join implementation and join responsibilities to make Phnom Penh Capital clean without waste from 2014 onward

Roles and Responsibilities defined in the draft Sechkdey Nenam

1. Waste Management and Environment Division of PPCH

a) Encourage waste collection company to prepare clearly the program for waste cleaning, collection, and transportation for each street in Phnom Penh.
b) Inspect and give warnings and fines to waste collection companies in Phnom Penh which are fail to perform on good cleaning, timely collection as set in the waste transportation program; as well as making dirt and leachate on the streets.
c) Encourage Cintri to expand solid waste cleaning, collecting and transporting service to areas not yet available (besides 20 new Sangkats).
d) Reset the price table and edit service price for all residents, business place, service, company, factory, enterprise, public, and private sectors in Phnom Penh Capital city.
e) Compromise on cleaning service fee when has a dispute or protest between the clients and service providers.
f) Encourage local authorities to monitor, coordinate, and adjust the operations of the waste collection company to operate efficiently.
g) Take action on construction site owners to properly store construction waste and construction materials and take action on the transportation of sand, rock, soil, activity that fall on the streets, affecting the environment's public orderliness.
h) Guide to all residents, businesses, services, companies, factories, enterprises, public and private sectors in Phnom Penh to have trash bins.
i) Educate, guide, and encourage all citizens and traders must to take the waste to waste bin properly follow the waste collection program and location determined.
j) Take lead and collaborate to produce educational spots for public dissemination to citizens about the waste separation, waste storage, waste packages, waste disposal, and time of waste collection with radios and televisions.
k) Advise to all markets to be environmental friendly by doing regular cleaning and locating suitable containers to be properly installed and transported.
l) Set and divide the respective task between the market contractor (Pheasy), car parking contractor (surrounding the market) and waste collection company about their task in cleaning and collecting waste inside the market, around the marketand at the parking lots.
m) To prepare proper roads for trucks into the landfill that does not cause the traffic jam for garbage trucks.
n) Advise to Sarum Trading Co., Ltd., which manages the industrial waste landfill to prepare properly landfill with technical standards, good environment, and not affecting the people in the area.
o) Find the possibility of investment partners in the collection, management and solid waste recycle.

p) Orient and monitor project plan, measure and work direction to strengthen and expand the scope of waste management, waste separation and fines to be coverage for all Khans and Sangkats throughout Phnom Penh.
q) Prepare various regulations such as Decision, Deika and Measures to encourage waste management and solid waste collection services can take place smoothly without obstruction and on time.
r) Continue to encourage the implementation of waste separation plan throughout Phnom Penh.
s) Use existing penalties and create a punishment working group consisting of Phnom Penh Capital Hall, Departments, relevant entities to effectively inspect and advise and penalty to the perpetrators following Deika on measures and Fine mechanism for disposal, cleaning, waste collection and transportation in Phnom Penh Capital City as well as other related regulations.
t) Strengthen strict penalties to everywhere for those who throw away the waste and to the waste collection company that is not properly performed according to the tasks set out in this instruction.
u) Monitoring and encourage to Khans, Sangkats, departments and relevant entities to carry out the tasks set out in this instruction effectively and conduct assessments to find the missing points for improvement.
v) Monitoring meeting and evaluates on the work that the service providers and relevant organizations have implemented so far and continues to implement effectively as well as summarize the results of the work to report to the Governor of Phnom Penh.
w) Improve the landfill infrastructure and operation to avoid any traffic jam of waste transportation and take record of any incidents at the landfill for reporting and intervention on time.
x) Prepare planting trees around the landfill to reduce odor emitted from the landfill that affecting to environment and surrounding people.
y) Improve drainage system for waste leachate and treatment system before its overflow into public canals.

2. CINTRI Company

1. Develop Planning and Business Responsibility

a) Have to strictly respect and implement with all regulation, laws, contracts, and other regulations related with cleaning, collecting and transporting solid waste services.
b) Be responsible for solid waste cleaning, collecting, and transportation from residential areas, business places, services, companies, factories, enterprises, public and private entities in Phnom Penh to be regularly clean following its waste collection program.
c) Develop business plan, Service Management short term-long term, Waste Collection operation activity plan in its service area send to PPCH for consideration and approval.
d) Develop detail activity plan about the waste collection service according to the actual circumstances of each Khan, Sangkat, by setting the number of means of transportation, collection materials, and sufficient workforce to ensure cleaning is well performed.
e) Ensure the waste cannot be congestion in the streets at risk, such as demonstrations, or strikes of CINTRI's workers who did not want to transport waste.
f) Have enough trucks, machinery, tool, and materials for waste collection service to ensure the effectiveness of doing this service.

2. Develop Solid Waste Cleaning, Collection and Transportation Program

a) Develop and set solid waste cleaning, collection and transportation program clearly with the consent of local authorities and PPCH.
b) Promote and provide waste collection program to all local authorities, Khans, Sangkats, villages, residents, business location, enterprises, services, factories, public and private entities in Phnom Penh to know for easy to release waste in parallel with transport times.

3. Prepare to storage waste bin in Market, Parks, Public

a) Prepare to have enough public waste bins in public parks, commercial centers, markets, Boulevard and major roads, and at the point, close to public institutions, etc., in accordance with the practical needs, in collaboration with Khan / Sangkat authorities so as to facilitate the waste storage.
b) At some markets need to add more big waste bins to separate wet waste and dry waste (Damster Waste Bin) for proper waste separation.
c) Eliminate the waste containers near the canal (open sewage system).

4. Education

a) Collaborate with Waste Management Division to develop program and short training spots in media to educate citizens to know about the waste transportation system and waste collection schedule for properly discharge their waste in consistent with waste collection schedule.
b) To Collaborate with local authorities, departments, relevant entities to regularly educate people in Phnom Penh about proper waste cleaning, separation, package, storage, and waste disposal with every way.

5. Waste clean, collection and transportation to landfill

a) Ensure the soil cleaning on the streets and bridges are regularly clean with the waste collection schedule at some roads and bridges, which were set. Soil waste shall be placed in waste bins or carts for immediately transportation, not store along the roads or bridges.
b) Ensure the waste collection to waste trucks dose not litter on the road, and clean the collection site to be clean.
c) Ensure waste transportation to landfill by avoiding waste littering, leachate along the streets and waste flying in the air.
d) To ensure waste cleaning, collection and transportation in all streets are clean and on time as set in program. In the case of being late (not follow the program) it will be under a warning and fines.
e) Develop waste collection by carts at small roads that waste trucks could not reach in.
f) Collaborate to reduce and eliminate illegal waste depot and large waste storage places (Damster) that affect to city beauty and environment through increasing waste carts and direct transfer to waste trucks.
g) If waste collection service is late from 2 days onwards, the company needs to provide information in writing letters to Phnom Penh City Hall with clear reasons.
h) Do not pauses waste collection service at all residential, business place, service, company, factory, enterprise, public and private entities in Phnom Penh Capital city without any prior agreement from Phnom Penh City Hall.
i) Implement waste cleaning, collection and transportation service to all its service areas, no matter those areas have not enough economy competency.

j) While collecting waste at residents, waste trucks must drive slowly and find a suitable location for parking following the traffic law properly as well as make a suitable sound or lights to inform to the citizen.
k) Employees, and workers of the company must wear their uniforms, which are properly labeled and safe at the time Complete the task
l) Company shall be provide the bonus to workers during Khmer New Year, Phcum Ben Day, and Water Festival for their continue to provide the waste collection service during the holiday.
m) Develop and set up the location for waste collection points (Rent or Purchase) for proper waste transfer to ensure not affect to traffic, public welfare and beauty.
n) Establish collection points for the storage of waste carts and other materials for providing better service and do not leave them at public areas.

6. Means of Solid Waste Transport and Road Cleaning

a) Use waste trucks that are good quality and having proper technical standard, number plates, and vehicle technical inspection following the traffic law to ensure to providing service safety and efficiency.
b) Add enough means of waste transportation as required with real demand of Khans and Sangkats to the current and future increasing amount of waste.
c) Use waste trucks which are suitable with road size and traffic situation in Phnom Penh Capital City.
d) Continue to install more trucks for road cleaning in Phnom Penh and these trucks and equipment must ensure its quality and technical standards.

7. Collecting Fee of Waste Cleaning, Collection and Transportation

a) Proper implement through the basic price table of waste transportation service fee that set by Phnom Penh City Hall.
b) Must pay landfill fee to Phnom Penh City Hall following the content guidelines as set in letter No. 322 SCN of the Council of Ministers dated 13 March 2007.
c) Compromise the waste transportation service fee with citizen and business owners who have appeal; adjust price in consistent with its types of locations to be appropriate and do not to exceed the price that set in the basic price table of waste transportation service fee with prior agreement from Phnom Penh City Hall before making contracts with the customers.
d) Comprehensively disseminate about the basic price table of waste collection and transportation service fee to customers and public.

8. Report and meeting participation

a) Prepare monthly reports, quarter, semester and annual reports about its working result that implemented and target of work to Phnom Penh City Hall regularly and copy to departments and relevant entities.
b) Regularly participate in meetings through the invitation from Phnom Penh City Hall and local authorities. At any meeting if company director cannot participate, company representative will be participate instead of director and must to have right to decide and answer in the meeting.

9. Management, Monitoring, and Collaboration

a) Company should collaborate with authorities, Khans and Sangkats on solid waste collection service to be effective.
b) One representative of company should be assigned to each Sangkat, so it is easy to contact and handle the work on time.

3. Khans/Sangkats

a) Educate and introduce to citizens to proper waste packaging, storage, and waste disposal at the place and time that have set in waste collection program.
b) Monitor on waste collection service implementation and contact to waste collection Company to collect and clear all waste, and regularly clean at their own location.
c) Promote and encourage on recycling activities or solid waste recycle at their own location.
d) Strictly management on Junk shops and all types of solid waste recycle places, also advice to those owners to get permission from Phnom Penh City Hall.
e) Do statistics or inventory on all solid waste recycle places and amount of waste types that have recycle at their own location then report to Phnom Penh city hall.
f) Take lead of the Khans and Sangkats' police and environment officers to prevent, advise and fine to who dispose their waste illegally at public area.
g) Prepare and request to environment department to put forbidden banners for illegal waste disposal at some main places.
h) Facilitate to set up location for waste collection points and public waste bins that do not affect the traffic, public welfare and beauty.
i) Follow up on waste cleaning of waste collection service to be regularly, and to disposal waste at the place that set by competent institutions and Phnom Penh city hall.
j) Encourage all local market committees to disseminate waste collection program and task assigned to seller in and around the market to apply effectively together.
k) Monitor and follow up the activities of waste generation, cleaning, collection and transportation that are not implemented in accordance with the deadline by giving a warning and fines.
l) Assign its local legal enforcement officers to punish those who throw their waste littering illegally, improper discharge their waste in terms of location and timetable of waste collection program.
m) Ensure that there is no waste congestion in their location by cooperation with waste collection company.
n) Monitor and promote the activity of waste transportation through the task assigned regularly. In the case that the companies have not complied with their transportation programs, including waste littering from the trucks during their transportation, flow of leachate along the road, and remaining waste pile, please report to the PPCH about the location where the company did not perform to get advise and punishment to the company.
o) Organize public street order for selling, parking, and etc. to make it easier for companies to clean up, collection and transportation waste.
p) Guide people to take care of cleanliness and clean the sidewalks in front of their houses or location. In case

q) Introduce the citizens to participate in eliminating waste depot on the roadside, the streets, the public streets and the sewers.
r) Direct the relevant authorities to conduct procedures in accordance with the procedures of solid waste management and waste services in their respective localities.
s) Be responsible for keeping public awareness campaign every three months in order to remind people about environmental hygiene, or to organize a public cleaning program in collaboration with waste collection company, volunteer, students and NGOs.
t) Collaborate to reduce public waste pickers by checking the time between waste discharge and waste collection.
u) Cooperate with the company to agree on the program of waste discharge and waste collection and specify the exact location for waste storage.
v) Advise the construction site owner should properly dispose of construction waste without mixing with the general waste.
w) Every festivals or events must advise the event owners to make sure that the sites are cleaned at the end of the events, such as weddings, concerts, etc.
x) Identify the wrong perpetrator who has disposed their waste illegally and summon the person for education and fines.
y) Sub-committees of Khan / Sangkat shall make reports on the situation of waste, fines, results, challenges, solutions and suggestions,

4. Duties and obligations of Citizens

a) Participate in cleaning and maintain around the houses, businesses, services, and public areas, and keeping your waste bins and public waste bins proper and firmly.
b) Separate and pack your garbage and throw them in a waste bin or plastic bag in front of your home or proper place and generate on time.
c) Discharge your waste in accordance with the collection and transportation program within 1 hour before the truck come. In any case of late, do not leave garbage on the sidewalk or on the road
d) For branch and tree leafs must cut it shortly and package properly to make it easily inserted into the truck.
e) Owners are required to transport their construction waste without leaving on the sidewalk or on the road.
f) For vacant landlords, they must close the fence and prevent waste from being disposed of there, cause of creating an illegal deport that affects the residents living nearby.
g) Do not throw waste on the streets, on the roads, in the canals, in the markets, or in public places in Phnom Penh.
h) Do not allow waste to scatter or discharge waste water in front of the houses, landlord and plots around its home, and not to be disposed at another location or area.
i) Do not allow your pets to poop on the ground and tear waste bag in front of your home and public area.

j) Every wedding party, ceremony, and other events that will take place in front of the house, business location and on the streets, the program owner will be responsible for clearing and collecting garbage, packing and storing properly after the ceremony.
k) In the case of a dispute about collection and transportation fee waste owners must be discussed with local authorities and service providers in order to reach agreement on payment of fees and to be paid on a regular basis.

5. Public Markets

a) Each market committee has to cooperate with the waste collection and transport service provider to determine the waste collection site properly so that service providers can collect and transport waste on time.
b) Have at least 2 big containers available to store organic waste and inorganic waste as much as possible and the actual situation without compromising welfare and traffic congestion.
c) Continue to advise sellers to separate the waste into two types, organic and inorganic waste, and properly packaged in their waste bins.
d) Monitor the task of cleaning and collecting waste of market contractor and contractors of parking centers around the market thoroughly.
e) Install waste bins as much as possible to serve people's disposal of waste in the market during shopping.
f) Educate and fines to those who throw waste littering in the market.

6. Market Investors, Contractors of Parking Centers around the Market and Market Contractors

a) Market investors have to ensure the environment in and around the market clean regularly and responsibility to organised temporary waste storing
b) For market contractors have responsibility for cleaning and collecting waste in and around the market regularly and transport to market container.
c) For contractor of parking centers have responsibility to clean and collect waste in and around parking center both market side and in front of citizen’s house site regularly and transport to market container.

7. Phnom Penh Capital Department of Environment

Must serve as an assistant to PPCH in cooperation with the Waste Management Division as follows:

a) Prepare strategy and action plans on waste collection and transportation, temporary waste collection points, and waste disposal in Phnom Penh.

b) Educate and disseminate laws and regulations related to solid waste management in Phnom Penh.
c) Organize data management by the information technology system on sources and types of solid waste and statistics of waste recycling business in Phnom Penh.
d) Participate in monitoring the Master Plan and a detailed plan on the solid waste collection program conducted by CINTRI and other service providers.
e) Instruct to environmental officers in each Khans to cooperate with Khan and Sangkat authorities to inspect the situation of waste and provide services to clean, collect and transport solid waste regularly and report to Khans to find the solution.
f) Inspect, advice, and punish companies that clean, collect and transport waste, service providers of waste management, departments, units and stakeholders who violate this guideline by implementing the laws and regulations adopted by PPCH.
g) Provide close collaboration with Khan and Sangkat authorities to prepare penalties and provide training to law enforcement agencies on effective enforcement mechanisms and procedures.
h) Continue to organize banners on illegal banners within fines for waste littering under Inter-Ministerial Declaration (Interior – Environment) No. 80, dated February 25th, 2003 in some public places where people always throw their waste.
i) Monitor and evaluate the results of the waste separation and reduction of plastic bag consumption in markets and reporting results to PPCH.
j) Review and evaluate the implemented results to give competition scores for Khans, Sangkats, markets, units and relevant departments who have good practices.

8. Phnom Penh Capital Department of Public Works and Transport

a) Clean and collect waste along the gardens, resorts and public places under its competent jurisdiction and packaged properly to store at designated location as soon as CINTRI collection arrive. And do not place them in a public trash bins that is located in these locations.
b) Set up the place for waste bins in the garden and check the amount of waste bin can be enough.
c) Strengthening the park's security agencies to increase alerting, punishing and fines those who are throwing waste in the park and location under it competent to be active and strict.
d) Clean and collect the garbage and waste at the sewers regularly and transport them to the landfill.
e) Cooperate with police forces of Phnom Penh Capital and local authorities to intervene in all types of offenses, which constitute an obstacle to the process of cleaning, cleaning and fines for disinherited dumpsters in public opinion.
f) Collaborate with Waste Management Division, DoE and Waste Cleaning, Collection and Transportation Company to clearly prepare its activity plan for waste cleaning, collect and transportation at its management site.
g) Prepare regular reports on the performance of the work done and the monthly orientation to the PPCH.

9. Phnom Penh Capital Department of Land Management, Urban Planning, Construction and Cadastral

a) Give advice to all construction site owners to keep the construction waste inside the fence of the construction zone and do not mix the construction waste with general waste.
b) For new buildings such as: big buildings, Borey, private supermarkets, public markets, hotels, public and private establishments, public and private hospitals, factories, restaurants, resorts, pagodas ... in its construction project (plan), it is necessary to prepare and install waste storage space and a large container with suitable waste amount storage capacity.

10. Phnom Penh Capital Department of Health

Advise all hospitals, poly clinics, and small/large clinics in Phnom Penh should implement the guidelines on implementation of the task of improving solid waste management in Phnom Penh especially proper packaging of medical and residual wastes by separate and discharge at the specified time.

11. Phnom Penh Capital Department of Information and Phnom Penh Television

a) The Department of Information should introduce all TV and radio presenters to disseminate the contents of the guidelines on how to improve solid waste management in Phnom Penh.
b) Phnom Penh television Post # 3 has the following tasks:
    - Prepare reports, interviews and dissemination activities to improve the implementation of regulation related to solid waste management in Phnom Penh.
    - Continuing to disseminate the awareness, punishment and waste separationspots more often.
    - Prepare new video spots that educate and advise the citizen to participate in the waste cleaning in front of their houses, maintain sewage system regularly by properly store, pack, separate and discharge their waste at the specified time in cooperation with the waste management Division and related departments.
    - Disseminate the waste collection and transportation program at Khans, Sangkats and this Instruction to make everyone aware and implement.

12. Phnom Penh Capital Department of Tourism

a) To educate, promote and guide all tourist resorts and tourist destinations as well as tourism business owners to separate, storage, package and generate of waste properly at the specified time.

b) Determine the assessment rating of clean resort without waste littering through clean city policy.

13. Phnom Penh Capital Department of Education, Youth and Sports

a) To disseminate the plan of waste separation and waste collection programs to all public and private schools in Phnom Penh and ask them to disseminate to the students and practice for the clean city.
b) Introduce all schools to install waste bins and education by creating a competition program on public awareness about storage and discharge of waste in Phnom Penh.

14. Phnom Penh Capital Department of Commerce

Give some advises to all business locations and services which signed the listed at Department of Commerce to incorporate this instruction and require them to have waste bin as well as storage, package, separate and discharge of their waste properly at the specified time.

15. Phnom Penh Capital Department of Industry and Handicraft

a) Give some advises to factory owners, handicrafts and business locations under the management of the Department of Industry to incorporate the guidelines on implementation of the task of improving the waste management in Phnom Penh as well as storage, package, separate and generate of waste properly at the specified time.
b) Extracts the data of factory locations and solid waste processing facilities in Phnom Penh.

16. Phnom Penh Capital Department of Labor and Vocational Training

a) To promote and advise factory owners, enterprises, trade unions, staffs, workers and employees to follow instructions on implementation of the task of improving the waste management in Phnom Penh, which is intended for storage, package, separate and generate of waste properly at the specified time.
b) Encourage to separate resident waste from industrial waste, as well as to recommend installing waste bin for storage both kind of waste properly.

Unofficial Translation *(the articles in sub-decree below were recorded as it's necessary to the thesis's discussion and analysis*)

Kingdom of Cambodia
National Religion King

Royal Government of Cambodia
Council of Minister
No.: 36 ANRK.BK

Phnom Penh, April 27, 1999

SUB-DECREE
On
SOLID WASTE MANAGEMENT

CHAPTER 1

General Provisions

Article 1: The purpose of this sub-decree is regulate the solid waste management with proper technical manner and safe way in order to ensure the protection of human health and the conservation of biodiversity.

Article 2: This sub-decree applies to all activities related to disposal, storage, collection, transport, recycling, dumping of garbage and hazardous waste.

Article 3: Technical term used in this sub-decree shall have the meaning ascribed there to:

a. Solid waste refers to hard object, hard substances, products or refuse which are useless, disposed of;
b. Household waste is the part of solid waste which does not contain toxin or hazardous substance, and is discarded from dwellings, public buildings, factory, market, hotel, business building, restaurant, transport, recreation site,….etc;
c. Hazardous waste refers to radioactivity substances, explosive substances, toxic substances, inflammable substances, pathogenic substances, or other chemical substances which may cause the danger to human (health) and animal or damage plants, public property and the environment. The hazardous waste may be generated from dwelling houses, industries, agricultural activities, business and service activities, mining…etc. The type of hazardous waste is listed in the Annex of this sub-decree.

ANNEX

Type on the hazardous waste

1. Fibrous and clothing waste from textile and garment factory;
2. Paper wastes from paper mill industry;

3. Sludge waste from factory waste water treatment and product manufacturing processes;
4. Combustion residues from coal-fired power plants;
5. Plastics waste from production or use of plasticizers;
6. PCB waste from use of PCB contained in discarded air conditioners, TVs and microwaves;
7. Rubber waste from production or use of resins and latex;
8. Oil waste from oil refinery, use of lubrication oils, washing oils;
9. Acid waste;
10. Alkalis waste;
11. Metal waste and their compounds

Zine (Zn)	Selenium (Se)	Tin (Sn)	Vanadium (V)
Copper (Cu)	Arsenic (As)	Barium (Ba)	Cobalt (Co)
Nickel (Ni)	Antimony (Sb)	Beryllium (Be)	Tellurium (Te)
Lead (Pb)	Titanium (Ti)	Uranium (U)	Silver (Ag)

12. Soot and dust waste from incineration facilities, treating exhaust gas;
13. Wastes from used or discarded electricity lamp;
14. Wastes from production or use of battery;
15. Wastes from production and use of paints, lacquers and pigments;
16. Wastes from production and use of inks and dyes;
17. Explosive wastes;
18. Infectious disease wastes;
19. Agriculture drug wastes;
20. Ash waste from incinerator or combustion;
21. Wastes from expired products;
22. Wastes from film productions;
23. Wastes from treatment plans of polluted soil;
24. Wastes from production of drugs and medicines, and expired drugs;
25. Inorganic fluorine wastes;
26. Cyanide wastes;
27. Asbestos wastes;
28. Phenols wastes;
29. Ethers wastes;
30. Wastes from production and use of solvents;
31. Wastes from production and use of dioxin and furan;
32. Radioactive wastes;

Unofficial Translation *(the articles in Prakas below were recorded as it's necessary to the thesis's discussion and analysis*)

Kingdom of Cambodia
National Religion King

Ministry of Environment
Council of Minister
No.: 36 ANRK.BK

Phnom Penh, July 3, 2001

Prakas
On
Minister of Environment

- Having seen…
- Having seen…
- Having seen…

Hereby Decides

Article 1: Licenses Sa Rom Trading Co Ltd, #22 Aeo, Street 430, Sangkat Toul Tum Puong, Khan Chamkarmon, represented by the Company's director Mr. Yu Sa Rom, male, aged 29, Cambodia, holder of ID#024215 PP , with his birthdate of 07 September 1992, to construct an industrial solid waste dump site and operate waste collection and transportation business, as well as to monopolize the storage of industrial waste in Phnom Penh and Kandal province.

Article2: In construction of the industrial waste dump site……

Article 3: The company shall comply with the instructions from the institutions…...

Article 4: During the operation of industrial waste collection and transportation business, the company shall ensure public safety and the quality of the environment around dumpsite, and shall report monthly to Ministry of Environment about quantity of collected waste and storage.

Article 5:
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Article 9: This prakas shall come into force from the date on which it is signed.

Minister of Ministry of Environment

Signed and Sealed

Mok Mareth