SUSTAINABILITY OF MUNICIPAL SOLID WASTE MANAGEMENT IN ULAANBAATAR, MONGOLIA: BENCHMARKING APPROACH FOR SYSTEMS IMPROVEMENT

By

Byamba Bolorchimeg,

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Dedicated to my family;

To my grandmother whose legacy I carry through my work;

To my father who taught me what is important in life.

The environment and the economy are really both two sides of the same coin. If we cannot sustain the environment, we cannot sustain ourselves.

– Dr. Wangari Maathai

DECLARATION

This dissertation is the result of my own work and includes nothing, which is the outcome of work done in collaboration except where specifically indicated in the text. It has not been previously submitted, in part or whole, to any university of institution for any degree, diploma, or other qualification.

ABSTRACT

Drivers from resource value of waste to public health and environmental protection have been shaping the municipal solid waste management (MSWM) systems and how we view and handle waste throughout history. The example of developed countries demonstrates this evolution, where the systems have highly evolved in terms of technical and socio-economic aspects. However, the situation in developing countries is more complex than ever due to a growing number of challenges such as rapid population growth, informal settlements, inequality, lack of regulations and financial instruments. The solutions for improving the MSWM in developing countries need to be specifically designed to meet the needs of a given municipality/community, considering all the local features.

The capital city of Mongolia, Ulaanbaatar (UB) is facing unprecedented consequences of rapid urbanization and population increase coupled with economic growth and lack of proper regulations in place. A large population of UB resides in "*ger* districts" (named after the traditional nomadic dwellings), which lack basic infrastructure and not connected to water supply, sewage and central heating systems. The city's MSWM is becoming one of the most critical challenges, causing a threat to public health and the surrounding environment. In this study, "Wasteaware" benchmark indicators were applied to assess the current system for MSWM in UB according to its physical components: (1) public health, (2) environmental protection, and (3) resource management; and governance aspects: (4) inclusivity, (5) financial sustainability, and (6) sound institutions, proactive policies. The benchmark indicators' results revealed that UB had mostly surpassed the levels of low- and lower-middle-income countries for Public Health, Environmental Control and Institutional Aspects, and met the prerequisites for modernizing its waste management system. However, there are still major steps ahead to fully transition to a modern system including quality service provision in low-income areas, occupational health and safety, environmental protection and integration of the informal sector. Access to capital for investment remains to be one of the biggest challenges. Availability and reliability of data is still a critical issue that requires priority as it is the backbone for planning of the MSWM and setting of targets with clear pathways to achieving them.

Waste management initiatives designed for one part of the city/community could potentially ignore the needs of other areas in the same region. Due to the two existing types of residential areas - apartment and *ger*, a public questionnaire was conducted in order to see the differences of the two types of residencies and their implications on the waste management service; and it is especially critical for policy formulations that will in turn affect the service users. The research generated essential baseline information regarding behaviours and attitudes held by both residential areas that could help improve the current service provision. The results of the public questionnaire revealed that there are significant differences between apartment and *ger* areas in terms of demographic and socio-economic aspects. Differences in waste handling and collection affect the cost of waste collection services, not in favour of the more socio-economically vulnerable residents. Willingness to pay more money for service improvement also varies based on the type of residency as well as the age of the respondents. The lack of systematic educational and behaviour change programs makes it more challenging to improve the current situation through public engagement and support. Residents of both areas agreed that the citizens are the most responsible stakeholder in waste management, which reflects the public mentality and need for progressive actions towards public education and behaviour change.

This study brought significant contributions to the existing literature gaps for UB and identified its key strengths and areas for further improvement. Results of public questionnaire and benchmark indicators could inform decision makers on shaping the most effective policies. I conclude that an improvement in data collection and reporting, and widespread consultation with all stakeholders would impact positively on the systems improvement of the MSWM in UB.

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LIST OF ABBREVIATIONS AND ACRONYMS

A.s.l.	Above sea level
BGD	Bayangol district
BZD	Bayanzurkh district
ChD	Chingeltei district
CSR	Corporate social responsibility
EPR	Extended producer responsibility
GNI	Gross national income
GHG	Greenhouse gas
GPS	Global Positioning System
GWMO	Global Waste Management Outlook
ISWA	International Solid Waste Association
ISWM	Integrated sustainable waste management
IRS	Informal recycling sector
IWB	Itinerant waste buyer
JICA	Japan International Cooperation Agency
KhUD	Khan-Uul district
KOICA	Korea International Cooperation Agency
LGOE	Local government owned enterprise
LLC	Limited liability company
MDDS	Morindavaa disposal site
MFD	Material flow diagram
MNRA	Mongolian National Recycling Association
MNT	Mongolian tugriks (currency unit)
MSW	Municipal solid waste
MSWM	Municipal solid waste management

NA	Not applicable
NEDS	Narangiin Enger disposal site
PS	Product stewardship
PSD	Public service department
RDF	Refuse-derived fuel
SBD	Sukhbaatar district
SKhD	Songinokhairkhan district
STAN	subSTance flow ANalysis
SWM	Solid waste management
TUK	Waste collection company "*Tohijilt Uilchilgeenii Kompani*"
TsDDS	Tsagaan Davaa disposal site
UB	Ulaanbaatar
UBPUA	Ulaanbaatar Public Utility Agency
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environment Programme
US	United States of America
US $	United States dollars (currency unit)
WASH	Water, sanitation and hygiene

LIST OF APPENDICES

1 INTRODUCTION

The growing concern of waste is one of the most evident by-products of urbanization (Hoornweg & Bhada-Tata, 2012). As the population increases in urban settlements the production of waste also progressively increases. The practice of waste management differs significantly in the developed and developing countries. Particularly, the lack of reliable and up-to-date data which is the lifeblood of decision-making, is the norm in developing countries (UNSD, 2013; Wilson et al., 2015). Ulaanbaatar (UB), Mongolia is one of the cities faced with unprecedented consequences of rapid urbanization and population increase alongside with lack of proper rules and regulations in place. The city's municipal solid waste management (MSWM) is facing critical challenges, however, there is a gap in the peer-reviewed literature as well as data that is describing the system with reliable sources. The other gap is that policy makers currently do not formulate policy based on systems analysis which identifies strengths and weaknesses in the MSWM in UB. Moreover, waste related matters differ within a city, across communities. UB has two distinct residential areas – apartment and *ger*. The *ger* areas (named after the traditional nomadic dwellings) are sprawling settlements that lack basic infrastructure: not connected to water supply, sewage and central heating systems. There is a gap in the knowledge surrounding the degree and extent of behavioural and attitudinal differences in the two types of residential areas of *ger* and apartment.

Solid waste management (SWM) is a global issue. Three broad drivers, resource value of waste, public health and environmental protection, have shaped the evolution of SWM systems. However, currently there is a huge discrepancy between the situations of developed and developing countries, where the former is characterized by tightly defined engineered systems (Chang et al., 2011; Marshall & Farahbakhsh, 2013), whereas the latter is predominantly occupied with removal and collection services. Consequently, global comparison of cities irrespective of income level can be useful in various contexts (Wilson et al., 2015), especially in assisting the MSWM systems of developing countries.

The remainder of this thesis is organized as follows.

Chapter 2 brings forth background information on the research.

Chapter 3 explains the materials and methodology used throughout the research, as well as the concerns and limitations.

In Chapter 4, UB's MSWM system was assessed using benchmark indicators according to the physical and governance features. Global comparison is done in order to gain insight about the current development of UB's system regarding various aspects.

In Chapter 5, the two types of residential areas in UB are studied to determine if there are differences in behaviours and attitudes of the residents, and whether the differences have actual implications toward waste management. A public questionnaire was used to survey the residents in these two distinct residential areas.

A general discussion is provided in Chapter 6 that gives a comprehensive analysis which covers all the physical components and governance aspects with regards to the different residential types. Finally, the main findings are concluded and recommendations are given in Chapter 7.

2 BACKGROUND

2.1 Solid waste management drivers

Municipal Solid Waste Management (MSWM) is one of the most important public services, as waste is ever growing due to urbanization and population increase. The MSWM systems around the world have been shaped by three broad groups of drivers from resource value of waste to public health and environmental control (Wilson, 2015). Evolution of these drivers over the last one thousand years is illustrated in Figure 2.1.

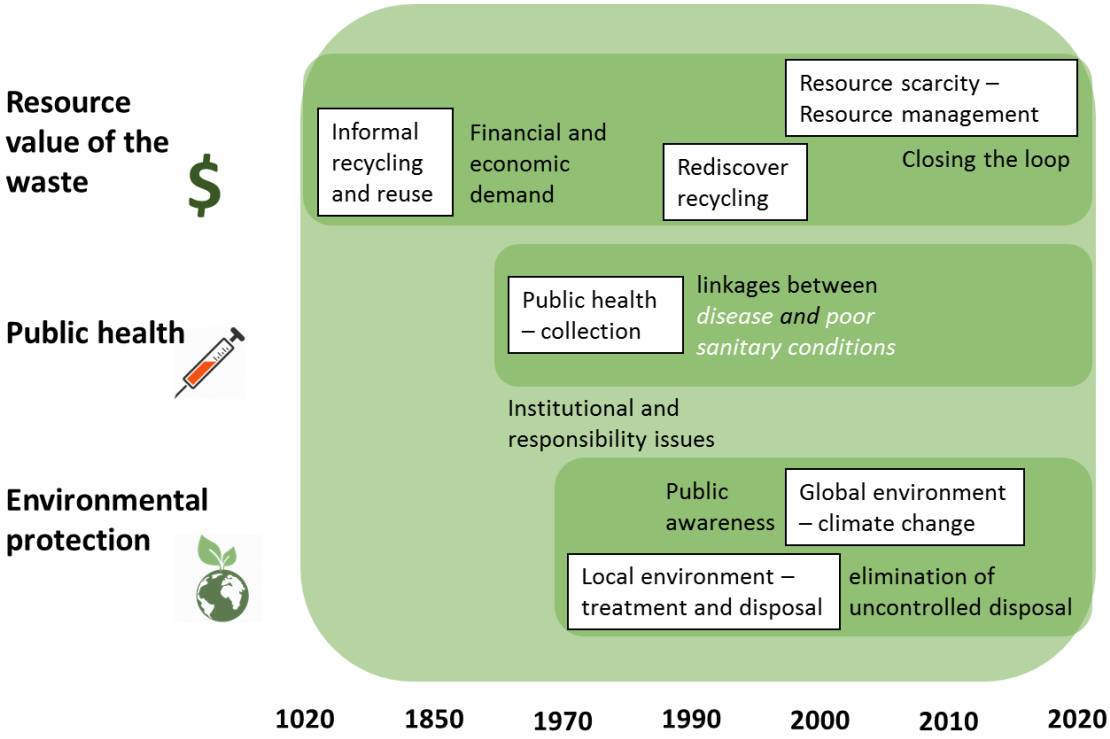

Figure 2.1 Historical development of waste management drivers (adapted from (Wilson, 2015)).

2.1.1 Resource value of waste

The earliest driver, informal recycling and reuse was that of financial value of waste. Throughout the Industrial Revolution, when cities started being more concentrated, large numbers of the urban poor were informally extracting recyclables or reusable items as 'street buyers' or through waste picking. This situation can be observed on the example of developing countries to date, where the municipalities do not have proper recycling programs or systems in place and the informal sector acts as the main

player that contributes to resource recovery while saving the municipalities the costs of collection and disposal (Sim et al., 2013; Vergara et al., 2011). As the disposal costs were rising and the public were increasingly opposed to new sites, the developed countries had to 'rediscover' recycling as part of their MSWM since the 1980s. However, this recycling and other top levels of the waste hierarchy, such as waste prevention and waste minimization were increasingly driven by the concern over the depletion of virgin raw materials and resource scarcity (Wilson, 2015).

2.1.2 Public Health

During the cholera epidemics, which struck the newly industrializing countries of Europe and North America from the 1830s, a causal link was made to decaying organic waste. Hence, municipal solid waste collection became part of the public health revolution, and part of the public service as we know today (Wilson, 2015).

2.1.3 Environmental protection

The standard way of handling waste until the emergence of the environmental movement in the 1960s and 1970s was uncontrolled disposal or burning, which severely impacted the local environment through air, soil and water pollution etc. Hence, comprehensive environmental legislations were introduced and environmental standards tightened. Waste sector's contribution to the climate change can be accounted in various ways: directly through methane generation from landfills and uncontrolled waste burning, as well as indirectly through unsustainable consumption and usage of products that end up in landfills (Wilson, 2015).

2.2 Developed VS developing countries

According to the Global Waste Management Outlook (GWMO) prepared by the United Nations Environment Programme (UNEP) and the International Solid Waste Association (ISWA), approximately two billion tonnes of municipal solid waste (MSW) is being generated worldwide per annum (Wilson, 2015). About half of this is generated in the longstanding high-income developed countries; however, further increase will predominately be from developing countries by 2030 (Hoornweg et al., 2013).

There is a huge gap in waste management practices between developed and developing countries. The developed countries' solid waste management (SWM) is

characterized with well-defined engineered systems, whereas the developing world is predominantly preoccupied with collection and removal services to date (Hoornweg et al., 2013). When the current methodologies of developed countries are applied to the practices of developing countries, many obstacles are present due to complexities that exist in the developing world (Marshall & Farahbakhsh, 2013; Scheinberg et al., 2010; D. C. Wilson, 2007). These complexities include rapid economic growth, population increase, inequality, informal settlements, lack of financial instruments, and inadequate capacity of local governments (Al Sabbagh et al., 2012; Chen et al., 2010; Guerrero et al., 2013; Marshall & Farahbakhsh, 2013; Vergara & Tchobanoglous, 2012). Therefore, in order to solve SWM problems in developing countries, the solutions should be designed specifically to meet the needs of a given municipality or a community while taking into account all its specific features.

MSWM is a multifaceted system that fits the concept of *system of systems*, which pools together the resources and capabilities of a collection of a few dedicated systems or subsystems to form a more complex metasystem by offering more functionality and performance than the sum of its constituent systems (Chang et al., 2011). It implies that the interconnectedness of various aspects of MSW is far more important for the system's overall functionality and performance.

Since 1960s, systems analyses using engineering models, analysis platforms and assessment tools have been assisting SWM agencies of developed countries. However, there are limitations in terms of applicability of systems analysis tools in developing countries (with the exclusion of some, e.g. see Chang et al., 1997; Chang & Wang, 1996; Charnpratheep & Garner, 1997), as majority of the models were developed in high income countries (Chang et al., 2011). Even in the developed countries, prior to 2000, the focus of these models was solely on economic and environmental spheres, without recognizing the social aspects (Marshall & Farahbakhsh, 2013; Morrissey & Browne, 2004). These models did not consider all relevant stakeholders, from government officials, industry and formal private sector service providers to local communities and waste pickers; and did not consider the full cycle from waste to final disposal (Marshall & Farahbakhsh, 2013; Morrissey & Browne, 2004). Most models did not take holistic perspective of the SWM system; rather focused on isolated problems within the larger system (Chang et al., 2011; Marshall & Farahbakhsh, 2013; Shmelev & Powell, 2006).

Therefore, MSWM analysis needs to consider socio-economic, environmental, financial and institutional aspects, as integrated approaches are a promising tool for tackling the current situation of waste management in developing countries (Chang et al., 2011; Guerrero et al., 2013; Marshall & Farahbakhsh, 2013). Finally, the issue of data availability and reliability needs to be addressed for successful management of waste and its negative impacts.

2.3 Waste management performance indicators

Performance indicators are a good basis for assessing the status quo, which is the one of the most critical steps towards improving the system. They also enable comparison with other systems and track changes or progress over time (Wilson, 2015).

The recent initiatives for developing performance indicators for waste management have been presented in Table 2.1 in chronological order. Except for the final three initiatives that are applicable to all countries from low- to high-income levels, most of the cases have been applied to a certain geography or other locations that are bounded with similar socio-economic characteristics and are limited in terms of applicability. ‘Wasteaware’ benchmark indicators by Wilson et al. (2015) have been applied to more than 50 cities of various income levels and are based on the framework of Integrated Sustainable (Solid) Waste Management (ISWM) (Figure 2.2) which recognizes all the physical and governance aspects of waste management system.

Table 2.1 Overview of recent initiatives for developing performace indicators for waste management (adapted from (Wilson, 2015))

No.	Reference	Purpose/Description	Applicability	Extent of use
1.	Polaz & Teixeira (2009)	Sustainability Indicator for SWM	Brazil	One city in Brazil
2.	CEPT University (2010)	Performance Assessment System for urban water, sanitation and solid waste	India	400 urban local bodies in two Indian states
3.	Ministry of Urban Development in India (MoUD, 2010)	Service level benchmarks for water supply, sanitation and solid waste management in Urban Local Bodies	India	Widespread but results not yet published
4.	Armijo et al., (2011) & alike	Various methodological proposals for a SWM indicator set	Brazil (others in Europe)	None One case study each
5.	Bringhentia et al. (2011)	Evaluation of programs for selective collection of MSW including social inclusion	Brazil	Indicators validated but not tested
6.	Huang et al. (2011)	Assessment of the performance of SWM collection	People's Republic of China (PRC)	307 local governments
7.	Mendes et al. (2012)	Evaluation of MSWM services using a Balanced Score Card	Europe	One municipality in Portugal
8.	Wilts (2012)	Measuring progress in national waste prevention programs	Europe	One case, Germany
9.	Menikpura et al. (2013)	Assessment of the performance of recycling, treatment and disposal as a component of sustainable SWM systems	Thailand	One municipality in Thailand
10.	Munizaga & Garcia (2013)	Garbometer: Evaluation on MSWM systems	Spain	One city in Spain
11.	Zaman & Lehmann (2013)	Development of a zero waste index for measuring performance of SWM	High-income cities	Three cities (Adelaide, San Francisco, Stockholm)

12.	Greene & Tonje (2014)	Comparison and ranking of SWM programs in the U.S.	US	10 municipalities in New York State
13.	Hotta et al. (2014)	Monitoring progress of 3R efforts towards a green economy. Discussion paper and factsheets on performance indicators in the 3Rs & resource efficiency	Low-, middle- and high-income countries	None (Discussion paper and factsheets)
14.	Romualdo (2014)	Benchmarking performance of a national hazardous waste management system	Low-, middle- and high-income countries	Proposed indicator set tested in seven countries (four in Europe plus one each in Africa, Asia and Latin America)
15.	Wilson et al. (2015) (Also, Scheinberg, Wilson, Rodic (2010); Wilson, Rodic et al. (2012); Soos et al. (2013))	'Wasteaware' ISWM benchmark indicators to compare performance of SWM in cities	Low-, middle- and high-income countries	Tested in 39 cities in six continents; being used to monitor progress in 19 cities in Egypt.

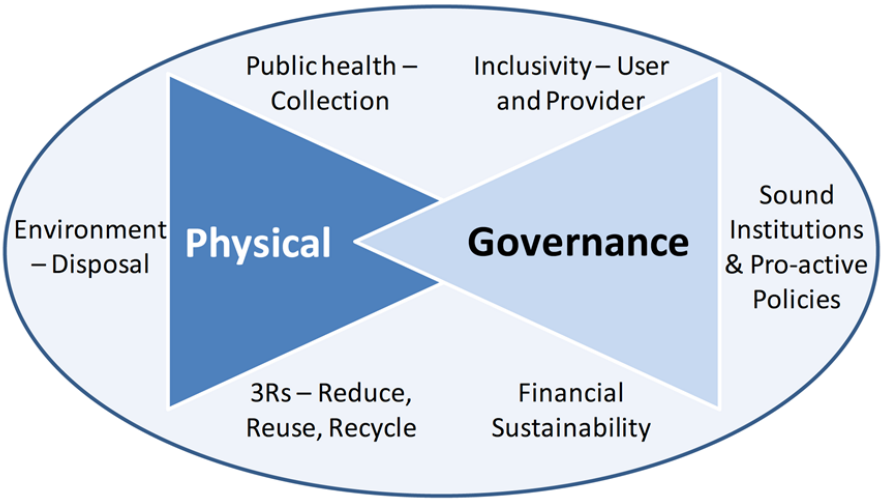

Figure 2.2. The Integrated Sustainable (Solid) Waste Management (ISWM) Framework (Wilson et al., 2015).

2.4 Municipal Solid Waste Management in Ulaanbaatar, Mongolia

Ulaanbaatar (UB), the capital city of Mongolia, is one of the cities facing unprecedented consequences of rapid urbanization, population increase and economic growth. A little over 40% of the total country's population resides in this city (MSIS, 2015). A large part of this population resides in informal settlements, "*ger* districts", which lack basic infrastructure (SDoU, 2015). The MSWM of the city is facing critical challenges, making it one of the most pressing issues concerning public health, the environment, and resource efficiency. However, there is insufficient peer-reviewed literature (Altantuya et al., 2012; Batkhuyag et al., 2016.; Delgermaa & Matsumoto, 2016) describing the system and providing enough details with reliable data to form the basis of decision making for UB's waste management.

2.4.1 Policies and Current Practices

Environmental Protection law of Mongolia (1995) placed responsibilities on the various administrative divisions and sets out the rights of citizens concerning waste management services. Mongolian Law on Waste Management (17 May 2012) regulates relations arising from collection, transport, storage and landfill of household and industrial waste as well as promoting the re-use of waste as an alternative to virgin

materials. An important local bylaw on "Funding of waste management and transport operations and consolidation of waste management service fees", which regulates waste management activities connected to MSW generating from domestic and commercial premises, was enacted on 15 May 2015.

City-scale waste management is facilitated by the municipal government. UB's city council known as the Citizen's Representative Khural is in charge of appointing the mayor. Within the mayor's office, the Public Service Department (PSD) is in charge of formulating the city's waste management policies and its related work. At the district level, the infrastructure and public service department within the district governor's office is in charge of implementing the policies regarding waste management and its related work in its designated territory.

The districts contain several subdivisions called "*khoroos*". *Khoroos* are then further divided into *khesegs*, which is the smallest unit of administration. Waste collection is provided at the district level. Each district is divided into "service zones" that consist of one or several *khoroos*. Waste service providers known as *TUKs* in Mongolian (*Tohijilt Uilchilgeenii Kompani*), are appointed to each zone and are in charge of waste collection, removal and transport services, as well as the cleaning of public spaces of their designated districts.

There are three disposal sites in UB that use varying degrees of landfill technology: Narangiin Enger (NEDS), Morin Davaa (MDDS) and Tsagaan Davaa (TsDDS). The incoming waste categories include waste from households (*ger* and apartment), streets and public spaces, commercial, construction and demolition (C&D) and waste from dams, drainage, and sewage sludge, and other (including industrial, medical, secondary raw materials and summer house waste). Medical waste is treated by an autoclave system at NEDS prior to secured burial in the same disposal site.

2.4.2 Uncertainties in Solid Waste Management of Ulaanbaatar

MSW definition ambiguity: According to the Mongolian Law on Waste Management (2012), there is no legal definition of MSW, as is the case for some countries that do not use the term "municipal solid waste" or "MSW" in their native languages (Kawai & Tasaki, 2016). This hinders to estimate the amount of MSW generation, as there are various waste categories coming from different sources.

Japan International Cooperation Agency (JICA) worked on UB's SWM from 2005 to 2012 (JICA, 2007, 2012), and made significant contribution in the formal waste management sector such as constructing sanitary landfill sites with weighbridges, procuring waste collection trucks, strengthening the capacity for SWM and conducting waste generation and composition studies and so on. Nevertheless, the system is still inadequate in terms of basic requirements.

Lack of data: Availability of reliable and up-to-date data is one of the biggest challenges in developing countries as well as in UB, which is related to the inadequacy of data collection and reporting. However, this might constitute a barrier to action, or allow incorrect assumptions resulting in incorrect actions (Wilson et al., 2015). There are no regular waste generation and composition studies conducted. There is a lack of data on informal recycling which accounts for most of the recycling activities. Recyclable waste is informally recovered from the MSW stream and flow into the recyclable stream during each process (Kawai & Tasaki, 2016) of discharge, collection, transport and disposal. Therefore, there is an urgent need to address these uncertainties, which occur in solid waste management.

3 MATERIALS AND METHODOLOGY

3.1 Study area

Mongolia is a landlocked country situated in East Asia, bordered by China and Russia (Figure 3.1). In 2015, the gross national income (GNI) per capita was US $3830, which is classified as a lower-middle-income country (World Bank, 2016). In 2014, Mongolia was classified as an upper-middle-income country for one year (World Bank, 2015).

UB is situated in the north centre of the country and lies at an elevation of about 1350 m a.s.l. in a valley on the Tuul River. It is the country's administrative, cultural, commercial and financial capital. In 1990, Mongolia transitioned to democracy and market economy, which brought a series of unprecedented changes, especially in the development of the capital city's structure. During that time, an intense rural to urban migration took place and UB's population growth resulted in a large-scale increase of informal settlements—"*ger* districts"—across the city (Byambadorj et al., 2011). *Ger* is a traditional dwelling that is unique to nomads in the steppes of Central Asia.

Ger districts lack basic infrastructure such as water supply, sanitation and proper drainage systems that increases the exposure to water, sanitation and hygiene (WASH) borne diseases (Uddin et al., 2014). Due to the lack of a centralized heating system, a majority of the households use stoves for cooking and heating that are fuelled by the burning of coal, wood and other combustible materials and waste. *Ger* districts and apartment type residential areas represent 58% to 42%, respectively, of UB, as shown in Figure 3.2 (SDoU, 2015). During the transition period between 1990 and 2002, there was, in essence, no regulation in terms of urban planning and, as a result, many "illegal" buildings were built; *ger* districts in UB grew by 58% during this time (Amarsaikhan et al., 2009; Byambadorj et al., 2011). However, in recent years, the growth rate of *ger* districts has been declining (see Figure 3.3) (SDoU, 2015).

The study's target area includes six central districts—Bayangol (BGD), Bayanzurkh (BZD), Songinokhairkhan (SKhD), Sukhbaatar (SBD), Khan-Uul (KhUD) and Chingeltei (ChD), as shown in Figure 3.1, totalling 3256.6 km^2. In 2015, 1.27 million people resided in these districts (MSIS, 2015). Each district has apartment and *ger* areas; however, the proportion varies among them (see Table 3.1).

Figure 3.1. (a) Mongolia is a landlocked country situated in East Asia. (b) Ulaanbaatar (UB) is the capital city. (c) UB consists of six central districts: 1, Bayangol; 2, Bayanzurkh; 3, Songinokhairkhan; 4, Sukhbaatar; 5, Khan-Uul; and 6, Chingeltei.

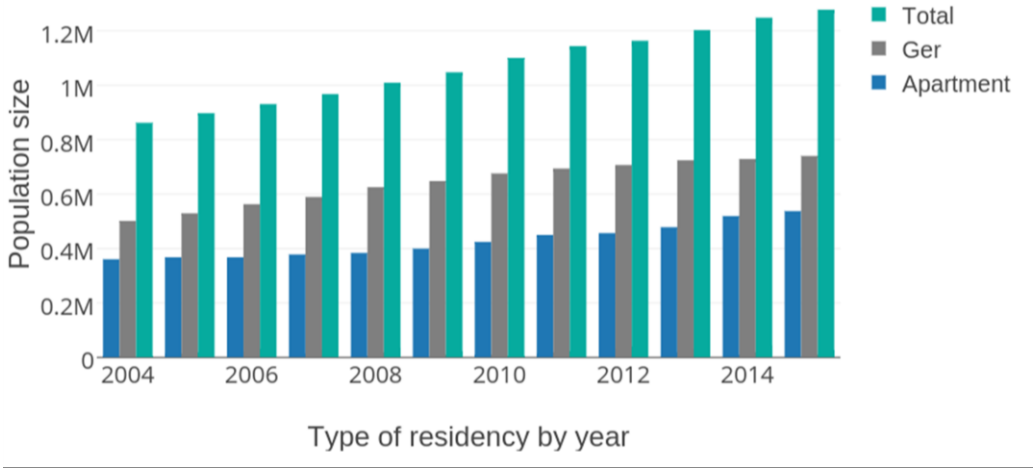

Figure 3.2. Population growth of UB from 2004–2015 (data obtained from (SDoU, 2015)).

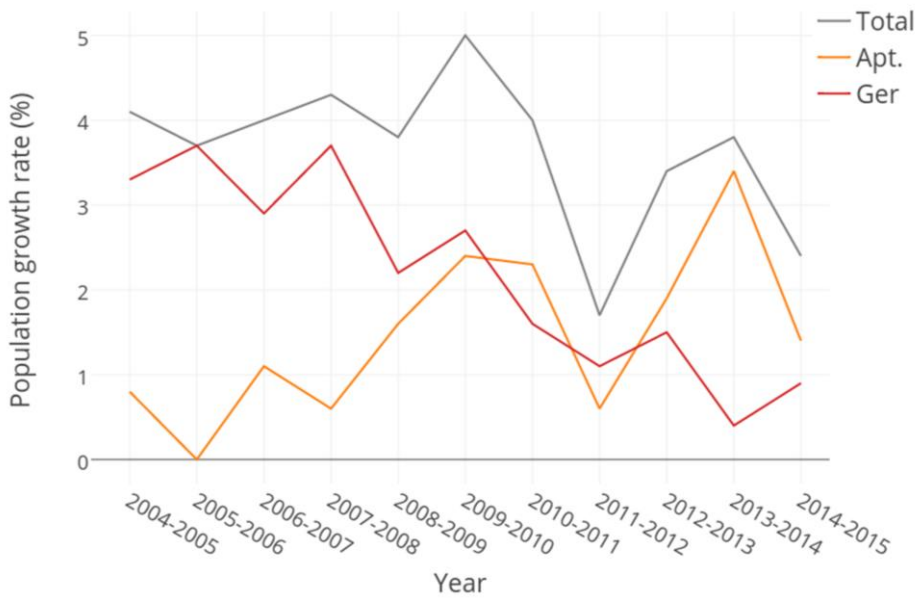

Figure 3.3. Population growth rate of UB from 2004–2015 (data obtained from (SDoU, 2015)).

Table 3.1. Population of Ulaanbaatar city's districts and the corresponding ratio of apartment and *ger* areas

	District	Total population	Apartment	*Ger*
1.	Bayangol (BGD)	205,663	78%	22%
2.	Bayanzurkh (BZD)	320,852	41%	59%
3.	Songinokhairkhan (SKhD)	307,224	24%	76%
4.	Sukhbaatar (SBD)	137,633	46%	54%
5.	Khan-Uul (KhUD)	150,946	51%	49%
6.	Chingeltei	154,819	19%	81%
	TOTAL	1,277,137	42%	58%

Districts Bayanzurkh and Songinokhairkhan make up approximately 50% of the total city's population; while collectively comprising about 56% of the total residents living in the *ger* area (Songinokhairkhan alone accounts for one third of the *ger* area). Bayangol district has the least number of the total residents of the *ger* area with 6.2%. Chingeltei district has the least number of residents living in the apartment area with 5.5%.

3.2 Site visits and data collection

Fieldwork was conducted, which consisted of site visits, interviews with the key stakeholders, consulting of official documents and reports; conducted in UB from 25 August to 24 September 2015. Data from previous reports and scientific papers were also used. Interviews were conducted with previously identified key stakeholders which included local and municipal government officials, *TUKs*, landfill site workers, Non-Governmental Organizations (NGOs), recycling association, auditors and public inspectors (summary is presented in Table 3.2) (Appendix 3).

A public questionnaire was also conducted during the fieldwork. The questionnaires were distributed in apartment and *ger* areas, as well as markets, schools, offices in order to diversify the pool of respondents.

Table 3.2. Summary of meetings, interviews and site visits for data collection during the fieldwork

Stakeholder		Date	Objectives
City	Public service department (Mayor's office)	1 September, 16 September	An overview of the MSW system, related information
	Ulaanbaatar Public Utility Agency	11 September	Official reports, interview with the director, information on disposal site management
Landfill sites	Narangiin Enger disposal site	7 September	Site visit, interview with the site manager and waste pickers, observation of the

			waste recording process
	Morin Davaa disposal site	12 September	Site visit
	Tsagaan Davaa disposal site	12 September	Site visit
District level administration	Sukhbaatar district department of infrastructure and public service	11 September	Information on the roles and duties of the department at the district level
	Bayangol district department of infrastructure and public service	15 September	
	Sukhbaatar district public inspector	22 September	
Waste collection company (TUK)	Chingeltei TUK	7 September	
	Waste collection truck – crew	19 September	Followed the crew for one day, collecting waste from commercial entities and *ger* district and disposing at Tsagaan Davaa disposal site
International organizations	The Asia Foundation	31 August	
NGOs	Mongolian national recycling association NGO	9 September	Overview of the roles and duties as auditor for waste service provision
	Health Policy Institute of Mongolia NGO	15 September	
	"Ulaanbaatar" Saemul association for supporting of city development NGO	16 September	

3.3 Benchmark Indicators

The indicators were assisted by fieldwork, which consisted of site visits, interviews with the key stakeholders, and consulting of official documents and reports; conducted in UB from 25 August to 24 September 2015. Data from previous reports and scientific papers were also used. Interviews were conducted with previously identified key stakeholders which included local and municipal government officials, *TUK*s, landfill site workers, Non-Governmental Organizations (NGOs), recycling association, auditors and public inspectors.

The collected data were used to assess the MSWM system according to its physical components and governance aspects. Physical components consist of (1) public health, (2) environmental protection, and (3) resource management. Governance aspects consist of (4) inclusivity, (5) financial sustainability, and (6) sound institutions, proactive policies (Figure 3.4). Each of these components and aspects are represented with their corresponding quantitative and qualitative indicators. There are four quantitative and eight qualitative indicators in total. The details are as follows: the physical components are comprised of four quantitative (numbered as 1.1, 1.2, 2 and 3, corresponding to each component, the same applies to all indicators) and three qualitative (multi-attribute, composite) indicators (numbered as 1C, 2E, and 3R); the governance aspects are in turn comprised of five qualitative indicators (numbered as 4U, 4P, 5F, 6N and 6L). The quantitative indicators are represented by a single numerical value in percentage (%). The qualitative indicators are comprised of 5–6 variables that are each given a score of 0, 5, 10, 15 or 20 (from low to high), consistent with Likert-type measurement scales (Carifio & Perla, 2008; Likert, 1932; Wilson et al., 2015), corresponding to practices that were exceptionally bad/lacking, notably worse than the average, average, notably better than the average, and exceptionally good, respectively. These variables' scores are then summed together into the score for their qualitative indicators. The benchmark indicators' results obtained for UB were then compared to four reference cities (Wilson et al., 2015) of all income levels (high, upper-middle, lower-middle and low) classified based on GNI per capita (World Bank, 2016). The cities are: Monrovia (Liberia), low income; Lahore (Pakistan), lower-middle income; Guadalajara (Mexico), upper-middle income; and Belfast (UK, Northern Ireland), high income levels. Mongolia is considered a lower-middle-income country.

Figure 3.4. "Wasteaware" benchmark indicators' components (Wilson et al., 2015).

All of the four reference cities were chosen because they have unique similarities with UB. For instance, Liberia and UB have similar population size of around one million people. Lahore is a city which is in the same income level. Guadalajara and UB have similar waste generation per capita. And Belfast and UB have a similar fraction of organic waste. The comparative analysis with the four cities demonstrates an example of global comparison that can give more perspective on finding solutions to local waste management challenges.

The results obtained would help SWM system by identifying strengths to build upon and areas for improvement. The objective of the study was to make policy recommendations and course of action to UB's authorities and by extension to the international community, especially other developing countries that are faced with similar problems.

3.3.1 Data

Key waste-related data (waste generation and composition) are part of the supporting information for the benchmarking methodology, comprising the basic information (Beigl et al., 2008) for successful planning, handling and operations optimization of waste management system. Various primary and secondary data were used to evaluate the key waste-related data and the benchmark indicators as shown in Figure 3.5.

According to the Global Waste Management Outlook (GWMO), MSW is waste from households and smaller businesses and institutions (Wilson, 2015). In the Mongolia Law on Waste Management, household waste is defined as waste generated from domestic premises and waste of similar composition. For this paper, MSW is waste from households (*ger* and apartment) and waste from streets and public spaces.

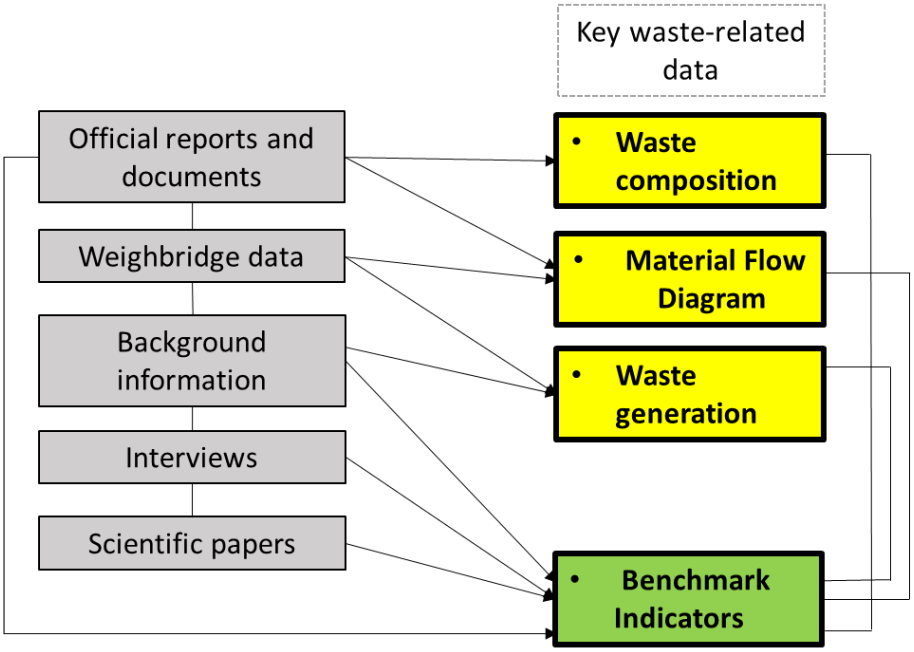

Figure 3.5. Methodological flow chart.

3.3.1.1 Waste generation

The waste generation per capita was calculated based on the weighbridge data at the disposal sites of NEDS, MDDS and TsDDS for year 2015 that was obtained from Link Engine LLC (in charge of the system maintenance and support services for weighbridge data registering software).

3.3.1.2 Waste composition

The composition of household waste was extrapolated from JICA studies of 2010–2011 (JICA, 2011a, 2011b) and was compared to the averages of other countries according to all income level groups (Wilson, 2015).

3.3.1.3 Material flow

"Wasteaware" benchmark indicators are accompanied by a material flow diagram (MFD). However, due to uncertainties in waste flow and insufficient data on recycling aspects, the MFD was constructed using the currently available weighbridge data of 2015 in combination with JICA's recycling estimates with an attempt to give some overview of the informal recycling activities (JICA, 2012). The MFD was constructed using the STAN material flow analysis software (Cencic & Rechberger, 2008).

3.4 Public questionnaire

Due to the existing two types of residential areas, a public questionnaire (Appendix 1 & 2) was conducted in order to see the differences of the two types of residencies and their implications on the waste management service. The questionnaire was devised to examine residential behavior and attitudes towards waste management in the city of UB. Questions and topics were selected to investigate not only attitudes and behavior towards waste issues, but also perceptions and future concerns related to waste management in UB.

Twenty-two (22) waste management questions were included in the questionnaire, along with 9 demographic questions. Questionnaires included like type scale questions, multiple choice and open-ended questions. The questionnaire was designed with the following 2 sections:

1) Demographic questions: age, gender, occupation, household size, district and khoroo of residency, type of residency (apartment or *ger*), and whether originally from UB or not
2) Waste management questions

A total of 520 questionnaires were collected, which was viewed as being representative at the 95% confidence interval and gave a confidence interval of 4. Questionnaires were distributed among apartment and *ger* areas residents, as well as public places, offices, schools and market places where people from all backgrounds gather.

Questionnaire design

Section 1. Demographic information

Section 2. Waste management

3.5 Uncertainties in the collected data

There are discrepancies between weighbridge data from landfill sites and data that is compiled by UBPUA and reported to PSD at Mayor's Office. There are several explanations to this matter. Link Engine LLC developed the software for registering weighbridge data in 2007. From 2007 until May 2015, UBPUA was in charge of running and the maintenance of the system and its support services. From May 2015, Link Engine LLC took over the system and became in charge of its maintenance and support. According to Link Engine LLC, in the past during power outages or when the computer or the database was damaged, everything was recorded outside of the system manually. However, they reported this problem was resolved after they took over the system. This could be one of the main reasons for such discrepancies before May 2015. Additionally, the data collected at weighbridge is not used for detailed analysis (specifically for policy matters); therefore, the data is compiled to give a general overview on a monthly/quarterly/yearly basis. The data could be obtained for further detailed analysis by third party upon request. However, another thing to consider for using the weighbridge data is a reliability issue. Issues with data handling and reporting in developing countries (Al Sabbagh et al., 2012) are quite common and need to be treated with careful consideration.

Amount of time spent in the field affects the outcome of research. The longer the researcher spends in the field, the better understanding of the local conditions and circumstances will be gained. This is not always feasible in terms of various resources such as finance and time. However, I was able to spend one full month in the field and gather as much valid data that was available.

4 Assessment of the current state of Municipal Solid Waste Management in Ulaanbaatar, Mongolia using Benchmark Indicators

4.1 Introduction

The purpose of this study is to analyse the current state of MSWM of UB, Mongolia by using the ISWM "Wasteaware" benchmark indicators (Wilson et al., 2015), based on the work of UN Habitat's city profiling methodology for SWM for countries of both developed and developing backgrounds (Scheinberg et al., 2010). A comprehensive performance measurement of both physical components and governance aspects of SWM was conducted while considering all relevant stakeholders. The methodology was tested on more than 50 cities (Al Sabbagh et al., 2012; Masood et al., 2014; Sim et al., 2013; Wilson et al., 2012), which validates the approach and is very suitable especially for cities that are still in the early stages of developing their SWM systems. To achieve a more realistic analysis, I used in situ data collected from the most reliable sources. The results would be useful for establishing an optimized system of solid waste management through informed policy making, effective use of financial and human resources, focusing on areas of critical importance, and by adopting a holistic approach. The effectiveness of a city's SWM system can also be used as a proxy indicator of good governance (Wilson et al., 2015), and how the city/municipality deals with its environmental problems and urbanization issues.

4.2 Results and Discussion

4.2.1 Waste Generation and Composition

In 2015, the total amount of all waste registered at all three landfill sites was 969.1 thousand tonnes (Figure 4.1 showing all the waste categories) arriving at NEDS, TsDDS and MDDS with the proportions 47%, 36.8% and 16.2%, respectively. MSW waste includes waste from household (apartment and *ger*), and streets and public spaces that accounts for 53.9% of total waste registered at weighbridges. MSW generation of UB city is 1.12 kg per capita per day (408.82 kg per capita per year). This number should be considered as the minimum, since recyclables are extracted in the stages prior to disposal. More information about the recycling process is included in Section 4.4 on resource management. The waste generation amount exceeds the threshold of 1kg per capita per day, making UB a "higher waste generating" city (Wilson et al., 2015).

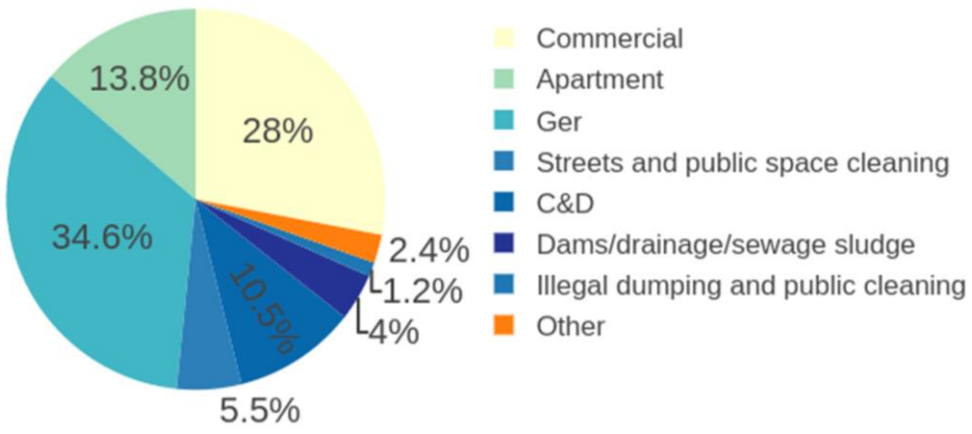

Figure 4.1. Weighbridge data of 2015 (Other waste includes: industrial waste, hospital waste, secondary raw materials and waste from summer houses; data from Link Engine LLC (2015)).

Mongolia is considered a lower-middle-income country, however, according to JICA's study (JICA, 2011a, 2011b), UB's household waste composition had qualities of countries from all income levels (Table 4.1 and Figure 4.2). For instance, UB has only about 33.7% organic fraction, which is similar to high-income countries. The amount of paper (7.7%) and metals (2.1%) were comparable to lower-income countries. The percentage of plastic (14%) waste was in the higher range compared to all other income countries' waste composition. The percentage of bottles and glass (29%) was significantly higher than the rest. This could be explained by the amount of consumption of products that come in glass jars and bottles, however this should be further investigated for clarity. The percentage of recyclables including paper, plastic, metal, bottles and glass accounted for approximately half (52.8%) of the total waste amount. In this survey, ash from stoves in the *ger* area was excluded. In the wintertime, the amount of ash in the *ger* areas increases to an amount equal to the total waste generation from both apartment and *ger* areas combined.

Table 4.1. Comparison of waste composition results of Ulaanbaatar (UB) with averages of all income level countries (Wilson, 2015) (data for UB's household waste composition study 2010–2011 (JICA, 2011a, 2011b))

	Low	Lower-middle	Upper-middle	High	Ulaanbaatar
Organic	53%	53%	46%	34%	33.8%
Paper	6%	11%	19%	24%	7.7%
Plastic	7%	9%	12%	11%	14%
Glass	2%	3%	5%	6%	29%
Metals	2%	3%	4%	5%	2.1%
Textiles	2%	3%	3%	1%	2.4%
Other	28%	18%	11%	19%	11%

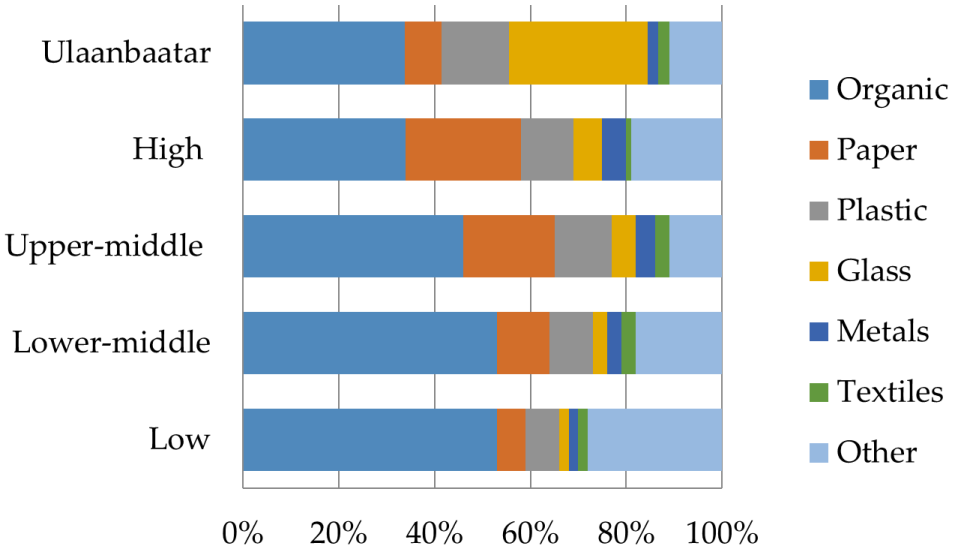

Figure 4.2. Waste composition comparison of Ulaanbaatar with averages of various income level countries (Wilson, 2015) (data for household waste composition study 2010–2011 (JICA, 2011a, 2011b)).

4.2.2 Public Health (Waste Collection)

Waste collection service is the primary requirement for eliminating the negative impact of waste on public health. According to the PSD, about 85% of the total waste generated is being captured by the SWM system. However, this needs to be further investigated based on detailed, reliable data and quality research. Nonetheless, based on field observations, there are open dumps that are not being cleared: the amount of illegally dumped waste registered at weighbridges accounts for only 1.2% of total incoming waste amount (see Figure 4.1), which implies the amount of waste that is still not being captured by the SWM system could be significant and posing threat to the public health directly and through contamination of the surrounding environment.

In terms of residential waste, the waste collection method and frequency differ in both areas of *ger* and apartment. In apartment areas, households dispose their garbage in waste collection containers, whereas in *ger* areas the waste collection is primarily on a door-to-door basis. For this reason, there are more waste collection points/containers in apartment residential areas compared to *ger* district areas. There is medium incidence of accumulated waste around collection points/container (see score for 1C.1). In some of the central apartment areas where there are no waste collection containers, the waste is gathered in front of the apartments or along the road.

Waste collection frequency in apartment and *ger* areas is 1–2 times a week and 1–2 times a month, respectively. Due to the characteristics of *ger* areas (horizontally spread and poor infrastructure), waste collection is costlier and more labour and time intensive. Waste collection was about once a month in some of the *ger* areas, which was changed to twice or more in recent years, especially since the launch of the "model *khoroo*" project (Asia Foundation, 2015). The Asia Foundation's "model *khoroo*" project was directed to improving waste management in *ger* areas. One of the outcomes of the project was to create a set waste collection schedule (as it was vague and not being followed) with a frequency of twice a month, which became the mandatory requirement for *TUKs*. However, the renewed schedule system is still being adopted by districts and *khoroos*, and needs more effort on its actual implementation. According to a public inspector of Sukhbaatar district, the difference between waste collection frequencies of 1 and 2 is very evident. Therefore, a minimum frequency of twice a month should be uniformly attained by all *ger* districts' waste collection services (as this could impact the

open dumping) before considering other factors such as seasonal, economical and sanitary etc.

The situation in low-income districts especially in the marginal areas is very critical with high incidence rates of accumulated waste, illegal dumps and open burning (hence the score for 1C.3). According to the PSD, 90–95% of households in UB receive waste collection service, excluding some marginal areas that are difficult to access due to steep and narrow roads. Those households dispose their garbage in their surrounding environment (i.e., drains and watercourses). However, this number should be subject to further investigation.

TUKs, the waste collection companies collect waste from households whether they have paid the waste service fees. Collection of waste service fee was previously collected by *TUK* in the *ger* areas, however this is no longer the case. Each *TUK* makes contractual agreement directly with the districts, and is paid based on their performance (Section 4.5 describes financial aspects and other governance features in more details). Waste collection and disposal is monitored by auditor NGOs and through documents including the driver's record stamped by the dispatcher at the weighbridge, the *kheseg* leader's record and finally the *khoroo* governor's confirmation of the work performance. *TUKs* are also obligated to invest 2% of the contract fees for training of their workers and educating citizens regarding waste related issues (see score for 1C.5). Thus far, the *TUKs* have made brochures, pamphlets and educational comics and distributed to the households of their corresponding districts. This work could be more impactful, if further coordinated with municipal scale programs in a systematic way.

There are no waste transfer stations; waste is directly transported to the disposal sites. As for waste collection trucks, there are both open and contained types. Most of the vehicles require human labour, especially during winter for the handling of ash from the *ger* areas (see score for 1C.4). At the time of the fieldwork, there were 18 *TUKs* with 274 trucks (seven of which are private *TUKs* with 91 trucks), operating on the premises of six central districts. A certain number of the trucks have a GPS system installed for monitoring their location, and speed; with sensors installed for fuel expenditure. According to the field survey, due to financial difficulties, one of the biggest remaining challenges is upgrading the vehicles and the machinery.

In terms of the health and safety of collection workers and street cleaning staff, most of the *TUKs* provide annual health-checks, boots, gloves, overalls and high visibility vests. The work is labour intensive and working conditions are harsh especially in the winter (see score for 1C.6).

In recent years, the municipality of UB made an effort focused intensively on street cleaning in the city centre, main roads and popular places where people gather (see score for 1C.2). Ulaanbaatar Public Utility Agency (UBPUA) is in charge of the city's public area cleaning (including dams, drainage and sewage sludge), operating a total of 25 trucks. According to the 2014 report by PSD, the salary for street cleaners at UBPUA was increased by 20% (average salary is 600–750 thousand MNT (US $306–382)) and drivers by 11.13% (600 thousand MNT (US $306)) and waste collectors by 19.7% (567 thousand MNT (US $289)), while the total number of workers per job category was increased by 63% (total 604 street cleaners), 7.5% (288 drivers) and 4.3% (416 waste collectors) compared to the numbers of 2013 [US $1 = 1960 MNT (2015)].

The benchmark indicators for Public Health were scored based on the points discussed above and a summary of the evaluation for the benchmark indicators and their comprising variables is shown in Table 4.2. The quantitative indicator scores are 92.5% (average of PSD's reported number) for waste collection coverage (1.1) and 85% (1.2) for waste captured by the SWM system. Consequently, the score for the qualitative indicator (1C) is 50%.

Table 4.2. Assessment of public health, including two quantitative (1.1, 1.2) and one qualitative (1C) benchmark indicators

No.	Short Name	Score	Observations
1.1	Waste collection coverage	92.5%	
1.2	Waste captured by the SWM system	85%	
1C.1	Appearance of waste collection points	10	Medium incidence of littering was seen
1C.1	Effectiveness of street cleaning	15	Low incidence of littering was seen
1C.3	Effectiveness of collection in low-income districts	5	High incidence of littering was seen
1C.4	Efficiency and effectiveness of waste transport	10	Medium compliance
1C.5	Appropriateness of service planning and monitoring	10	Medium compliance
1C.6	Health and safety of collection workers	10	Medium compliance
1C	Quality of waste collection and street cleaning service (Total score—normalised)	50%	

4.2.3 Environmental Control (Waste Treatment and Disposal)

It was found that 100% of waste which is captured by the system is destined for treatment or disposal in the three controlled disposal sites. Out of the three sites, NEDS, is the most advanced landfill site, an engineered facility that was constructed by JICA, whereas the other two sites are controlled facilities (see score for 2E.2). It has adequate vehicular access to the site with paved roads and is better in terms of overall security. However, all the sites can be accessed easily. All the sites have weighbridges and keep records of all the incoming waste statistics, including incoming waste volumes, weights and categories. Other properties such as waste composition, waste moisture, density etc., have not been researched. Waste is unloaded under supervision of a site staff. There are waste pickers in each disposal site that collect recyclables for a living. They account for

most of the fires set at the landfill sites, especially during winter for heating purposes (see score for 2E.1).

No Environmental Impact Assessment was done at these sites, except for NEDS and MDDS in the initial stages. Only NEDS has some type of leachate and landfill gas management. The sites are not operating to their full capacity in terms of environmental controls (see score for 2E.3). The aforementioned points are summarized in Table 4.3.

Table 4.3. General information on the three disposal sites of Ulaanbaatar

Description	NEDS	MDDS	TsDDS
Amount of waste received in 2015	47%	12%	37%
Reception and general site management			
Vehicular access (paved roads)	√	–	–
Traffic management	√	√	√
Site security	√	–	–
Waste reception and record keeping	√	√	√
Waste unloading	√	√	√
Control over nuisance	√	–	–
Control of fires	√	–	–
Waste treatment and disposal	Medium/High (Engineered facility)	Medium (Controlled facility)	Medium (Controlled facility)
Degree of monitoring and verification of environmental controls			
Environmental Impact Assessment	±	±	–
Incoming waste volume, weights and categories	√	√	√
Waste composition and related properties	–	–	–
Control of odour, emissions (GHG)	–	–	–
Ground and surface water control	–	–	–
Leachate and landfill gas	√	–	–

√ indicates that there are practices in place; – indicates absence of practices or very low quality and inadequate standards; and ± indicates there are records although have not been updated.

UBPUA oversees the operations of each disposal site. There have been significant improvements made in terms of some technical aspects; however, the sites are not managed according to high standards. The frontline operational staff lack technical training. Moreover, due to financial difficulties, the broken vehicles and machineries at the sites are not upgraded, routinely maintained or repaired (see score for 2E.5).

Currently, there are no waste-to-energy facilities in UB. However, a refuse-derived fuel (RDF) facility was constructed with the assistance of the Korea International Cooperation Agency (KOICA). The state inspection agency's results state that the facility was not constructed according to the specifications and the laws of Mongolia (inadequacy of ventilation and heating facilities) (KOICA, 2015). Additionally, the facility could not operate due to 3 main reasons (occurrence of blocking condition from not installing the crusher of RDF production facility, inclusion of harmful substances in the RDF ingredient and absence of RDF consumers) (KOICA, 2015), and currently operates as a sorting facility of apartment area waste.

The staff is provided with boots, gloves, overalls, and high visibility vests. Some types of safe operating procedures are in place and enforced. However, there have been no health checks or inoculations for the workers at these disposal sites. No effort has been made to consider the conditions of workers who are operating heavy machinery or work directly on the landfill sites under hazardous working conditions (hence the variable 2E.6 was scored low).

The evaluation for the benchmark indicators and their comprising variables for Environmental Control are shown in Table 4.4. The qualitative indicator (2E) received a score of 50%.

Table 4.4. Assessment of environmental control, including one quantitative (2) and one qualitative (2E) benchmark indicators

No.	Short Name	Score	Observations
2	Controlled treatment or disposal (%)	100%	
2E.1	Degree of control over waste reception and general site management	15	Medium/High level of control
2E.2	Degree of control over waste treatment and disposal	10	Medium (Controlled facility)
2E.3	Degree of monitoring and verification of environmental controls	10	Medium compliance
2E.4	Efficiency of energy generation and use (Used for energy recovery facilities only)	NA	
2E.5	Degree of technical competence in the planning, management and operation of treatment and disposal	10	Medium compliance
2E.6	Occupational health and safety	5	Low compliance
2E	Degree of environmental protection in waste treatment and disposal (Total score—normalised)	50%	

4.2.4 Resource Management

In order to give general understanding and visual representation of UB's waste flow, an MFD was calculated and constructed (see Figure 4.3). According to JICA studies (JICA, 2012), recycling activities were identified at three stages, discharge, collection and disposal, and recycling rates were estimated. The provided estimates were applied on the 2015 weighbridge data (Figure 4.1).

Calculation:

- Recycling amount *at discharge* (F5, F6 in Figure 4.3): According to JICA's waste generation study, 9% of generated waste from apartment (26.5 g/person/day out

of 294 g/person/day—extrapolated averages of summer and winter seasons) and 9.3% from *ger* areas (18 g/person/day out of 192 g/person/day, ash excluded) were extracted and sent to the recyclables' market. (The ratio of ash to general waste from *ger* area was 69% to 31%, respectively).

- Recycling amount *at collection* (F12): 1.3% of apartment and commercial waste, and 2% of *ger* area waste (ash excluded) was extracted by waste collection workers and entered the recyclables' stream.
- Recycling amount *at disposal* (F13): 1.15% of incoming waste to the landfill was being extracted by waste pickers and went into the recyclables' market (1.3% in winter and 1% in summer).

Consequently, the waste generation amount and recyclables' stream were calculated based on the above information. The recyclables are processed and recycled domestically (F15) or exported to China (F16). Other waste (F11) includes: industrial waste, hospital waste, secondary raw materials and waste from summer houses.

Based on the constructed MFD, 45,632 tonnes of recyclables, accounting for 5.5% of MSW and commercial waste, are extracted from the waste stream through the informal recycling sector and should be considered as the minimum recycling rate due to using recycling estimates of 2010–2011 (JICA, 2012). According to unofficial sources, the recycling sector, namely the Mongolian National Recycling Association (MNRA), claims that the amount can go up to 30%. However, the data on informal recycling sector are quite rare and unreliable; there is no clear evidence for it. Therefore, more focus should be directed to researching recycling activities.

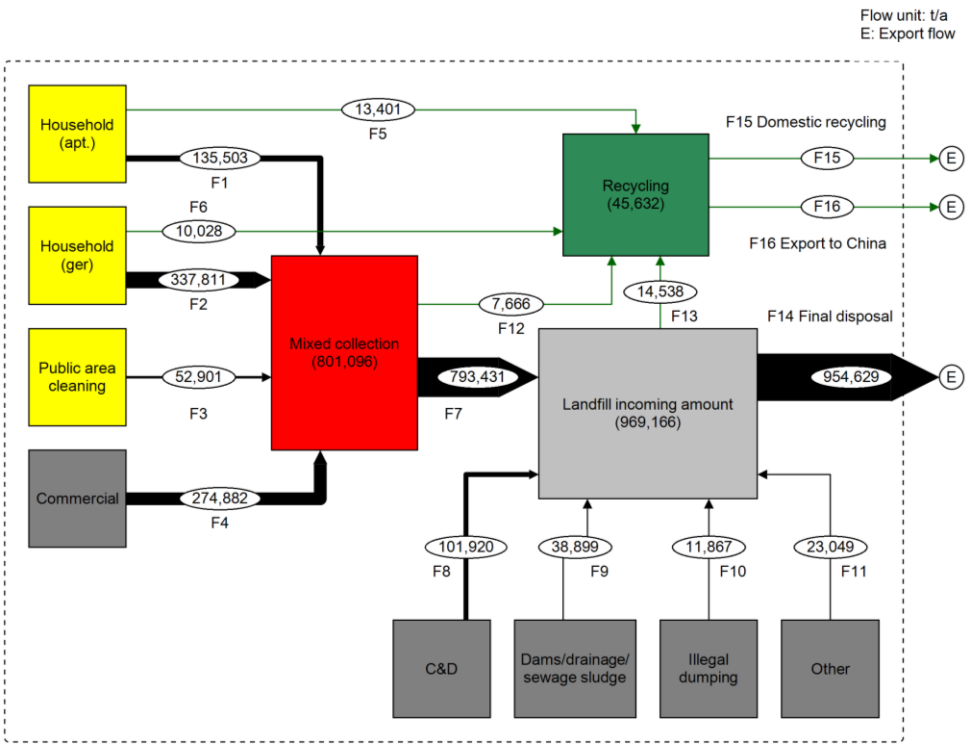

Figure 4.3. Sankey type material flow diagram (MFD) for municipal solid waste (MSW) in Ulaanbaatar, 2015. All flows are estimates in t year^{-1}. The landfill incoming amount data are weighbridge data obtained from three landfill sites. The recycling rates were calculated based on JICA studies (JICA, 2012).

Recyclables are recovered at several points: by watchmen, apartment owners' union workers, waste pickers and residents during discharge; MSW collection workers during the collection process; and by waste pickers during the disposal process and flow into recyclables' market, which is mainly handled by the informal recycling sector.

Between 0 and 1% of recyclables are clean source-separated materials; all recycling is extracted from mixed wastes (see score for 3R.1). Currently, there are no widespread programs for waste separation at source. Citizens feel discouraged to separate waste due to mixed collection and the lack of recycling facilities. There is little or no separation of organic materials, except for the feeding of dogs with leftover food which is quite a common practice (see score for 3R.2). Ash is separated at source in winter in *ger* areas due to its sheer volume compared to summer months, when it is not segregated (Kamata et al., 2010). In winter, it is collected in metal drums or sacks, however, at the collection point, it is mixed with general waste.

Focus on waste reduction, reuse and recycling has been publicly discussed and reflected in the laws and bylaws especially during recent years. However, the implementation of these policies has been insufficient (see score for 3R.3). As pointed out in Section 4.1, waste generation amount per capita per day is over the threshold of 1 kg, which means waste reduction issue must be of equal importance to resource recovery.

The main body that represents the informal recycling sector is the MNRA that protects the rights of its members and acts as a lobbyist for influencing the law enforcement. Among the main members, there are 200 kiosks (itinerant waste buyers (IWB)), and 12 recycling facilities. One of their main activities is focused on organizing the kiosks and regulating the system of separation, collection and transport of recyclables. Through the kiosks that deal with waste pickers, MNRA had plans to obtain relevant information and to reach out to those waste pickers. Currently, in collaboration with PSD, MNRA is working on a project called "Eco Park" at the NEDS and TsDDS, where recycling facilities will be concentrated and where they plan to create job opportunities for waste pickers. The main hurdles are financial resources and access to capital. Integration of the informal sector with the formal SWM system is still very low on the priorities (see score for 3R.4).

There are few recycling facilities in UB. The issue of environmental protection is rarely highlighted or physically monitored other than in paperwork. There is low compliance regarding actual environmental protection in recycling. Only a select number of facilities take extra caution in the occupational health and safety of their workers, such as Altan Orshikhui, a company that recycles used oil to make fuel, and recycles car tires and plastics. However, the rest of the industry, including the IWBs, waste pickers and recycling facilities, has low compliance regarding the occupational health and safety of their workers (see scores for 3R.5 and 3R.6).

The evaluation for the benchmark indicators and their comprising variables for Environmental Control is shown in Table 4.5. The aforementioned circumstances lead us to score the qualitative indicator (3R) at 25%. Data on the informal recycling sector are insufficient. Therefore, more attention should be given to this issue.

Table 4.5. Assessment of resource value, including one quantitative (3) and one qualitative (3R) benchmark indicators

No.	Short Name	Score	Observations
3	Recycling rate (%)	5.5%	
3R.1	Source separation of "dry recyclables"	0	All recycling is extracted from mixed waste
3R.2	Quality of recycled organic materials	0	Little or no separation
3R.3	Focus on the top levels of the waste hierarchy	10	Medium focus
3R.4	Integration of the community and/or informal recycling sector (IRS) with the formal solid waste management system	5	Low focus
3R.5	Environmental protection in recycling	5	Low compliance
3R.6	Occupational health and safety	5	Low compliance
3R	Quality of 3Rs—reduce, reuse, recycle—provision (Total score—normalised)	21%	

4.2.5 Governance

4.2.5.1 User Inclusivity

As described in Section 4.2 for Public Health, the two types of residential areas are quite distinct in terms of receiving waste collection services. Marginal areas, especially in the *ger* areas are facing more challenges due to the difficulty to access these services and the lack of a sufficient monitoring system (see score for 4U.1).

Authorities do have a legal obligation to consult with and involve citizens in decisions that directly affect them, especially in matters concerning landfill siting (see scores for 4U.2 and 4U.3). Feedback mechanism is in place; however, the efficiency should be further investigated through public survey (see score for 4U.4).

At the district level, waste management departments are in charge of educational materials and awareness raising campaigns. TUKs are also in charge of creating awareness raising programs and educating the citizens of their corresponding districts. The municipality is in charge of initiating and monitoring educational programs and awareness raising activities. The interviews conducted with key personnel of the waste sector, including public inspectors and local government workers reveal that citizens' mentality and behaviour are the most difficult challenges. It also indicates that there is no systematic educational and awareness raising programs, which need to be developed based on thorough research (see score for 4U.5).

Developing countries are faced with massive rural to urban migration, in low levels of law enforcement, lack of adequate planning and promoting and measuring behavioural change (Vergara & Tchobanoglous, 2012). As a result, citizens' attitude and behaviour patterns become one of the biggest challenges when dealing with waste management, taking into consideration that citizens are a crucial part of the system itself. This example has been observed in UB, where there have been efforts to raise the consciousness of the community through introducing a new term for recyclables, *dakhivar*, and placing waste bins that segregate recyclables and non. This kind of change could be researched through public questionnaire and improve further behaviour change initiatives (see score for 4U.6). The score for User Inclusivity (4U) is 54% (Table 4.6).

Table 4.6. Qualitative assessment of benchmark indicator (4U) for user inclusivity

No.	Short Name	Score	Observations
4U.1	Equity of service provision	10	Medium compliance
4U.2	The right to be heard	15	Medium/High compliance
4U.3	Level of public involvement	10	Medium compliance
4U.4	Public feedback mechanisms	10	Medium compliance
4U.5	Public education & Awareness	10	Medium compliance
4U.6	Effectiveness in achieving behaviour change	10	Low compliance
4U	User inclusivity (Total score—normalised)	54%	

4.2.5.2 Provider Inclusivity

The current system enables both public and private sectors to deliver stable SWM services. There are currently 10 local government owned enterprises (LGOE) and seven private waste collection companies operating in UB. All companies are treated fairly based on the procurement laws and procedures of the government in order to achieve a high degree of openness, transparency and accountability (see scores for 4P.1, 4P.2, 4P.4 and 4P.5).

MNRA is the main body that represents the informal sector including IWBs, private recycling facilities and waste pickers. However, waste pickers are not yet directly benefitting from their activities, although it is envisioned to allow for the inclusion of waste pickers. Currently, the purpose is solely on strengthening the structure of the association and organizing the kiosks. The informal sector is dominantly in charge of extracting recyclable materials in the waste stream from discharge to the disposal sites. Currently, there are no municipal recycling programs. Therefore, the informal sector should be carefully factored into the equation when creating national and municipal recycling plans (see score for 4P.3). The score for Provider Inclusivity (4P) is 55% (Table 4.7).

Table 4.7. Qualitative assessment of benchmark indicator (4P) for provider inclusivity

No.	Short Name	Score	Observations
4P.1	Legal framework	10	Medium compliance
4P.2	Representation of the private sector	10	Medium compliance
4P.3	Role of the "informal" and community sector	10	Medium compliance
4P.4	The balance of public vs. private sector interests in delivering services	15	Medium/High compliance
4P.5	Bid processes	10	Medium compliance
4P	Provider inclusivity (Total score)	55%	

4.2.5.3 Financial Sustainability

The MSWM service, excluding the maintenance of disposal sites, is covered by the citizens' waste service tax fee and additional government subsidy. Waste collection *TUKs* are in charge of collecting, transporting and disposing waste at disposal sites. They then get paid according to their implementation. The disposal site activities and finances are fully covered by the municipality.

The current budget covers most current operating costs, but insufficient for most of the maintenance costs. As mentioned in Sections 4.2 and 4.3, there are many aspects that need to be improved, from waste collection in the *ger* areas to technical improvement of *TUKs* and disposal sites (see scores for 5F.1, 5F.2 and 5F.5). Moreover, access to capital for investment remains to be one of the biggest challenges for UB's SWM (see score for 5F.6).

Since January 2013, the waste service fee is collected in a form of tax and consolidated at the district taxation office. In 2014, the waste service fee payment rate in the apartment area was 81.2%, and in *ger* area was 57% (see score for 5F.3). The total number of business entities and organizations in operation was 26,598, out of which 17,132 were in contractual agreements with *TUKs* with a service fee payment rate of

90%. Currently, citizens in apartment areas are paying 2000 MNT (US $1.02), and citizens in *ger* areas are paying 2500 MNT (US $1.27), which were set back in 2006 in the ordinance 182 by the municipality and have not changed since (see score for 5F.4). The price is higher in *ger* areas due to collection service requiring more resources in these areas as mentioned in Section 4.2. However, there are more economically vulnerable citizens residing in the marginal areas of *ger* districts, and there is no exemption or subsidy for users who can least afford to pay, which should be subject to consideration. In terms of business entities and organizations, each district has their own set tariffs based on the size and type of businesses and organizations.

The waste service fee collection method differs in both *ger* and apartment areas. In *ger* areas, the waste service fee is paid together with the electricity bill since July 2011 by electric distribution company (formerly done by *TUKs*) and 23% of the fee is taken as a transaction fee. With this new method of charging waste service fee with electricity bill, the waste fee collection rate increased from 28% in July 2011 to 57% in 2014. However, it must be noted that the transaction fee of 23% is deducted from the total amount. In *ger* areas, inside a single *khashaa* (fence), 2–3 households reside, of which only one household pays waste service fee. In such circumstances, waste service fee collectors gather money from these households, and 23% of the service fee is given as a reward. Additionally, the transient population (Kawai & Tasaki, 2016) of the *ger* areas are not considered in calculating the generation of waste, which remains an uncertainty.

In apartment areas, the service fee is paid together with the utility bills and 6% of the fee is taken as a transaction fee by UB Housing Public Services Company. The score for Financial Sustainability (5F) is 46% (Table 4.8).

Table 4.8. Qualitative assessment of benchmark indicator (5F) for financial sustainability

No.	Short Name	Score	Observations
5F.1	Cost accounting	10	Medium compliance
5F.2	Coverage of the available budget	5	Covers most current operating costs
5F.3	Local cost recovery—from households	15	50–74% of the total number of households are using and paying for waste collection services
5F.4	Affordability of user charges	15	Medium/High compliance
5F.5	Coverage of disposal costs	5	Charged rate covers some costs of operation
5F.6	Access to capital for investment	5	Low compliance
5F	Financial sustainability (Total score—normalised)	46%	

4.2.5.4 Sound Institutions, Proactive Policies (National Framework)

The Mongolian Law on Waste Management (2012) addresses solid waste management requirements, based upon which the municipal "Regulation on funding of waste management and transport operations and consolidation of waste management service fee" (2015) was enacted. However, the above law was insufficient to regulate the complex issues arising from various waste related aspects. In the beginning of 2017, the process of enactment of the new law formulation began after being once returned back to the Parliament in 2016 (see score for 6N.1).

There are several national plans and strategies towards green and sustainable development. Concepts of Mongolian Sustainable Development 2030 were approved by provision of State Great Khural on 19 February 2016. Green Development Policy was approved on 13 June 2014, which includes targets of decreasing the amount of waste going to landfill by 40% and increasing recycling rate up to 40% (see score for 6N.2). However, these goals should be realistic and actionable with a clear pathway to achieving them. Mostly, these goals are set based on insufficient research, data and information.

There are guidelines for local authorities implementing the laws and strategies. However, the current approaches to solving MSW related issues are not holistic enough. The baseline study for all the targets are insufficient, and oftentimes do not reflect the real picture, which in turn hinders the achievement of these goals and targets. The Ministry of Environment, Green Development and Tourism is the national institution responsible for making policies. However, they are not responsible for the implementation process and its coordination. The implementation of the regulations is undertaken by the municipal government (see scores for 6N.3, 6N.4 and 6N.5).

No effort has been made in implementing the extended producer responsibility (EPR) or Product Stewardship (PS). This issue has been discussed in some ways by introducing an added import tax on products that cannot be reused. However, this issue is no longer being discussed (see score for 6N.6). On the other hand, the informal sector through their involvement in the “Eco-Park” wants to create job opportunities for waste pickers as a form of corporate social responsibility (CSR). Based on these facts, the score for the qualitative indicator (6N) is 46% (Table 4.9).

Table 4.9. Qualitative assessment of benchmark indicator (6N) for national SWM framework

No.	Short Name	Score	Observations
6N.1	Legislation and regulations	10	Medium compliance
6N.2	Strategy/Policy	10	Medium compliance
6N.3	Guidelines and implementation procedures	10	Medium compliance
6N.4	National institution responsible for implementing solid waste management policy	10	Medium compliance
6N.5	Regulatory control	10	Medium compliance
6N.6	Extended producer responsibility (EPR) or product stewardship (PS)	5	Low compliance
6N	Adequacy of national framework for solid waste management (Total score—normalised)	46%	

4.2.5.5 Sound Institutions, Proactive Policies (Local Institutional Policies)

Within the municipality, the Public Service Department (PSD) at the Mayor's Office is responsible for ensuring that SWM services are planned, delivered and funded. The municipality funds the SWM's collection and transport services through subsidies, and fully funds the disposal and disposal site's maintenance.

In terms of institutional capacity, JICA's project on "Strengthening the capacity for SWM" (JICA, 2012) was one of the most significant contributions towards effective training, in both the classroom and the field. The PSD consists of the following members: head of the department; and officers responsible for landscaping, assets and signs in public areas, greenery, architectural and landscape drawings, advertisement and information facilities, waste, construction and industrial waste, waste recycling plants and waste collections points, and medical and hazardous waste, with four out of nine officers being directly in charge of waste related matters (see scores for 6L.1 and 6L.2).

The citywide SWM strategy and plans are improving but are not adequate enough. The national strategy is not clearly translated to regional (city, district, community) levels. In the six central districts of the municipality, both public and private sectors are present. The collection companies hold contractual agreements with the district governors. All the waste collection companies work closely with the PSD and attend meetings and seminars regarding waste service requirements. Since 2015, the auditor NGOs started monitoring the work implementation of waste collection companies in collaboration with citizen's groups. There were three auditor NGOs for the six central districts. Each NGO consists of 2-3 staff members that conduct daily inspections. In terms of efficiency, 2–3 staffs cannot check all the areas. There could be more effective ways of monitoring, for instance leveraging the power of the public (see scores for 6L.3 and 6L.5).

In terms of availability and quality of data, there has been improvement especially since installing the weighbridges. However, there is an urgent need for more quality data and improving data collection and reporting methods (see score for 6L.4).

The municipal government works very closely with the districts and the districts are also well-connected. UB is a unique city within Mongolia, as it is the capital city that is home to more than one third of the country's population. However, in recent years, the situation of SWM is becoming an increasing issue in other cities as well as in the rural areas. As a result, inter-regional and inter-municipal cooperation needs to be strengthened to enable capacity building and knowledge sharing. Currently, the flow of recyclables from rural areas also should be studied closely (see score for 6L.6). For the above reasons, the score for the qualitative indicator (6L) is 58% (Table 4.10).

Table 4.10. Qualitative assessment of benchmark indicator (6L) for local institutional coherence

No.	Short Name	Score	Observations
6L.1	Organizational structure/coherence	15	Medium/High compliance
6L.2	Institutional capacity	15	Medium/High compliance
6L.3	City-wide SWM strategy and plan	10	Medium compliance
6L.4	Availability and quality of SWM data	10	Medium compliance
6L.5	Management, control and supervision of service delivery	10	Medium compliance
6L.6	Inter-municipal (or regional) cooperation	10	Medium compliance
6L	Local institutional policies (Total score—normalised)	58%	

4.3 Comparative Analysis

The MSWM of UB was assessed using the "Wasteaware" benchmark indicators and the results were compared to four cities of various income levels (Wilson et al., 2015). Data for SWM is very rare and oftentimes unreliable; this holds especially true for developing countries. However, in this assessment, the best possible data with reliable sources were used to mark the current baseline. This in turn works as a solid foundation for further quality research studies to be conducted.

In Table 4.11 and Figure 4.4, a summary of the benchmark indicators' results are shown and compared with four reference cities of each income level according to the World Bank's country classification based on GNI per capita (World Bank, 2016).

Table 4.11. Summary results for the "Wasteaware" benchmark indicators for Ulaanbaatar and comparison to other cities

No.	Category	Indicator	Results				
City			Monrovia [1]	Lahore [1]	Ulaanbaatar	Guadalajara [1]	Belfast [1]
Country			Liberia	Pakistan	Mongolia	Mexico	UK, Northern Ireland
Background information on the city							
B1	Country income level	World Bank income category	Low	Lower-middle	Lower-middle	Upper-middle	High
		GNI per capita	$370	$1140	$3830	$9640	$38,250
B2	Population	Total population of the city	1,021,768	8,160,000	1,277,137	4,664,924	218,000 city only
B3	Waste generation	MSW generation (tonnes per year)	287,000	1,916,000	522,000	2,000,000	149,000
Key waste-related data							
W1	Waste per capita	MSW per capita (kg per year)	230	219	408	440	683
W2	Waste composition		4 key fractions—as of % of total waste generated				
W2.1	Organic	Organics (food and green wastes)	50%	65%	33.7%	53%	35.1%
W2.2	Paper	Paper and card	5%	2%	7.7%	9%	21%
W2.3	Plastics	Plastics	13%	12%	14%	10%	6%
W2.4	Metals	Metals	2%	0.1%	2.1%	1.4%	3.3%
Physical components							
1.1	Public health—waste collection	Waste collection coverage	33% (M)	77% (M)	92.5% (M/H)	95% (M/H)	100% (H)
1.2		Waste captured by the system	30% (L)	80% (M)	85% (M)	95% (M/H)	98% (M/H)
1C		Quality of waste collection service	M (58%)	M (58%)	M (50%)	M (50%)	H (100%)

No.	Category	Indicator	Results				
City			Monrovia [1]	Lahore [1]	Ulaanbaatar	Guadalajara [1]	Belfast [1]
Country			Liberia	Pakistan	Mongolia	Mexico	UK, Northern Ireland
2	Environmental control—waste treatment and disposal	Controlled treatment and disposal	70% (L/M)	8% (L)	100% (H)	95% (H)	98% (H)
2E		Degree of environmental protection in waste treatment and disposal	M (45%)	L/M (37%)	M (50%)	M (60%)	H (100%)
3	Resource management—reduce, reuse and recycle	Recycling rate	8% (L)	35% (M)	>5.5% (L)	12% (L/M)	35% (M)
3R		Quality of 3Rs—Reduce, reuse, recycle—provision	L/M (33%)	L (17%)	L/M (21%)	L (13%)	H (83%)
Governance factors							
4U	Inclusivity	User inclusivity	M/H (67%)	L/M (37%)	M (54%)	M (46%)	M/H (79%)
4P		Provider inclusivity	M (60%)	M (50%)	M (55%)	L/M (40%)	M/H (80%)
5F	Financial sustainability	Financial sustainability	M (46%)	M (54%)	M (46%)	L/M (40%)	H (100%)
6N	Sound institutions, proactive policies	Adequacy of national SWM framework	L (17%)	L/M (29%)	M (46%)	M/H (67%)	M/H (66%)
6L		Local institutional policies	M (46%)	M/H (62%)	M (58%)	M (46%)	H (100%)

GNI, Gross National Income; MSW, Municipal solid waste; B, Background info; W, Waste information; 1 1C, Public health; 2, 2E, Environmental control; 3, 3R, Resource value; 4U, User inclusivity; 4P, Provider inclusivity; 5F, Financial sustainability; 6N, National framework; and 6L, Local institutions. Indicators were assessed into five categories and colour coded: low performance (L), red; low/medium (L/M), red-amber; medium (M), amber; medium-high (M/H), amber-green; and high (H), green. [1] Wilson et al. (2015).

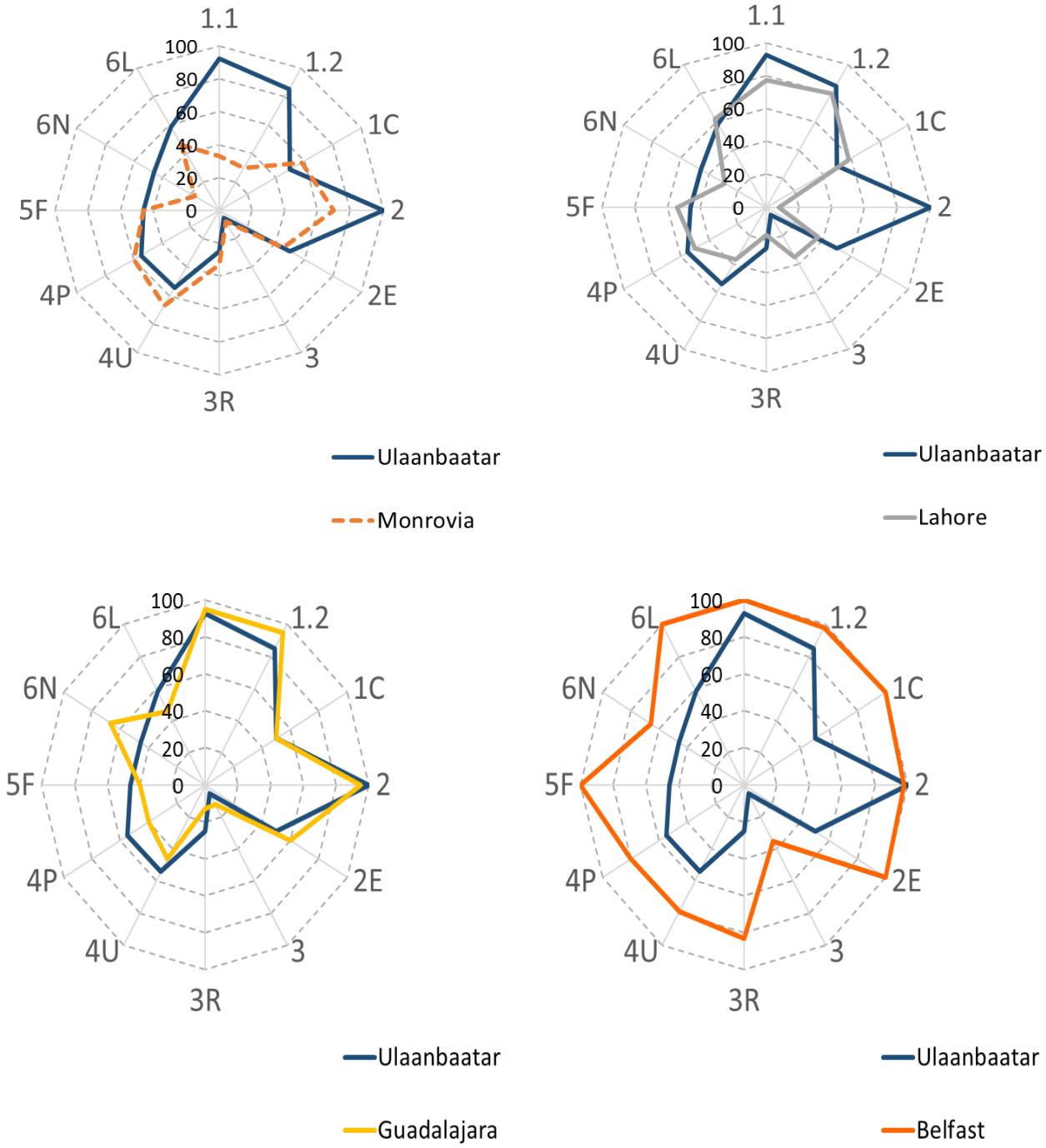

Figure 4.4. Summary of results for benchmark indicators of Ulaanbaatar compared low and lower-middle-income (upper); and upper-middle- and high-income countries (Wilson et al., 2015) (lower).

Waste collection coverage of UB is comparable to the upper range of middle-income countries (Table 4.12) (Scheinberg et al., 2010; Wilson et al., 2012). For controlled disposal, UB's score is similar to the higher income countries. However, UB's recycling rate is comparable the lower range of lower income countries. It can be seen that the higher range of recycling rate in lower-income countries is quite higher than upper-middle income countries.

Table 4.12. Comparison of the three quantitative indicators to the ranges of other income categories (Scheinberg et al., 2010; Wilson et al., 2012)

	(1.1) Waste collection coverage	**(2) Controlled disposal**	**(3) Recycling rate**
Higher income	100%	100%	10-70%
Upper-middle	70-100%	80-100%	1-30%
Lower-middle	60-100%	0-100%	5-50%
Low	35-85%	0-85%	5-30%
UB	>90%	85%	>5.5%

UB's case was compared to four reference cities of all income levels; however, each city shared unique similarities to UB. Monrovia and UB have a similar population size, which can give perspective on various characteristics. UB scored higher in terms of the quantitative values of public health and environmental control, and in terms of national framework. However, for inclusivity UB scored lower.

Lahore is from the same income category as UB. UB score higher for waste collection coverage, controlled disposal, user inclusivity and national frameworks. Lahore's recycling rate was significantly higher than UB's.

From the above comparisons (3 qualitative indicators to the ranges of all income levels, and complete comparison of all the benchmark indicators to reference cities from low- and lower-middle-income countries) indicate that UB's performance has surpassed

the levels of low- and lower-middle-income countries in most aspects (including Public Health, Environmental Control and Governance Aspects).

Guadalajara and UB share similar waste generation rates per capita, where similar policy approaches can be applied in terms of waste minimization. UB scored very close to most of the aspects. However, main differences were in inclusivity and local institutional coherence (higher scores for UB), and waste captured by the system, controlled disposal and national framework (Guadalajara scoring higher).

Belfast and UB's fraction of organic waste was similar, as UB's content of organic waste was similar to higher income countries. Belfast's scores for qualitative indicators for Public Health, Environmental Control, Resource Management were significantly higher, as well as the indicators for Financial Sustainability and Local Institutional coherence.

Waste generation was 408.8 kg per capita per year equivalent to 1.12 kg per capita per day (which is the minimum amount), meaning the amount of waste generated falls above the threshold of 1 kg per person per day and into the category of a "higher waste generating" city (Wilson et al., 2015). This means that the issue of waste minimization should also be taken critically as well as waste recycling. For waste composition, the content of organic waste was the lowest among the other four cities as well as the comparison results to the averages of countries from all income levels (see Section 4.1) and can be attributed to the levels of high-income countries. The content of paper and metals were in the normal lower range, the content of plastics in the normal higher range. However, the amount of bottles and glass was significantly higher than the averages of other cities. The amount of recyclables including paper, plastic, metal, bottles and glass accounted for roughly half of the total waste amount. This can be explained by the fact that due to UB's climate there are less seasonal fresh fruits and vegetables resulting in a large amount of imported consumer goods and products and their packaging. There needs to be more effort in conducting a detailed and up-to date waste composition study as well as research on waste flow. The basic data on waste generation and waste composition are the most important components for MSWM planning and plays special role in educating the stakeholders. Therefore, such type of research should be a priority.

UB's results for benchmark indicators show that in terms of Public Health, Environmental Control and Institutional Aspects, UB has surpassed the levels of low- and lower-income countries and satisfied the prerequisites for modernizing its waste management system. However, there are still some major steps ahead in order to fully transition. The highest performing indicators, (1.1) Waste collection coverage and (2) Controlled treatment and disposal, and are consistent with the projects of JICA and Asia Foundation that have been directed to improving SWM. However, the "quality" indicators for Public health (1C) and Environmental control (2E) reveal that there is room for improvement. Quality service provision should be extended to the marginal areas by setting a collection frequency of at least twice a month in *ger* areas. In terms of Inclusivity, certain progress has been made for Provider Inclusivity (4P) in the formal SWM sector; however, there is still more needs to be done for the informal sector inclusivity. Additionally, users (4U) are an integral part of the system and programs related to behaviour change and awareness raising should be conducted in a systematic manner.

The lowest scoring indicators are (3) Recycling rate and (3R) Quality of 3Rs provision, which implies the urgent need for quality data on recycling activities and research; as the country declared its plans and strategies towards green and sustainable development. The informal sector should be considered carefully when introducing recycling programs. Moreover, they have the expertise and knowledge on the waste composition and materials that are recyclables. Therefore, the existing informal sector recycling should be utilized and integrated into the formal waste management system. Thus, it requires extensive research on this point.

Financial Sustainability (5F) scored average within the same range as other developing countries, since the lack of financial instruments is one of the biggest bottlenecks in these countries. Therefore, international influence and involvement account for the greater portion of the investment in SWM. However, to have successful projects and collaborations, first and foremost specific needs of local communities should be met and prioritized in accordance with the local features. The example of KOICA's RDF facility is an example of not complying with the local needs and not considering the impact of the facility on the system as a whole, although the site is now used as a material sorting facility. This in turn implies that local municipalities and government (6N, 6L) officials need to be knowledgeable about the problems at hand and recognize the areas

with the most favourable outcomes and significant impacts on the system. Policies and strategies need to be realistic based on sufficient research and data; moreover, prioritizing smaller goals on a consistent basis is far more effective. Clear roles and responsibilities of stakeholders should be further elucidated, as well as engaging all stakeholders in the decision-making process.

4.4 Chapter summaries

The current state of SWM varies greatly in developed and developing countries. There are several factors for such discrepancies. The problem of waste is more complex in developing countries, due to their current socio-economic and cultural distinctions, lack of financial resources, capacity of municipal and local governments and the public's attitude. Systems perspective can help construct the situation in developing countries by taking into account all present complexities.

Among the complexities that are faced by UB, as well as other developing countries, lack of data and lack of appropriate data collection is the foremost critical issue that needs to be tackled. Reliable and up-to-date data are the cornerstone for further progress, which in turn demands improved data collection and reporting. These include 1) waste generation; 2) waste composition (by households and other sources coming to landfill sites); 3) other properties (such as waste moisture, density and calorific value); and 4) waste flow taking into account recycling at various stages including the informal recycling sector. The results reveal that the percentage of recyclables is high (mostly extracted by informal sector as waste pickers, whose roles and contributions are rarely noted). By utilizing all the recyclables and building on the existing informal sector recycling activities, UB has a great potential of becoming resource efficient while eliminating the negative impact of waste on human health and the environment.

Behavioural change and raising awareness must go hand in hand with the targets set for sustainable and green development goals by guiding the public with clear and actionable steps. Without knowing the impact of their actions, the public is less motivated and less likely to respond to any new policies and programs. Therefore, presenting the public with educational programs that reflect the current situation of waste in a holistic way (i.e., the actual waste composition of a household and its impacts) can help to create a shift towards achieving behavioural change. Nonetheless, engagement of all

stakeholders is required in order to make further progress in the modernization of waste management.

The study brought significant contributions by filling the existing literature gaps for UB and identified its key strengths and areas for improvement. “Wasteaware” benchmark indicators are accompanied by a material flow diagram (MFD). However, due to uncertainties in waste flow and insufficient data on recycling aspects, the MFD was constructed based on the available data. It is recommended to address these limitations in future research.

5 BEHAVIOURAL AND ATTITUDINAL DIFFERENCES OF TWO TYPES OF RESIDENCIES (APARTMENT AND *GER* AREAS) AND THEIR IMPLICATIONS ON THE WASTE MANAGEMENT SERVICE

5.1 Introduction

UB's *ger* areas are unique to UB's urbanization linked to the culture of Mongolian nomadic people. Since the 1960s-1980s, throughout the first wave of urban transformation, residential apartments started replacing many of the *ger* districts in the central area (Byambadorj et al., 2011; Chinbat et al., 2006). However, up to this day the number of *ger* residents outweigh the number of apartment areas', especially the fringe areas home to the majority of poor households having migrated from nomadic communities (Uddin et al., 2016).

There are differences among the apartment and *ger* areas in terms of spatial and physical aspects. The objective of this study was to examine whether there are differences in terms of behaviors and attitudes held by the two types of residencies regarding waste management issues. Results of public questionnaire can be a basis for informed decision making and for choosing the most effective policies.

5.2 Results and Discussion

Results and discussion are divided into two parts and are presented in the following order shown in Figure 5.1.

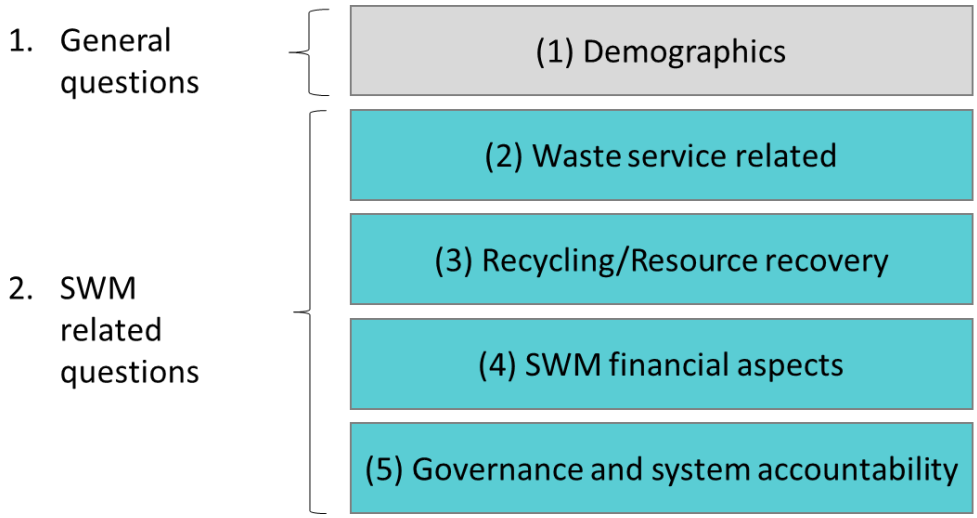

Figure 5.1. Results of questionnaire analysis divided into 2 general categories.

(1) Demographics

In total, 520 questionnaire responses were collected, which corresponded to a response rate of 94% because questionnaires were distributed, filled in my presence and returned. Majority (67.9%, N=351) of the respondents were female while 32.1% (N=166) were male. Out of all respondents, 58.2% (N=294) were from apartment and 41.8% (N=211) were from *ger* areas; with 15.2% representing BGD, 17% from BZD, 23% from SBD, 11% from SKhD, 10% from ChD and 23% from KhUD.

The results of a χ-square test of independence suggested a significant association between the type of residence and whether the respondents were originally from UB (χ^2 (1, n=517) =4.896, p=0.027). Respondents residing in *ger* areas who are not originally from UB accounted for 44%, whereas 34.4% of apartment area residents reported not being originally from UB (Figure 5.2).

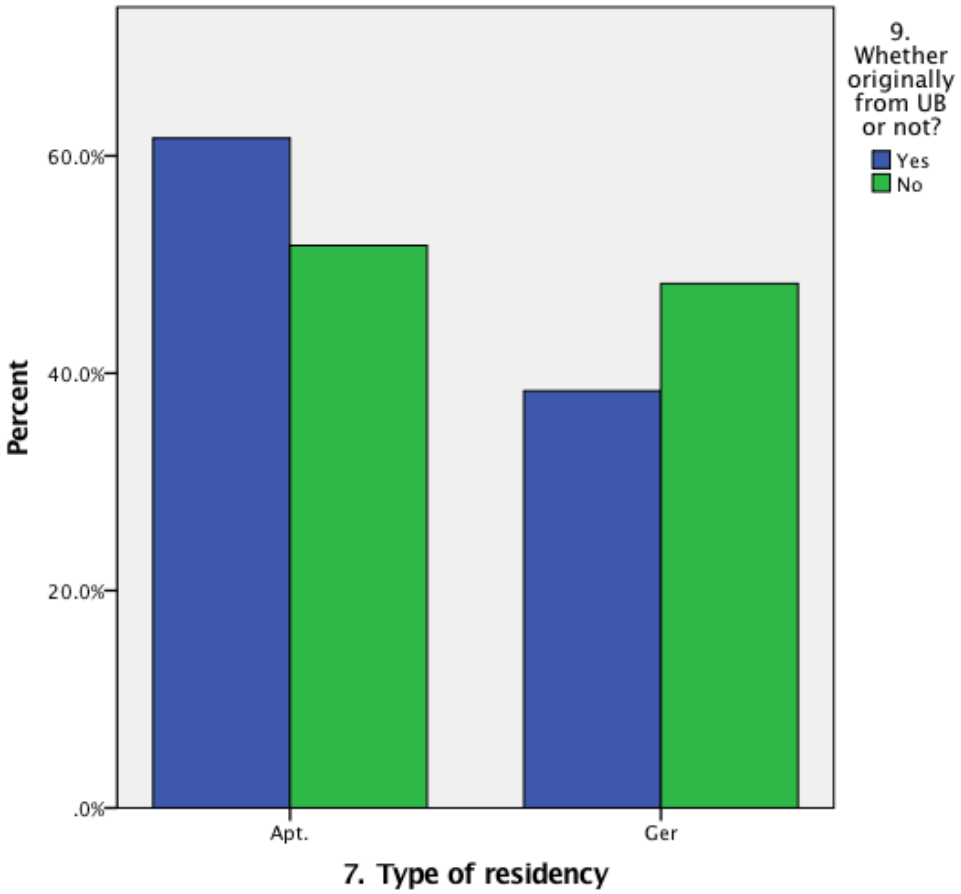

Figure 5.2. Percentage of responses in apartment and *ger* areas and whether originally from UB.

The results of a χ-square test of independence suggested a significant association between the type of residence (apartment & *ger*) and education level (χ^2 (4, N=515) =75.021, p<0.001). Respondents with higher education were more in apartment areas 74.9%, whereas the number was 38.4% in *ger* areas. While the number of respondents with vocational education and lower accounted 61.6% in *ger* areas, the number in apartment areas was 25.1% (Figure 5.3). It can be clearly seen that the two areas of residencies differ socio-economically: *ger* areas with more socio-economically lower population than the apartment's.

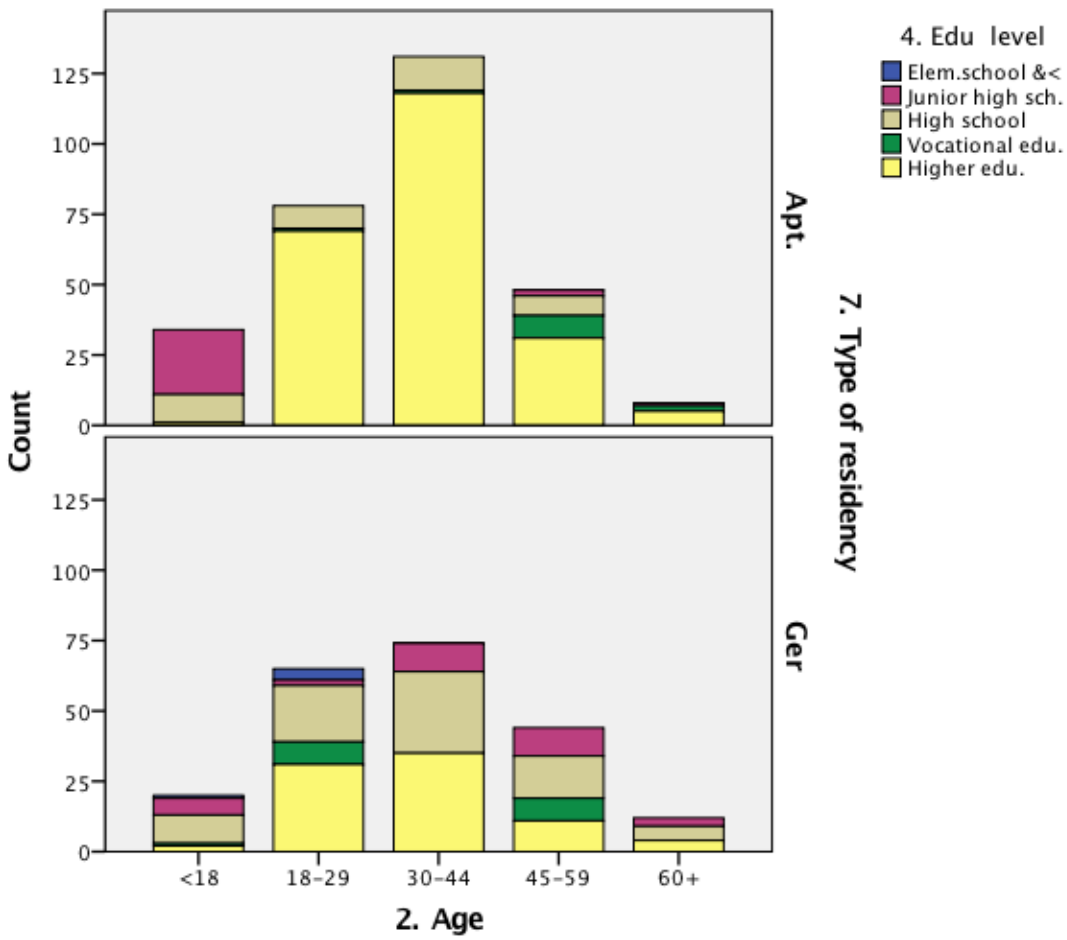

Figure 5.3. Number of response counts in apartment and *ger* areas and educational level of each age group.

(2) Waste service related

The results of a χ-square test of independence suggested a significant association between the type of residence and waste disposal method (χ^2 (4, n=503) =223.791, p<.001). Around 88.5% of respondents residing in apartment areas dispose their waste at waste collection containers/points, while 61.1% of respondents in *ger* areas give their waste directly to waste collection trucks, on a door-to-door basis. Approximately 7.2% of respondents in *ger* areas admitted to openly dumping waste due to absence of waste collection points/containers. Due to differences in geo-spatial and physical aspects, the waste collection method differs.

A significant association was also found between type of residence and how well do waste collection trucks follow their schedule (χ^2(4, n=509) =21.431, p<.001). In apartment areas 42.2% of the respondents reported not knowing the schedule of waste collection trucks, which was 22.9% in *ger* areas. This is due to the different ways of waste collection methods in both areas; *ger* areas are dominated with door-to-door collection, whereas apartment area residents have waste collection points/containers. This also implies that there is more interaction and engagement between the residents of the *ger* area and the formal waste management providers.

The results of a χ-square test of independence suggested a significant association between type of residence and the frequency of waste collection service (χ^2 (7, n=495) =211.864, p<.001). In apartment areas waste collection service comes once to twice a week for 61% of the respondents, while for 74.2% of the residents in *ger* area waste collection service comes once to twice a month.

The results of a χ-square test of independence suggested a significant association between type of residence and presence of accumulated waste around collection points (χ^2(4, n=504) =11.067, p=.026). Respondents residing in *ger* areas chose from 'high incidence' to 'very high incidence' of accumulated waste around collection points more (52.6%), than apartment area respondents (38.7%).

Due to low frequency of waste collection service in *ger* areas, there is more incidence of accumulated waste in *ger* areas compared to the apartment areas.

(3) Recycling/Resource recovery

The results of a χ-square test of independence suggested a significant association between the type of residence and whether the respondents separated waste into recyclables and non-recyclables (χ^2 (2, n=507) =6.645, p=0.036) and whether the respondents reused or recycled/sold recyclable waste (χ^2 (3, n=518) =17.662, p=.001). Since there's no waste separation programs, majority of the respondents chose that they do not separate or recycle waste. However, among those who did separate and reuse or recycle, 25.8% of *ger* residents responded they do separate garbage, while 17.3% of apartment residents did; reuse and recycling/selling of recyclable materials was also reported more in *ger* areas than apartment, 18.3% and 10% respectively.

The results of a χ-square test of independence suggested a significant association between the age of respondents and whether they reused or recycled/sold recyclable waste (χ^2(12, n=519) =21.314, p=.046). The higher the age goes, the more the recycling activity tended to be, which implies that the younger generation performed very poorly compared to the older age groups. This implies that the role of educational institutions is very critical.

Respondents were asked whether they would support if waste separation was initiated. Majority (85%) answered that they would support (see Figure 5.4). However, it was found that the support for new initiatives was also dependent on other factors, such as increased transparency, improvement in the service provision and increased engagement with the public etc.

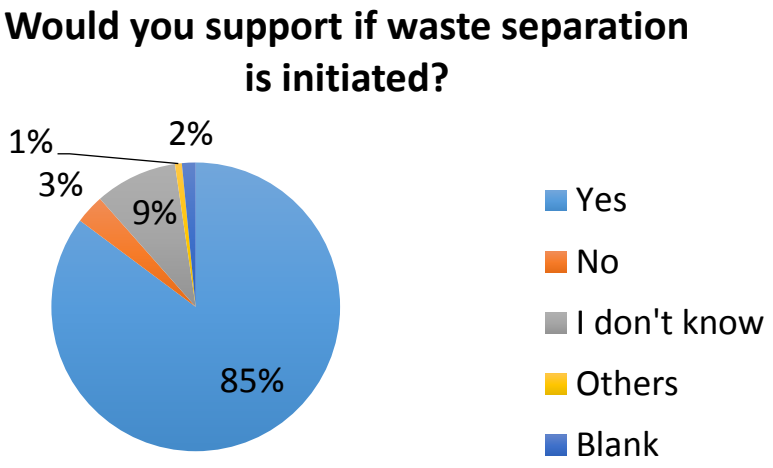

Figure 5.4. Percentage of responses and whether the respondents would support if waste separation was initiated.

The results of a χ-square test of independence suggested a significant association between district of residence and satisfaction level with the waste collection service ($\chi^2(20, n=492) = 47.159, p<0.001$). Districts with highest level of satisfaction were from Khan-Uul district (43.7% - 'satisfied' to 'very satisfied'), and Sukhbaatar district (with 41.6% - 'satisfied' to 'very satisfied'). Districts with the lowest level of satisfaction were from Bayangol district (32.6% - 'Not satisfied at all' to 'Not satisfied'), and Songinokhairkhan district (with 34% - 'Not satisfied at all' to 'Not satisfied'). The other two districts Bayanzurkh and Chingeltei, averaged to approximately 25-26% - 'Not satisfied at all' to 'Not satisfied'.

The results of a χ-square test of independence suggested a significant association between district of residence and whether the respondents would support if waste separation were initiated ($\chi^2(10, n=494) = 19.454, p=0.035$). Respondents of Khan-Uul district had highest respondents to support waste separation (93%), the lowest was Songinokhairkhan district with 78%.

According to the aforementioned results on satisfaction level and support for waste separation initiatives, it can be said that the current level of satisfaction with the service can affect future waste management related initiatives. Therefore, improving the current level of service is a precondition to introducing more complex initiatives.

(4) SWM Financial Aspects

The respondents were asked whether they were willing to pay more money for service improvement. The results revealed that majority (36%) were not willing; and 31% were willing to pay more money (Figure 5.5). However, there is still a substantial percentage of respondents (30%) that were not sure if they would be paying more money. This implies that willingness to pay more money might be dependent on various factors and changes, such as service improvement, increased involvement stakeholders and interaction with the public, which should be accounted as an opportunity.

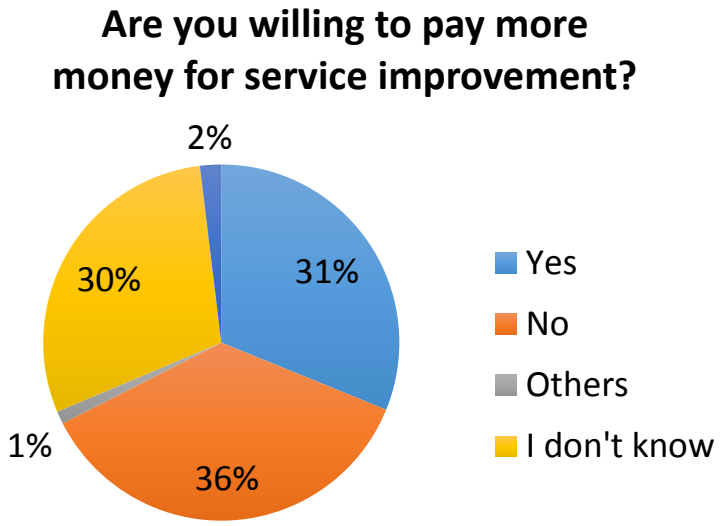

Figure 5.5. Percentage of responses and whether the respondents are willing to pay more money for service improvement.

The results of a χ-square test of independence suggested a significant association between type of residence and the respondents' opinion on waste collection fee ($\chi^2(6, n=518) = 16.402$, $p=0.012$), and respondents' willingness to pay more money for improved waste management/collection service ($\chi^2(2, n=502) = 10.330$, $p=0.006$). Approximately 20% of respondents residing in *ger* areas chose that waste collection fee was 'very expensive' to 'expensive', while this number was around 9.6% in apartment areas (Figure 5.6). Around 10% of respondents residing in apartment areas chose the waste collection fee was 'cheap' to 'very cheap', while this number was around 5.1%.

Majority of respondents (37.3%) of apartment area residents were willing to pay more money for service improvement, while majority of respondents (44.3%) of *ger* area residents were not willing to pay more money for service improvement (Figure 5.7).

A significant association was also found between age and willingness to pay more money for improved waste management/collection service ($\chi^2(8, n=503) = 19.095$, $p=.014$). The higher the age of respondents, the less willing they became to pay more money for service improvement.

Financial aspects do depend on the type of residency and the age of respondents. In *ger* areas there are more residents who are more socio-economically vulnerable than the apartment areas.

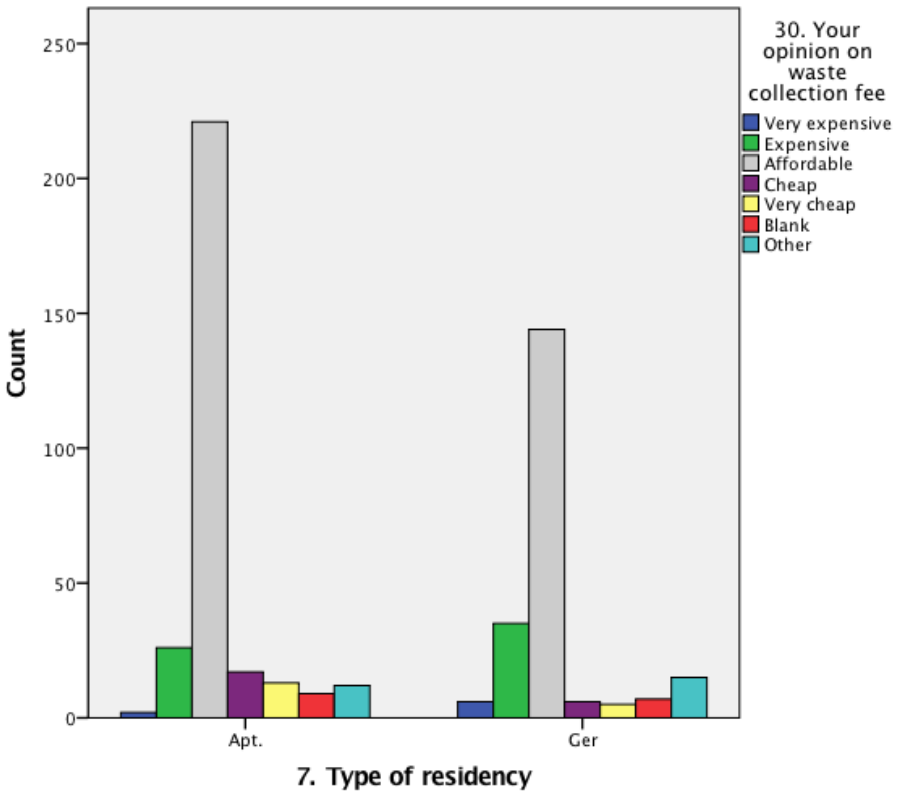

Figure 5.6. Number of response counts in apartment and *ger* areas and opinion on waste collection fee.

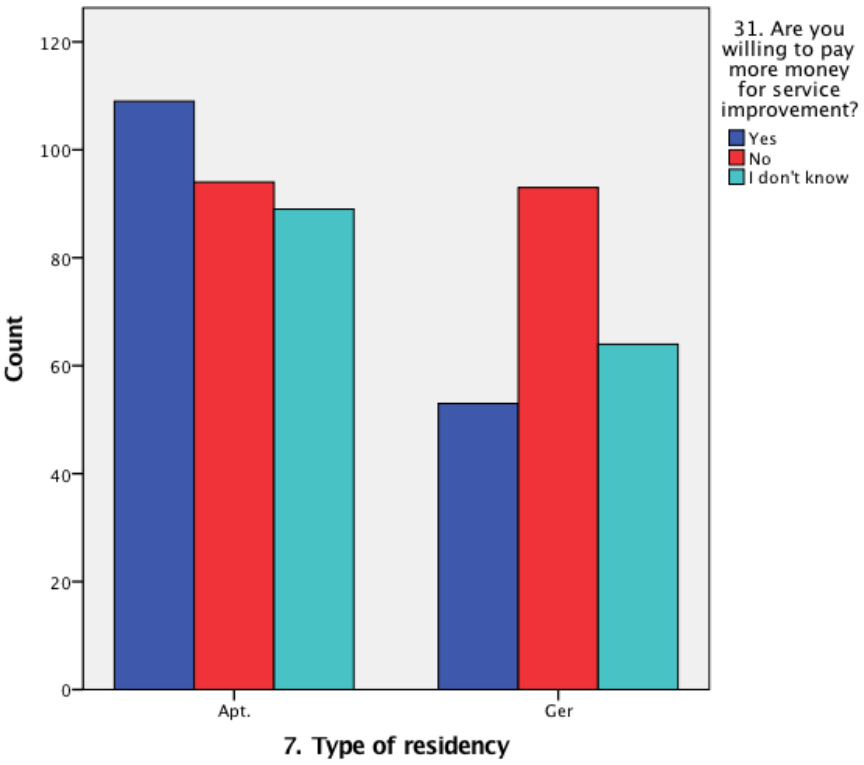

Figure 5.7. Number of response counts in apartment and *ger* areas and willingness to pay more money for service improvement.

(5) Governance and System Accountability

Respondents were surveyed about their usage of feedback mechanisms. Majority of the respondents (64%) have never used the feedback mechanism (Figure 5.8) while 18% of the respondents answered they did not know how to. Although there are feedback mechanisms in place, they are not being properly advertised and promoted among the users.

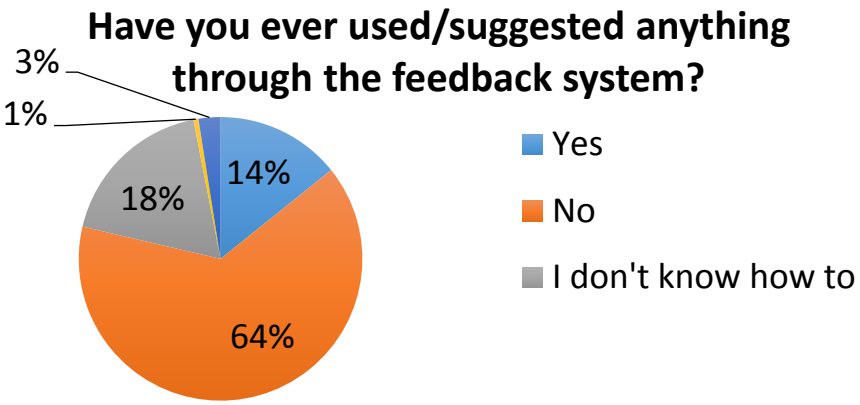

Figure 5.8. Percentage of responses and whether the respondents had ever used or suggested anything through the feedback mechanism.

The results of a χ-square test of independence suggested a significant association between the type of residence and whether the respondents ever used/suggested anything through the feedback mechanism ($\chi^2(2, n=502) = 6.057$, $p=.048$). Respondents residing in *ger* area reported to had used/suggested anything through the feedback mechanism more (19%), than those residing in apartment area (11.7%).

The results of a χ-square test of independence suggested a significant association between education level and respondents' perception whether the public voice is being heard in decision-making process ($\chi^2(8, n=505) = 18.110$, $p=.020$). About one third of all the resondents reported to not knowing whether the public voice was being heard in decision making process. The higher the education level, the less the respondents thought the public voice was being heard in SWM decision making, planning and implementation process. It indicates the current level of trust of the citizens to the government. The situation should be approached more cautiosly as the association of educational level and the perception whether the public voice is being heard in decision making can act as both hindrance or as an advantage.

Respondents in the questionnaire were asked to identify reasons behind littering and the most responsible stakeholder (from a prescribed list). The most number of

respondents regarded ‘people’s mindset’ to be the biggest reason behind littering, and ‘citizens’ to be the most responsible stakeholder (Figure 5.9, 5.10).

The result of a χ-square test of independence suggested a significant association between a respondent’s type of residence and whether they believed people’s mindset to be the reason for littering ($\chi^2(1, n=507) = 6.336$, $p=0.012$). Approximately 63% of all respondents said they believed that people’s mindset is the reason for littering; however, this response is approximately 68% for those in apartments areas, while 57% for those in *ger* areas.

The result of a χ-square test of independence suggested a significant association between a respondent’s type of residence and whether they believed citizens to be an important stakeholder ($\chi^2(1, n=502)=17.102$), $p<0.001$), TUK to be an important stakeholder ($\chi^2(1, n=502)=4.353$, $p<0.001$), and Khoroo to be an important stakeholder ($\chi^2(1, n=502)=11.472$), $p<0.001$). Approximately 57% of all respondents reported that citizens are an important stakeholder; closer to 46% in *ger* areas, and approximately 65% in apartment areas. Approximately 40% of respondents believed TUK is an important stakeholder; however this response was around 44% in apartment areas and 35% in *ger* areas. In terms of important stakeholders, around 60% of *ger* areas residents believed khoroo is an important stakeholder, while this response was about 45% in apartment areas.

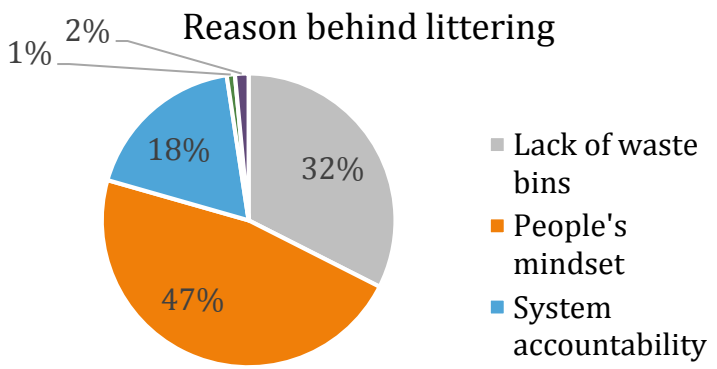

Figure 5.9. Percentage of respondents and the reason behind littering.

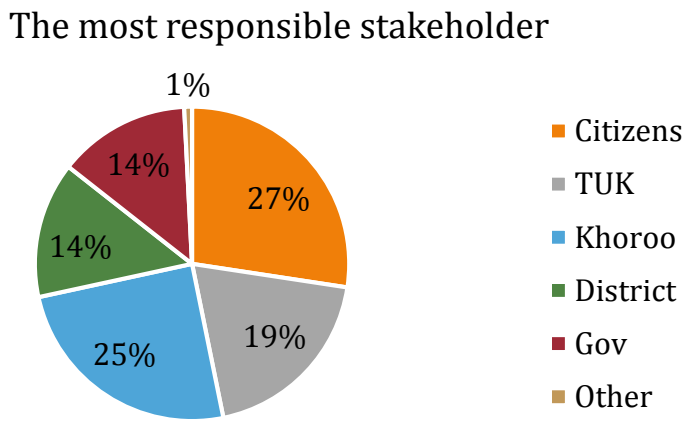

Figure 5.10. Percentage of respondents and the most responsible stakeholder.

Analyses of responses about important stakeholder for waste management issues were also conducted on educational level. The results of a χ-square test of independence suggested a significant association between respondents‘ education level and whether they believed citizents to be an important stakeholder ($\chi^2(4, n=500)=27.680$), $p<0.001$). Education level was also significantly associated with respondent's belief that TUK is an important stakeholder ($\chi^2(4, n=500)=11.164$), $p=0.025$). A significant association was also found between education level and whether they believed government is an important stakeholder (χ^2 (4, n=500)=10.088), $p=0.039$). Approximately 65% of respondents with higher education believed citizens are an important stakeholder. This number dropped to 45% for those with lower education level. Approximately 44% of respondents holding higher education degree chose that TUK is an important stakeholder. This response dropped to 34% for those with lower degrees.

Views about the reason behind littering and the most important stakeholders varied by type of residency and by educational level. It can be explained due to the differences of circumstances in both types of residencies. Therefore, the approach to solving waste related issues should take into cosideration these differences more.

5.3 Chapter summaries

The results of the public questionnaire indicated that there are differences in behaviors and attitudes not only according to the types of residencies but as well as age, educational level and district of residency.

In terms of socio-economic differences, the education level is higher in apartment areas compared to the *ger*. The number of respondents who migrated to UB was more in the *ger* areas.

Due to the lower frequency of waste collection in *ger* areas (1-2 per month, as opposed to 1-2 per week in apartment areas), there is more incidence of accumulated waste compared to the apartments'. This implies that the protection of public health is lower in these areas. Even some respondents admitted to open dumping waste in the surroundings due to waste collection not coming.

Due to the settings and circumstances of *ger* areas, there is more interactions of *ger* area residents with the formal waste service providers and the local government, as the collection of waste is door-to-door. However, door-to-door collection is more labor and time intensive, which can end up being costlier. Therefore, the frequency of waste collection is also low. Respondents of *ger* areas admitted to having used the feedback mechanism more than the apartment areas residents, which also implies that there is more interaction.

According to the results, the recycling activity is higher in the *ger* areas which can be explained by the physical characteristics of *ger* areas and the socio-economic backgrounds of the residents. Young people tended to recycle less, which implies that there is need for comprehensive programs by educational institutions.

The current satisfaction level with the service tended to influence future waste separation initiative. It should be noted that in order to introduce more complex initiatives, improving the current level of service is a precondition.

Majority of the respondents perceived the current waste service fee to be affordable. However, residents in *ger* areas were less willing to pay more money for service improvement as currently the amount of fee is slightly higher than that of apartments. It was also observed that willingness to pay more money might be potentially dependent on various factors such as service improvement, increased involvement stakeholders and interaction with the public.

A majority of the respondents answered that citizen's mentality is the reason behind littering and that citizens are the most responsible stakeholder. It implies that there is urgent need of awareness raising programs and behavior change initiatives. It should also be noted that the views about the reason behind littering and the most important

stakeholders varied according to the type of residency and educational level as well. The waste management policies would be more effective if the abovementioned differences are considered and incorporated.

The research generated essential baseline information on the differences of behaviors and attitudes held by residents in apartment and *ger* areas towards waste management issues. Not only differences in residential areas, but also differences based on education level, age, district of residency were found. These differences should be taken into consideration when formulating city-wide MSW policies and strategies. Especially building upon the existing strengths should be prioritized. In *ger* areas, residents are closer to the formal waste providers and the local government which should be leveraged for behavior change initiatives.

6 GENERAL DISCUSSION

Public Health

In terms of Public Health, the quantitative indicators – (1.1) waste collection coverage (percentage of households receiving waste collection service) and (1.2) waste captured by the system, scored quite high. The qualitative indicator (1C), however, scored 50% implying the quality of service must be improved. Waste collection is not adequate in low-income districts, where majority of poor households have migrated from nomadic communities (Uddin et al., 2016), as was confirmed by the public questionnaire. Waste collection method is mainly door-to-door basis, which makes the collection service costlier and more time and labor intensive, consequently influencing the frequency of collection. Due to a low waste collection frequency, more waste is accumulated in *ger* areas according to field observations and results of questionnaire analysis. Waste generation was also reported high according to the weighbridge data and JICA studies (JICA, 2012), mainly due to ash generation in the winter season. A higher percentage of respondents in the *ger* area admitted to openly dumping waste, which is also connected with the littering issue. A majority of respondents acknowledged that the main reason behind littering is people's mindset. The proportion of respondents with the same opinion were less in *ger* areas. The most responsible stakeholders were identified as 'citizens', 'sub-districts' and 'TUK' waste collection companies. For apartment area residents, 'citizens' were identified as the most responsible stakeholder, on the other hand, in *ger* areas 'sub-districts' were the most responsible stakeholder. Protection of public health is lower in these areas. Therefore, quality service provision should be extended to the marginal low-income areas. On the other hand, waste service providers also face difficulties. According to the waste collection truck driver and collectors, citizens as service users "treat the waste service workers disrespectfully and do not consider the labor that requires to load the garbage into the truck, especially in the winter season when ash is collected in 200 l drums and do not help with the loading. Other times people might verbally insult or get angry". Waste workers are associated to low social status situation that leads to a low motivation among the waste employees (Guerrero et al., 2013; Vidanaarachchi et al., 2006). Advertisements towards changing attitudes of citizens in this specific aspect of waste management has been initiated with slogans such as 'Thank you for respecting my work'. The underlying problem might also be related to the values of people and social norms.

Environmental Control

According to the quantitative indicator, 100% of waste goes to controlled treatment or disposal, which is consistent with the progress that has been reported in middle-income countries (Scheinberg et al., 2010; Wilson et al, 2012). However, the qualitative indicator assesses the quality of the service, which scored 50%. Occupational health and safety is the most critical aspect that needs to be addressed, followed by improving the environmental control standards. The sites are not operating to their full potential, as the technical competence in the planning, management and operation is still inadequate. This problem is also partially dependent on the financial circumstances, which brings into question more budget allocation for this service. According to UBPUA representative, who admitted that there is inadequacy in terms of conducting proper environmental impact assessment, and that landfill citing should involve careful consideration especially regarding the local environment and inhabitants. It was also confirmed that the staff on the landfill site are not highly skilled, therefore due to limited budget workers with higher skillsets are preferred to be sent for trainings. There has been significant progress in terms of waste reception and record keeping. However, there were still some discrepancies in the data reporting, which needs to be further investigated and enhanced. Littering also causes threat to the environment, which should be taken into account. The main reason for littering was identified as 'people's mindset'; however, the proportion of respondents with the same answer was higher in the apartment areas as opposed to the *ger* area with 68% to 57% respectively.

Resource Management

As targets for resource recovery – reducing landfilled waste amount by 40%, increasing recycling rate to 30%, have been set in the documents such as Concepts of Mongolian Sustainable Development 2030, Green Development Policy, the pathway to achieving the targets should be as equally important. Both the qualitative and quantitative indicators scored the lowest. The recycling rate was around 5.5%, which should be taken as the minimum amount. There are currently no source separation of dry recyclables or organic materials; only ash from *ger* districts are source separated in winter, however during collection gets mingled in the mixed collection. Ash content is quite substantial in *ger* area's waste fraction. Similar scenarios were presented in the past, such as in London

during the end of 19th century and beginning of 20th century, where household ash was an important raw material for bricks and 'breeze' (Wilson, 2007). In Ulaanbaatar, however, ash from thermal power plants have only started being used as raw material for construction industry in the recent years (MNB, 2016; Oyungerel, 2017; Tseesuren, 2016). Research on exploring the use of household ash has been initiated (Davaabal et al., 2016), and some small-scale projects of making products from household ash have started (BGD, 2016). However, there is still some controversy in terms of safety issue of using the ash without properly treating it from harmful substances (Oyungerel, 2017). This issue needs to be further investigated and researched.

According to the public questionnaire it was found out that the recycling activity is more in *ger* areas, due to their socio-economic backgrounds and the physical characteristics of the *ger* areas. However, the recycling activity of younger people was less than the older generation, which implies that the educational programs are lacking or insufficient, and the participation of educational institutions in not effective. The older generation tends to reuse and recycle out of economic necessity and driven by the financial incentive, however, through education the younger generation can be the changemaker in the household and increase the recycling activity.

Majority of the respondents would support if waste separation was initiated. However, satisfaction level with the current service provision tends to influence future waste service initiatives. Constant monitoring of service quality and satisfaction level of users is a precursor to introducing more complex initiatives. Separation of ash in wintertime in *ger* areas is already evidence of waste separation, which makes these areas a potential place where waste separation policies be introduced at the point of waste generation.

Recycling is mainly conducted by the IRS whose contribution is not fully acknowledged. Nonetheless, it should be carefully factored into the equation when creating national and municipal recycling plans. It has been found that the informal sector works more profitably as each individual nodes on the recycling chain makes profit on the example of Bogota, Colombia (Vergara et al., 2011). However, within the IRS, waste pickers are on the bottom of the hierarchy of specialization and value chain, which is characterized by high risk and hazardous activities and tend to get the least benefits. The examples of Belo Horizonte, Brazil and Pune, India show successful inclusion of waste

pickers (Dias, 2011; WIEGO, 2014) through cooperatives that provide legal rights and protect their welfare and safety. The MNRA, which is the main entity that represents the informal recycling sector, operates in 4 main directions that are towards (1) organizing the itinerant waste buyers – related to issues of waste separation, collection and transport of secondary raw materials – recyclables; (2) recycling facilities; (3) seminars, workshops, scientific work directed to the society as a whole; and (4) the Eco Park, recycling complex. Even within the mission of MNRA, the issue of waste pickers is not given a top priority. According to an interview with a waste picker at NEDS it was confirmed that there was some type of organized structure among waste pickers who were grouped in brigades, and even if fire occurrences would happen, it was dealt in an organized manner. And it was confirmed that waste pickers did prefer this kind of structure. There is a seminar/education room at the NEDS operated by an NGO, directed towards the kids of disposal site workers and waste pickers. Such kind of existing facilities and practices can be built upon and further utilized for cooperation and assistance.

The environmental protection and occupational health and safety remain to be the major concerns for resource management as well, as proper monitoring and inspection procedures are lacking.

Inclusivity

In terms of user inclusivity, there are legislations in place for the right to be heard; however, the actual implementation is not adequate. According to the public questionnaire majority of the users rated the waste service to be fair. Around half of the respondents did not think that the public voice is being heard in the decision making. However, the higher the education level, the less the respondents thought the public voice is being heard, which indicates the current trust level to the government. Majority of the respondents have not used the feedback mechanism; number of respondents having used the feedback mechanism was less than the respondents who did not know how to use. However, there more respondents to have used the feedback mechanism in the *ger* area, than the apartment area. In general, *ger* area residents' interaction and engagement level with the waste providers and local government was more than apartment areas'. Users of both *ger* and apartment areas held different views on issues such as the most responsible

stakeholder and reasons behind littering. According to an interview with a public inspection worker “Citizens’ mentality and behavior are one of the most challenging issues and unless it is tackled, other solutions will not work as effectively”. The formal waste providers especially in *ger* areas, where the collection is door-to-door basis, can serve as the main educators of service users by promoting various awareness raising materials and information. However, the lack of systematic educational and behaviour change programs make it more challenging to improve the current situation through public engagement and support.

For provider inclusivity, there has been certain progress in terms of formal waste management sector, however the informal sector lags behind and their role needs to be acknowledged and further addressed. The public and the private sectors are equally represented. The informal sector is not being represented, especially the waste pickers who are, as explained, in the most vulnerable and bottom part of the informal sector hierarchy.

Financial Sustainability

In general, the current budget cannot cover the full operational and maintenance costs of collection and disposal services. Local cost recovery from households scored high; however, the service fee collection rate in *ger* area is lower than in apartment areas: 57% to 81.2%. According to the public questionnaire, respondents in *ger* area were less willing to pay more money for service improvement. There will certainly be resistance to pay increased rates for a service that is perceived to be deficient. Additionally, there are more residents in *ger* area from socio-economically vulnerable backgrounds who can least afford to pay. Therefore, there needs to be service fee exemption or subsidy for users who can least afford to pay should be subject to consideration in low-income districts. The respondents in apartment area were more willing to pay more money for service improvement, which might be dependent on their socio-economic and educational backgrounds as demonstrated by the questionnaire survey. Also, the younger generation were more willing to pay more for service improvement. In general, willingness to pay more money might be also potentially dependent on various factors that ensure more engagement with the public, more transparency and improvement in waste service provision.

Access to capital for investment remains to be the biggest challenge, which brings international influence as the most dominant provider of financial assistance. However, in most cases the solutions designed for the targeted communities do not comply with the conditions, characteristics and local features of these communities. In order to avoid such happenings, the local governments should be the most knowledgeable about the current MSWM systems and the problems. Finding various financial sources for covering service costs should be sought out.

Sound Institutions, Proactive Policies

The strategies and policies towards green and sustainable development do include targets for increasing the recycling rate and decreasing the amount of landfilled waste. However, the pathways of achieving them should be clear. Policies should be put in place that requires producers and importers of goods and products to bare some of the financial burdens of waste management through EPR and PS by introducing special tax or incentives.

Solid waste is given low priority in comparison to other municipal activities by politicians (Moghadam et al., 2009), which results in limited trained and skilled personnel in the municipalities (Sharholy et al., 2008). There has been a special project of JICA that was directed toward capacity building in waste management, to which a lot of the progress that took place over the past decade can be attributed to. However, the current problems cannot be solved without further investment in the waste management workers. For instance, the capacity building in the local sub-district governments needs to be done, as respondents in *ger* areas identified 'sub-districts' to be more responsible in waste management related issues, such as monitoring the service provision, participating in the educational aspects and awareness raising. Feedback mechanisms can be utilized to maximize their full benefits and help strengthen institutions.

In terms of local institutional coherence, the city-wide SWM strategy and plan must be improved hand in hand with the management, control and supervision of service delivery. A lack of education and training of local staff may lead to misreporting of local MSW data (Kawai & Tasaki, 2016), which is the foremost important aspect of MSWM and the backbone of planning and setting of targets. The availability and quality of MSW

data needs to be urgently prioritized. This in turn can help with all the rest of the MSWM aspects such as planning, decision making and educating the public.

Occupational Health and Safety

Occupational health and safety both at disposal sites and recycling, where the working conditions fall into the description of the “3D”, dirty, difficult and dangerous, jobs (ILO, n.d.), should be ensured through proper policies. Protecting workers in hazardous conditions should be prioritized as occupational health and safety risks of waste disposal operations often go beyond obvious safety hazards to a variety of chronic and acute health concerns (Platner, 2011). Hazardous work environments are common to waste disposal operations, water and sanitation services, sewage treatment and domestic waste collection. “Occupational safety and health hazards include microbiological and medical waste, chemicals, inadequate ergonomics, motor vehicles, confined spaces and electrical and mechanical equipment. Identified health symptoms and illnesses include upper respiratory, dermatological, upper and lower extremity musculoskeletal, cardiovascular, central nervous system and visual problems. Additional concerns include lacerations, heat exhaustion and stroke” (LeGrande, 2011).

Currently the waste collection workers do receive health check-ups and proper equipment such as boots, gloves, high visibility vests etc., however the case varies from company to company and the standards need to be tightened. The disposal site workers are not getting these full benefits such as medical check-ups. As disposal sites are not operating to their full capacity, the workers are also exposed to more risks and hazards.

However, the situation in the informal recycling sector is more critical as the activities of IRS are not recognized by the formal waste sector and the government, especially the waste pickers who are exposed to most of the hazards. The waste pickers extract recyclables directly from streets and from the landfill sites, and they sell the materials to itinerant waste buyers and middlemen. First of all, the waste pickers are doing a service to the municipalities by filling a gap in the recycling sector that should have been the responsibility of the municipalities. Secondly, by protecting the rights of waste pickers and providing assistance to ensure their occupational health and safety, would reduce the amount of health care cost and prevent diseases. Otherwise it could be a threat to public health. Among the top priorities in controlling occupational safety and health

hazards in the waste sector included “integrating informal sector work into the formal work process” and “integrating occupational safety and health concerns when introducing process change plans, particularly during transitions from open dumping and landfills to more complex and potentially more hazardous enclosed operations such as composting, mechanical or manual separation for recycling, waste to energy operations or incinerators” (Platner, 2011).

7 CONCLUSIONS AND RECOMMENDATIONS

This thesis has examined the current state of municipal solid waste management from physical and governance features. The current municipal solid waste management of Ulaanbaatar, Mongolia is at an intermediate stage of development. In terms of Public Health, Environmental Control and Institutional Aspects, UB has surpassed the levels of low and lower-middle-income countries and sufficed the prerequisites for modernizing its waste management system. However, there are critical steps needed for further improvement. The research also generated essential baseline information on the socio-economic, behavioral and attitudinal differences identified for two types of residencies (apartment and *ger* areas). The results of public questionnaire and benchmark indicators can be utilized to formulate new waste management strategies and modify existing ones.

7.1 Conclusions

The study brought significant contributions to the existing literature gaps for UB, demonstrating systems analysis and public questionnaire as tools for gathering evidence based information to form policy recommendations.

Differences in behaviors and attitudes have been identified for apartment and *ger* areas that can enhance the policies that are directed to these areas.

The 'Wasteaware' benchmark indicators have served to be a useful tool for analyzing the MSWM system. The usage of the tool proved to be effective, however, certain improvements could be done to enhance the applicability of the indicators to cities from various backgrounds.

The study revealed that the current budget cannot cover the full operational and maintenance costs of collection and disposal services that is affecting the public health and the environment. Access to financial capital remains to be one of the biggest challenges.

The environmental standards in disposal and recycling activities are not following proper regulations, which in turn affects the occupational health and safety of the workers both in disposal and recycling.

Recycling is conducted by the IRS, whose rights are not acknowledged and protected. As a higher waste generating city, top levels of waste hierarchy such as waste minimization and prevention need to be given equal priority as recycling.

Service users do acknowledge the reason behind littering is people's mindset, and that citizens are the more responsible stakeholder. However, lack of comprehensive educational programs makes it more difficult to effectively achieve behavior change among citizens.

Key waste-related data is still lacking as proper data collection and reporting methods are not in place. Without reliable and up-to-date data, the planning, decision-making and evaluation of the service delivery will not be done effectively.

Capacity of local government and waste workers is inadequate as waste management involves complex decision making and accounting for various factors that needs critical thinking and creativity. The local government should be the most knowledgeable about the current circumstances and problems, especially in dealing and making negotiations with international donors. The local government is the key entity to having successful projects and collaborations.

7.2 Recommendations

Formulation of policies and strategies should be conducted based on proper data and information with enough evidence, in order to maximize the outcomes as financial and human resources are limited.

The found differences in behaviors and attitudes of the two residential types should be taken into consideration in policy making.

The 'Wasteaware' benchmark indicators should be made more flexible to accommodate some of the cultural and geographic aspects.

Optimization of collection (method and frequency) and transport, inclusive of low-income districts, should be conducted ensuring the public health is being protected and impact on the environment is minimized. Financial sustainability can be sought out through the adjustment of the service fee, ensuring that the full cost of waste service is estimated based on sufficient research and is transparent and open to public scrutiny. EPR and PS should be introduced to put some of the financial burdens on producers and importers through special tax or incentives.

Environmental standards in disposal and recycling activities should be tightened through policy with a view of protecting not only the surrounding environment but also the health and safety of the workers (especially informal sector waste pickers).

Integration of the IRS should be focused, especially recognizing the rights of waste pickers by providing the necessary assistance to safe and secure work environment.

Comprehensive educational and awareness raising programs for behavior change should reflect the current situation of UB and providing citizens with actionable steps stating their impacts clearly. It should be done systematically so as to avoid inconsistent information throughout the municipality, where the educational institutions, the districts and collection companies are in charge of producing their own programs, which would be more effective if conducted in coordination.

Proper data collection and reporting should be enforced and prioritized as it affects all other aspects of MSWM.

Capacity building should be conducted at local government and at service levels and conducted periodically in order to stay up-to-date with information regarding new discoveries and technologies in waste handling, and to motivate the waste workers.

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9 APPENDICES

APPENDIX 1 QUESTIONNAIRE IN MONGOLIAN

Улаанбаатар хотын хатуу хог хаягдлын менежмент

Хоккайдогийн Их Сургуулийн Байгалийн Шинжлэх Ухааны Сургуулийн докторантурын судалгаанд хувь нэмрээ оруулж тусална уу! Улаанбаатар хотын хатуу хог хаягдлын менежментийг хамтдаа сайжруулцгаая!

Хүйс

◯ Эр ◯ Эм

Нас

◯ <18 ◯ 18 - 29 ◯ 30 - 44 ◯ 45 - 59 ◯ 60+

Эрхэлдэг ажил

Боловсролын түвшин

◯ Бага сургууль ба түүнээс доош ◯ Бүрэн бус дунд ◯ Бүрэн дунд ◯ Тусгай дунд ◯ Дээд

◯ Бусад

Оршин суугаа дүүрэг, хороо

Оршин суугаа хороолол

◯ Гэр хороолол ◯ Орон сууц

Гэр бүлийн гишүүдийн тоо

◯ 1-2 ◯ 3-5 ◯ 6-8 ◯ 8-аас дээш

Уугуул Улаанбаатарынх эсэх?

◯ Тийм ◯ Үгүй

Хэрэв хөдөө орон нутгаас шилжин суурьшсан бол, хэзээ хаанаас шилжин суурьшсан бэ?

1. Та хог тээвэрлэлтийн хуваариа мэддэг үү?

◯ Тийм ◯ Үгүй ◯ Барагцаагаар

2. Хогны машин хувиараа хэр мөрддөг вэ?

◯ Сайн мөрддөг ◯ Дунд зэрэг ◯ Маш муу ◯ Огт мөрддөггүй ◯ Мэдэхгүй

3. Хог ачих үйлчилгээ таны оршин суугаа газарт хэр тогтмол ирдэг вэ?

◯ 7 хоногт 1 (Гаригууд:) ◯ 7 хоногт 2 (Гаригууд:)

◯ Сард 1 (Гаригууд:) ◯ Сард 2 (Гаригууд:) ◯ Огт ирдэггүй

◯ Бусад

4. Хог хаягдал ачих үйлчилгээнд хэр сэтгэл хангалуун байдаг вэ?

◯ Огт хангалуун биш ◯ Хангалуун биш ◯ Дунд зэрэг ◯ Хангалуун ◯ Маш хангалуун

5. Та гэрийнхээ хог хаягдлыг хаана хаядаг вэ?

◯ Тогтоосон хогийн цэг/Бункерт ◯ Хогны машинд шууд өгдөг ◯ Зам дагуу

◯ Тогтоосон хогийн цэг байхгүй учраас ойр орчиндоо (гуу жалга, голын сайр, даланд) ил задгай хаядаг

◯ Бусад

6. Тогтоосон хогийн цэг болон хогны савны эргэн тойронд ил задгай хог хаягдал цуглардаг эсэх

◯ Маш ихээр ◯ Их ◯ Дунд зэрэг ◯ Бага ◯ Маш бага

7. Ил задгай хог хаягдал ямар шалтгаанаас үүсч байна вэ?

◯ Иргэдийн ухамсраас ◯ Хогны савны дутмаг байдлаас

◯ Хариуцлага тооцох тогтолцоо муу учраас (торгууль г.м.)

◯ Бусад

8. Хотын төв хэсгийн гудамж зам талбайд ил задгай хог хаягдал хэр их байдаг вэ?

◯ Маш их ◯ Их ◯ Дунд зэрэг ◯ Бага ◯ Маш бага

9. Танай гэрийн ойр орчинд ил задгай хог шатаах, хууль бусаар (гуу жалга, даланд) хог хаясан үзэгдэл хэр их байдаг вэ?

10. Та хог хаягдлаа ангилан ялгаж хаядаг уу (дахин ашиглах боломжтой ба боломжгүйгээр)?

◯ Тийм ◯ Үгүй

11. Дахиврыг (дахин ашиглах боломжтой хог хаягдлыг) тушаах эсвэл өөр нэгэн хэлбэрээр дахин ашигладаг уу?

◯ Тийм (Жишээ нь:) ◯ Үгүй

◯ Бусад

12. Органик хог хаягдлыг дахин ашигладаг уу? (Жишээ нь: нохой хооллох, ургамал ногооны хальсийг бордоонд ашиглах...)

◯ Тийм ( ) ◯ Үгүй

◯ Бусад

13. Хэрэв хог хаягдлыг ангилан ялгах үйл ажиллагааг нэвтрүүлбэл та дэмжих үү?

◯ Тийм ◯ Үгүй ◯ Мэдэхгүй

◯ Бусад

14. Ард иргэдийн дуу хоолой хог хаягдлын менежментэд шийдвэр гаргах хэмжээнд нөлөөлж чадаж байна уу?

◯ Тийм ◯ Үгүй ◯ Мэдэхгүй

◯ Бусад

15. Хог хаягдлын асуудлаар санал хүсэлт гаргаж байсан уу?

◯ Тийм ( ) ◯ Үгүй ◯ Яаж гаргахаа мэдэхгүй

◯ Бусад

16. Хог хаягдлын хураамж төлдөг үү? (Төлдөг бол хэдийг?)

◯ Тийм (2500₮, 2000₮) ◯ Үгүй

◯ Бусад

17. Хэрэв төлдөг бол яаж төлдөг вэ?

- Байрны менгетэй хамт
- Цахилгааны төлбөр дээр гардаг
- Байцаагчид
- Бусад

18. Хог хаягдлын хураамжийн талаарх таны бодол

- Маш хямд
- Хямд
- Боломжийн
- Үнэтэй
- Маш үнэтэй
- Бусад

Та хог хаягдлын менежментийг сайжруулах зорилгоор илүү хураамж төлөхөд бэлэн үү?

- Тийм
- Үгүй
- Мэдэхгүй
- Бусад

19. Хог хаягдлын талаарх таны сэтгэлийг хамгийн ихээр бухимдуулж байгаа асуудал юу вэ?

20. Хог хаягдлын менежментийг хэрхэн сайжруулах талаар таны санал?

21. Доорх нэгжүүдээс аль нь илүү хариуцлага хүлээх ёстой вэ? (1-ээс дээш хариулт сонгох боломжтой)

- Иргэд
- ТҮК
- Хороо
- Дүүрэг
- Засгийн газар
- Бусад

Танд маш их баярлалаа! Энэ өдрийг сайхан өнгөрүүлээрэй!
:)

APPENDIX 2 QUESTIONNAIRE (ENGLISH TRANSLATION)

Municipal Solid Waste Management in Ulaanbaatar, Mongolia

We appreciate your contribution to filling a survey devised for doctorate research of Hokkaido University's Graduate School of Environmental Science to improve the municipal solid waste management in Ulaanbaatar from.

Sex

◯ Male ◯ Female

Age

◯ < 18 ◯ 18 – 29 ◯ 30 - 44 ◯ 45 - 59 ◯ 60 +

Main occupation

_____

Highest level of education completed

◯ Elementary school or less ◯ Junior high school ◯ High school

◯ Vocational education ◯ Higher education

◯ Other _____

District and sub-district of residence

_____

Type of residence

◯ Ger district ◯ Apartment district

Household size

◯ 1-2 ◯ 3-5 ◯ 6-8 ◯ >8

Did you migrate to Ulaanbaatar?

◯ Yes ◯ No

If yes, please specify when and from where

_____

1. Do you know the waste collection schedule?

◯ Yes ◯ No ◯ Approximately

2. How well do waste collection trucks follow their schedule?

◯ Very well ◯ Fairly ◯ Very bad

◯ Do not follow at all ◯ I don't know

3. Waste collection frequency

◯ Once a week ◯ Twice a week ◯ Once a month ◯ Twice a month

◯ Do not come at all ◯ Other: _____

4. Satisfaction level with waste collection service?

◯ Not satisfied at all ◯ Satisfied ◯ Fairly ◯ Satisfied ◯ Not satisfied

5. Where do you dispose your garbage?

◯ Waste collection container/point ◯ Directly to waste collection truck

◯ Along the road ◯ Open dumping ◯Other_____

6. Presence of accumulated waste around collection points/containers

◯ Very high incidence ◯ High incidence Medium incidence

◯ Low incidence ◯ Very low incidence

7. What is the reason behind littering?

◯ People's mindset ◯ Lack of waste bins ◯ System accountability

◯ Other _____

8. Is there incidence of littering in the main streets and central areas?

◯ Very high incidence ◯ High incidence Medium incidence

◯ Low incidence ◯ Very low incidence

9. Is there incidence of accumulated waste/open dumping/ open burning near your neighborhood?

◯ Very high incidence ◯ High incidence Medium incidence

◯ Low incidence ◯ Very low incidence

10. Do you separate waste into recyclables and non-recyclables?

◯Yes ◯ No

11. Do you reuse or sell recyclables?

◯Yes (for example:) ◯ No

◯ Other _____

12. Do you recycle organic waste? (for example: feeding dogs, making composting..)

◯Yes (for example:) ◯ No

◯ Other _____

13. Would you support if waste separation is initiated?

◯ Yes ◯ No ◯ I don't know

◯ Other _____

14. Do you think the public voice is being heard in solid waste management decision making, planning and implementation process?

◯ Yes ◯ No ◯ I don't know

◯ Other _____

15. Have you ever used or suggested anything through the feedback mechanism?

◯Yes ( ) ◯ No ◯ Don't know how to

◯ Other _____

16. Do you pay waste collection fee?

◯ Yes (2500MNT, 2000MNT) ◯ No

◯ Other _____

17. If so, how do you pay?

◯ With utility bills (apartment) ◯ with electricity bill

◯ Directly to the officer ◯ Other _____

18. What is your opinion on waste collection fee?

◯ Very cheap ◯ Cheap ◯ Affordable

◯ Expensive ◯ Very expensive

19. Are you willing to pay more money for service improvement?

◯ Yes ◯ No ◯ I don't know

◯ Other _____

20. What is the thing most critical issue that bothers you regarding solid waste management?

_____

21. Your opinion on how to improve the current state of solid waste management

_____

22. Which stakeholder is more responsible? [multiple choice is possible]

◯ Citizens ◯ "TUK" waste collection company ◯ Sub-districts

◯ Districts ◯ Government

◯ Other _____

Thank you very much! Have a nice day!

:)

APPENDIX 3 INTERVIEWEE LIST

Interview #	**Occupation**	**Gender**	**Age Range**
1	International organization officer	M	≤35
2	PSD official	M	35-54
3	Disposal site manager	M	35-54
4	Waste picker	F	35-54
5	*TUK* representative	F	35-54
6	MNRA representative	F	≤35
7	UBPUA representative	M	≥55
8	District official	M	35-54
9	District official	M	≤35
10	NGO official	M	35-54
11	NGO official	F	35-54
12	Waste collection crew	M	≥55
13	Waste collection crew	M	35-54
14	Waste collection crew	M	35-54
15	Public inspection officer	F	≥55