Discussion Paper

Situation of Municipal Solid Waste Management in African Cities - An Interpretation of the Information provided by the First ACCP Meeting

Mitsuo YOSHIDA, Advisor, Global Environment Department, Japan International Cooperation Agency (JICA)

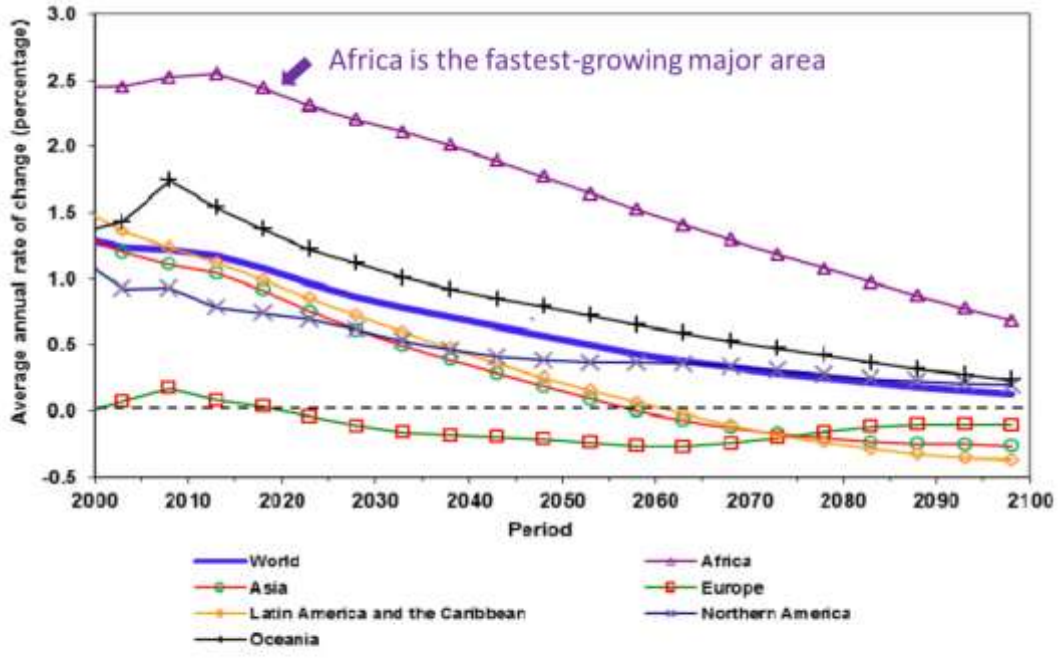
Introduction

The condition of the municipal solid waste management (SWM) of Africa is critical. Under the general expansion of human population and rapid urbanization in Africa, the amount of municipal solid waste is increasing drastically. However, the public authority capacity to implement the municipal SWM service in each country is limited. As a result, many municipal solid wastes are not collected or treated/disposed-off appropriately, which has caused public health issues and environmental problems.

In this paper, based on the information provided by the First ACCP Meeting in April 2017 in Maputo, Mozambique, the author describes the current situation and challenges of municipal SWM in Africa. The present paper has been submitted as a springboard for the discussion in the Second ACCP Meeting to be held in June 2018 in Rabat, Morocco.

1. Urbanization and environment

In many African cities, the amount of municipal solid waste is increasing rapidly due to population expansion and urbanization. Africa is the fastest-growing major area in population change as shown in Fig. 1 (UNDESA, 2015). Like the countries in East Asia, South Asia, and the Middle East, a huge expansion can be observed in many cities in Africa, south of sub-Sahara, where the urbanization rate exceeds 5% (UNDESA, 2011).



Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Population Prospects: The 2015 Revision*. New York: United Nations.

Figure 1: Average annual rate of population change by major area, estimates, 2000-2015, and medium-variant projection, 2015-2100

With rapid urbanization, many slums are cropping up in and around the urban areas. Moreover, degradation of public health conditions and deterioration of the urban environment are becoming big social problems. The issue of solid waste is one of the problems, and city inhabitants are generating large sources of municipal solid waste as the size of the population is closely related to the amount of waste generated.

The urban population of Africa plays an indispensable role in the amelioration of the city sanitation environment, which is likely to triplicate in 2050 from about 450 million people (40% of the total population) and was linked with various kinds of economic infrastructure buildings. However, the current condition of the municipal SWM of African countries was reported as severe in the First ACCP Meeting: Municipal waste management is the responsibility of each municipality (city) or local government, but its implementation capacity is often weak, facilities and equipment are insufficient, and maintenance, management, and waste disposal are often not carried out properly. The central government or the provincial government's guidance, coordination, and management system for instructing the municipality are not in place appropriately. To implement appropriate municipal SWM service, the infrastructure and hardware, such as facilities and equipment, as well as the "implementation system," such as organization, institution, fiscal, and human resources, are indispensable. However, the policy priority on SWM for the decision-maker is rather low, and the fiscal allocation to the SWM project is not sufficient. There is a tendency to turn down policy priority unless there is constant economic growth or a serious social problem.

According to the cross-country analysis on population change and urbanization (UNDESA, 2015), population change patterns can be divided into three groups from the dynamics of urban and rural population change (Fig. 2). The first group is of countries plotted in the upper right quadrant, indicating that as urban population increases, the rural population also increases. Most African countries, some Asian countries, and Latin American countries fall under this category. The second group indicates a pattern wherein urban population increases but rural population decreases. This is widely recognized in Asia, Latin America, Europe, North America, and others. In the third group, urban population and rural population both decrease, and this is recognized in high-income countries of Europe, Asia, and North America. Looking at economic development, it can be suggested that there will be a shift from the upper right (the first group) to the middle (the second group) and the lower left (the third group). Currently, African countries form the first group but eventually the population of rural areas will decrease, and the urban population will continue to increase (the population dynamics will change from upper right to lower left) as predicted. This suggests that urban waste problems will become even more severe in Africa.

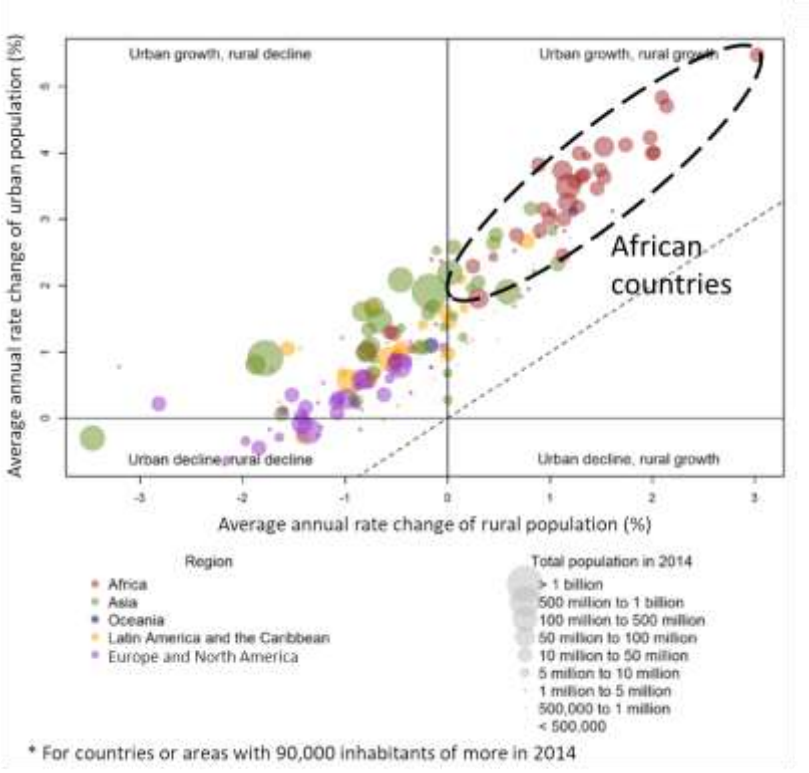


Figure 2: Population growth rate in urban and rural areas by country (%). The vertical axis shows urbanization rates, and the horizontal axis shows population growth rates in rural areas. Source: UNDESA (2015)

Such phenomenon of population change in rural and urban areas can be explained by Harris-Todaro's rural-urban migration model (Harris and Todaro, 1970). If the expected income is higher in urban areas than in rural areas,

population migration from rural areas to cities will continue to occur. A concentration of production and consumption due to urbanization stimulates economic activity in urban areas through economic merit by concentrating various economic agents, that is, agglomeration economies. As a result, productivity in the city improves and employment opportunities increase. Looking at the relationship between urbanization and economic growth (GDP/capita) in Asian cities, a positive correlation can be observed and generally, as the urbanization rate increases by 1%, GDP/capita is said to increase by 0.05% approximately (Fig. 3).

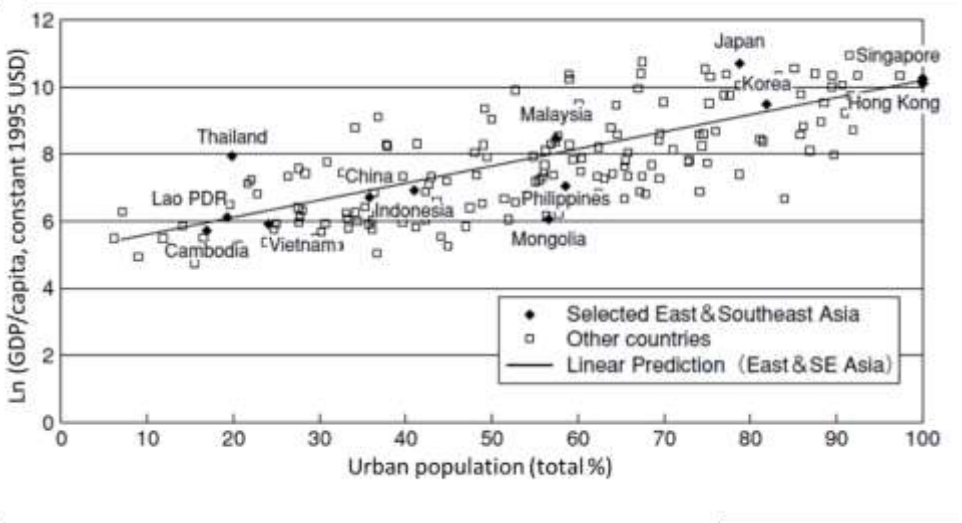


Figure 3: Correlation between urbanization rate (horizontal axis: % of urban population) and economic growth (vertical axis: natural logarithm of GDP/capita (USD) based in 1995). The solid line shows the linear prediction of the correlation between the eastern and Southeast Asian countries. Source: Iimi (2003)

However, while urbanization has the benefits of agglomeration economies, it brings about waste, flue gas, and sewage (i.e., environmental burden) generated by the concentrated population. If left untreated, apart from waste problems, urban environmental problems such as air pollution, water pollution, soil contamination, etc., will occur. This means that while the urban environment is a public good, it has the characteristics of a non-exclusive and competitive common pool resource, where its use is free but competitive because there is limited tolerance of the environment. When the urban environment is not adequately managed, its use exceeds the allowable amount of the environment and environmental quality deteriorates.

Environmental management countermeasures according to capacity and urban environment load, that is, waste management and wastewater treatment, become necessary. Various economic, social, and environmental problems accompanying such urbanization are collectively referred to as the “urban problem.” As the urban problem progresses, it will eventually hinder the profit of the agglomeration economies. Therefore, from an environmental and economic point of view, environmental management, including SWM, is required.

2. Urbanization without economic growth in Africa

In sub-Saharan Africa, urbanization seemingly does not bring economic growth, which is a prerequisite of the cost burden mechanism that has been described so far. The left diagram in Fig. 4 shows the relationship between urbanization and economic growth as recognized in East Asian and Pacific countries and displays positive correlations similar to Figure 3. However, the right diagram, which plots Sub-Saharan African data, shows little economic growth corresponding to urbanization. It highlights the situation where the population continues to be concentrated in the city without economic growth in these countries.

A characteristic of Africa's municipal SWM problem is that waste problems occur under "urbanization without economic growth." Therefore, despite various urban problems due to urbanization, the burden mechanism of the countermeasure cost cannot be simply dealt with by the conventional East-Asian model in Sub-Saharan Africa.

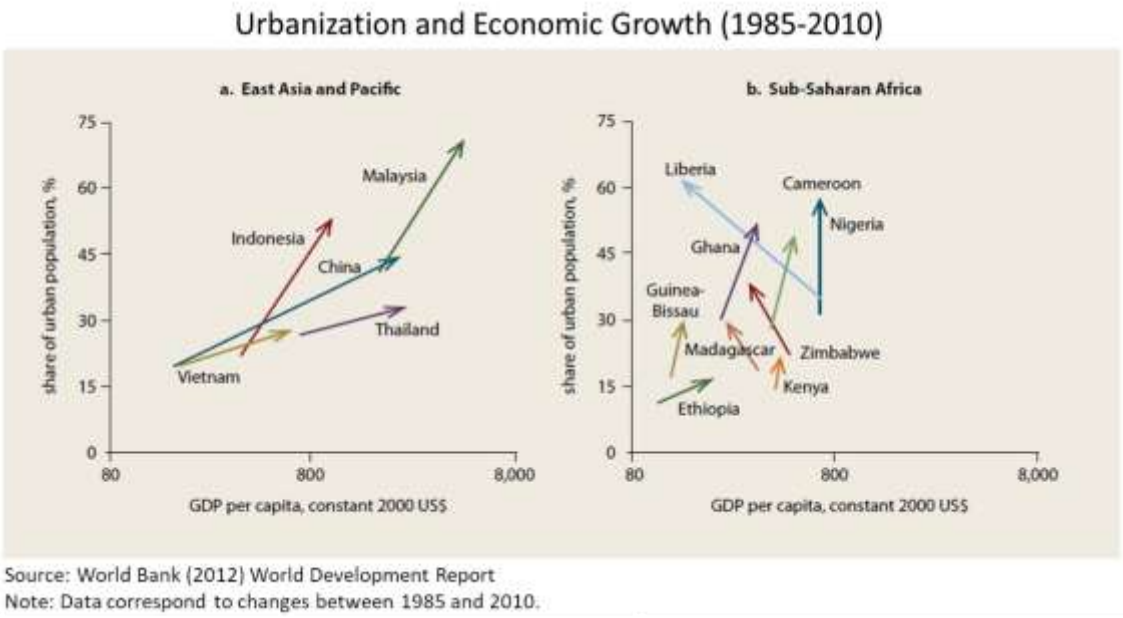
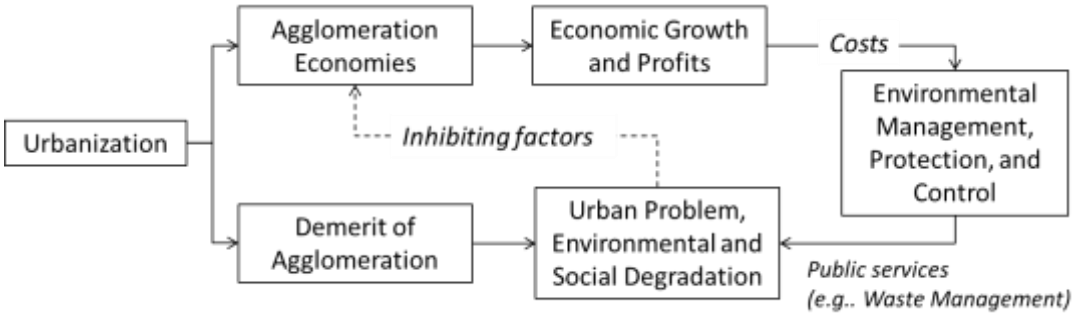


Figure 4: Changes in the urbanization rate (vertical axis: % of population) and economic growth (horizontal axis with logarithmic scale: GDP/capita) for (a) East Asian-Pacific countries and (b) African countries. Urbanization, that is, moving the population from rural to urban areas, does not always bring about economic growth. Source: World Bank (2012)

The cause is complex: an economic structure where urbanization does not lead to economic growth may be attributable to the fact that there is a focus on the export of resources, but the local manufacturing industry has not yet developed. The profit and capital of the agglomeration economies due to urbanization is flowing out of the country. Informal economic activity covers a substantial part of the real economy and, therefore, the acquisition of actual economic activity is insufficient (AfDB, 2013). In any case, these concerns relate to issues of national policy and at a governance level higher than the dimension of municipal SWM, which indicates the issues of strengthening national governance capacity including the involvement of the informal sector. Therefore, sustainable SWM, under the phenomenon of urbanization without economic growth in Sub-Saharan Africa, cannot be achieved merely by improving the waste management activities, but requires improvement of national policy and enhancement of governance.

BOX 1: Who should pay the cost?

The urban environment is a public good. It has the characteristics of a non-exclusive and competitive common pool resource, where its use is free but competitive because the tolerance of the environment is limited. When the urban environment is not adequately managed, the use, exceeding the allowable amount of the environment, increases and environmental quality deteriorates. The cost for this environmental management countermeasure, for example, solid waste management, is generally required to be borne by beneficiaries of the service and beneficiaries from the agglomeration economies caused by urbanization. The figure below schematically shows this relationship.



Concept of cost burden on environmental load caused by urbanization. Cost of public services such as municipal SWM must be borne by beneficiaries of the service and beneficiaries from agglomeration economies caused by urbanization. Source: Yoshida (2016)

3. Current status of municipal waste management system in Africa

Based on the results of the questionnaire survey and the workshop of the First ACCP Meeting, the status of municipal SWM system in Africa is summarized. The targeted countries are as shown in Table 1. The questionnaire was answered by 13 countries/cities of 24 target countries. Also, all the countries below participated in the workshop of the First ACCP Meeting.

Table 1: Participating countries of the First ACCP Meeting and their response to the questionnaire survey.

s/n	Country	Participants	City data	Country data
1	Djibouti	2		○
2	Namibia	2	○	○
3	Senegal	2		
4	Kenya	1	○	
5	Zimbabwe	2	○	
6	South Africa	1	○	○
7	Côte d'Ivoire	2		
8	South Sudan	2	○	○
9	Sudan	2	○	○
10	Ethiopia	2	○	
11	DRC	2		○
12	Republic of the Congo	2		
13	Burkina Faso	2		○
14	Niger	2	○	○
15	Morocco	2		
16	Zambia	2	○	
17	Malawi	2	○	○
18	Uganda	1	○	
19	Egypt	2	○	○
20	Nigeria	2	○	○
21	Ghana	2	○	○
22	Madagascar	2	○	○
23	Cameroon	2		
24	Botswana	2		

In the information obtained, the background and data on the current state of waste management, viewed from a material aspect, is as follows: (i) Population (2016), (ii) Economy (GNI/capita-PPP, USD), (iii) Human Development Indicator (HDI-2016) *, (iv) Total waste generation amount in 2012(ton/day) **, (v) Waste generation rate per capita (ton/day/capita) **, (vi) Estimation of waste generation amount in 2025 (ton/day) **, (vii) Service coverage (population, %), and (viii) Rate of direct dumping without treatment (ton, %).

* Data source: UNDP (2016), ** Data source: World Bank (2012)

A detailed examination on data quality was not carried out and the data provided by each country were used for analysis without modification.

3-1. Waste generation

We will describe the characteristics of the waste generation amount for each African country based on the survey results. Figure 5 is a data plot of countries in Africa on the diagram by UNEP-ISWA (2015). The vertical axis indicates the generation amount (kg/capita/year) and the horizontal axis in the logarithmic scale denotes the average annual income per capita (USD; GNI/capita/year). Closed symbols have been given by UNEP-ISEWA (2015) as data for various countries in the world. The data on African countries is shown in an open symbol plot. The average values of the world exhibit an almost linear relationship as shown by the dashed line (UNEP-ISWA, 2015), indicating that the correlation between economic growth and waste generation is a logarithmic function.

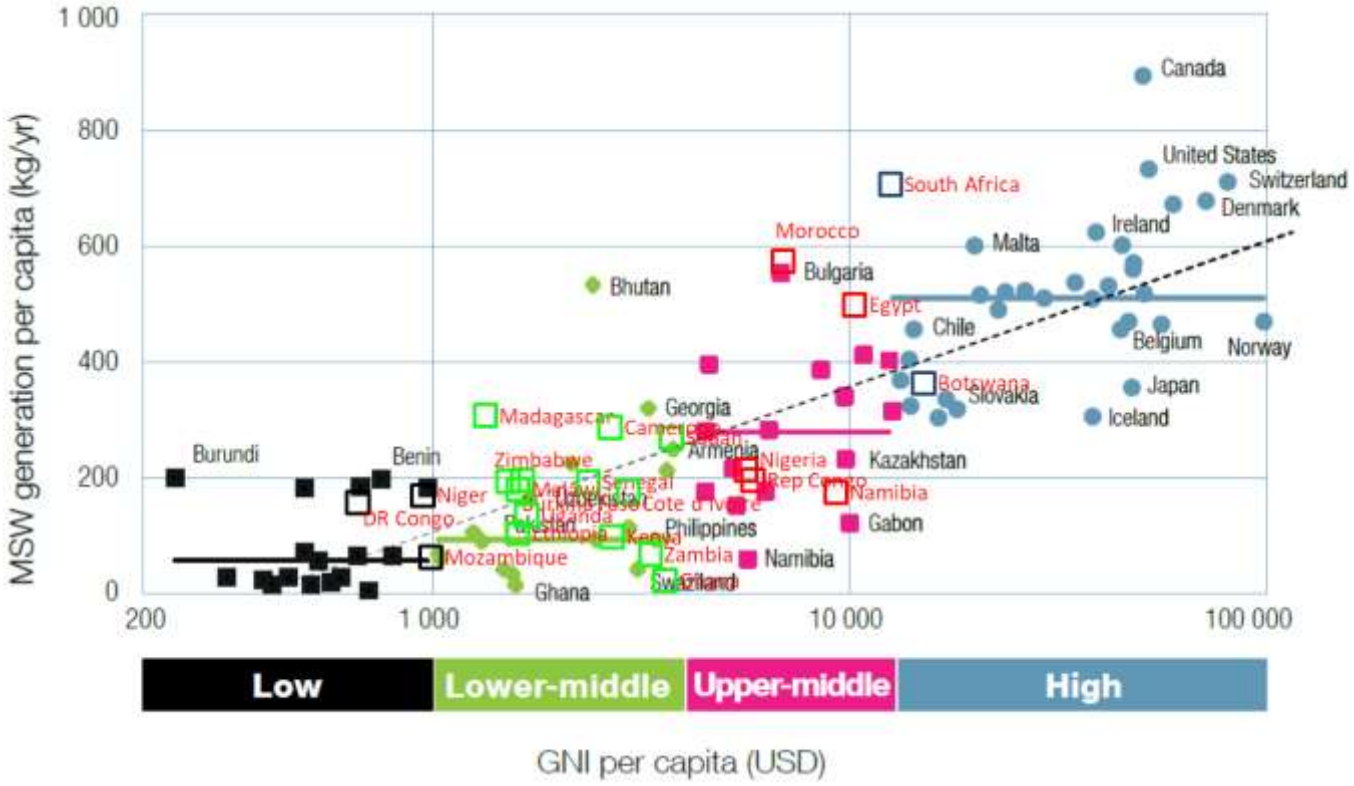


Figure 5: Correlation between annual waste generation per capita (vertical axis) and GNI/capita (horizontal axis). The open symbols denote the data of Africa in this study and the closed symbols denote the data of other countries in the world, adopted from UNEP-ISWA (2015). The dashed line is a linear approximation given by UNEP-ISWA (2015).

The data of African countries generally compliments the average trend in the world, and many countries show relatively small amounts of waste generation. However, the waste generation rate of some countries shows an extremely high value according to the degree of economic development. The Democratic Republic of Congo and Niger, belonging to the low-income countries group, clearly indicate too much waste generation in comparison with the world average. Middle-income countries such as Madagascar, Cameroon, Zimbabwe, Egypt, and Morocco have a very high waste generation rate. South Africa, a high-income country, also shows extremely high figures of waste generation. In these countries, it can be said that the issue of waste reduction at generation sources, such as each household and office, is necessary.

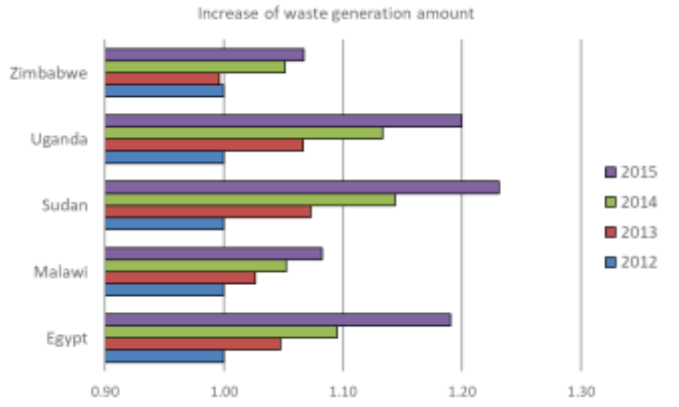


Figure 6: Changes in the average amount of waste generation in each of the five African countries from 2012 to 2015, where the horizontal axis denotes the normalized value by the waste generation amount in 2012.

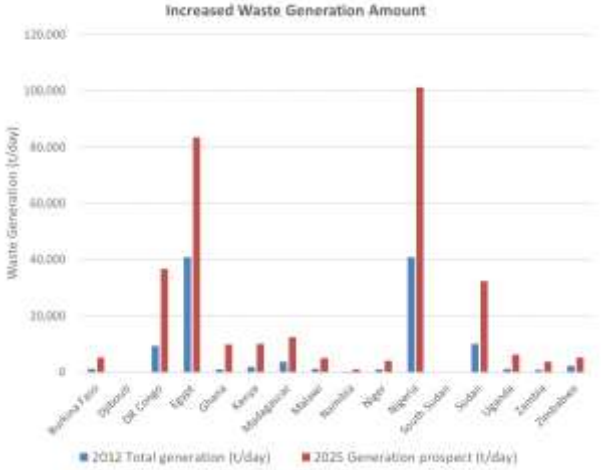


Figure 7: Estimation of waste generated per day in 2025 for 16 African countries. Data Source: World Bank (2012)

On the other hand, Ghana, Zambia, Namibia, Congo (the Republic of Congo), and Nigeria are countries where the waste generation volume is relatively small. Although there is still room for consideration for the representation and reliability of the data itself, it is necessary to reduce the waste amount in some African countries, which is a major challenge, and it will be necessary to provide environmental education and raise public awareness for that. There is a need to share good practices of countries that have succeeded in waste reduction.

The increased rate of waste generation from 2012 to 2015 for five African countries, Egypt, Malawi, Sudan, Uganda, and Zimbabwe, is shown in Fig.6. In all these countries, the amount of waste generation rapidly increased, reaching about 1.2 times over the four years. The World Bank (2012) made an estimate of the amount of African waste generated in 2025 (Figure 7). It also stated that the total amount of solid waste generated per day in Africa would reach 200 thousand tons or more in 2015. The results of the present survey of five countries are almost consistent with the World Bank estimate (2012).

3-2. Collection and transportation of waste in Africa

Is the waste generated in cities properly collected and transported? The variation in the non-collection rate of cities around the world according to economic development (middle to low income countries; GNP/capita<4,000 USD) is shown in Fig. 8. The horizontal axis shows the economic development (GNP/capita) whereas the non-collection rate (%) is seen on the vertical axis. Open symbols show the data of African countries and closed symbols show that of other cities around the world. As is clear from this diagram, waste collection and transportation services are generally enhanced according to economic growth, and nearby GNP/capita = 4,000 USD. Most cities can collect almost all the waste generated. It is generally said that the waste collection rate improves greatly from GNI/capita = 2,000 to 3,000 USD (UNEP-ISWA, 2015).

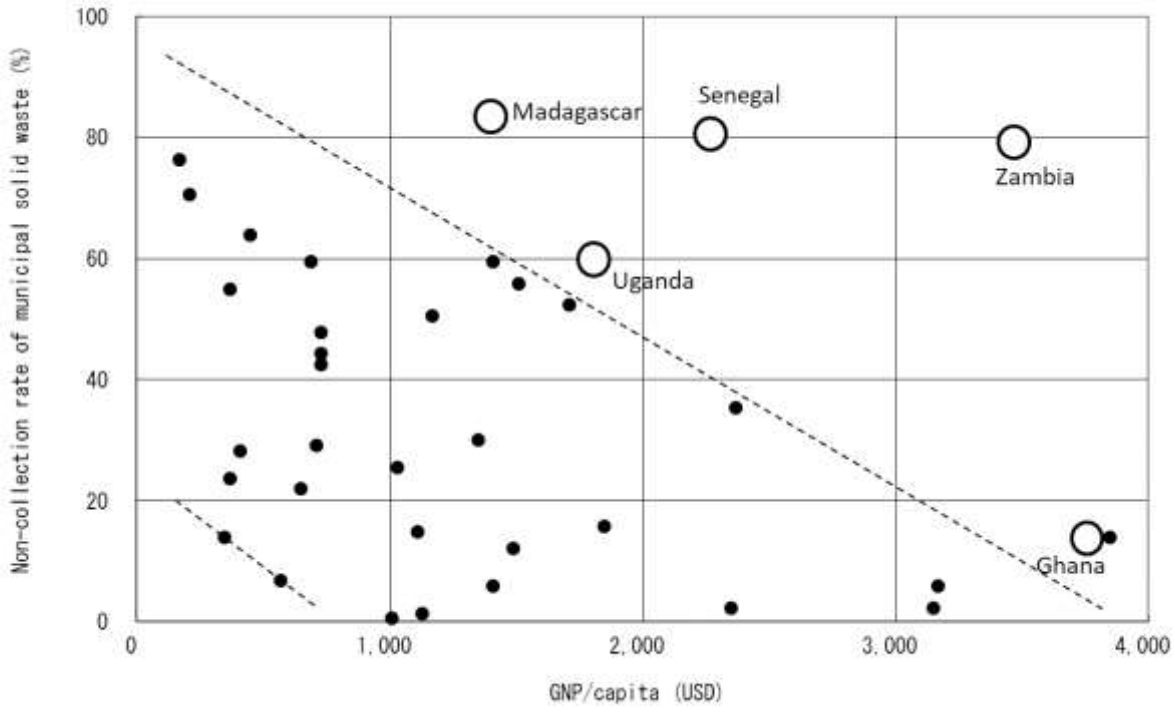


Figure 8: Relationship between the non-collection waste rate (%; vertical axis) and economic development (USD; GNP/capita). Open symbols show the data of African countries, and closed symbols show that of other cities around the world. The waste collection and transportation services tend to improve according to the economic development, by GNP/capita = 4,000 USD. However, in the case of Africa, it deviates from this trend and the non-collection rate is considerably higher. Data Source except African data: JICA

Figure 9：Uncollected waste at a roadside in Nairobi. Source: The Star, January 22, 2016

Figure 10：Hulene dumpsite and waste pickers in Maputo, Mozambique. Photo taken by the author (April 2017)

However, in the case of African cities, it is largely out of this trend (Fig. 8) that the non-collection rate is very high for the degree of economic growth. Unfortunately, the generated waste is not properly collected and transported. This figure indicates that there is a huge issue regarding waste collection and transportation in Africa. In this survey, although data could only be obtained from the five countries shown, the absence of data itself indicates that the collection and transportation service does not function well.

The image shown in Fig. 9 is an example of uncollected waste at an African city roadside. Because of waste being left unattended, it does not only spill onto the streets but also deteriorates public health and may lead to a surge in pests.

3-3. Final disposal dumpsites in Africa

The collected waste is transported to final disposal sites and landfilled. Fig. 11 shows the management level of final disposal sites of various cities (middle to low income countries) in the world. The management level of the disposal site is classified into four levels on the vertical axis whereas the economic development indicator (GNP/capita) on the horizontal axis plots the final disposal sites of the world. The classification of disposal site management levels 1, 2, 3, and 4 range from sanitary landfills to uncontrolled open dumpsites. Level 4 is a hardly-managed open dumpsite (see picture in Fig. 10), Levels 3 and 2 are somewhat controlled dumpsites, and Level 1 is a sanitary landfill. Plotting with closed triangles indicates the status of disposal sites in various countries around the world. The degree of the management level of the disposal site gradually improves with the degree of economic growth. The improvement front is indicated by a broken line, and sanitary landfill appears around GNP/capita = 4,000 USD. The state of the final disposal site in Africa is indicated by the plotted circles. However, it is plotted above the broken line at the front. This indicates that the management level of Africa's final disposal site is average or less than average than the global average. The problem of the final disposal site is that the lowest level of open dumpsite, Level 4, is dominant among the four management levels.

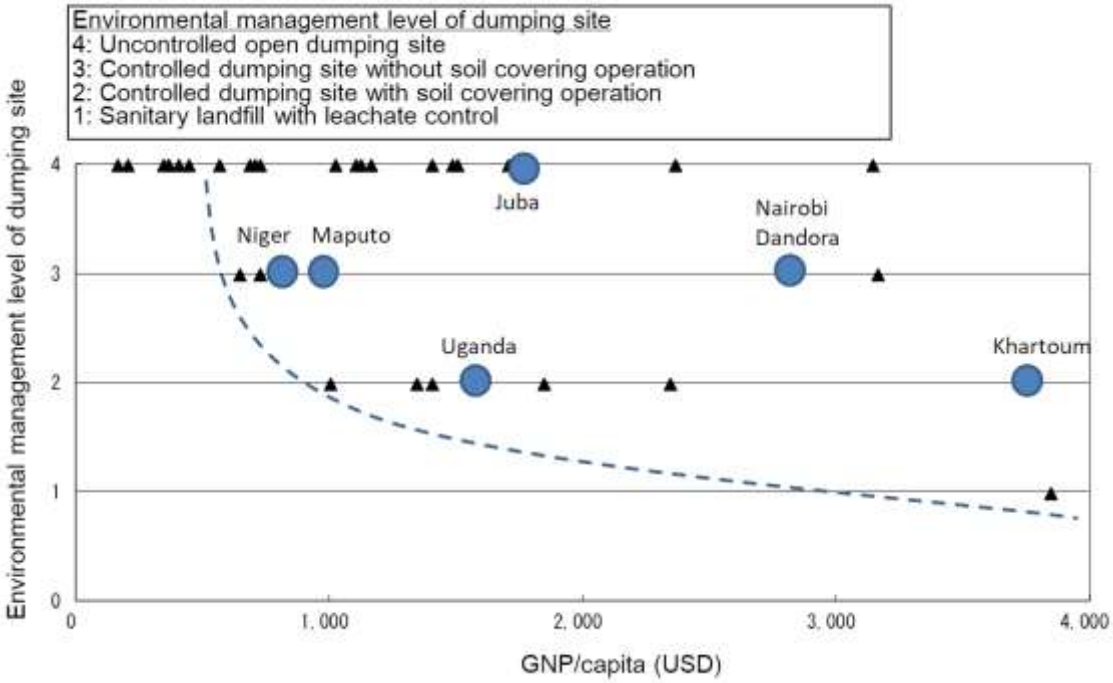


Figure 11: Correlation between management level of final disposal site and economic growth (GNP/capita). The dashed line indicates the front line for improving the management level. Black triangles indicate the data of other countries around the world and the circles indicate the data of African countries obtained from the present study.

In other words, in most African cities, municipal solid waste is collected and transported inadequately, as described in the previous section, and in most cases, solid waste is discarded in uncontrolled open dumpsites. Under such harsh conditions, unfortunate accidents occur frequently at the final disposal sites. In April 2018, a severe dumpsite collapse occurred at Maputo's final disposal site (Fig. 10) leaving 16 people dead. Similarly, in March 2017, an open dump site collapsed in Ethiopia's Addis Ababa, killing 62 people. Insufficient management of the final disposal site is dangerous for the residents and causes environmental pollution. It should be noted that many of these residents are socially vulnerable waste pickers who collect recyclables from the final disposal site and essentially contribute to municipal waste management in other ways.

3-4. Reduction of waste by intermediate treatment

As the basic municipal SWM service of collecting, transporting, and finally disposing of generated waste is promoted, the total amount of solid waste steadily increases due to urbanization. However, there is limited land for the final disposal site and a limited dumpsite capacity. Securing a new final disposal site in Africa is becoming difficult. Therefore, it is necessary to promote “reuse and recycle” by introducing intermediate treatment technologies in the middle of the SWM flow, and to reduce the volume of the final disposal waste. The present survey revealed that several cities in Africa are advancing various efforts to introduce intermediate treatment technologies (see Annex 1), but they are still in the beginning stage. Metal (aluminum, copper, and iron), used paper, cardboard, old clothes, and hard plastic etc. are recyclables for material recycle. Apart from this, composting and biogas production are also undertaken.

The ratio (%) between total waste generated and recycled volume by the intermediate treatment is as follows: Algeria 3%, Cameroon 5%, Madagascar 3%, and Morocco 4%, that is, within the range of 5% or less. This is not a very high rate and the rest is landfilled. Recycling items are affected by the local market; for example, in Mozambique, where there is no glass bottle recycling market, large quantities of glass bottles are crushed and discarded in the dumpsite. With regard to recovering energy other than material recycling, waste incineration and electric generation facility has been introduced in Addis Ababa and biogas power generation has been introduced in Uganda. South Africa has many advanced cases. However, Africa is at a preliminary stage in this regard (Fig. 12).

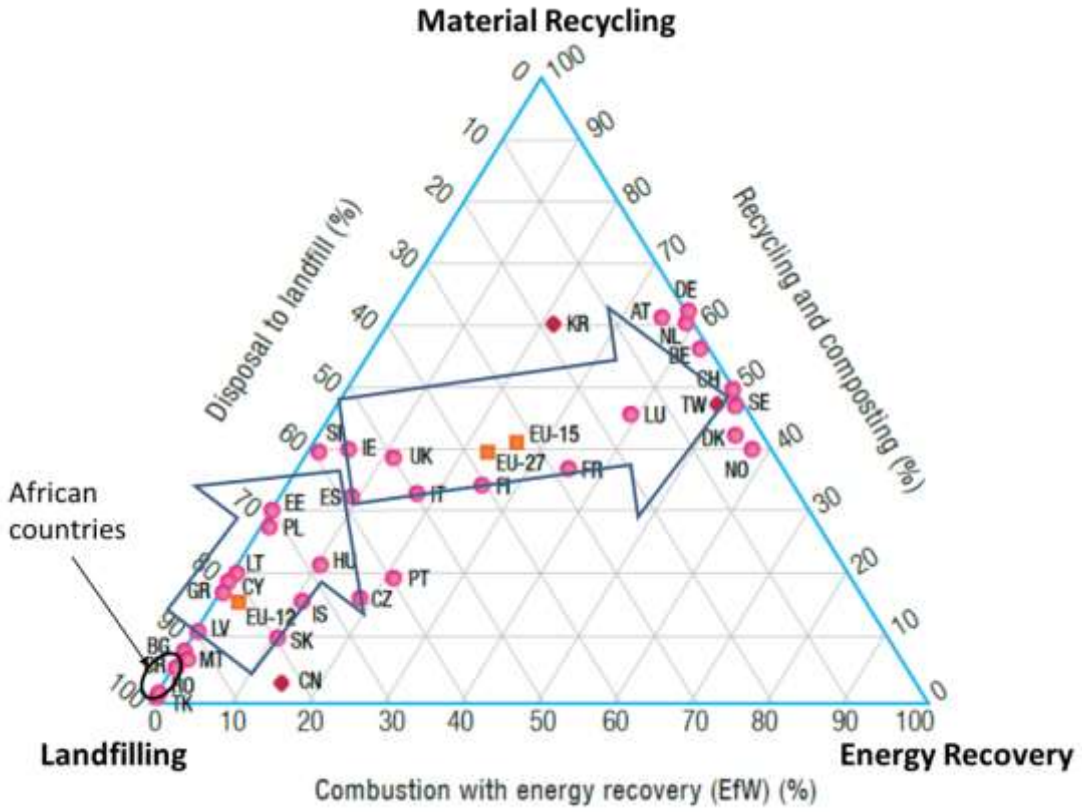


Figure 12: Widely recognized development trend of SWM. The state of most African countries is direct landfilling, and the promotion of material recycle will be an issue in the near future. Data Source: UNEP-ISWA (2015)

The triangular diagram (Fig. 12) shows the development trend of waste management throughout the world, using three terminal components: the bottom left terminal point "Landfilling," the top terminal point "Material Recycling," and the bottom right terminal point "Energy Recovery." The average trend of worldwide SWM development is shown by two arrows to reduce the amount of landfilling as much as possible and to promote material recycling. Waste-to-Energy is introduced and advanced to energy recovery, and ultimately the amount of landfilling approaches almost zero (UNEP-ISWA, 2015). African countries are still close to the starting point (full landfilling) and are in the rudimentary stage. Therefore, the basic direction of improvement of SWM in Africa will be dealt with in a way that promotes material recycling. It will be a challenge in the future to improve the system and to involve the private sector and informal sector in the formal SWM system, which is currently responsible for material recycling.

3-5. Development stage of waste management in Africa

The history of waste management in the world is broadly divided into four stages (Yoshida, 2012). The first stage is for securing public health and establishing waste collection and transportation services in the cities. The second stage is for protecting the environment, which refers to properly disposing collected solid waste, thereby minimizing environmental impact. The third stage is for introducing intermediate treatment technologies and reducing final disposal volume. The fourth stage is to form a material cycle society or a circular economy not only for waste management but also to effectively utilize resources for sustainable development (Fig. 13).

Each city in Africa is currently being addressed with a focus on ensuring public health through the establishment of collection and transportation of waste (the first stage). In a regional city, which has been established to a certain extent, the construction of a second stage sanitary landfill site is being considered. The third stage is still in trial, except for the spontaneous activities of the informal sector.

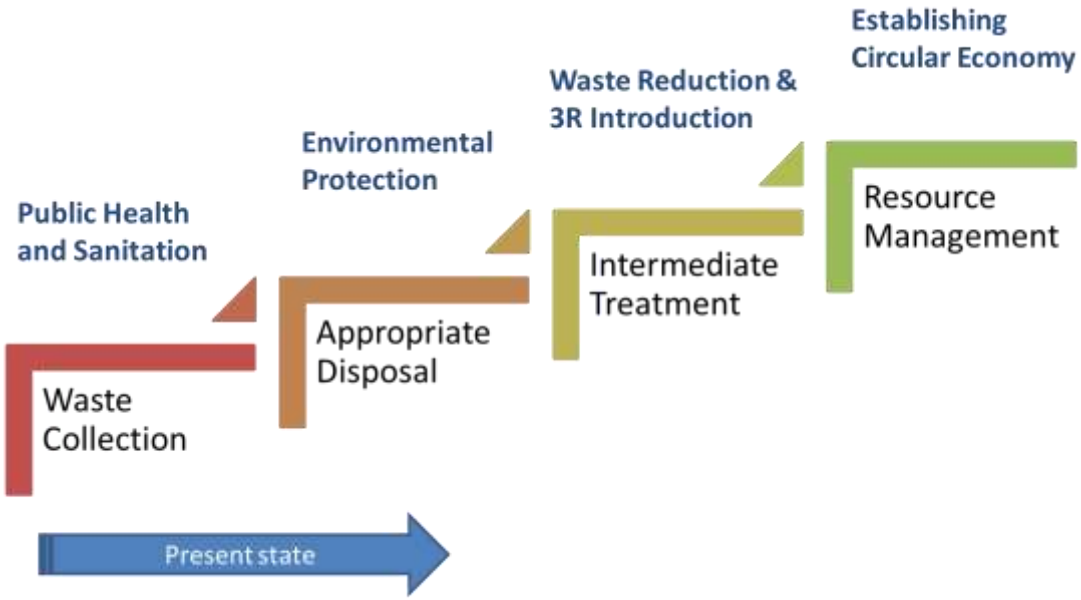


Figure 13: Present position of SWM in Africa (shown by the arrow) within the four-stage development model for SWM. The model has been adopted from Yoshida (2012).

3-6. Problem analysis of urban waste management project in Africa

The results of the problem analysis workshop held at the First ACCP Meeting (2017) are summarized in Fig. 14. The workshop was organized by three groups: Group-1 (Ethiopia, Malawi, South Sudan, Uganda, and Zimbabwe), Group-2 (Botswana, Egypt, Ghana, Kenya, Namibia, Nigeria, Sudan, and Zambia), and Group-3 (Burkina Faso, Cameroon, Cote D'Ivoire, DR Congo, Djibouti, Madagascar, Morocco, Mozambique, Niger, Congo, Senegal, and South Africa). In the workshop organized by the three groups, the current problems faced by existing SWM projects were analyzed according to each of the four management components: waste generation/discharge, collection and transportation, intermediate treatment, and final disposal (Fig. 14).

(1) There were three major problems in the "waste generation/discharge" component: (i) rapid increase of waste generation under urbanization, (ii) scattering of waste along the streets in the city, and (iii) insufficient waste collection and transportation service. The following three reasons were pointed out about the cause of the problems: rules on waste and compliance were not ensured, law enforcement and legal regulations were not adequately formulated, and education or awareness raising was insufficient.

(2) Regarding the "collecting and transporting" component, two problems were commonly reported: (i) The first was insufficient facilities and equipment for collecting solid waste against the amount to be collected, and a limited service coverage rate. (ii) The second problem was that, depending on the city or country, private collection and transportation service providers largely implemented waste collection but as these non-governmental business activities were not properly authorized, supervised, and controlled by the public authority, it often caused illegal or irregular disposal of solid waste in and around cities.

(3) In the "intermediate processing" component, (i) technological management problems concerning compost production from municipal waste were pointed out, (ii) efforts for introducing Waste-to-Energy such as the waste incineration power generation started at Addis Ababa in Ethiopia. (iii) Since Africa was still at a very rudimentary stage, there were many difficulties regarding the introduction of various technologies for intermediate processing, (iv) the market of recyclables did not grow sufficiently in Africa, and (iv) economic incentives for recycling were hard to formulate. Due to this, cost recovery concerning the operation and maintenance of equipment and facility was a very serious problem and, thus, sufficient collaboration with the private sector was required. Without close cooperation, there is no sustainable development of intermediate processing technology.

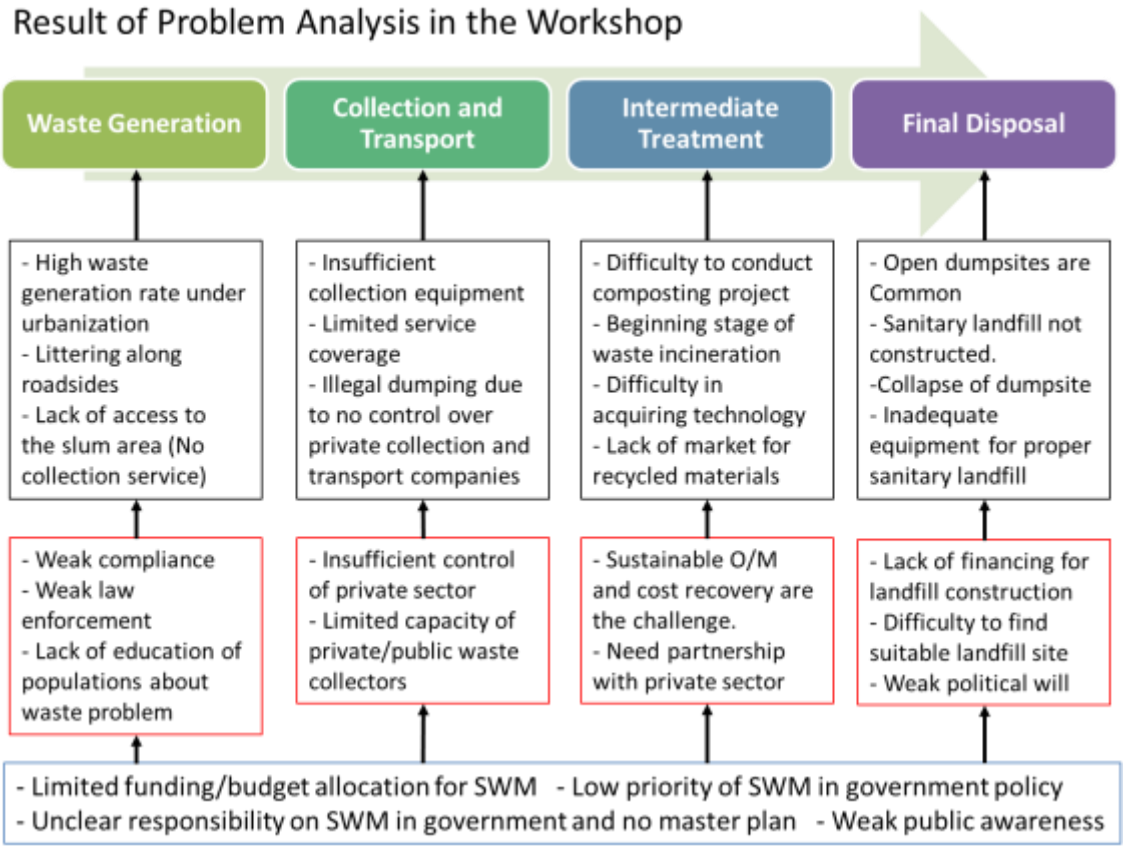


Figure 14: Summary of the result of problem analysis in the workshop in the First ACCP Meeting (April 2017).

(4) The problem in the "final disposal" component was that (i) open dump sites continued to occupy an overwhelmingly large area in Africa and a somewhat sanitary disposal was constructed in a small area. (ii) Under such circumstances, there were many casualties due to overloading at open dump sites and accidental garbage collapses. (iii) It was quite difficult to acquire suitable land for constructing a landfill disposal site, and the capital investment for construction was also insufficient.

(5) Four problems were recognized overall for SWM, which were common causes or were a background to the problems of the above-mentioned four management components. The first common problem was that since the public authority and politicians did not necessarily prioritize waste management projects, there were very limited financial measures. The second common problem was that there was ambiguity in the basic implementation system so the responsibility and mandate for waste management was not set clearly. The third common problem was that the actual situation of SWM (data concentration) and the underdeveloped master plan and implementation plan was insufficiently grasped. The fourth common problem was the weak public awareness about waste management and the environment. These collectively outlined the results of the problem analysis on SWM in Africa.

4. Implementation structure of municipal SWM system

SWM system covers various activities for the entire life-cycle of waste from generation, collection and transportation, and intermediate treatment to final disposal. To activate the system, technical components along with organizational, institutional, economic, and societal components are required.

Based on the questionnaire survey, the outline of the implementation structure of SWM system, including organizational, institutional, economic, and social components, is summarized and a preliminary capacity assessment is made.

4-1. Business form of SWM

First, the business form of the implementation system is classified into the following three types:

1) Mainly undertaken as a direct publicly-owned business (directly managed)

2) Entrusted to private enterprises or licensed and implemented in private (privatized)

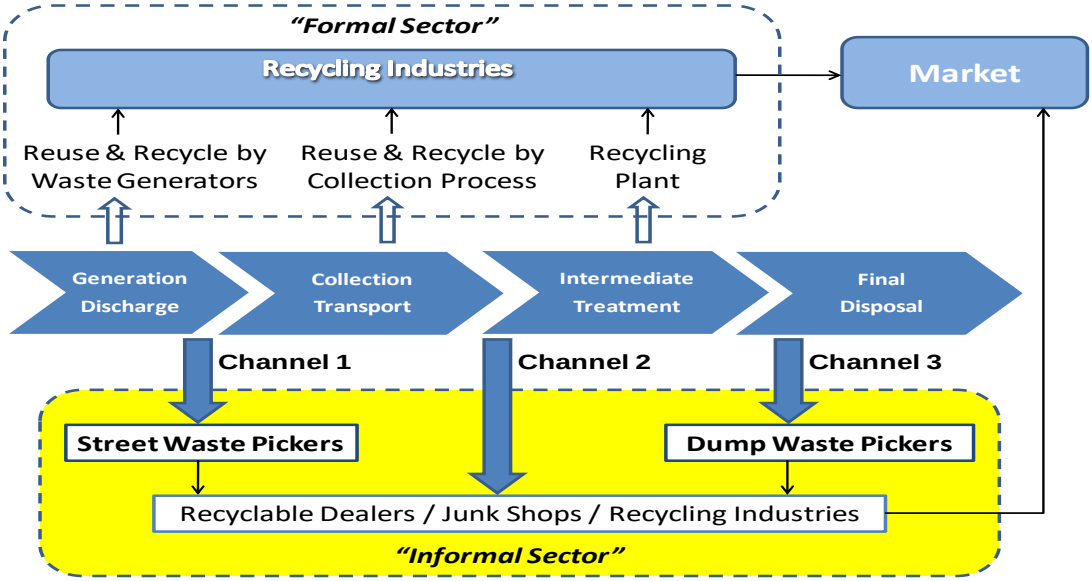
3) Disorganized waste management businesses, both conducted by public and private firms without administrative supervision and coordination (mixture of uncontrolled private and public direct operations).

The results are shown in Fig. 15, where 47% are directly managed, 29% are privately owned, and 24% are a disorderly mix of public and private operations.

Figure 15: Business form of municipal SWM in 17 African countries.

BOX 2: Informal sector in SWM

Municipal SWM is conducted not only by the formal sector (public organizations and licensed private business, etc.) but by the informal sector (waste pickers and unlicensed business, etc.) as well. The formal and informal sector activities in SWM flow, collection and transportation, intermediate treatment, and final disposal are summarized in the figure. The large arrow shown in the middle part of the figure indicates the flow of SWM processing, and the zone above the arrow refers to activities of the formal sector authorized by public authorities, which include the officially-recognized reuse and recycle activities. On the other hand, the zone below the arrow shows the activities of reuse and recycle by the informal sector, which are not officially recognized. The informal sector is generally active through three channels in the zone below the arrow: (i) Channel 1: Reusables and recyclables are collected from waste generation sources or discharge points by street waste pickers. (ii) Channel 2: Reusables and recyclables are collected by waste collection/transportation or intermediate treatment workers from the stage of collection and transportation to intermediate treatment. (iii) Channel 3: Reusables and recyclables are recovered from the solid waste brought to the final disposal site by dump waste pickers. Reusables and recyclables recovered from the waste pickers flow to junkshops, middle dealers, recycling industries, and eventually come into the market. Informal sector activities are through the three channels. Waste pickers in the informal sector are generally socially vulnerable people, such as slum inhabitants and small-scale private recyclers, who contribute to the promotion of reducing the waste amount through reuse. If the public sector properly recognizes their role and supports and coordinates with them, which means an integration to SWM, it will be possible to construct a more reasonable and efficient SWM system.



Source: Yoshida (2010)

4-2. Capacity assessment method of waste management system

In order to assess the capacity of municipal SWM system, a questionnaire survey and workshop/interview were held using the Development Level Indicator (DLI) for four issues, A, B, C, and D. The rating includes a six-level evaluation from "0" (a state of nothing done) to "5" (a state of full implementation), and the minimum level for system implementation is defined as "3." These DLIs can correspond to individual, organizational, and institutional/societal levels (JICA, 2005). The four issues of DLI are as follows:

A) Status of establishing a legal/institutional system concerning municipal SWM: The DLI (A) rating is indicated by six levels (0 to 5) as shown in Table 2(A). This shows the level of capacity at the institutional level on waste management.

B) Status of establishing an implementing organization of municipal SWM: The DLI (B) rating is indicated by six levels (0 to 5) as shown in Table 2(B). This shows the level of capacity at the individual and organizational levels for waste management.

C) Establishment of financial system for municipal SWM: The DLI (C) rating is indicated by six stages (0 to 5) as shown in Table 2(C). This relates to the capacity at organizational and institutional/societal levels related to waste management.

D) Availability of SWM data: This shows the status for grasping the actual condition of municipal SWM. The DLI (D) rating is indicated by six levels (0 to 5) as shown in Table 2(D). This relates to the capacity at organizational and institutional/societal levels related to waste management.

Table 2(A): Establishment of a legal/institutional system (laws, regulations, standards, and guidelines) on municipal SWM

Rating	Description of DLI (A)
0	The legal system on SWM is not in place.
1	Only a conceptual definition on waste is mentioned by a basic law and not a specific definition.
2	There is a general definition on waste management but not a specific one.
3	There is a specific law(s) indicating specific definitions for waste management.
4	There are detailed bylaws, regulations, standards, and guidelines for law enforcement and effective implementation.
5	There is a law, policy, and/or plan for achieving the SDG Goal 11 (sustainable cities and communities) and Goal 12 (responsible production and consumption)

Table 2(B): Establishment of an implementing organization

Rating	Description of DLI (B)
0	There is no public office or implementation agency for SWM.
1	There is an office in-charge on SWM in the central government, but no implementation agency is established. Control for SWM is not functional.
2	Implementation agencies for SWM are partly established in large cities and in the central government.
3	Implementation agencies have been established over the country but are not always functional.
4	Implementation agencies are mostly functioning and central government office controls and supports them.
5	There is a central government office and local implementing agencies having policies and plans to achieve SDG Goals 11 and 12.

Table 2(C): Establishment of a financial system for municipal SWM

Rating	Description of DLI (C)
0	There is no public budget and financing for implementing or controlling SWM
1	There is very limited public budget for SWM but almost no budget allocation or financing

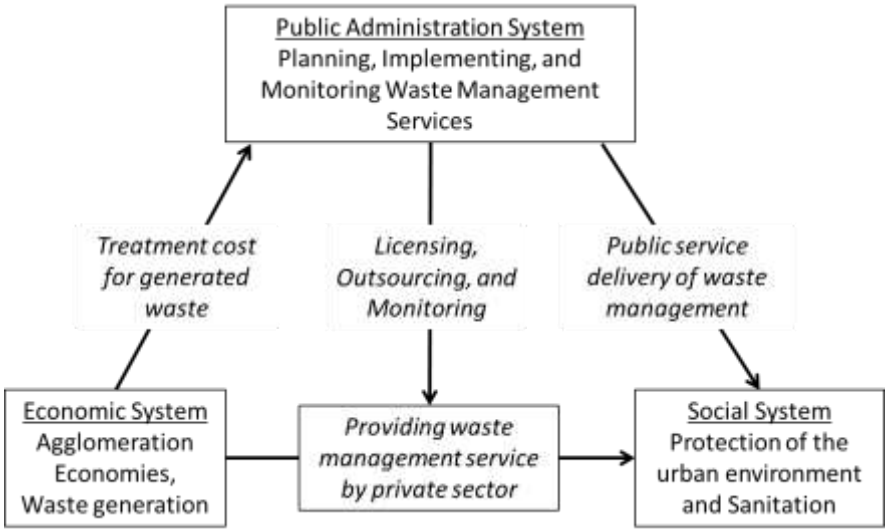
	for local SWM implementation. Actual SWM services are mostly by private sector without any public control.
2	There is limited financial mechanism for implementing SWM service controlled by public sector mainly in large cities.
3	A financial system has been established for implementing SWM service under public or public-private partnership, but it is still fragile and unstable in the investment.
4	A financial system for SWM has been fully established under public or public-private partnership, which is stable and sustainable.
5	A financial system for SWM targeting SDG Goals 11 and 12 has been fully established under public and public-private partnership.

Table 2(D): Availability of SWM Data (waste generation, composition, service coverage, recycling, and disposal, etc.)

Rating	Description of DLI (D)
0	No public data is available.
1	Some data is available, but the reliability is uncertain.
2	There is limited reliable data but spot data in academic research and/or survey by donor agencies is available.
3	Public authority collects SWM data, but not periodically, and there is a variation in data quality.
4	Public authority accumulates SWM data systematically and publishes them periodically.
5	Public authority accumulates SWM data and indicators relating to SDG Goals 11 and 12 for monitoring sustainable development policy.

BOX 3: Role of the administration

An effective and transparent institutional framework is essential for good governance in a municipal SWM. Without such a framework, the municipal SWM cannot function or sustain itself. In addition, a municipality must have the capacity and the organizational structure to manage finances and services in an efficient and transparent manner. Clear budgets and lines of accountability are essential (ISWA, 2010). To establish effective and efficient SWM in urban areas, the major three systems: economic system, social system, and public administration system, should be properly coordinated (Yatsugi, 2004). The economic system generates economic profit under the agglomeration economies and, at the same time, is a major waste generator. The social system provides and protects the urban environment for people. The public administration system must collect the cost for the treatment of generated waste from the economic system and deliver public service of waste management for the social system. Under the mechanism of public-private partnership (PPP), the public administration system is expected to control the private municipal SWM service activities through licensing, outsourcing, cooperation, and monitoring. In order to further develop the relationship among the three systems, economic instruments like unit pricing, deposit refunds, product charges, recycling subsidies, and taxes on primary product inputs are important tools.



Providing SWM services by private sector and administrative roles (modified from Yatsugi, 2004).

4-3. Results of analysis using DLI

Based on the descriptions of the above four types of DLI, the capacity rating of municipal SWM system is evaluated by country and the results are summarized with other socio-economic information and SWM data, as shown in Table 3. Fig. 19 illustrates each rating by country, together with the national income level (GNI/capita).

Table 3: Rating results of DLIs (A), (B), (C), and (D). Population, GNI/capita, and HDI (Human Development Index) have been adopted from UNDP (2016). Waste generation (W(t/d)), waste generation rate (rate (kg/capita/year)), and prediction of waste generation amount in 2025 (W2025 (ton/day)) have been adopted from the World Bank (2012).

Country	Population	GNI	HDI	W(t/d)	Rate	W2025	A	B	C	D	Operation	Collect %
Djibouti	560,979	3,216	0.473				3.0	2.5	3.0	2.0	Direct	
Namibia	2,303,000	9,770	0.640	356	0.50	1,103	2.0	3.5	3.0	2.5	Direct	
Senegal	14,500,000	2,240	0.494	2,438	0.52	7,643						21%
Kenya	45,500,000	2,881	0.555	2,000	0.30	10,171	1.0	2.0	3.0	3.0	Private	
Zimbabwe	14,600,000	1,588	0.516	2,356	0.53	5,277	2.0	2.0	3.0	2.0	Direct	
South Africa	53,100,000	12,087	0.666	53,425	2.00	72,146						
Cote d'Ivoire	20,800,000	3,163	0.474	4,356	0.48	10,974						
South Sudan	11,300,000	1,882	0.418				0.5	1.5	1.0	0.5	Mix	
Sudan	38,800,000	3,846	0.490	10,000	0.79	32,467	1.5	2.0	2.0	2.5	Direct	
Ethiopia	96,500,000	1,523	0.448	3,781	0.30	19,690						
DR Congo	80,000,000	680	0.435	9,425	0.50	36,735	1.0	1.0	1.0	1.0	Mix	
Rep. Congo	4,600,000	5,503	0.592	1,096	0.53	2,759						
Burkina Faso	19,034,397	1,537	0.402	1,288	0.51	5,174	3.0	2.5	3.0	2.5	Direct	
Niger	17,138,707	889	0.353	1,068	0.49	4,127	1.5	2.0	2.0	1.5	Direct	
Morocco	33,500,000	7,195	0.647	23,014	1.46	44,389	3.0	3.0	4.0	3.0	Mix	72-100%
Zambia	15,000,000	3,464	0.579	842	0.21	3,774	2.5	2.0	2.5	3.0	Direct	20%
Malawi	13,066,320	1,073	0.476	1,151	0.50	4,926	1.5	2.5	2.0	2.5	Mix	
Uganda	38,800,000	1,670	0.493	1,179	0.34	6,313	2.0	3.0	3.0	3.0	Private	39%
Egypt	92,897,000	10,064	0.691	40,822	1.37	83,583	1.5	3.0	3.5	3.0	Private	
Nigeria	177,155,754	5,743	0.527	40,969	0.56	101,307				2.5		
Ghana	26,900,000	3,839	0.579	1,000	0.09	9,857	1.0	2.0	3.0	3.0	Private	85%
Madagascar	24,430,325	1,320	0.512	3,734	0.80	12,485	1.0	2.0	2.0	2.0	Direct	18%
Cameroon	22,800,000	2,894	0.518	6,082	0.77	17,194						
Botswana	2,000,000	14,663	0.698	890	1.03	2,227						
Mozambique	28,000,000	1,098	0.418	1,052	0.14	7,247					Private	

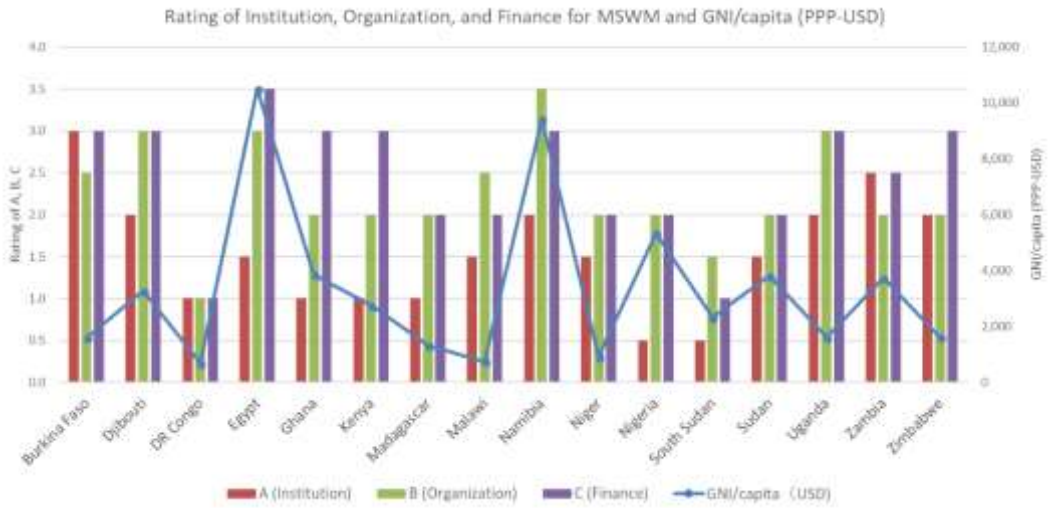


Figure 16: DLI Rating (bar diagram) and gross national income per capita (polygonal line) for each country.

A) Status of legal/institutional system

The average DLI (A) rating of the 16 countries on the development status of the legal system, standards, and guidelines is 1.75. Djibouti, Burkina Faso, and Morocco have a high rating of 3.0 while South Sudan has a low rating of 0.5. Except for the three countries mentioned above, the DLI (A) indicates a very low rating, which means the state of establishment of the legal system concerning SWM is lacking, and the actual SWM project is carried out without a well-defined legal and institutional basis. The responsibilities of SWM implementation are not legally clarified in many countries.

B) Status of implementing organization

The average DLI (B) rating of the 16 countries on the status of improvement of the implementing organization is 2.28. Namibia, Morocco, Uganda, and Egypt have a high rating of 3.0 while D.R. Congo has a low rating of 1.0. Despite the inadequacy of the legal/institutional system setup, SWM authorities are being assembled in large cities. In many countries, however, local cities have been left behind and SWM services have not yet covered the entire population.

C) Status of SWM financial system

The average DLI (C) rating for the 16 countries concerning the development status of waste management finance is 2.56. Morocco and Egypt have a high rating of 4.0 and 3.5 respectively while D.R. Congo and South Sudan have a low rating of 1.0. A financial system was established for SWM for all countries, except the above two with the 1.0 rating, and public-private partnership (PPP) started in large cities.

D) Availability of SWM data (waste generation amount, collection rate, recycling amount, and final disposal amount etc.)

The average DLI (D) rating of 17 countries is 2.32. Kenya, Morocco, Zambia, Uganda, Egypt, and Ghana have a high rating of 3.0 while South Sudan has a low rating of 0.5. SWM data and related social data serve as basic information for planning and implementing the SWM project, but in a majority of countries, the SWM data is quite basic (generation amount, etc.), and could be obtained based on researchers' spot investigation data, etc.

4-4. Correlation among DLI ratings

Based on the concept of Cross Country Analysis, we examined the mutual relationship between these four DLI ratings:

(1) Institutional Capacity (DLI (A)) and Organizational Capacity (DLI (B))

Figure 17 illustrates the correlation between the ratings of DLI (A) (legal/institutional system) and DLI (B) (implementing organization), which shows a weak positive correlation ($r^2 = 0.2993$). As shown in the figure legend, different colored plots show the difference in business form as mentioned in the previous chapter. Red is primarily implemented by private firms supervised by public authority or public-private partnerships, blue suggests waste management services that are directly carried out by the public authority, and yellow is a mixed public and private business with almost no public control and coordination. Focusing on the business form, public direct-managed type (blue) and private type (red) appear when the ratings of DLI (A) and the DLI (B) are relatively high, whereas when both DLIs are relatively low, a mixed disordered type business (yellow) is presented.

(2) Organizational Capacity (DLI (B)) and Financial Capacity (DLI (C))

The correlation between the ratings of DLI (B) (Organizational) and DLI (C) (Financial) is shown in Fig.18. There is a positive correlation ($r^2 = 0.5704$), indicating that organizational capacity development and financial development are closely linked. In the case of a private business with control, the financial capacity rating of DLI (C) is high. In the case of mixed type without control, the financial capacity is low.

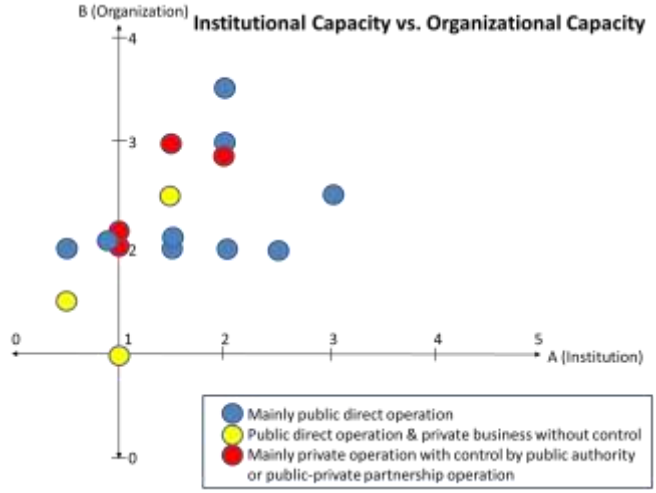


Figure 17: Correlation between Ratings of DLI (A) (legal/institutional) and Indicator B (implementing organization). No clear correlation seen between both indicators. Few institutional and organizational capacities can be identified in SWM service when the business type is a mix of public and private, without control by public. Determination coefficient (r^2) = 0.2993

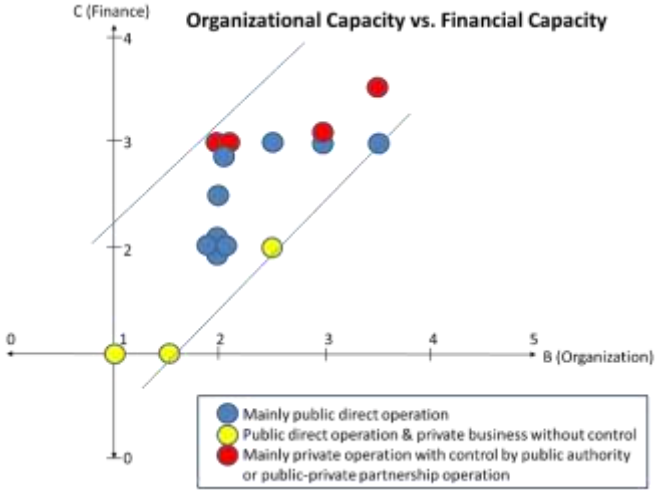


Figure 18: Correlation between the ratings of DLI (B) (Organizational) and DLI (C) (Financial). There is a positive correlation between the two indicators. In general, private or public-private partnership operation has a high rating of DLI (C). Determination coefficient (r^2) = 0.5704

(3) Institutional Capacity (DLI (A)) and Financial Capacity (DLI (C))

The correlation between the ratings of DLI (A) (Institutional) and DLI (C) (Financial) is displayed in Fig. 19. They do not show a weak positive correlation, which suggests that there is a link between the establishment of a legal/institutional system and the establishment of a sustainable financial system. In the case of private business type, the ratings of DLI (C) is always high, while in the case of disorderly mixed type business without control, the rating of DLI (C) is always low, which means that financial stability is related to business style.

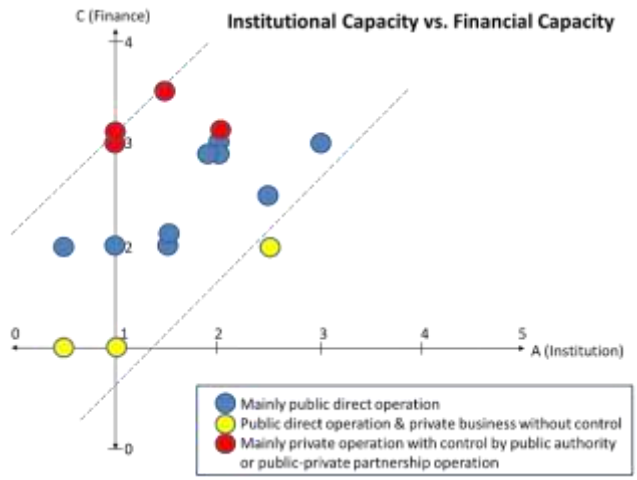


Figure 19: Correlation between the ratings of DLI (A) (Institutional) and DLI (C) (Financial). A weak positive correlation can be observed.
Determination coefficient (r^2) = 0.3939

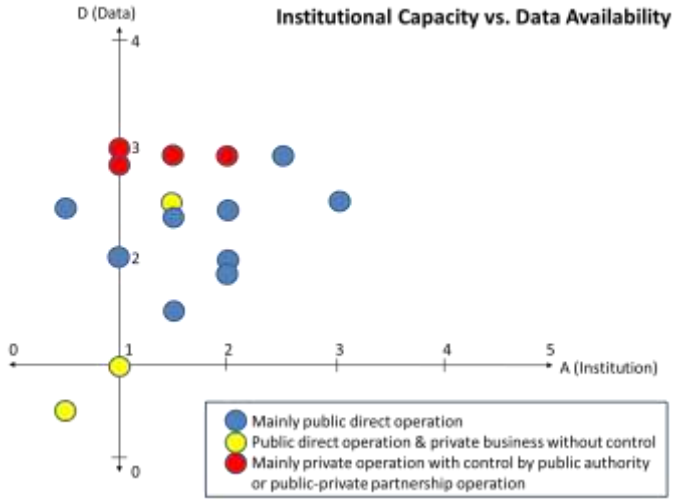


Figure 20 Correlation between the ratings of DLI (D) (Data availability) and DLI (A) (Institutional). No clear correlation between both indicators. Data availability (rating of DLI (D)) is high in private business with control.
Determination coefficient (r^2) = 0.1656

(4) Availability of SWM Data (DLI (D)) and Other Indicators

The correlation between the ratings of DLI (D) (Data availability) and DLI (A) (Institutional) is shown in Fig.20, DLI (D) (Data availability) and DLI (B) (Organizational) in Fig. 21, and DLI (D) (Data availability) and DLI (C) (Financial) in Fig. 22. No correlation is observed in DLI (D) and DLI (A), but in the other three cases, positive correlations can be observed. In the well-controlled private operation system, the availability of SWM data is relatively well functioned.

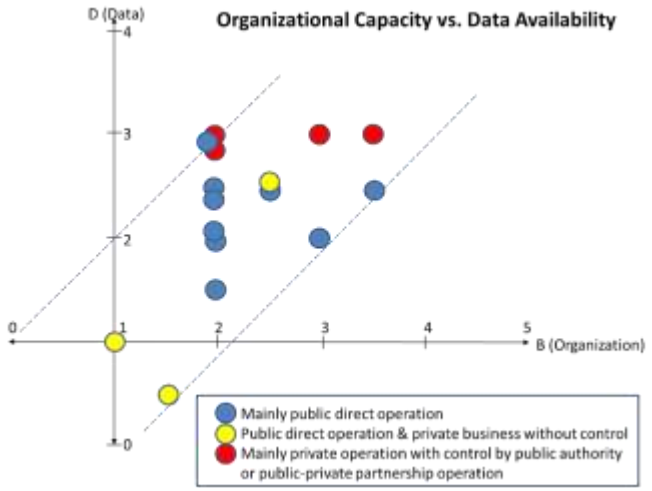


Figure 21: Correlation between the ratings of DLI (D) (Data availability) and DLI (B) (Organizational). A weak positive correlation can be observed between both indicators. Determination coefficient (r^2) = 0.395

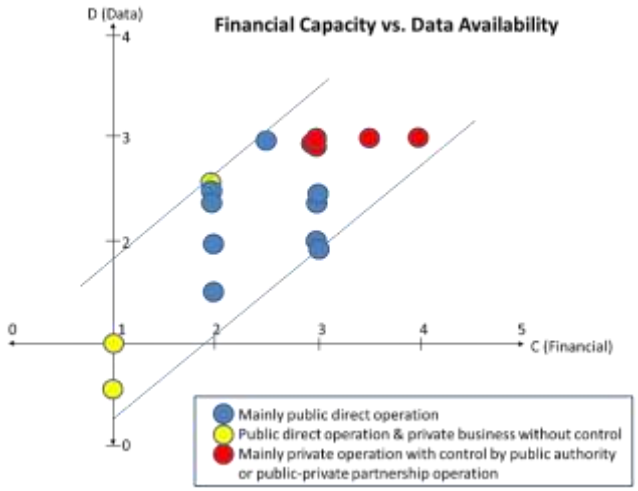


Figure 22: Correlation between the ratings of DLI (D) (Data availability) and DLI (C) (Financial). A positive correlation can be observed between both indicators. Determination coefficient (r^2) = 0.634

(5) Correlation between the ratings of each DLI and HDI

The Human Development Index (HDI; UNDP, 2014) is a statistical index that combines life expectancy, adult literacy rate, school enrollment rate, and Gross Domestic Product (GDP/capita) etc. Fig. 23 shows the relationship between HDI and the ratings of DLI (A), (B), and (C).

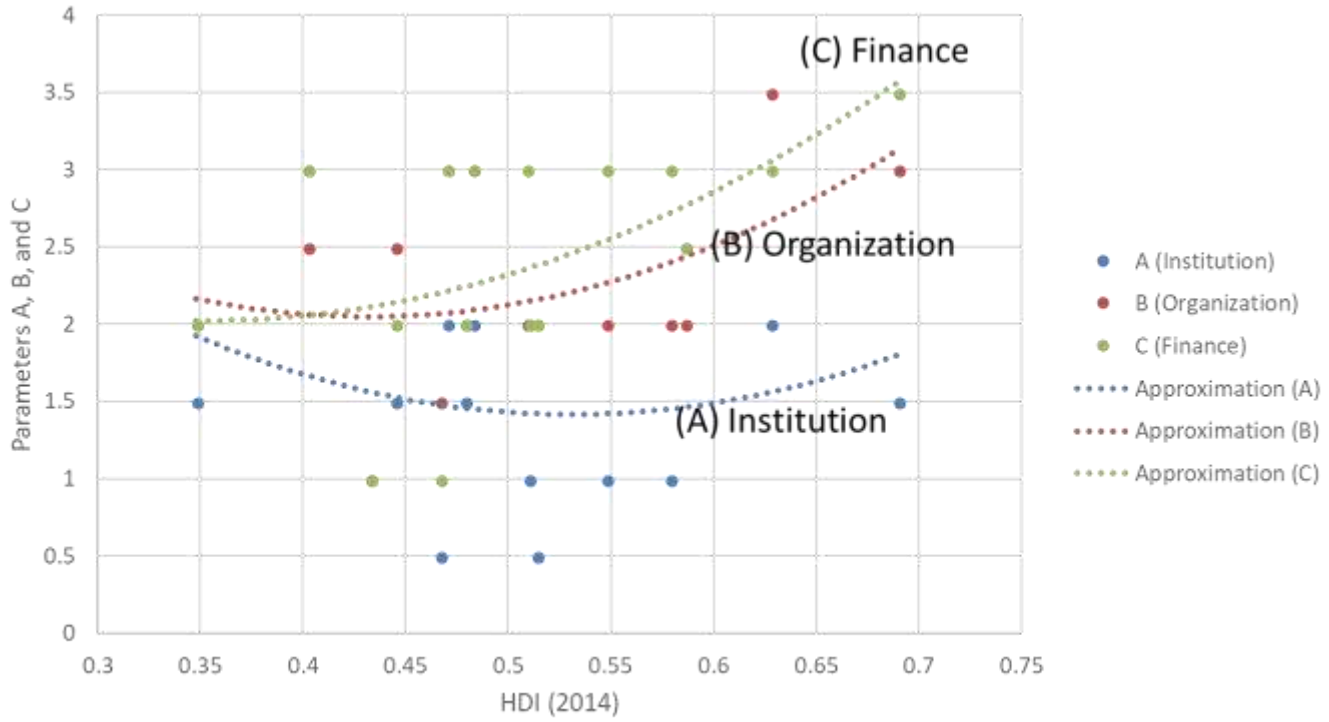


Figure 23: Relationship between HDI and the readings of DLI (A), (B), and (C). HDI (2014) is taken on the horizontal axis and the rating of each DLI is taken on the vertical axis. The dotted line shows each polynomial approximate curve. DLI (B) and (C) show positive correlation with HDI, but DLI (A) is almost constant without being affected by HDI. Source of HDI: UNDP (2014)

The HDI of African countries shows a wide range from 0.35 to 0.69, where the ratings of DLI (B) and (C) increase according to the improvement of HDI. This means that the progress of human development results in an enhancement of organizational and financial capacity in SWM. However, the rating of DLI (A) is almost constant (flat) indicating that the progress of human development does not lead to the improvement of the legal/institutional system.

(6) Correlation between the ratings of each DLI and economic development

Using GNI/capita (USD in purchasing power parity) as an indicator of economic development, the progress of economic development is related to the ratings of DLI (A), (B), and (C) (Fig. 24). As seen in the case of HDI, the ratings of DLI (B) (organizational) and DLI (C) (financial) exhibit a positive correlation with economic development (GNI/capita). However, about the rating of DLI (A) (institutional), it remains constant (flat) as a whole, which goes against economic development. This suggests that institutional development is a somewhat unique issue that does not necessarily lead by economic development in few African countries.

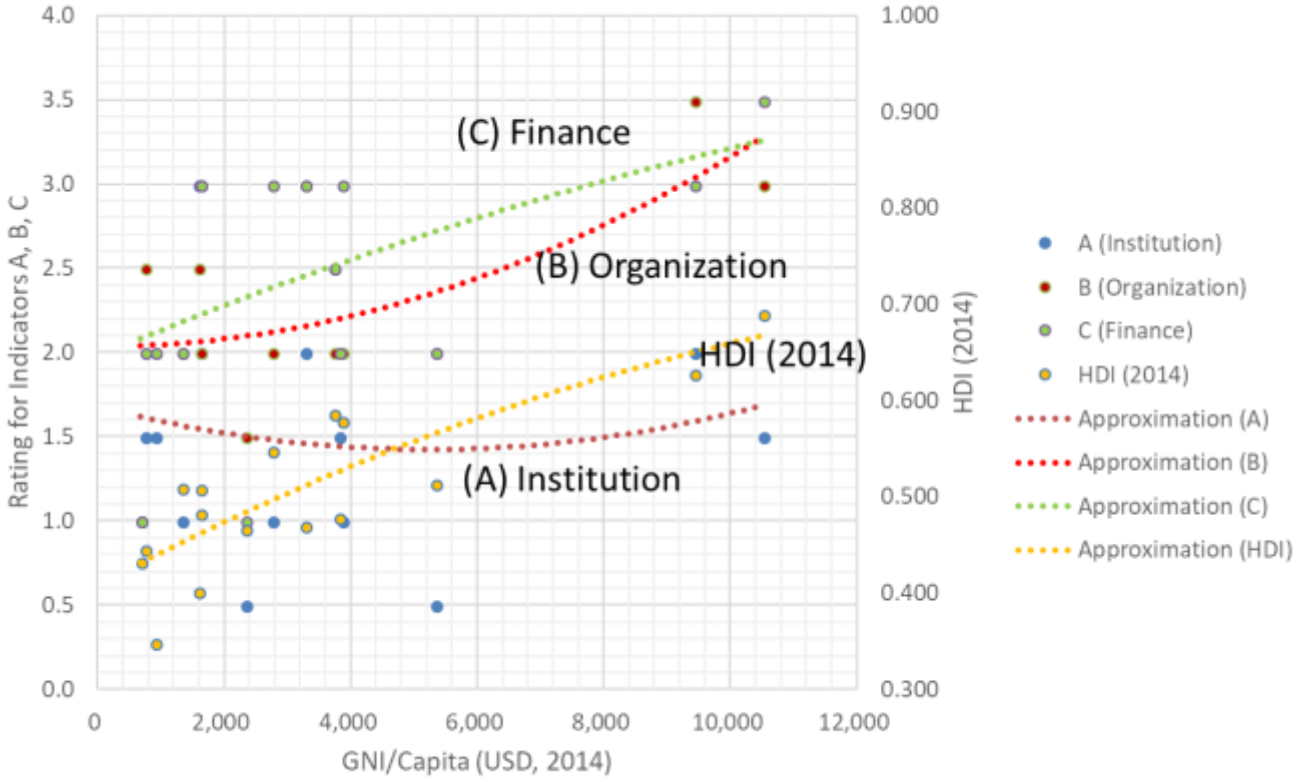


Figure 24: Relationship between the average national income per capita (GNI/capita), the readings of DLI (A), (B), and (C), as well as HDI. GNI/capita (USD in purchasing power parity) is taken on the horizontal axis, the ratings of DLI (A), (B), and (C) on the left vertical axis, and HDI (2014) on the right vertical axis. The dotted line is a polynomial approximate curve for each relationship. The source for GNI/capita and HDI has been adopted from UNDP (2014).

4-4. Summary of capacity assessment using DLIs

Based on the above-mentioned observations, the following points were clarified regarding the capacity of municipal SWM system in African countries. The determination coefficient (r^2) for each correlation is summarized in Table 4.

Table 4: Determination coefficient (r^2) based on regression analysis among the ratings of DLIs (A), (B), (C), and (D).

	A	B	C	D
A	-	0.2993	0.3939	0.1656
B		-	0.5704	0.3945
C			-	0.6335
D				-

(1) It was revealed that there were positive correlations between DLI (B) (organizational) and DLI (C) (financial), and DLI (C) (financial) and DLI (D) (data availability). This means that organizational development is an inevitable challenge for financial enhancement, and SWM data availability will be improved when the financial capacity is enhanced.

(2) There were also some weak correlations between DLI (B) (organizational) and DLI (A) (legal/institutional), and DLI (B) (organizational) and DLI (D) (data availability). This means that organizational development is linked to the legal/institutional capacity, and if the organizational capacity is enhanced, SWM data availability is improved.

(3) On the other hand, there was no clear correlation between DLI (A) (legal/institutional) and DLI (B) (organizational), and DLI (A) (legal/institutional) and DLI (D) (data availability). Separate from the task of legal/institutional capacity strengthening, some unique efforts are probably necessary for organizational development and acquisition of SWM data. In the well-controlled private-operating business, the acquisition and consolidation of SWM data is relatively well functioned.

(4) Private outsourcing and private partnership (PPP) projects show a relatively strengthened capacity at the organizational and financial level. The availability of SWM data is also good. It is necessary to strengthen the capacity of the role of administrative authority for supervision, monitoring, and coordination with the private sector.

(5) There is a positive correlation between HDI and the ratings of DLI (B) (organizational) and DLI (C) (financial). On the other hand, there is no correlation with the rating of DLI (A) (institutional). This means that while factors of human development make a certain contribution to improve organizational and financial aspects as an external condition of SWM, they do not concern themselves with the improvement of the legal/institutional development. In order to develop a legal system and institution, its own efforts are necessary.

(6) An indicator of economic development (GNI/capita) is positively correlated with the ratings of DLI (B) (organizational) and DLI (C) (financial). However, it does not show any correlation with DLI (A) (institutional). Similar to the correlation with HDI, economic factors have little relation with the enhancement of the legal/institutional development. This indicates that improvement of general capacity, such as economic growth or human development, does not always automatically improve the legal/institutional system for SWM.

5. Development drivers for SWM in African countries

What is the development driver (promotional factor or agent) for SWM activities? Based on the argument by Wilson (2007), six drivers in two groups are set up according to the current situation in Africa. As technical drivers of SWM, the following three drivers can be identified: (1) Securing public health and sanitation, (2) Protecting the environment, and (3) Promoting sustainable resource management. As underpinning social drivers in SWM, the following three drivers are given: (4) Responsibility of legal/institutional system and policy direction, (5) Public consciousness concerning public health and environmental conservation, and pressure of public opinion, and (6) Economic benefit and job creation (see Fig. 25).

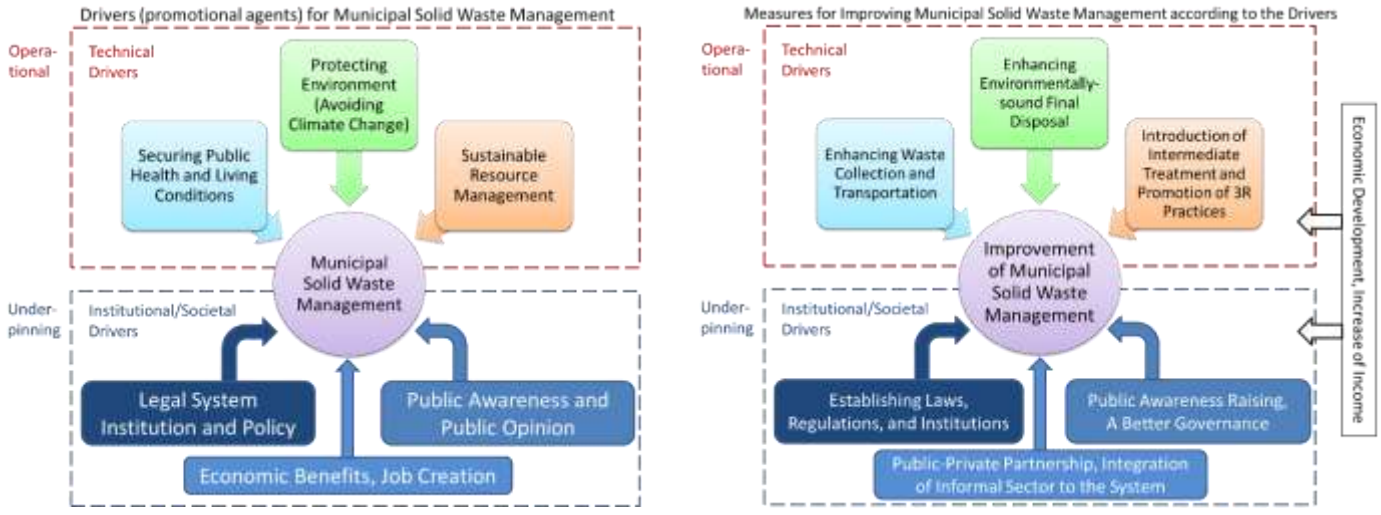


Figure 25: Development drivers for SWM in African cases (left hand figure) and measures to enhance each driver (right hand figure).

The driver (1) is a means to improve the public health of the city, which leads to enhance the capacity of waste collection and transport. The driver (2) leads to environmental conservation measures, closure of open dumpsites, and establishment of sanitary landfills. It also includes mitigation measures for greenhouse gases. The driver (3) aims for reasonable resource management for sustainable development, leading to measures that deal with the 3Rs, the introduction of Waste-to-Energy, and the formation of a circular economy. The driver (4) creates the duty on the legal/institutional system, or the requirement of government policy, which relates with the development of detailed rules, standards and guidelines, and formulation of detailed policies, strategies, and plans. The driver (5) secures economic benefits in SWM and job creation in developing countries, which will lead to cost recovery measures, establishment of financial sustainability, promotion of public-private partnership, and integration of informal sector into SWM system. The driver (6) leads measures to raise awareness on environmental and waste problems, promotion of environmental education, and issues relating to social inclusiveness and democratic governance. The latter drivers (4), (5), and (6) are the driving forces behind the SWM activities, and the former three drivers (1), (2), and (3) are the factors in the operation level (Fig. 25).

In Africa's SWM projects, there are situational differences in each city, but some common weaknesses are recognized. Firstly, inadequacies regarding clarification of responsibilities are acknowledged, based on the legal/institutional system, policy formulation, and planning. Secondly, weak public awareness regarding environment and waste problems is recognized by a wide range of decision-makers, residents, and other stakeholders.

In the workshop of the First ACCP Meeting, the opinions given by the waste management administrative officials in each country included the improvement of public health in urban areas through the establishment of collection and transportation and environmental protection through improvement of disposal sites, which correspond to a technical driver. However, to enhance not only the drivers at operation levels, but more basic and social drivers behind them as well, that is, institutional building and public awareness raising, including government officials and policy makers, are desired.

BOX 4: Capacity Development support

In order to promote sustainable municipal SWM, a capacity development (CD) support or technical assistance by external donor is expected. Municipal SWM encompasses numerous factors particularly in urban areas. The challenge of CD support in municipal SWM is also widely diversified. There are three categories of CD support subjects as shown in the figure: Category 1 (Support Subjects – Group 1) corresponds to capacity enhancement at the social and institutional level; Category 2 (Support Subjects – Group 2) corresponds to capacity enhancement at the organizational (public administration) and managerial level; and Category 3 (Support Subjects – Group 3) corresponds to capacity enhancement at the technical and technological level (Yoshida, 2016; see figure).

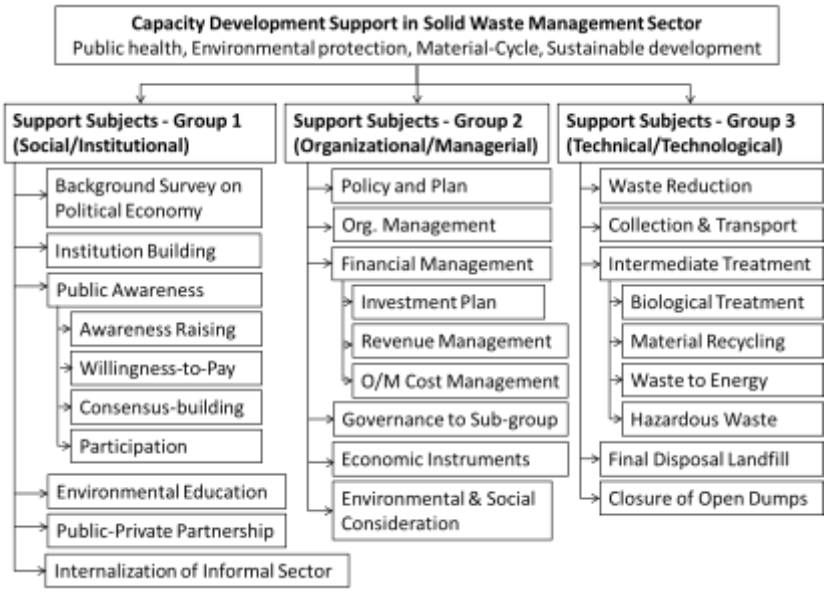
Group 1 covers social and institutional issues, which are the enabling environment and conditions for municipal SWM. It consists of six support subjects: background survey of socio-political economy, promotion of institution building, promotion of public awareness, strengthening environmental education, promotion of public-private partnership including micro-finance and financial inclusion, and internalization of informal sector. The support subject "public awareness" is subdivided into four specific subjects: public awareness raising, promotion of willingness-to-pay waste related fee/tax, consensus-building on siting of SWM facilities, and participation of citizens in municipal SWM activities, such as community-based SWM. Group 1 is the background of SWM and is closely related to the subjects of economic system and social system, without which the public service activity of SWM would not function.

Group 2 relates to organizational issues of SWM implementing agency, which consists of six support subjects: formulation of policy and plan, strengthening organizational management, strengthening financial management, governance to subgroup (e.g., guidance and support to local government from central government), promotion of economic instruments for participation and public-private partnership, and strengthening environmental and social consideration (e.g., environmental assessment). The support subject "financial management" is further subdivided into three specific subjects: preparation of investment plan, strengthening revenue management, and strengthening O/M cost management and cost recovery.

Group 3 includes technical and technological issues in SWM. They are frequently discussed as elements of solid waste management system. It contains five support subjects: waste reduction techniques (such as source separation and home composting etc.), improvement of collection and transport, introduction of intermediate technologies, improvement of final disposal landfill, and safety closure of open dumpsite. The support subject "intermediate treatment" includes four specific subjects: biological treatment, material recycling, waste-to-energy, and hazardous waste treatment.

These three groups of support subjects are interrelated and have a mutual cause and effect. According to the development level of SWM, priority issues should be changed. It is not necessary for the donor to support all subjects,

but the support subject(s) should be selected based on the capacity assessment as well as policy direction on municipal SWM given by the urban city authority.



6. Actions required for improving SWM in African cities

Based on the above-mentioned analysis, the following two issues can be identified in order to cope with the waste crisis, which is expected to occur in the near future in African cities.

(1) The most urgent SWM issues in Africa cities are strengthening waste collection and transportation for securing public health in urban and residential areas, closing open dumps for environmental conservation, and constructing a final sanitary landfill. It is essential to understand the current situation including waste generation amount, waste composition, and actual waste stream. To cope with these issues, capacity strengthening in SWM system and capacity development at the institutional level are necessary.

(2) The development of capacity at the institutional level is the most delayed in African countries. The task to strengthen the capacities at the institutional level in SWM requires special efforts independent of human development and economic development. Although the legal system varies from country to country, when SWM service is attempted, it is necessary to clearly define the following: the definition of waste, the responsibility for SWM service, the rule of waste collection and disposal, etc. Fig. 25 outlines the Japanese legal/institutional system and corresponding activities by administrative level. In Africa, there are many countries conceptually prescribed by the basic law, however those corresponding to individual laws, standards, enforcement orders, enforcement regulations, and guidelines at the national level are often unestablished. In local governments as well, regulations and enforcement regulations are not prepared, which result in insufficient policy, strategy, plan, local level master plan, and individual operation plans.

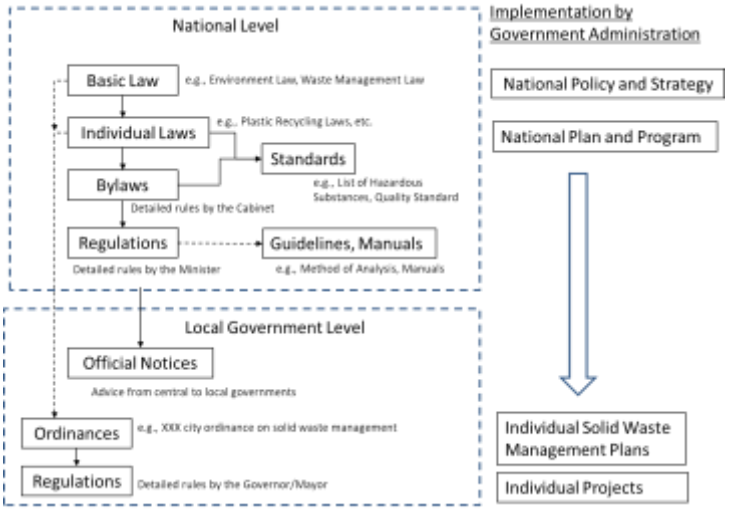


Figure 26: Outline of the national and local government level legal/institutional system for SWM.

BOX 5: JICA's cooperation in SWM in African countries

JICA has been supporting the improvement of waste management in large cities under the policy "Promotion of comprehensive waste management," TICAD-V Yokohama Action Plan (2013-17). It has been implementing technical cooperation, grant aid, and soft loan projects for seven countries: Sudan, South Sudan, Morocco, Mozambique, Kenya, Nigeria, and Zimbabwe. In these countries, SWM components such as waste collection and transportation, introducing 3R policy, public awareness, and landfill management, have been focused on. In order to appropriately plan and implement such aid and cooperation project, an accurate assessment of the current SWM situation is indispensable. In this regard, "Africa Urban Waste Management Information Collection Confirmation Survey" (Development Survey Type Technical Cooperation) is being implemented, and human resources are being developed so that African countries can obtain reliable data on their own. Also, with the aim of nurturing human resources engaged in SWM projects in Africa, the "Africa Region-focused Knowledge Co-creation Program" has been started in cooperation with Yokohama City. It plans to accept a total of 20 trainees from African countries each time and, in January 2018, the first course was held. The second training course will be held in August 2018. It is expected that this effort will contribute to the improvement of human resource development capacity of those who implement the SWM project in each city of Africa.

6. Conclusions

(1) Municipal solid waste is rapidly increasing in African cities due to population increase and urbanization. This will accelerate in the near future and, in the coming ten to fifteen years, the amount of municipal waste is estimated to double. Under such a situation of waste crisis, "improvement of waste collection service for securing public health" and "closure of open dumpsites and construction of sanitary landfills for protecting the environment," are priority issues for enhancing SWM activities.

(2) However, the present SWM is insufficiently established in African cities and countries, and the capacity development in SWM is urgently required. Based on the analysis of the newly defined development level indicators (DLIs), capacity strengthening at individual, organizational, and financial levels can be expected through economic growth (GNI/capita) and human development (HDI), but for the legal/institutional level, economic growth and human development do not result in capacity strengthening under present African conditions. Special efforts for institutional building are required. Without such an institutional building, SWM will not be sustainable due to unclear responsibility for operation and maintenance.

(3) Trends of private sector involvement in SWM services are common in many cities in Africa. For promoting this movement satisfactorily, public administration authorities are required to appropriately control licensing, authorizing, contracting, supervising, and monitoring private activities based on the legal system.

(4) It is necessary to obtain accurate and reliable data on SWM. The present paper is just a preliminary analysis based on very limited data, and future revision based on new data is desired.

(5) Waste is like a mirror that reflects various aspects of a society. In fact, in a dirty city, local administration for municipal SWM is considered ineffective, institution is not well established, or public awareness of residents and community is insufficient.

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