The Republic of the Sudan
Ministry of Environment,
Natural Resources and Physical Development

The Republic of the Sudan

PROJECT FOR STRENGTHENING SOLID WASTE MANAGEMENT IN KHARTOUM STATE

Project Completion Report

February, 2017

Japan International Cooperation Agency (JICA)

Yachiyo Engineering Co., Ltd.

GE
JR
17 - 035

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Exchange Rate

SDG1	=	JPY 18.043 (February, 2017 JICA rate)
USD1	=	JPY 115.144 (February, 2017 JICA rate)
EURO1	=	JPY 123.185 (February, 2017 JICA rate)

Project Activity (Including related Activity)

		
Grant Aid collection vehicles arrived at Khartoum		Handover ceremony held by Sudan Government
		
Handover ceremony held by Sudan Government		Grant Aid collection vehicles (© Yoichi Takahashi/SHUEISHA)
		
Grant Aid collection vehicles (© Yoichi Takahashi/SHUEISHA)		Central Workshop by Grant Aid

		
Central Workshop by Grant Aid		Japan visit
		
Japan visit		Japan visit
		
Environmental education: Bus tour		Waste collection pilot project starting ceremony

		
Waste collection pilot project starting ceremony		Media conference on solid waste management project
		
KCC new building		Waste collection pilot project team start setting collection points
		
Sign board for collection points		Waste collection pilot project team start setting collection points

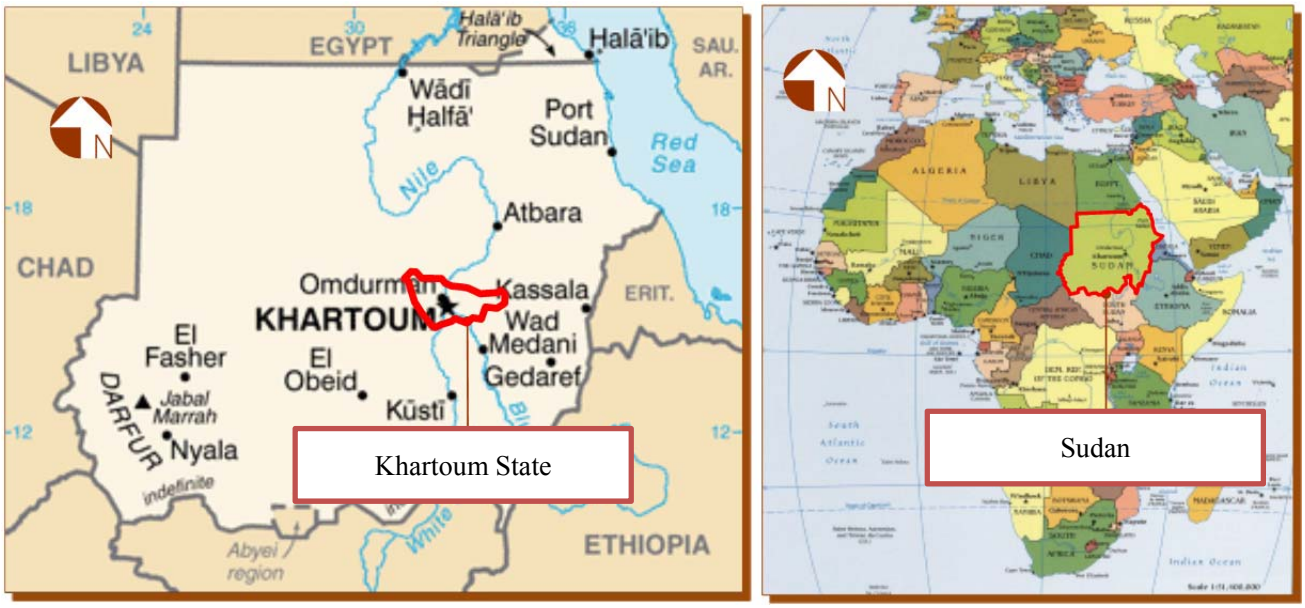
		
Waste collection pilot project : fixed time & fixed point collection		Waste collection pilot project : fixed time & fixed point collection
		
Safety & sanitation workshop at KCC		Collection worker wears safety gear and uniform
		
Citizens pilot project team		Data analysis at landfill site

		
National steering committee		Safety & sanitation workshop for collection workers
		
Topographic survey at landfill site		New AU office
		
National steering committee(Revised Master plan explanatory meeting)		AU Office opening ceremony

		
Safety & sanitation workshop at landfill site		Ministry of environment, natural resources and physical development
		
Umbadda transfer station construction by Khartoum state		Umbadda transfer station construction by Khartoum state
		
Collection workers wearing safety gear and uniforms		Collection workers wearing safety gear and uniforms

		
Karary pilot project team visits the pilot project explanation meeting at Khartoum		Karary pilot project team visits the pilot project explanation meeting at Khartoum
		
Ambassador of Japan invites solid waste management project team		Japan TV team visited JICA project site (© Yoichi Takahashi/SHUEISHA)
		
JICA evaluation team visited project site		AU office opening ceremony

Target Areas of this Project



Project Area Map (1/2)

Project Area Map (2/2)

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Abbreviations

AU	Administration Unit
BLCA	Bahary Locality Cleaning Affiliate
C/P	Counterpart
EfW	Energy from Waste
FPFT	Fixed Time and Fixed Point
HCC	Higher Council of Environment
HSDC	Higher Supervisory Department for Cleaning
JICA	Japan International Cooperation Agency
JLCA	Jabal Aulia Locality Cleaning Affiliate
KCC	Khartoum Cleaning Cooperation
KLCA	Karary Locality Cleaning Affiliate
KHLCA	Khartoum Locality Cleaning Affiliate
Khartoum LFS	Khartoum Landfill Site
LA	Locality
LCA	Locality Cleaning Affiliate
M/D	Minutes of Discussion
MEFPD	Ministry of Environment, Forestry and Physical Development
MENRPD	Ministry of Environment, Natural Resources and Physical Development
M/P	Master Plan
NSC	National Steering Committee
OLCA	Omdurman Locality Cleaning Affiliate
PC	Popular Committee
PP	Pilot Project
PDM	Project Design Matrix
SACKS	Supervisory Authority for Cleaning in Khartoum State
SLCA	Sharg En Nile Locality Cleaning Affiliate
SWM	Solid Waste Management
T&M	Time and Motion
ULCA	Umbadda Locality Cleaning Affiliate

Chapter 1 Work Implementation Basic Policy

1.1 Background, Circumstances and Purpose of the Project

1.1.1 Background and Purpose of the Project

Khartoum State in the Republic of Sudan (hereinafter referred to as "Sudan") has currently a population of approximately 7 million which generates about 6,000 tons of solid waste per day. The Supervisory Authority for Cleaning in Khartoum State (hereinafter referred to as "SACKS")[1] coordinates operations of seven Locality Cleaning Affiliates (hereinafter referred to as "LCAs") under the supervision of the Ministry of Environment, Forestry and Physical Development (hereinafter referred to as "MEFPD")[2], and operates the transfer stations and the landfills. Collection and transportation of waste in each locality is performed by the respective LCAs under the supervision of SACKS.

The equipment used for collection and transportation of solid waste has deteriorated, and operation is not currently being adequately managed. In 2013, in the collection work was being conducted in a manner that was clearly inefficient, with only about 65% of generated solid waste being collected. There were still many areas in the city where the streets were littered with uncollected waste, and this had exacerbated the sanitary environment in low-income residential areas in particular.

Although the equipment was old in 2013, a total of 301 waste collection vehicles were being operated in Khartoum State, enabling collection of waste to a certain extent. In addition, there are three transfer stations; however they are not functioning at an adequate level. The three landfill sites in Khartoum State are large, with a total area of 1,000 ha, and have adequate landfill capacity for the disposal of solid waste for the time being. On the other hand, awareness among residents on solid waste management (hereinafter referred to as "SWM") is extremely low, and the cooperation of residents is not currently being obtained. Although resources are not adequate, Khartoum State has the potential to achieve considerable development and improvement of SWM in the future.

The record of assistance provided in the solid waste management by JICA in recent years in Khartoum State is shown in Fig. 1-1. After receiving the results of the basic research in the environmental field conducted by JICA in February 2010, JICA dispatched JICA experts from 2011 to 2013. Japanese Grant Aid Project for Improvement of Solid Waste Management in Khartoum State (hereinafter referred to as "Related Grant Aid Project") was commenced in 2013. This "Technical Cooperation Project for Strengthening Solid Waste Management in Khartoum State (hereinafter referred to as "the Project")" was started in 2014.

[1] The name was changed to Higher Supervisory Department for Cleaning (HSDC) and then to Khartoum Cleaning Cooperation (KCC)

[2] Present name is Ministry of Environment, Natural Resources and Physical Development (MENRPD)

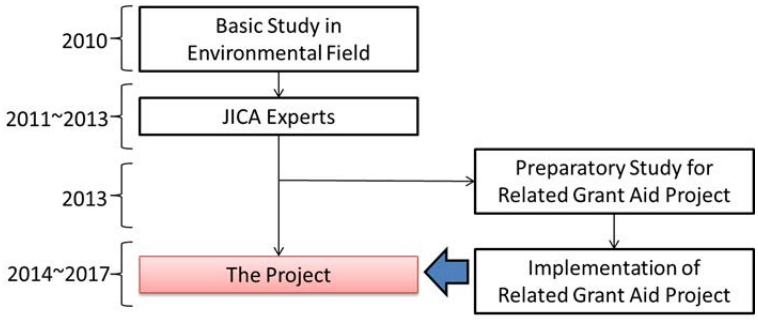
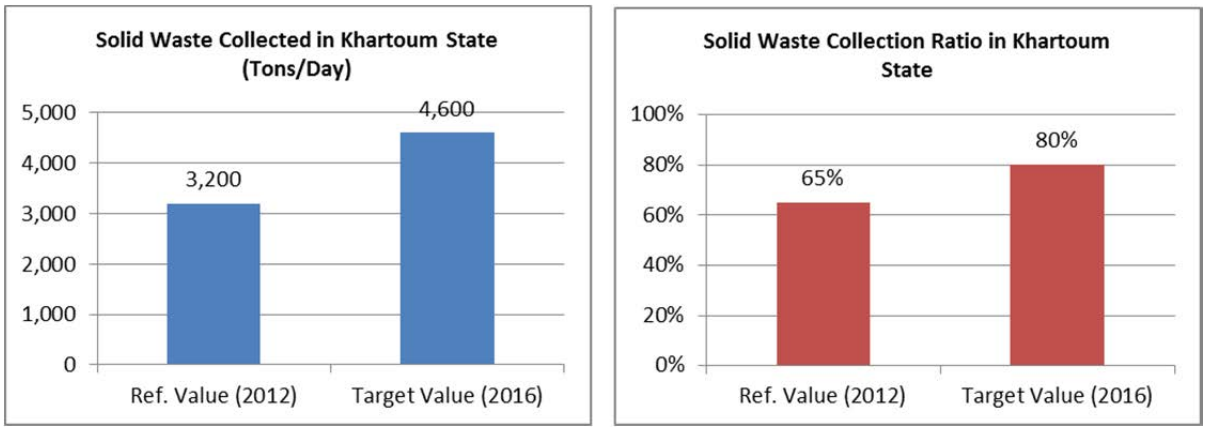


Fig. 1-1 Assistance in Solid Waste Management in Khartoum State by JICA in Recent Years

1.1.2 Outline of the Project for Improvement of Solid Waste Management in Khartoum State

In parallel with the Project, a related Grant Aid Project was implemented. This related Grant Aid Project covered provision of trucks for waste collection, heavy equipment for landfills and construction of a Central Workshop (vehicle repair shop) and provided soft component with the goal of improving SWM capabilities in Khartoum State. As shown in Fig. 1-2, the quantitative effects that are expected as a result of implementing the related Grant Aid Project consist of a solid waste collection amount of 4,600 tons/day by LCAs in Khartoum State by the target year of 2016 with a solid waste collection ratio of 80%.



Remarks: Waste collection ratio is calculated by dividing the amount of collected waste by the amount of waste generated. The amount of waste generated daily in 2012 was estimated to be 4,890 tons/day in 2012, and is forecast to be 5,752 tons/day in 2016.

Fig. 1-2 Quantitative Effects Expected by Project Implementation

The equipment provided is shown in Table 1-1, and a picture of the Central Workshop is shown in Fig. 1-2. The soft components 1) Strengthening management of Central Workshop and 2) Strengthening vehicle maintenance and management capacity were also provided.

Table 1-1 Equipment provided by Related Grant Aid Project

Content			Quantity
Waste collection equipment	Compactors	Used for collection of household waste and waste from markets.	42 units
	Container carrier / arm type (Carrier + container)	Mainly used for collection and transport of waste from markets.	56 units
	Collection containers		56 units
Landfill	Bulldozers	Used to place and compact waste at landfill sites	3 units

Content			Quantity
management equipment		and cover with soil.	
	Excavators	Used to excavate and obtain soil for covering the waste.	2 units
	Water tanker	Used to transport drinking water for office and waste pickers, and sewage from toilets.	1 unit
Central workshop vehicle maintenance equipment		Used for maintenance of vehicles at Central Workshop constructed under this project.	1 set
Local workshop vehicle maintenance equipment		Used for maintenance of vehicles at existing workshops.	1 set

Fig. 1-3 Picture of Central Workshop (for Vehicle Maintenance) Constructed by Related Grant Aid Project

1.2 Outline of This Project

1.2.1 Overall Goal and Project Purpose

The goals and output of the Project are as follows.

Overall Goal	: Improved SWM system is sustained in Khartoum State
Project Purpose	: The SWM system in Khartoum State becomes more efficient and effective.
Outputs	: M/P of SWM in Khartoum State is revised.
	: The capacity of waste collection and transport is improved.
	: The operation and management of the landfills are improved.
	: Improvement measures of the institutional setting and financial status in SWM are proposed.

1.2.2 Implementation Structure Based on Roles of Related Organizations in Sudan

The roles of related organizations in Sudan are stipulated in the R/D dated January 27, 2014. MENRPD whose name was changed to MENRPD is part of the central government, and is not an implementer of SWM. Therefore, the Project set a policy that SACKS whose name was changed to KCC would be a leading organization to implement the Project. The role of each related organization is described in Table 1-2.

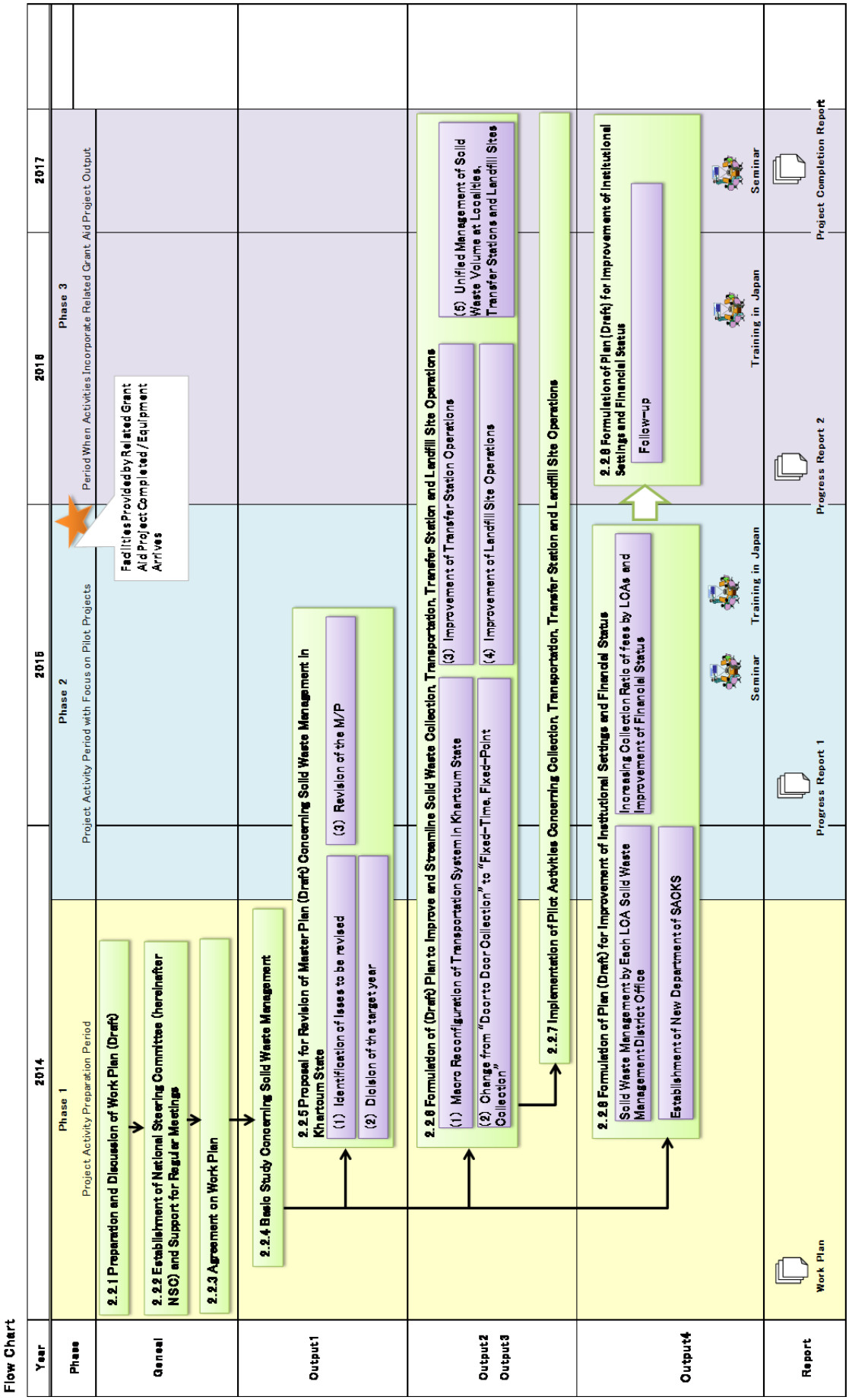
Table 1-2 Roles of Related Organizations in Sudan

Related Organization	Role
Ministry of Environment, Natural Resources and Physical Development (MENRPD)	Conduct overall administration / monitoring of project. In charge of environmental education and public relations activities. Formulate the revised M/P together with KCC. Serve as "Supervisory Organization" for the Project
Khartoum Cleaning Cooperation (KCC)	Drive project as central institution while supervising each LCA Serve as Counterpart (hereinafter referred to as "C/P") Organization of the Project
Each LCA	Take initiative for pilot projects and other activities at local level under the supervision of KCC. Serve as C/P Organization of the Project

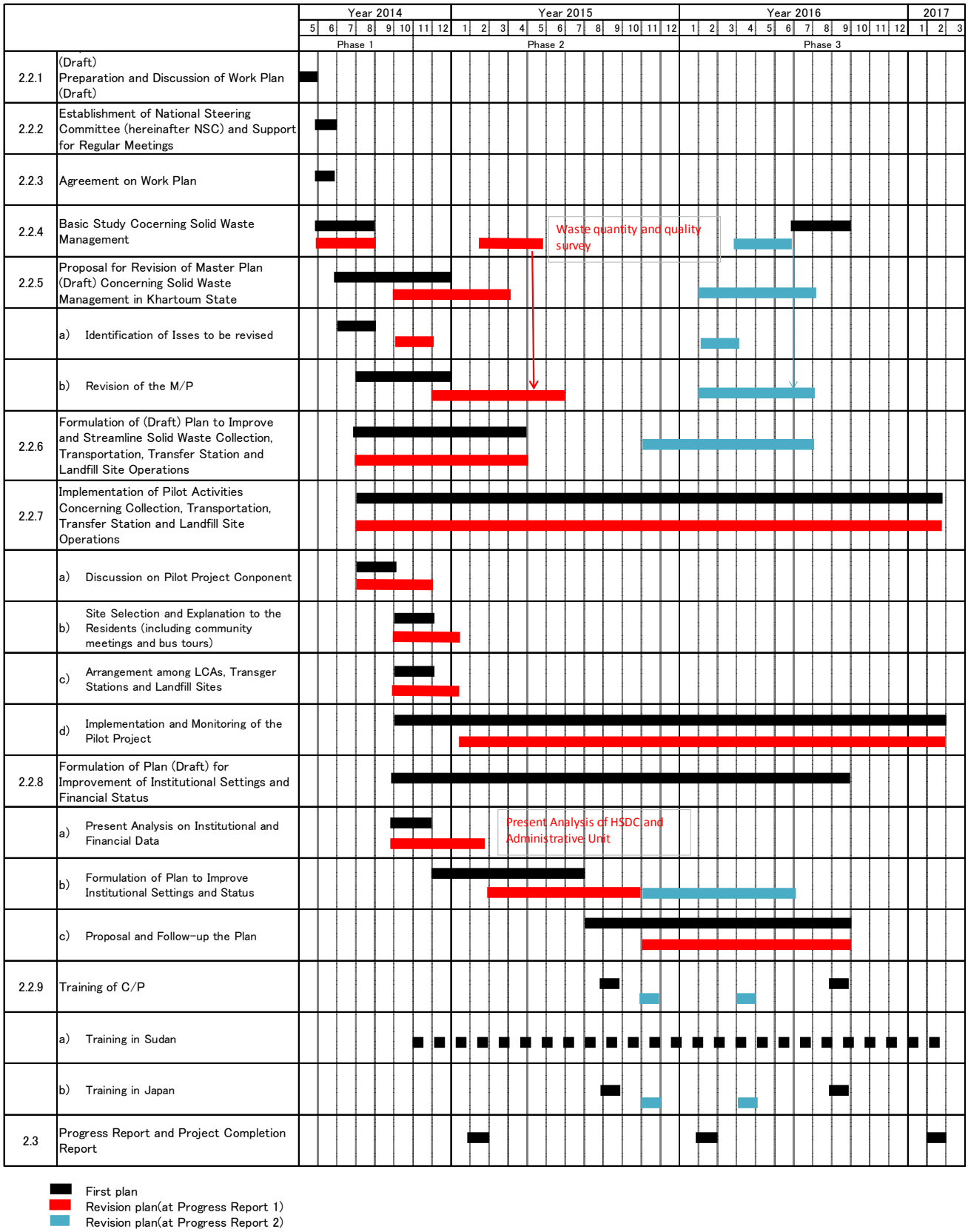
1.2.3 Work Schedule and Flow Chart

Flow Chart and Work Schedule for the Project are described from the next page.

Flow Chart


Year
2014
2015
2016
2017
Phase
Phase 1
Project Activity Preparation Period
Phase 2
Project Activity Period with Focus on Pilot Projects
Phase 3
Period When Activities Incorporate Related Grant Aid Project Output
General
2.2.1 Preparation and Discussion of Work Plan (Draft)
2.2.2 Establishment of National Steering Committee (hereinafter NSC) and Support for Regular Meetings
2.2.3 Agreement on Work Plan
Facilities Provided by Related Grant Aid Project Completed/Equipment Arrives
Output1
2.2.4 Basic Study Concerning Solid Waste Management
2.2.5 Proposal for Revision of Master Plan (Draft) Concerning Solid Waste Management in Khartoum State
(1) Identification of Issues to be revised
(2) Division of the target year
(3) Revision of the M/P
Output2
Output3
2.2.6 Formulation of (Draft) Plan to Improve and Streamline Solid Waste Collection, Transportation, Transfer Station and Landfill Site Operations
(1) Macro Reconfiguration of Transportation System in Khartoum State
(2) Change from "Door to Door Collection" to "Fixed-Time, Fixed-Point Collection"
(3) Improvement of Transfer Station Operations
(4) Improvement of Landfill Site Operations
(5) Unified Management of Solid Waste Volume at Localities, Transfer Stations and Landfill Sites
2.2.7 Implementation of Pilot Activities Concerning Collection, Transportation, Transfer Station and Landfill Site Operations
Output4
2.2.8 Formulation of Plan (Draft) for Improvement of Institutional Settings and Financial Status
Solid Waste Management by Each LCA Solid Waste Management District Office
Establishment of New Department of SAOKS
Increasing Collection Ratio of fees by LCAs and Improvement of Financial Status
2.2.8 Formulation of Plan (Draft) for Improvement of Institutional Settings and Financial Status
Follow-up
Seminar
Training in Japan
Seminar
Training in Japan
Report
Work Plan
Progress Report 1
Progress Report 2
Project Completion Report

Work Schedule



Chapter 2 Achievement of the Project

2.1 Achievement of Outputs

2.1.1 Output 1

Output1	Indicators	Achievement
The master plan of SWM in Khartoum state is revised.	1-1 A revised master plan of SWM in Khartoum is approved by Khartoum state.	Already achieved

The first draft of "The Solid Waste Management Master Plan in the Khartoum State" was developed in June 2016. Final draft was explained and approved in NSC in December 2016

2.1.2 Output 2

Output2	Indicators	Achievement
The capacity of waste collection and transport is improved.	2-1 The amount of collected waste increases from 3,200 ton/day in 2014 to 4,601 ton/day in 2017.	Expected to be achieved in 2017
	2-2 Waste collection fuel consumption per collection amount in 2017 is less than 6.4 L/ton which is one in 2014.	Already achieved
	2-3 Waste collection improvement plan is authorized.	Already achieved

For Indicator 2-1, latest record of waste collection amount in October 2016 is 3,727 ton/day and highest record of waste collection amount is 4,217 ton/day in March 2016. The target amount of collected waste is not yet attained; however, the annual rate of waste collection has been increasing since the initiation of the Project.

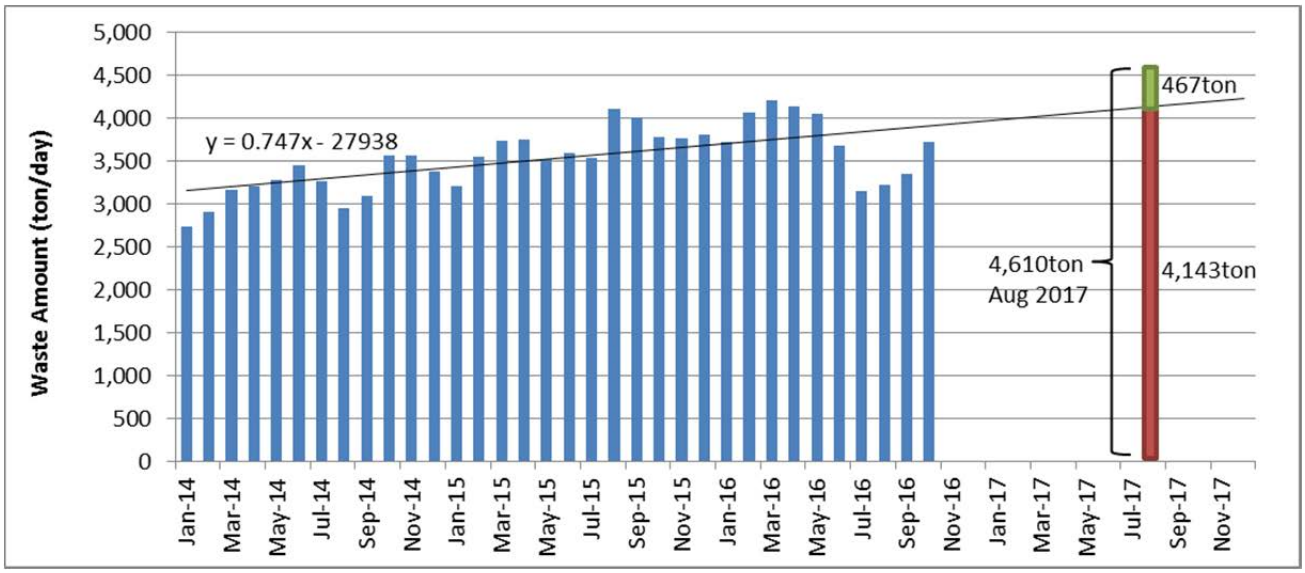
Waste collection vehicles of the related grant aid project started operation in March 2016, however, the waste collection amount was not increased as much as expected due to low operation rate of the container carriers. The related grant project was planned on the condition of that the container carriers would have daily 4 or 5 trips/vehicle/day, however number of the containers procured by the related grant aid project for the container carrier was only two per container carrier. Because of insufficient number of containers, the container carrier has not performed as expected. KCC has ordered the additional 100 containers and already received 20 containers in January 2017. The remaining containers will be sequentially delivered to KCC. After the delivery of the additional containers, it is expected that KCC can increase the waste collection capacity by 467 ton/day (40 units x 2.5 trips x 4.67 ton/day). Waste collection amount in Khartoum state will reach to 4,610 ton/day in August 2017, based on the estimation of the additional capacity of the new containers and the annual rate of waste collection. And then the indicator will be achieved.

Table 2-1 Record of Waste Collection Amount

Ton/day

	Indicator	March 2016 Highest record	Oct. 2016 Latest record	August 2016
Waste collection amount	4,601	4,217	3,727	4,143 (Estimation)
Expected waste amount by the additional containers *	-	-	-	467
Total	-	-	-	4,610

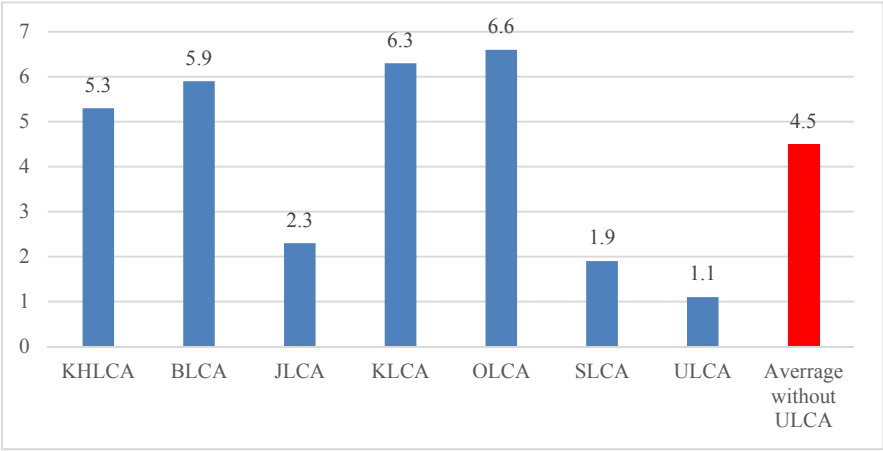
*: 40 vehicles × 2.5 trips/vehicles × 4.67 ton/trip



Source: Project for Strengthening Solid Waste Management in Khartoum State

Fig. 2-1 Future possibility in achievement of target amount of collected waste

Indicator 2-2 has been achieved as the average fuel consumption per collection amount of six LCAs was 4.5 L/ton (below the target of 6.4 L/ton) in the average of six LCAs in 2015 as shown following figure. This fuel efficiency is expected to be maintained through the end of the Project, if the conditions of improved SWM are not changed. Especially in the FTFP Pilot Project areas, waste collection efficiency by tracks has been improved according to monitoring results. Waste collection times in some Pilot Project areas of Karary and Khartoum have been reported to be reduced by 13% to 24% as compared with before the application of FTFP. These data show a remarkable improvement in operational efficiency of SWM.



Source: Project for Strengthening Solid Waste Management in Khartoum State

Fig. 2-2 Variation of fuel consumption per collected waste amount (L/ton) at each LCA in 2015

For the Indicator 2-3, the plan on "Waste Collection Improvement Pilot Project Introduction of FTFP Collection in KLCA and KHLCA" was drafted in July 2016. The plan was approved in December 2016.

2.1.3 Output 3

Output3	Indicators	Achievement
The operation and management of the landfills are improved.	3-1: An improvement plan of the landfills is made.	Already achieved
	3-2: The amount of waste disposed in the landfills increases from 3,200 t/d to 4,601 t/d.	Expected to be achieved in 2017
	3-3: Covering soil work is implemented once a week at least.	Already achieved

For Indicator 3-1, the "Improvement Plan on Khartoum Landfill Site (Second version)" was developed in June 2016, which included an implementation plan for covering soil work and recording landfill operation in the Khartoum landfill.

Indicator 3-2 has not been yet achieved as the disposal amount is 3,727 ton/day as of October 2016. The indicator, 4,601 ton/day of disposal waste, is expected to be achieved in August 2017, if the waste amount data management system introduced by KCC and LCA is accurately implemented.

For indicator 3-3, covering soil work is implemented regularly base on the improvement plan. According to the operational records for the Khartoum Landfill, covering soil was implemented almost every day. Even though the Improvement Plan has been developed, the landfill site has some operational issues. Particularly the landfill site is covered by smoke caused by setting fires to the buried wastes. KCC needs to tackle these issues for further improvement of the landfill operation.

2.1.4 Output 4

Output4	Indicators	Achievement
Improvement of the financial status in SWM is proposed.	4-1: A plan of institutional improvement of KCC and the localities is proposed, which includes the following issues. -Institutional framework -Financial status -Number of staff -Staff training programs	Already achieved
	4-2: The procedure after the proposal of the improvement plan is identified	Expected to be achieved in 2017

As for Indicator 4-1, the "Plan of Institutional Improvement of KCC and LCA (ver.3)" was completed and accepted in May 2016 by the counterparts. After the completion of the Institutional Improvement Plan, the procedures to implement this plan will be identified by both KCC and LCAs. Thus, Indicator 4-2 will be achieved by the middle of 2017.

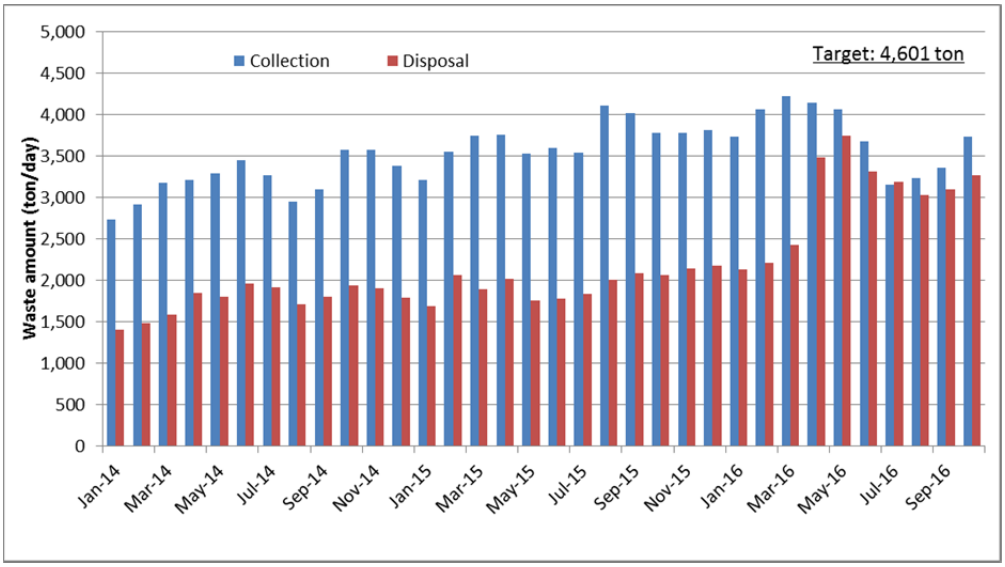
2.2 Achievement of Project Purpose

Project Purpose	Indicators	Achievement
The SWM system in KRT state becomes more efficient and effective.	1. The waste collection rate improves from 65% to 80% in 2017.	Expected to be achieved in 2017
	2. The coverage of waste collection fees by LCAs to total income of waste collection budget will be 80% in 2017.	Already achieved

For Indicator 1, the latest waste collection amount was 3,727 ton/day in October 2017. The amount of collected waste has been increased and estimated the indicator will be achieved in August 2017 as seen in "Indicator 2-1 of

Output 2" with comprehensive measures of the KCC and each LCA.

In addition to above mentioned two indicators on effectiveness of SWM system in KRT, the Project Team identified good progress on effective SWM service, that is remarkable decrease of illegal dumping or faulty recording. The evidence is that the gap of waste amount between collection and disposal has been rapidly diminished as only 459 ton/day in October 2016 which represents 12% difference between disposal and collection amount (seen in the following figure). This reduction of the gap between collection and disposal amounts was attributed by KCC programs for the prevention of illegal dumping and faulty recording by drivers, which indicates an improvement of waste collection fleet management and inspection under effective SWM.

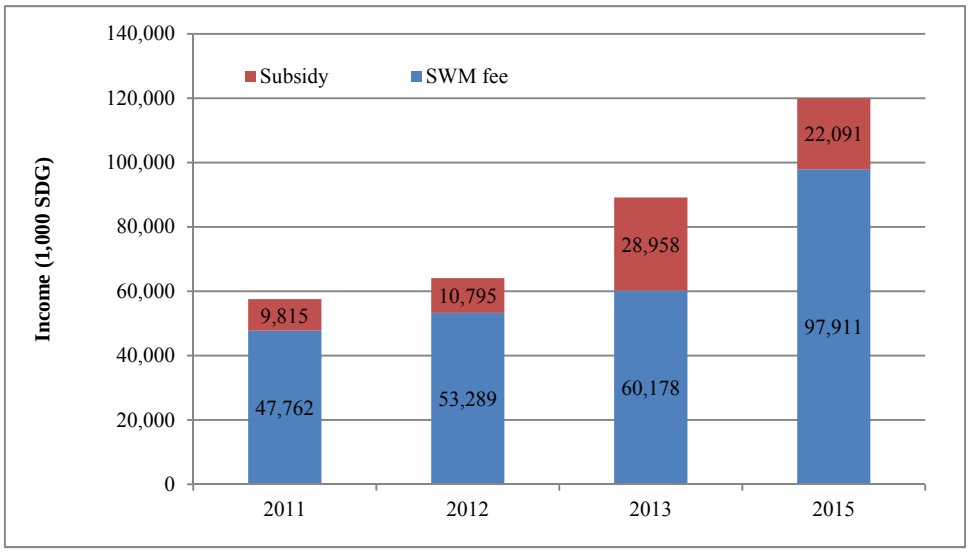


Source: Project for Strengthening Solid Waste Management in Khartoum State

Fig. 2-3 Gap between Collection and Disposal of Waste[3]

Indicator 2 was achieved since the total collection fee of all LCA was 97,911,000 SDG which represents 82% of the total income according to the financial record in 2015. Moreover, the annual LCA budget from waste collection fees paid by residents has doubled since 2011 (seen in following figure). This indicates that each LCA can increase their budget without depending on the state and regional subsidies.

[3] The calculation methods of between collection and disposal amounts of waste are different.



Source: Project for Strengthening Solid Waste Management in Khartoum State

Fig. 2-4 Increase in total LCA Budget in Khartoum State

On the other hand, above two indicators do not fully represent achievement of the project propose. Therefore, the Project applied supplemental indicators to measure efficiency of the SWM system. The annual operation and maintenance (O/M) cost of transfer stations to landfills per total amount of collected waste was slightly increased as shown in following table. However, taking the high inflation rate in this country into account, e.g. the increase of inflation rate is from 15 to 50% in each year, the real unit O/M cost has not been increased. It is concluded that the economic efficiency of the SWM service in KCC has been improved.

Table 2-2 Rate of O/M Cost (Transport from Transfer Station to Landfill and Landfill Operation) per Waste Amount

	O/M cost (SDG) (1)	Waste amount (ton) (2)	Unit cost (SDG/ton) (1)/(2)
2012	3,600,000	530,784	6.78
2014	6,000,000	687,600	8.73
2015	8,400,000	705,288	11.91
2016 (six months)	7,200,000	528,135	13.63

Source: Project for Strengthening Solid Waste Management in Khartoum State

Chapter 3 The capacity of waste collection and transport is improved (Output 2)

3.1 Activities to Establish the Pilot Project for Waste Collection and Transportation Improvement as a System

3.1.1 Pilot Project for Waste Collection Improvement -Fixed Place and Fixed Time Collection

The pilot project (PP) for waste collection improvement is the introduction of the Fixed Place and Fixed Time (FPFT) collection system by replacing the house-to-house collection on an irregular basis. Under this new collection system, the residents bring their waste to a designated location within a specific time. The Project also distributed plastic made waste bins (65 little) for residents to put out waste in the waste bins at the designated locations. FPFT collection system is expected to provide the following benefits:

- Trust building between the waste generators and the LCAs; the waste generators abide by putting out their waste to designated locations and during designated times while the LCAs commit to collect the waste from these locations and within the designated times.
- Improve the cleanness of the area by prohibiting putting out waste outside the specified collection time
- Decrease the time the collection vehicle spends on the collection route and thereby improve efficiency of waste collection
- Improve the working environment of collection workers

The implementation flow of the Pilot Project is described in the following table. The Project involved the Popular Committees (PC)[4] from the planning stage.

[4] PC consists of 20-30 elected representatives of local residents at each block. The size of bloc differs from hundreds to over a thousand households. Although PC members are volunteers, they collect opinions towards public services such as waste management, water supply, and health service, to convey to AU, Localities and other higher levels. They also supervise public services provided by the government. AU and Localities give instructions or messages to local residents through PC. Therefore, PC has a close link with local residents and can mobilize them. （Reference: City limits: urbanization and vulnerability in Sudan，2011）The Project has worked with PC to communicate with and send messages to residents, and organize community meetings in the bloc.

Table 3-1 Implementation Flow of the Pilot Project

Step	Description
Step 1 LCA Meeting	● Decision on the AU to be targeted ● Selection of the PP area within the AU, considering household number and area land use
Step 2 Meeting with PCs in the PP Areas	● Explain project content and confirm the PC interest and support to the project ● Arrange the community meetings program and schedule
Step 3 Holding Community Meetings	● Explain about solid waste and its management issues ● Explain about the FPFT system ● Answer community members' questions
Step 4 Existing Conditions Survey	● Survey on the present waste collection management in the PP area ● Questionnaires to/ and interviews with residents
Step 5 Preparing Details with LCA	● Develop the details for the FPFT system with the LCA
Step 6 Discussion with PC	● Explain and finalize the details of the FPFT system ● Arrange the bin distribution and launching ceremony
Step 7 Clean-up Campaign	● Clean-up the PP area together with residents, C/Ps and JPT ● Use the occasion to further inform the residents of the new system
Step 8 Bin Distribution and Setting up Collection Points	● Prepare the distribution system, transport the bins to the PP area and distribute them ● Select the suitable collection points in consultation with the residents and PC members ● Install signboards at the collection points
Step 9 Baseline Survey	● Conduct site visit, time and motion survey and questionnaire survey
After Implementation	● Continuous monitoring and public awareness ● Modify the system as may be required (for instance change of collection time and locations)

The FPFT started in Eldeem Wasat AU in Khartoum locality from March 2015 and in Althwara Wasat AU, Karary Locality from January 2015. The target areas are shown in the following figure.

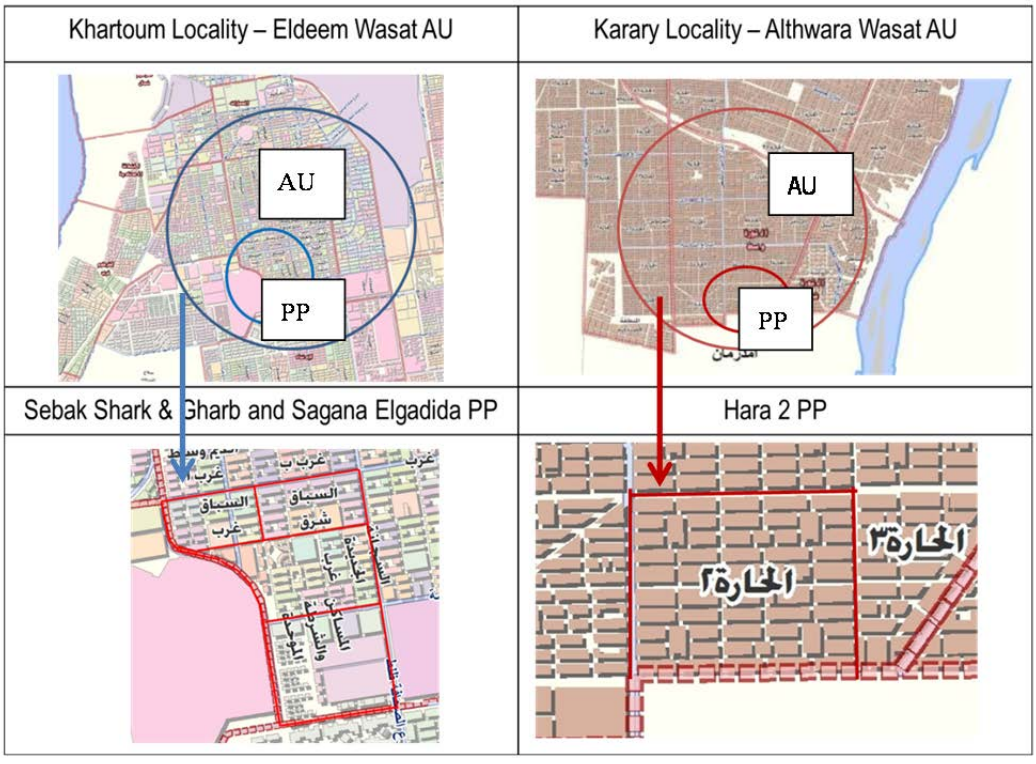


Fig. 3-1 PP Areas in Khartoum Locality and Karary Locality

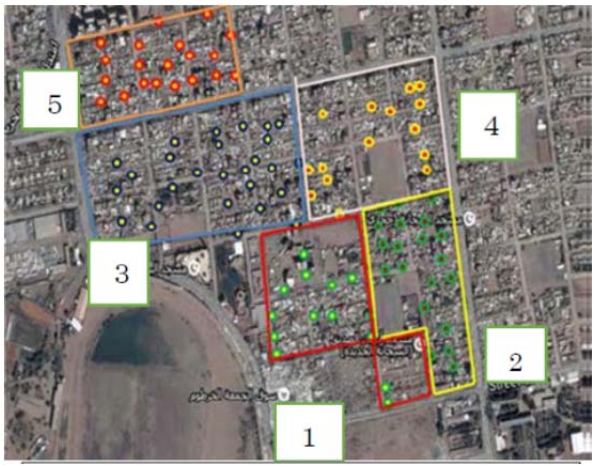


Fig. 3-2 Detailed PP Areas in Khartoum Locality

For the target area in Khartoum LCA, it is further divided to five smaller sections. The collection days and time differ from section to section. Even though the collection days and time is the same for two sections, the collection is done for each area by using two collection vehicles. There are many narrow lanes so that a big collection vehicle cannot enter some blocs of the target areas. For Karary, it is divided by a main road to the south side and north side. As the map shows, streets run in a grid in the target residential area. The collection starts from the southernmost street and finishes in the northern most street.

JPT with LCA and community members decided the collection points (60 meter each) and time as in the next table.

Table 3-2 Information of the Areas

Target AU	Area in the target AU	Collection days	Collection time	Population	No. of waste bins distributed by the project	No. of collection points (start → current)	Start
Thawara Wasat AU, Karary	Hara 2	Thursday and Sunday	8:00-	7,000 (648 House Holds)	1,000	110→80	Jan. 2015
Eldim AU, Khartoum	1. Almasaken wa Alshorta 5. Eldeem Wasat Gharb A.	Wednesday and Saturday	16:00-	7,000 (1,074 HH)	1,000	168→98	Mar. 2015
	2. Elsegana Elgadida Gharb 4. Elsebak Shark	Tuesday and Thursday	16:00-				
	3. Elsebak Gharb	Monday and Thursday	16:00-				

3.1.2 Process and Results of the Pilot Project

Almost two years have passed after the start of the PP. LCA and residents made efforts to follow the new collection system at the start and it appeared the new collection system was smoothly introduced. As the time passed by, however, LCA was not able to send the collection vehicles on time and residents lost interest in the new collection

system and stopped putting out waste on the designated point and time. The collection system returned to the house-to-house collection at all the target areas except Almasaken wa Alshorta (No.1 in the table above) in May 2015. JPT with LCA tried to right the situation by using means such as project weekly meetings to find problems and discuss countermeasures, continuous monitoring and continuous awareness raising activities.

(1) Monitoring and Project Weekly Meeting

The project has been organizing weekly meetings with KCC, LCA and area supervisors[5] to share information and discuss actions to be taken. JPT and LCA also have been conducting monitoring at least once a month for all the target areas. Problems found in the monitoring are shared and discussed in the project weekly meeting. Important information (for instance, late arrival of collection vehicles) was often not shared among concerned departments of LCA and KCC at first. The project weekly meeting enabled us to share such problems and discuss how to react as a team. The project weekly meeting was a good opportunity to discuss directions and methods of awareness raising activities targeting residents in the pilot areas. The major achievements of the meetings are as follows:

Table 3-3 Major Achievements of Project Weekly Meetings

		Problems	Solutions
1	Karary	1. Frequent delay of the collection vehicle. The collection vehicle was scheduled to collect waste in a busy road where many shops were located before the pilot area. Thus, the vehicle was likely to delay and packed of waste. And then, the vehicle became full of waste in the middle of PP area without finishing collection and went to a transfer station. The vehicle started collection after coming back from the transfer station, and it tended to be in the afternoon. 2. Low awareness of residents for the new collection system	1. Route change of the collection vehicle. It was decided that waste collection in the busy road before the PP area was stopped and the vehicle would start from the PP area. The vehicle did not need to go to the transfer station in the middle of collection in the PP area. Delay was decrease to a large extent. 2. Involvement of religious readers at mosques. LCA gave brochures explaining the FPFT system to Imams and asked them to talk to residents to cooperate. Men have started cooperating the new system since then.
2	Khartoum	1. Bad attitude of collection workers. They threw away bins and talked to residents in an aggressive way. 2. As the capacity of vehicle was small, it became full before finishing collection.	1. Instruction to the collection workers and changes of the collection workers. LCA instructed them to change behaviors and attitudes, but they did not. So LCA changed them. 2. Change to a bigger capacity vehicle
3	Both	1. Insufficient number of bins. The waste bins distributed by the project were not enough for all the households in PP areas. Many bins were stolen or broken. 2. Delay of the collection vehicles due to fire or broken-down of equipment in transfer stations and land fill sites	1. Distribution of additional bins bought by LCA to the PP areas. 2. The collection vehicles of the pilot areas were given priority to unload wastes in the transfer stations without queuing through information sharing with the transfer stations and land fill sites.

[5] An area supervisor follows the collection vehicle and directs collection workers no to leave waste uncollected and residents to bring waste to the collection points. Khartoum LCA hires a member of the PC as an area supervisor at each section.

JPT took initiative to conduct monitoring for the first one year, but both LCAs developed their own monitoring format and started monitoring from the second year. Both LCAs now takes records of the total time of collection, number of used collection points and problems faced.

(2) Implementation of Awareness Raising Activities

As the FPFT collection system is not possible without cooperation of residents, the project carried out many types of awareness raising activities. The table below summarizes such activities. The Department of Cleaning Promotion and Information (DCPI) was newly established in KCC in January 2016 to be in charge of public awareness. There was not such department at KCC at the start of the PP. Most of staff at DCPT was transferred from the Ministry of Health. They have knowledge and experiences of awareness raising and hygiene but do not know about solid waste management much. KCC is expected to play a leading role in awareness raising to expand the FPFT collection system to all the localities, so capacity development of the DCPI staff was one of the priorities in the Project.

Table 3-4 Summary of Awareness Raising Activities

	Activity	Time	Contents
1	Training of Public Awareness	June 2015	Target: LCA staff in PP, PC members including area supervisors Objective: To make LCA staff have knowledge and skills to do awareness raising activities Contents: JPT gave a lecture on • What the FPFT collection system is • Benefits of the FPFT collection system • Why we need to introduce the FPFT collection system • Division of roles between the government and citizens • Behaviors of residents need to be improved and their reasons • Factors which enable to change behaviors of residents • Ways to communicate residents
2	Study Tour	June 2015	Target : representatives of residents (the PC, women group, youth group) from each pilot area, AU, LCA and KCA staff Contents: • Observation of the FPFT collection at the best area, Almasaken wa Alshorta, by the participants • Presentations from the awareness unit of Khartoum LCA regarding awareness raising activities and efforts to send the collection vehicles on time.
3	Community Meeting	August and October 2015	Target : leaders of the target areas (the PCs, women groups, youth groups, religious leaders and other active community leaders). Contents: JPT and LCA explained the following topics to gain cooperation from residents • The benefits of the FPFT collection system • Why cooperation of residents is necessary • Behaviors of residents to be improved
4	Training for DCPI , KCC	April 2016	Target：staff at DCPI Contents: JPT gave a lecture on • FPFT PP • Factors which enable to change behaviors of residents • Ways to communicate residents
5	Two- Day Public Awareness	April 2016	Target : Khartoum LCA and KCC staff as well as some of the other LCAs staff

	Training at Khartoum LCA		Content: General manager and awareness staff from Khartoum LCA, awareness staff from Khartoum locality and JPT gave lectures on • Skills and knowledge required for awareness raising • Awareness raising required for FPFT collection
6	1st Workshop to Expand FPFT Collection System	April 2016	Target: 5 LCAs to introduce FPFT (only Jabal Awila, Bahary, Omdurman LCAs attended) and KCC staff Content: • JPT explained how to introduce FPFT collection and progress so far as well as awareness raising activities conducted by the Project • Karary and Khartoum LCA shared their experiences and lessons from FPFT
7	2nd Workshop to Expand FPFT Collection System	August 2016	2nd workshop was held as the attendance rate was not good at the 1st workshop Target: general manager and awareness staff from 5 LCAs to introduce FPFT as well as KCC and MENRPD staff Content: • JPT explained how to introduce FPFT collection and progress so far as well as awareness raising activities conducted by the Project • Karary and Khartoum LCA shared their experiences and lessons from FPFT
8	Field Visit and Video Shooting of FPFT Collection	October 2016	Target：DCPI staff of KCC Content：DCPI staff visited the PP site and did video shooting of FPFT to use as a visual material when KCC does awareness raising activities in the other localities.
9	Monitoring	Continuous	Karary and Khartoum LCA staff and JPT follow the collection vehicle to do monitoring of FPFT at the pilot areas. We give instructions both to collection workers and residents to follow the rules of FPFT. While we do monitoring, we visit each house and talk to residents.
10	House-to-House Visit	Continuous	Awareness staff of LCAs pay house-to-house visit in the target areas to talk to residents to raise their awareness.
11	Developing Brochures	Before the start of PP	Both LCAs developed a brochure of FPFT. The brochures were used at community meetings and for house-to-house visits.

Study tour

House-to-house visit by LCA awareness unit

Fig. 3-3 Awareness Raising Activities

FPFT collection system is adhered well in the pilot areas as of December 2016, as a result of the activities described above. There are still residents who put out waste on non-collection points and non-collection days, but these cases

are small in numbers. Many waste bins distributed by the Project became broken after two-year use so that the residents use other types of containers and plastic bags to put out waste. It was often observed that waste was put out without any containers or bags in the front of houses before the PP. The residents got accustomed to use any types of containers and bags to bring waste to the collection point through the PP so that waste is not scattered in the front of houses and on the roads now.

Collection point in Karary
(November 2016)

Collection point in Khartoum
(September 2016)

Fig. 3-4 Discharged waste by the resident at Collection Points

(3) Trust building between the waste generators and the LCAs

Trust has been built between residents and LCAs as the residents abide by putting out their waste to designated locations and during designated times while the LCAs commit to collect the waste from these locations and within the designated times. In addition, regular visits to the target areas by LCA staff to talk to residents have contributed to trust building. The next table shows the results of two questionnaire surveys conducted in the pilot areas, one was conducted by JPT before the PP and the other one was conducted by both LCAs one year after the start of PP. It is clear that satisfaction level of the residents toward waste collection service raised.

Table 3-5 Results of Questionnaire Surveys in Khartoum PP Area

	Before PP (October 2014)	After PP (March 2016)
Sample number	176	220
Collection vehicle keeps schedule	33%	88%
I put out waste on the designated point	60%	88%
Waste collection service is satisfactory	50%	79%

Table 3-6 Results of Questionnaire Surveys in Karary PP Area

	Before PP (October 2014)	After PP (March 2016)
Sample number	114	207
Collection vehicle keeps schedule	57%	Day 95% Time 87%
I put out waste on the designated point	57%	89%
Waste collection service is satisfactory	41%	86%

(4) Cleanness of the Areas

Waste was scattered and left along roads and water channels and on the open areas in both pilot areas as in the photos below.

	
Waste along a road in Karary	Waste along a road in Khartoum

Fig. 3-5 Waste Scattered and Left along Roads

This situation has improved much in the past two years. Such scattered waste has decreased and the areas have become cleaner. The possible causes behind the improvement are as follows:

- The time waste is put out outside has been shortened and residents use containers to put out waste. This prevents waste pickers and dogs from scavenging and scattering waste.
- Residents put out waste at the designated collection points by using waste containers and bags so that uncollected waste has decreased.
- Awareness on waste by residents has been raised and they have stopped throwing away waste on undesignated points.

(5) Shortened Collection Time

The time and motion survey was conducted and the total time spent for collection was measured in Karary and No.2 Elsegana Elgadida Gharb and No.4 Elsebak Shark out of the five sections in Khartoum before the start of the PP in January 2015. The Project has been doing monitoring since the start. The following table is the comparison of the collection time before and after the PP. The data of after the PP is the average of collected data through the monitoring from the start to December 2016. The collection time has decreased by 15% in Karary, 24 % in Khartoum No.2, 13 % in Khartoum No.4 respectively. It is expected that the collection time will be shortened further if collection workers stop segregating waste during collection. The collection workers segregate recyclable waste such as plastic bottles and metals to sell and supplement their low salaries. It is often seen that they stop the collection vehicle at the collection points to segregate waste.

Table 3-7 Collection time Before and After the PP

		Before the PP (Time and motion survey)	After the PP (the average data from the start to Dec.2016)[6]	Time Shortened	Shortened Ratio
Karary	Hara 2	189 minutes	161 minutes	28 minutes	15%
Khartoum	Elsegana Elgadida Gharb (No.2 on the map)	99 minutes	76 minutes	23 minutes	24%
	Elsebak Shark (No.4 on the map)	91 minutes	79 minutes	12 minutes	13%

(6) Improvement of Working Environment of Collection Workers

The collection workers do not need to run around to collect waste from all over the place as before, since the residents put out waste on the designated collection points. The collection workers can now stop to collect waste at the collection points. The use of waste bins and bags also has contributed to improvement of waste collection efficiency and hygienic environment.

(7) Increase in the Total Amount of Collected Waste Collection Fee and Fee Collection Rate

Both the total amount of collected waste collection fee and the fee collection rate have increased in both pilot areas compared to the data before the PP as in the next table. Only 10% out of the total houses had paid the waste collection fee before but about 40% paid one year after the start of the PP, although the fee collection rate decreased in 2016 in Karary. It is clear that residents pay waste collection fee if waste collection service is improved.

Table 3-8 Total Amount of Collected Fee and Fee Collection Rate in Karary PP Area

	Waste collection fee/month	Number of houses	Total amount of collected fee	Fee collection rate
Average of Nov. and Dec 2014	18 SDG	1,074	2,625 SDG	14%
Average of Jan. Feb. Sep. Oct. and Nov 2015	18 SDG	1,074	6,169 SDG	32%
Average of Jan. Feb and Mar 2016	18 SDG	1,074	8,183 SDG	42%

Source: Karary LCA

Table 3-9 Total Amount of Collected Fee and Fee Collection Rate in Khartoum PP Area

	Waste collection fee/month	Number of houses	Total amount of collected fee	Fee collection rate
November 2014	11 SDG	648	740 SDG	10%
April 2015	11 SDG	648	2,137 SDG	30%
December 2015	11 SDG	648	3,054 SDG	43%
May 2016	18 SDG	648	4,507 SDG	39%

Source: Khartoum LCA

[6] The data from July to September 2016 were excluded as it was in the rainy season and it took longer time than usual due to the bad condition of roads.

3.1.3 Lessons and Suggestions from the Pilot Project

Many lessons have been learned through the implementation of the PP. Khartoum state has a plan to expand the FPFT collection system to the other localities. Suggestions to introduce the FPFT collection system smoothly in other areas as well as lessons learned from the PP are summarized below.

(1) Improvement of the flow of collection and transportation to dispatch collection vehicles at the designated time

Dispatching collection vehicles at the designated time is an essential requirement for the FPFT collection. Delay of vehicles and cancellation of collection due to lack of vehicles make residents lose faith in the new system. However, there are many problems in Khartoum state to dispatch collection vehicles at the designated time.

Lesson	Comprehensive improvement is necessary from operation and management of collection vehicles to management of landfill sites If something happens, collection vehicles run easily short as a result of insufficient number of the vehicles and bad conditions of the vehicles. If the route of a collection vehicle even before and after the PP area is not determined carefully, the vehicle gets full in the middle and the vehicle is delayed for the designated time. It happened in the PP areas that the vehicles had to wait for long time to unload wastes at the transfer stations or to go to the landfill site due to fire or equipment breakdown in the transfer stations and landfill sites. There were cases that the type of the vehicle did not fit in with the conditions of the PP areas and it took time for collection. For instance, the vehicle was too big for the narrow roads in the PP area and could not collect wastes. The vehicle was too small to collect all wastes discharged in the area. All the concerned departments needed to share information and discuss countermeasures to such problems.
Suggestion	Minimization of problems through review of the overall flow of collection and transportation by all the concerned departments before introduction of FPFT collection system We can expect that overall condition will be improved in the future by handover of the collection vehicles and setup of the workshop by Japanese grant aid, and improvement in the transfer stations and landfill site by this project. Meanwhile, possible measures should be considered. It is necessary to dispatch the right type of vehicle to a target area and determine a good route including before/after the target area.

(2) Collection Workers' Behaviors, Attitude and Awareness of Safety

The project conducted safety training for collection workers in the PP areas and distributed uniforms and safety gears such as masks, gloves, shoes. They have started wearing the uniform to some extent but they still do not usually wear the safety gears. Their awareness that they themselves should protect them from dangerous waste is low. LCA sometimes receives complaints from residents about their bad attitude and behaviors, e.g. they throw bins, have a bad attitude to residents. Low salary of collection workers may be a one of factors of their dissatisfaction

and lack of professionalism

Lessons	It needs time to change behaviors, attitude and safety awareness of collection workers. LCA staff provided guidance on wearing uniforms and safety gears to the workers many times, but they were slow to react, saying they are binding. Some workers used to wear short pants and flip-flops. The situation has gradually improved though. It is effective to do monitoring and instruct how to improve. Improvements can be seen after we found problems and instructed the workers to improve the problems at every monitoring. The collection workers have stopped throwing bins away, leaving dropped wastes when putting wastes into the vehicle, and leaving wastes uncollected.
Suggestions	Implementation of regular training and monitoring Not only one-shot but regular training is required. Monitoring can be used to find out bad conducts and also to find out good conducts to give them incentives such as commendation. Improvement of working conditions and gaining pride for the work It is recommended to hire collection workers as a permanent staff. And it is preferable to create the working environment for collection workers to have pride in their work through training by KCC and activities to obtain understanding of residents for the collection work such as lectures by collection workers at schools.

(3) Use of Fixed Points and Bins

The project distributed big plastic containers as waste bins, but many bins were stolen[7].So residents say that they do not want to bring the bins to the fixed point which is not close to their houses. They are afraid their bins will be stolen. We often saw residents waiting near the bins until the collection finished. However, this fear could motivate them to put the bins at the fixed time. Residents also say that bins are too small for two-time collection per week, and it is too heavy for women and children to take the bins when the bins are full of waste. The bins were easily broken or deteriorated because they become heavy when they were full and the collection workers throw bins.

Lesson	Continuous awareness raising is essential. The use of the fixed points and bins has increased through continuous awareness raising about the benefits of the FPFT collection. Residents have started helping each other in bringing bins to the fixed points or watching bins not to be stolen. Collection points have been changed through discussion between LCA and residents for all to be satisfied with locations.
Suggestion	Consultation with residents as regard to fixed points and size and quality of bins and feedback from residents As for fixed points, residents should be involved when fixed points are decided so that they can help each other in bringing bins. Different size and shape of bins have been distributed in and out

[7] Stolen bins are usually sold to get cash. Some households use the bins to store water or foods.

	the PP areas. Bins should be improved based on feedback in terms of shape and durability from residents who have used different types of bins.

(4) How to put out waste

The project distributed bins, but plastic bags, other types of containers, card board boxes are used to put out waste. Some of the reasons are the number of bins distributed was not enough to all the households in the PP areas and the capacity of bin was not sufficient to keep waste for 3-4 days. Plastic bags, which they receive from shops when they buy something, are also used but the quality is bad and they are easily torn. This causes dropped out wastes from the tore plastic bags. There are many residents who want to put a big plastic bag inside the bins, too. Big plastic bags have become available at shops at last. Khartoum state has a plan to collect wastes both in bins and plastic bags.

Lessons	A rule as to how to put out waste is required Many types of waste containers or bags are used to put out waste, which causes dropped waste from such bags and containers. In addition, it is difficult for collection workers to decide which ones they should return or which ones they can throw into the collection vehicle. We sometimes saw residents running after the vehicle to get their containers or bags back, as the workers threw them in the vehicle. This leads to prolonged collection time and dissatisfaction of residents. Awareness raising for shops is necessary Although the PP areas are residential areas, there are some shops like grocery shops and tea shops. Shops generate much waste but they do not put out waste properly without using bins or bags. Waste is scattered around those shops. Residents complained about these problems caused by shops.
Suggestions	To develop a rule regarding how to put out waste There is a need to develop a rule and inform it to citizens. To conduct awareness raising activities to shops and offices LCA or AU should carry out activities to raise awareness of shop an office' owners in the target areas.

(5) Awareness Raising

The project conducted several awareness raising activities for the PP. KCC produced and broadcasted TV and radio programs for the environment. The LCA worked directly with residents. LCA staff made a brochure explaining the FPFT collection system, organized community meetings, and paid house-to-house visits to ask cooperation from residents. JPT and LCA have done monitoring and talked to residents, which produced good results. The study tour gave a great impact to the participants through observation of the actual FPFT collection.

Lessons	Continuous awareness raising is necessary Residents tend to lose motivations as time passes, so continuous awareness raising is necessary.

	Combination of different types of awareness raising was effective. It is effective to involve community leaders and members other than the PC The PC is the important entry point. It is important, however, to involve other community leaders and members. This is because most of the PC members support the ruling party and some residents do not want to follow them. In the PP areas, we involved Imams and women leaders and they played an important role to change behaviors and mindsets of residents.
Suggestion	To find active groups and leaders in the target area and cooperate with them It is imperative to build a mechanism to change behaviors and mindsets of residents by identifying active groups and leaders in the target area and making them to play a part.

3.2 Improvement of Waste Collection and Transfer Station Operations

3.2.1 Approach of the Project

JPT worked closely with the operation managers in each of the seven localities under the close coordination of KCC, to analyze the collection operations, identify the issues and propose the necessary improvements. Meetings were held, calling all the Operation Managers to KCC and separate meetings were held with each individual operation manager. Formats for data collection were prepared and the Operation Managers staff were trained on filling the required data. The analysis results of the collected data were discussed with the Operation Managers in order to develop a common understanding of the collection situation in each locality.

3.2.2 Generated and Collected Municipal Solid Waste Amounts

Various data was collected and analyzed by JPT. These included (1) data collected by each locality on their collection trucks operations, and (2) data collected by KCC on their trailers transport from the transfer stations to the landfills. JPT measured representative trucks to calculate the haul volumes, and using waste densities of 0.35 t/m3 for dump trucks and arm-rolls and 0.45 t/m3 for compactors, calculated the waste haulage in tons. Based on surveys at the transfer stations, the haul capacity percentages were estimated.

Analysis of data for one month period was then done with the results as shown in Table 3-10.

Table 3-10 Waste Collection Rates by Locality in 2016

	Khartoum LA	Omdurman LA	Bahary LA	Jabel Aulia LA	Umbadda LA	Sharg En Nile LA	Karary LA
Population (capita)	891,389	714,145	846,524	1,342,343	1,392,841	1,221,689	994,227
UGR (kg/cap/d)	1.53	1.12	0.82	0.71	0.51	0.52	0.61
MSW generated (t/d)	1,364	801	691	946	712	629	609
MSW amount collected (t/d)	886	544	470	484	501	378	366
Collection service (%)	65%	68%	68%	53%	68%	60%	60%

3.2.3 Conditions of Operations

(1) Truck Conditions

The waste collection trucks that are available in each locality and their working conditions as of July 2016, based on the data collected from the localities directly and KCC are shown in Table 3-11.

Table 3-11 Collection Trucks in each Locality

	Item	Khartoum LA		Omdurman LA		Bahry LA		Jabal Aulia LA		Umbada LA		Sharg En Nile LA		Karary LA		Khartoum State	
1	Truck number	119		104		95		95		111		100		81		705	
	Compactor	57	48%	36	35%	28	29%	34	36%	39	35%	33	33%	34	42%	261	37%
	Dump truck	45	38%	41	39%	49	52%	36	38%	48	43%	41	41%	23	28%	283	40%
	Arm roll	10	8%	12	12%	13	14%	8	8%	6	5%	7	7%	5	6%	61	9%
	Tractor	7	6%	15	14%	5	5%	17	18%	18	16%	19	19%	19	23%	100	14%
2	Capacity																
2.1	Volume (m^3)	1,194		854		828		815		999		856		816		6,362	
	Compactor	754	63%	444	52%	339	41%	405	50%	479	48%	384	45%	402	49%	3,207	50%
	Dump truck	280	23%	216	25%	347	42%	225	28%	343	34%	277	32%	241	30%	1,929	30%
	Arm roll	110	9%	104	12%	112	14%	83	10%	69	7%	81	9%	59	7%	618	10%
	Tractor	51	4%	90	11%	30	4%	102	13%	108	11%	114	13%	114	14%	609	10%
2.2	Weight (ton)[1]	493		343		324		326		398		338		326		2,547	
	Compactor	339	69%	200	58%	153	47%	182	56%	216	54%	173	51%	181	56%	1,443	57%
	Dump truck	98	20%	76	22%	121	38%	79	24%	120	30%	97	29%	84	26%	675	27%
	Arm roll	38	8%	36	11%	39	12%	29	9%	24	6%	28	8%	21	6%	216	8%
	Tractor	18	4%	32	9%	11	3%	36	11%	38	10%	40	12%	40	12%	213	8%
3	Age	119		104		95		95		111		100		81		705	
	1988 - 2000	4	3%	0	0%	3	3%	0	0%	0	0%	0	0%	0	0%	7	1%
	2001 - 2005	27	23%	21	20%	15	16%	8	8%	13	12%	11	11%	6	7%	101	14%
	2006 - 2010	40	34%	40	38%	28	29%	32	34%	41	37%	36	36%	54	67%	271	38%
	2011 - 2015	48	40%	43	41%	49	52%	55	58%	53	48%	53	53%	21	26%	322	46%
4	Condition	119		104		95		95		111		100		81		705	
	Operating[2]	73	61%	69	66%	90	95%	48	51%	62	56%	60	60%	42	52%	444	63%
	Out-of-order[3]	45	38%	29	28%	5	5%	47	49%	42	38%	40	40%	39	48%	247	35%
	Removed	1	1%	6	6%	0	0%	0	0%	7	6%	0	0%	0	0%	14	2%
5	MSW (t/d)[4]	1,364		801		691		946		712		629		609		5,752	
6	Haul Capacity																
	MSW/Capacity tot.[5]	2.8		2.3		2.1		2.9		1.8		1.9		1.9		2.3	
	MSW/Capacity Op.[6]	4.5		3.5		2.3		5.7		3.2		3.1		3.6		3.6	

(1) Weight in ton is estimated based on density of hauled waste (Compactors; 0.45 t/m3, Other trucks; 0.35 t/m3)

(2) Information on trucks in operation was obtained from the Localities. Degree of operation may differ from one locality to another.

(3) Out-of-order trucks include those under repairs or that have operation frequency of less than 50%. Degree of operation may differ from one locality to another.

(4) Generated Municipal Solid Waste calculated based on unit generation rates (UGR) in each locality and populations there

(5) Haulage capacity efficiency estimated based on total generated MSW divided by total fleet haulage capacity (assuming one trip per truck)

(6) Haulage capacity efficiency discounted by the Out-of-order rate

As of July 2016, 705 trucks were registered with the seven localities. There is an additional number of trucks (8-10 units) registered with HCEURP for use in cases of "rapid intervention" to remove un-collected wastes.

The trucks have been procured from 14 different manufacturers, in Asia, Europe and Sudan. Regarding truck type, overall compactors represent 48% of the total haul capacity in terms of volume, and 54% in terms of weight[8]. Dump trucks account for 40% and 48% respectively.

Overall 15% of the trucks are over 12 years old. Thanks to the Grant Aid project, the share of trucks in the 2011 to 2015 range is 46%. By locality, newer trucks have been distributed to the outer localities, while the inner localities

[8] Haul capacity in terms of weight is estimated as the product of truck volume x hauled waste density (assumed as 0.45t/m^3 for compactors and 0.35t/m^3 for other truck types

depend more on older trucks. Many of their trucks are out-of-order and waiting for repairs. Most of these trucks have not been in operation for over one year, and their overall share is 35%. In Jabal Aulia and Karary localities the situation is extremely severe with just short of 50% of their registered trucks being unfit for operation.

"Haul Capacity" refers to the generated waste in a locality divided by the haul capacity of all the trucks registered in that locality. The total haul capacity is 2.2 (5,752 ton of generated waste divided by 2,547 ton haul capacity). This means that in order to collect all the generated waste, each truck must make on average 2.2 trips.

However, it is more realistic to consider the actual haul capacity, where only 63% of the registered trucks are in operating conditions (refer to item 4 of the table). In such a case the haul capacity equals 3.4, and therefore more trips per truck are required.

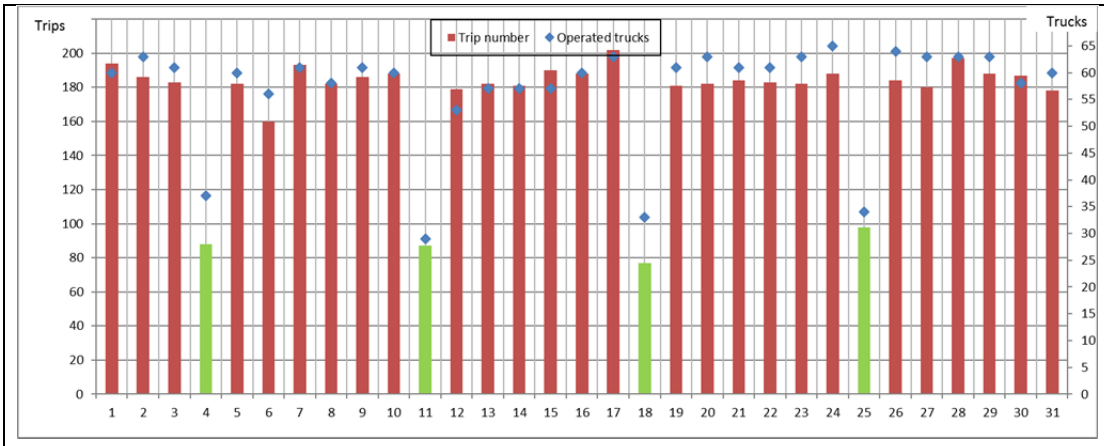
(2) Operating Conditions

(a) Trip Production

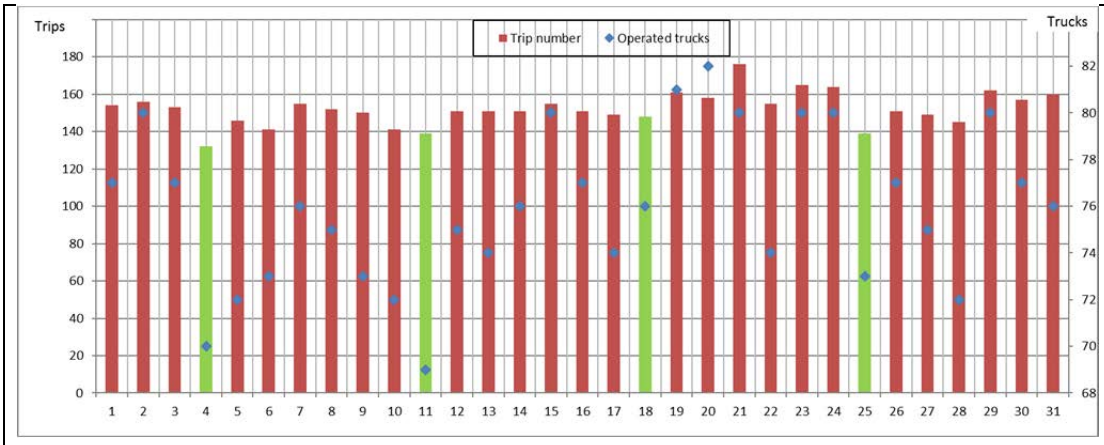
Trip production refers to the number of collection trips a truck can make in one shift. To increase truck efficiency a truck needs to make the maximum number of trips possible.

Excel sheets were prepared for each locality to record the actual trips produced by each truck, daily for the months of March and April 2016. Four of the seven localities filled in the excel sheets; Umbadda LCA, Bahary LCA, Karary LCA and Bahary LCA.

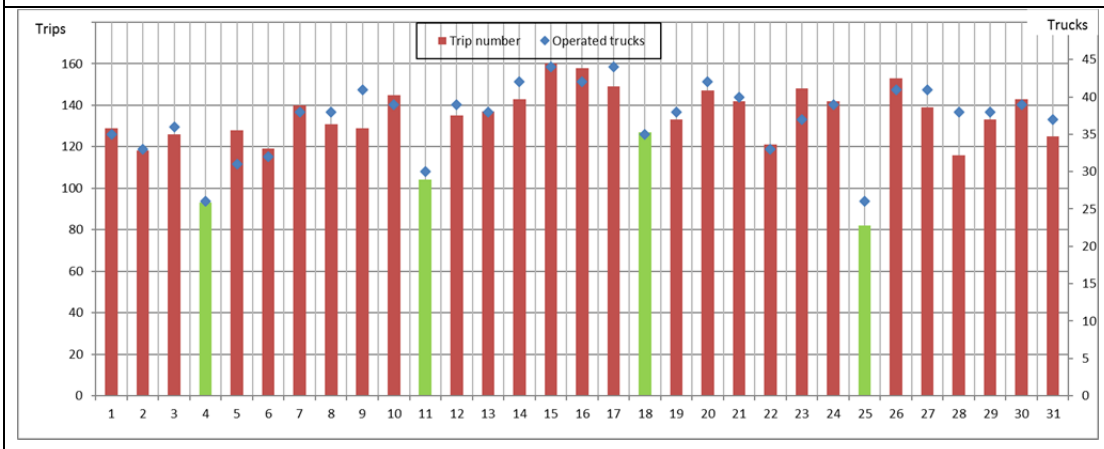
In March 2016, the fluctuation of the number of trucks operated and the produced number of trips on a daily base is shown in the following graph (Fig. 3-6).



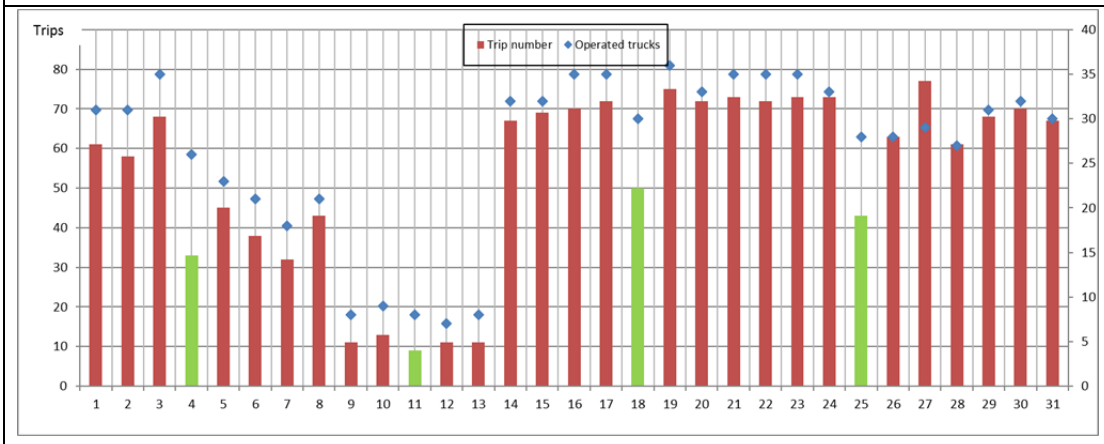
Omdurman LCA



Umbadda LCA



Bahary LCA



Karary LCA

Graph Axes: (1) Trips; Vertical left axis and red & green bars, (2) Trucks; Vertical right axis and blue squares, (3) Days; Horizontal axis

Fig. 3-6 Four LCA Collection Trucks Operation in March 2016

The actual number of trucks operated by LCA varied as shown in Table 3-12.

Table 3-12 Umbadda LCA – Average Trucks Operated and Trips Produced

	Weekdays (1)	Fridays (2)	Month (3)
(1) Omdurman LCA			
Average number of trips per day	184.8	87.5	172.3
Average number of trucks per day	60.4	33.3	56.9
Average trips/truck	3.1	2.6	3.0
(2) Bahary LCA			
Average number of trips per day	136.6	101.5	132.1
Average number of trucks per day	38.3	29.3	37.2
Average trips/truck	3.6	3.5	3.6
(3) Umbadda LCA			
Average number of trips per day	154.0	139.5	152.2
Average number of trucks per day	76.5	72.0	75.9
Average trips/truck	2.0	1.9	2.0
(4) Karary LCA			
Average number of trips per day	55.2	33.3	52.4
Average number of trucks per day	27.0	23.0	26.5
Average trips/truck	2.0	1.4	2.0
Notes: (1) 27 days in March, 2016, (2) 4 days in March 2016, (3) 31 days			

Both inner localities of Omdurman and Bahary produced an average of 3.0 and 3.6 trips/truck over the whole month, while for the outer localities of Umbadda and Karary the corresponding figure was 2.0 trips/truck. There is a need to improve trip production in the outer localities.

(b) Truck Operating Days

In terms of number of days each truck was operated the data for March 2016 was analyzed and the results depicted graphically in Fig. 3-7.

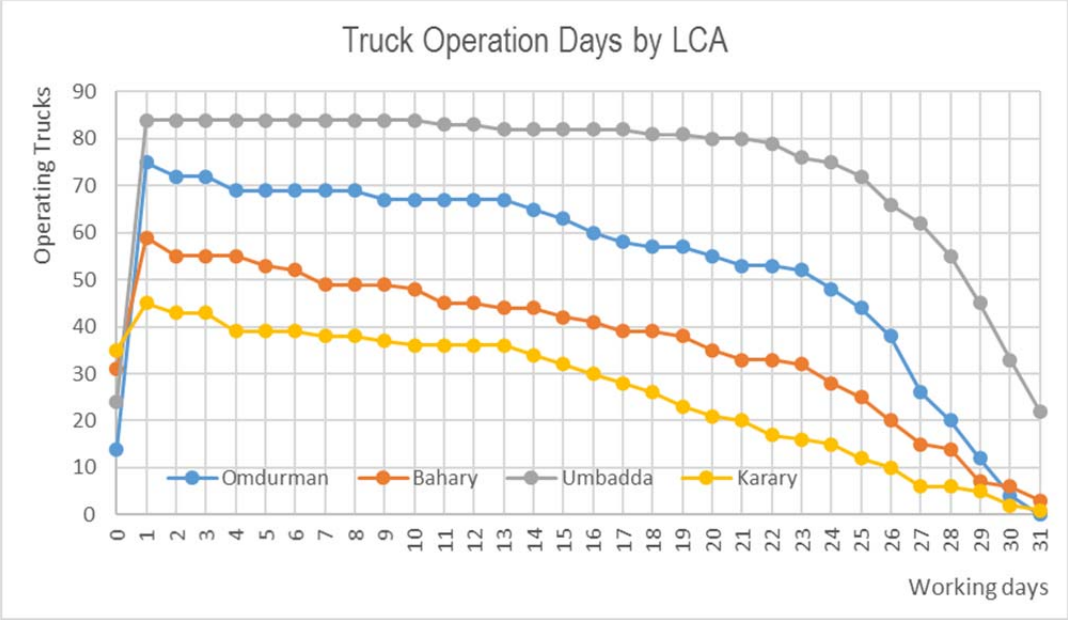


Fig. 3-7 Truck Operation Days by LCA

The vertical axis of the graph shows the number of operating trucks while the horizontal axis indicates the number of days each truck operated. The highest consistency level was in Umbadda where over 80 trucks were each operated for 20 days of the month. For the other three LCAs consistency levels were lower, at around 10 to 13 days.

On the other hand, out of the total trucks registered in each of Bahary LCA and Karary LCA, over 30 trucks in each were not operated at all in March 2016. In general, the trucks are not reliable due to old age and poor preventive maintenance and repairs.

(c) Collection Services in each AU

Operation Managers submitted their analysis of the present collection services conditions in each AU and each Operations Manager provided the following information for each AU;

- Percentage of waste collected from the AU (i.e. service coverage)
- The share of the collection frequency (daily, 2 days/week, 1 day/week, etc.) in each AU.
- The share of the discharge system (door-to-door, collection points, or containers) in each AU

To determine the collection service levels in each of the 105 AUs, discussions were held with each LCA Operations Manager, using the following table format (example is provided for Khartoum LCA). Similar table were prepared for all the seven localities and the results of the discussions were analyzed for each locality. Summary of the analysis is explained below.

Table 3-13 Format to Check the Service Levels in the Administrative Units (Ex. Khartoum LCA)

25th June 2016
LCA Ops Manager, Mr. Abdelazim

SN	AU	Solid Waste Collection Conditions									
		(1) Service rate	(2) Frequency				(3) Discharge System			(5) Remarks	(6) Priority
			(2.1) Daily	(2.2) 2d/week	(2.3) 1d/wk	(2.4) Campaigns	(3.1) At door	(3.2) Coll. points	(3) Containers		
ALL	Khartoum Locality										
1	Khartoum Shamal	80%		100%			100%			Commercial waste amount high Community uncoorperative	1
2	Khartoum Shark	70%		100%			100%			Community uncoorperative	1
3	Elriyadh and Eltaif	90%		100%			70%		30%	Community uncooperative	1
4	Arkoweit	50%		100%			100%			Community uncooperative	2
5	Elgariff	50%		100%			60%		40%	Community uncooperative	2
6	Soba	90%		100%			100%			Community uncooperative	2
7	Elsouk Elmahalley	60%		100%					100%	Commercial waste amount high	1
8	Gabra	50%		100%			100%			Community uncooperative	1
9	Elsehafa	60%		100%			100%			Community uncooperative	2
10	Alimtedad	80%		100%			100%			Community uncooperative	2
11	Elemarat	70%		100%			70%		30%	Community uncooperative	1
12	Eldeem	60%		100%			85%		15%	Community uncooperative	1
13	Khartoum Gharb	95%		100%			100%			Community uncooperative	2
14	Alshaghara	60%		100%			100%			Community uncooperative	2
15	Almanteka Alsenaaya	80%		100%				40%	60%	Community uncooperative	1

In Khartoum LA service coverage is over 75% in 6 AU, which is a good service level. All 15 AU are served 2 days per week, which is a collection frequency that supports efficient collection work. On the other hand, in 9 AU, 100% of the waste discharge there is door-to-door, which is an inefficient system.

In Omdurman LA service coverage is reported as 100% in 4 AU and over 75% in another 4 AU. These are high service levels. On the other hand, 100% of the collection frequency is daily in 4 AU, which leads to inefficient use of the trucks.

In Bahary LA collection service coverage is reported at over 75% in 3 AU, which is a positive indicator. However, 100% of the waste is discharged in front of the residences in 4 AU and this result in inefficient use of the trucks.

In Umbadda LA the collection service coverage was reported at 100% in 8 AU, which is very positive, but with 12 AU having 100% door-to-door discharge, truck efficient operation is doubtful.

Jabel Aulia LA reported two negative indicators, with 7 AU having less than 50% collection service coverage and 12 AU discharging 100% of their wastes in front of their living and working places.

In terms of collection service coverage, Sharg En Nile LA reported positively that 6 AU have more than 75% coverage while negatively that 4 AU have no collection service at all.

Karary LA reported that 4 AU out of its 10 AU are receiving collection service of over 75% which is a good indicator of the service, while on the opposite side 2 AU, or twenty percent of the total AUs in Karary have no collection service.

This analysis helps the respective LCAs to set priorities for each AU and to gradually shift from door-to-door discharge system to collection point and from collection frequency of daily collection to 2 days per week collection in order to improve the truck efficiency utilization and operate the trucks in other AU where there is low collection service coverage.

3.2.4 Transfer Stations Operation

At present, there are two transfer stations operating in Khartoum State. The analysis of KCC data for January 2016 is shown in Table 3-14.

Table 3-14 Waste Transported from Transfer Stations to Landfills

	Khartoum TS (2 ramps)	Omdurman TS (1 ramp)
(1) Number of trailer trips (January 2016)	927 trips	647 trips
(2) Average trailer trips per day	30 trips	21 trips
(3) Ave. tons transported from station per day	750 ton/d	525 ton/d
(4) Rate of total generated waste in Khartoum State	14%	10%

A survey was done together with KCC at the Khartoum and Omdurman Transfer Stations to confirm the working conditions and shares by waste categories. The results are for the incoming collection trucks fluctuations are portrayed graphically in Fig. 3-8.

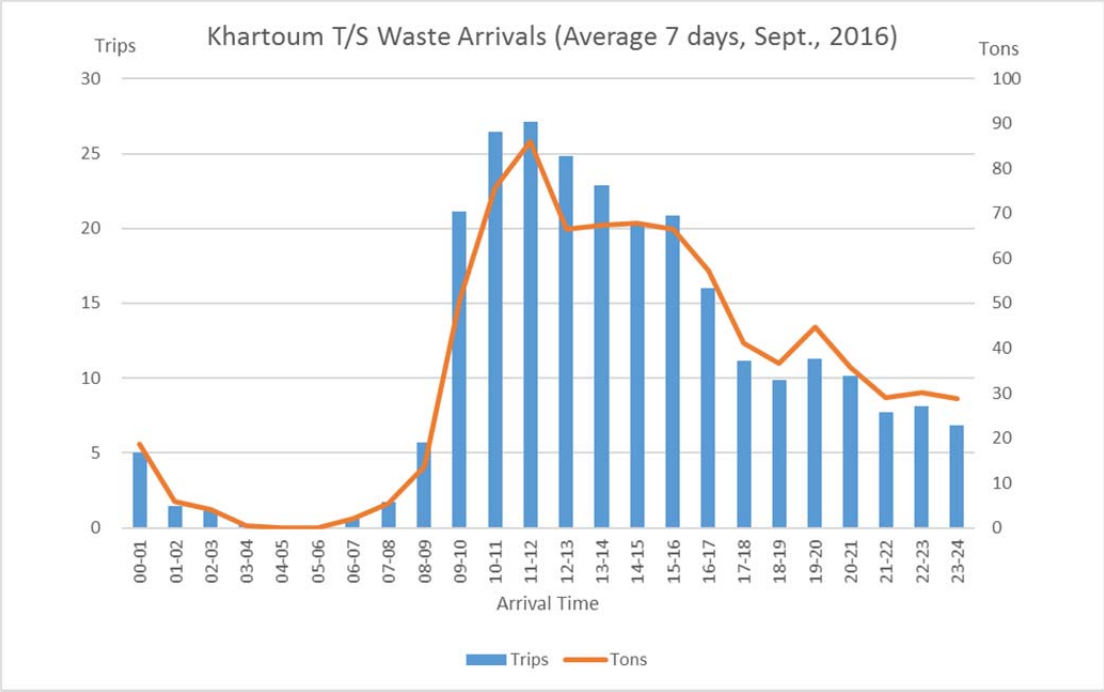


Fig. 3-8 Khartoum TS - Incoming Waste Fluctuation by Time

The one week data shows that on average 260 collection truck trips arrived at the Khartoum transfer station hauling in 834 ton/day of waste. Considering the values obtained from analyzing the KCC January 2016 data, it can be estimated that roughly 750 - 830 tons of waste are arriving at Khartoum transfer station daily. More accurate estimates can be made once the weighbridges are in use at the transfer stations.

3.2.5 Improvement Plans

Improvement plans both for waste collection and transfer stations have been prepared based on a mutual understanding of the issues. These are included in the revised master plan presented in Output 1 (Chapter 6 of this report).

Recommended short term improvements include the following.

- More accurate data collection, analysis and interpretation and reporting
- Expansion of the FPFT system based on the pilot projects and analysis of the existing collection conditions in each AU
- Improvement of designs at the newly planned transfer stations

3.2.6 Preparation of PP Plan on Khartoum Transfer Station Improvement

(1) Regular Cleaning

There were large amounts of openly dumped wastes around the transfer station and the transfer station resembled an open dumping site. Much of the dumped waste was removed and the transfer station was cleaned. In addition, cleaning the station became a part of regular work of the operation.

(2) Reduction of waiting line of waste collection vehicle through data analysis

Records of incoming waste collection vehicles and outgoing trailers to the landfill site were analyzed and unified with other records of the landfill site as integrated SWM record system.

(3) Repair and Maintenance of the Equipment

KCC would consider rehabilitation of the trailers and compaction equipment which compact the waste unloaded from waste collection vehicle and load the compacted waste to the trailers.

3.2.7 Safety and Sanitation Training

There are many vehicles transporting wastes in the transfer stations and the landfill sites so that there are many traffic accidents in the sites. Furthermore, the workers are working in unsanitary conditions due to the job for solid waste. The Project had many training for the workers on safety management and sanitary work. The safety and sanitation training for workers of the transfer station and the landfill was held on June 27th and 28th, 2015 at Khartoum Transfer Station

19 persons (14 workers from the transfer station and landfill, Mr. Mordus from KCC, Mr. Musharif, and others) attended on Day 1, and 21 persons (16 workers from the transfer station and landfill, Mr. Mordus from KCC, Mr. Musharif, and others) attended on Day 2. KCC distributed safety gears: 30 sets (uniforms, globes, masks and caps)

Details of the training are s as follows:

(1) Contents

[Day 1]

Time	Contents of Lecture	Lecturer
11:15 - 11:20	Opening remarks (introduction of Mr. Musharif as the external lecturer, and introduction of JICA)	Mr. Mordus (KCC)
11:25 -12:00	Safety of working (to identify the issues from the situation of collection, transfer station and landfill works)	Mr. Mordus (KCC)
12:00 - 12:05	Questions and answers	
12:05 - 13:05	Management of safety and sanitation ((1) management of working environment, (2) sanitary environment, (3) necessity of safety gears, (4) situation of the collection work)	Mr. Musharif (external lecturer)
13:05 - 13:30	Explanation of FTFP system, and discussion with workers	Mr. Mordus, Mr. Musharif
13:45-	Delivery of uniforms and safety gears	
-14:00	Commemorative photography	

[Day 2]

Time	Contents of Lecture	Lecturer
11:15 -11:35	Opening remarks (introduction of Mr. Musharif as the external lecturer, and introduction of JICA) Explanation of FTFP system	Mr. Mordus, Mr. Musharif
11:35 -12:15	Safety of working (to identify the issues from the situation of collection, transfer station and landfill works)	Mr. Mordus
12:15 - 13:20	Management of safety and sanitation ((1) management of working environment, (2) sanitary environment, (3) necessity of safety gears, (4) situation of the collection work)	Mr. Musharif
13:20 - 13:30	Discussion with workers	Mr. Mordus, Mr. Musharif
13:30-	Delivery of uniforms and safety gears	
-13:45	Commemorative photography	

Mr. Musharif gave an oral lecture. He explained how the working environment was very harmful, such as dioxin generation in the smoke from the landfill. He also instructed to give attention to how to deal with the equipment in order to secure the safety under such harmful situation, and explained the importance of the safety gear (caps, masks, globes, working uniforms and others). He told that JICA would provide the safety gear. And he warned the workers because of complaints from residents.

Lecturers answered questions from the workers after each lecture. After lectures, Mr. Mordus distributed the safety gear for each attendant according to the attendance list. After distribution, the representative of workers gave an address of thanks.

In Day 2, the situation of the transfer station such as illegal dumping was observed and found as not good. Mr. Mordus reported that it should be improved. KCC and JPT explained the necessity of wearing safety gear.

	
Introduction	Lecture
	
Lecture	Lecture
	
Lecture	Explanation of FTFP collection
	
Distribution of safety gears	Closing

Fig. 3-9 Safety and Sanitation Training to Operation Staff of Khartoum Transfer Station (1st Day)

	
Introduction	Introduction
	
Explanation of FTFP collection	Lecture
	
Lecture	Lecture
	
Distribution of safety gears	Closing

Fig. 3-10 Safety and Sanitation Training to Operation Staff of Khartoum Transfer Station (2nd Day)

3.3 Construction of T/S and procurement of new equipment by Khartoum State themselves

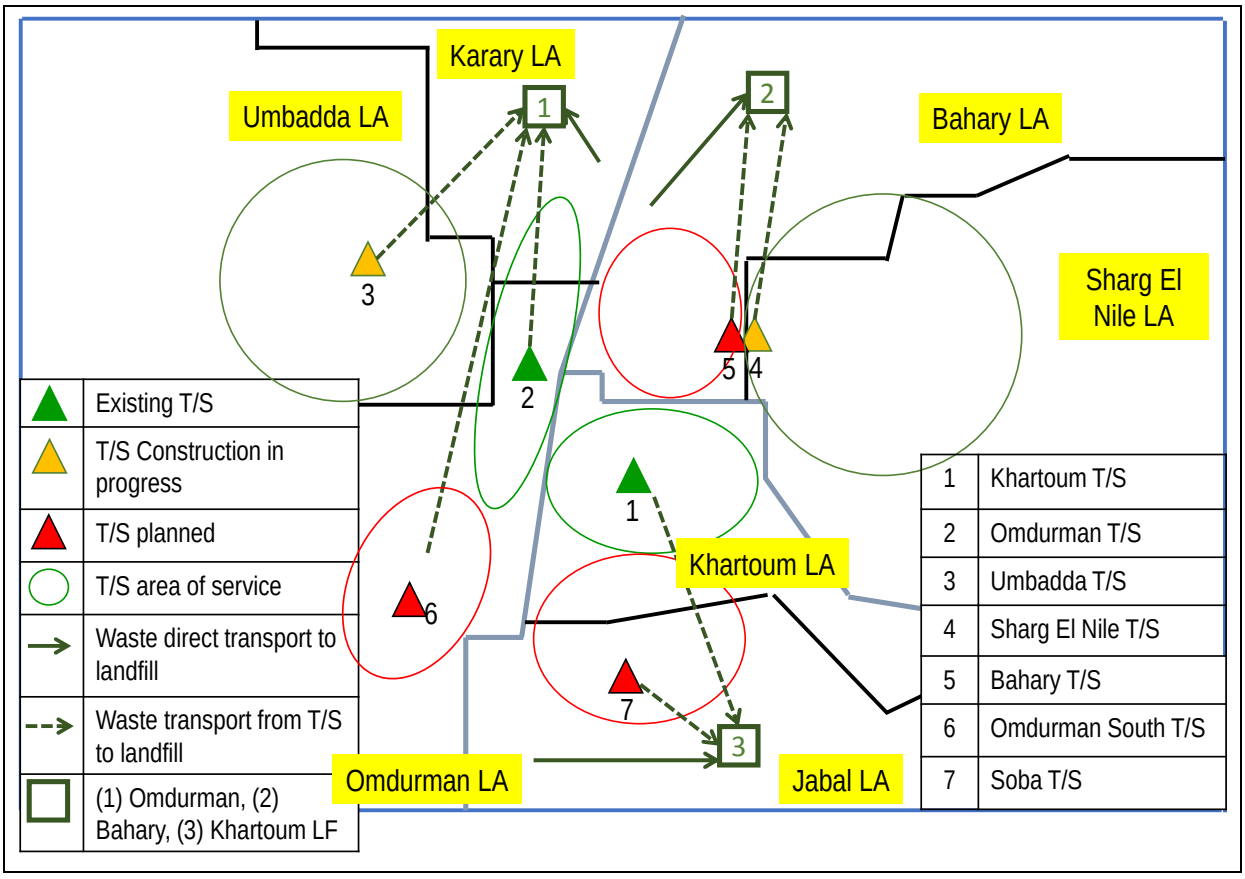
3.3.1 New Umbadda Transfer Station

KCC recognizes the need to expand the transfer stations and has been constructing the new Umbadda Transfer Station for the last two years. Concerning the design and construction JPT has provided improvement recommendations. The new station is expected to be opened in early 2017. KCC has procured three 32 m^3 dump trucks to provide secondary transfer from the new transfer station.

3.3.2 New Transfer Stations Equipment Requirements

The transfer station facility cannot function without sufficient and reliable trailers, heads and wheel loaders. JPT has advised that for each new transfer station the required equipment should be clearly estimated. Design and equipment estimations should be made based on the projections of incoming wastes.

Fig. 3-11 shows the schematic locations of the transfer stations, the areas they will serve and the solid waste flow in 2020. By the year 2020 it is planned to have seven transfer stations in operation in Khartoum State.



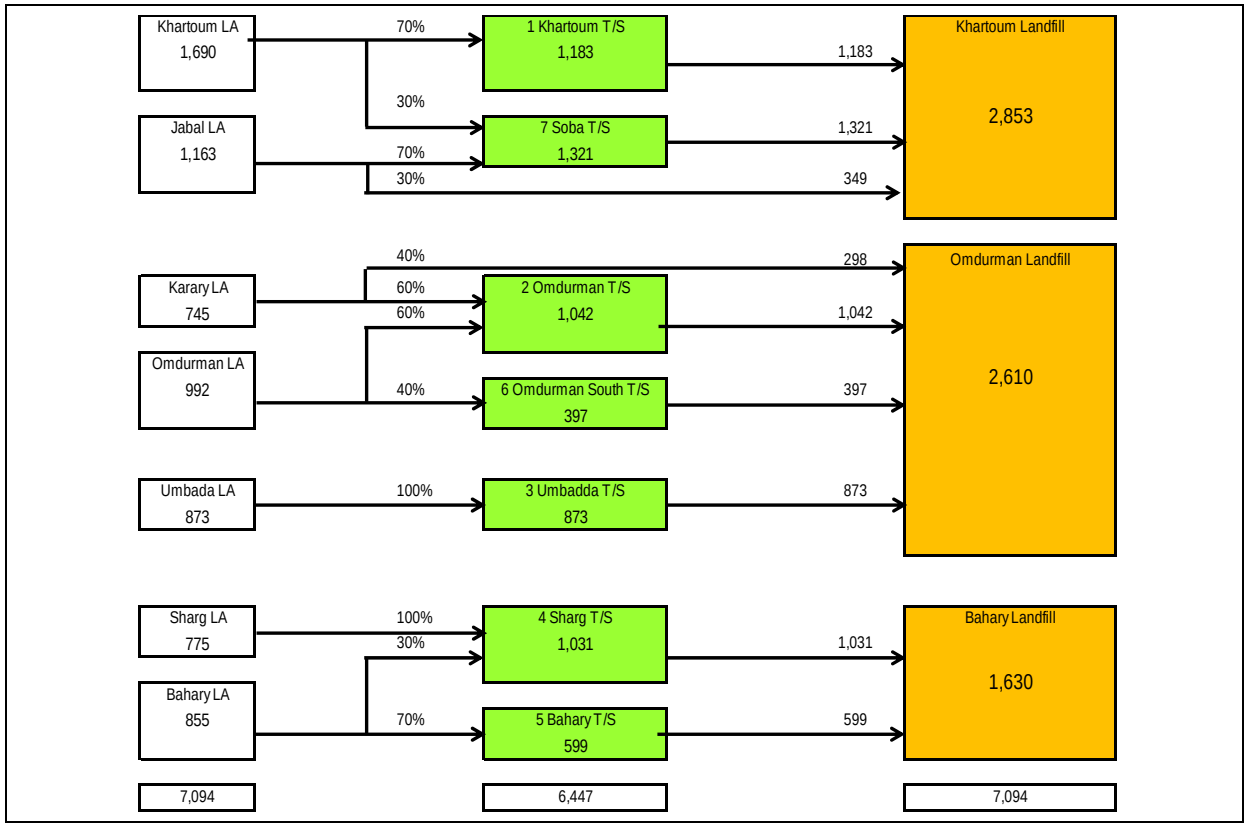


Fig. 3-11 Waste Flow in 2020

The amount of waste entering each transfer station in 2020 was used as the design capacity for that station. The amount of waste estimated for each transfer station was determined based on the total generated waste in the locality being served by the station and the share of the total generated waste arriving at the station. The shares were estimated based on the nearest station to the waste generation areas. For example, in the case of Khartoum Locality, 70% of the generated waste in that locality is estimated to go to the Khartoum T/S while 30% of the waste will be transported to Soba T/S.

In the case of Karary locality, the waste from the northern parts, estimated at 40% of the total generated waste in the locality will be directly transported to the Omdurman landfill which is closer than Omdurman T/S to the northern part. While waste generated in the southern part of Karary locality, where population density is higher than the northern part, estimated at 60% will be transported to Omdurman T/S.

The design capacities of the transfer stations have been estimated based on the total generated wastes, and not the collection rates. The reason for this is to provide factors of safety in case that localities can improve their collection rates more rapidly or that the population densities in the future change from the patterns foreseen at this time.

It is important to determine the design capacities of the stations. The amounts of waste forecast to enter the stations daily in 2020 have been adopted as the design capacities. The facilities of the transfer station, such as required land area, ramp dimensions, parking bays, queueing space, workshops and etc. should be designed according to the design capacities.

Table 3-15 shows the design standards for the new transfer stations.

Table 3-15 Design Standards for the New Transfer Stations

SN	Activity	A - Design Requirements (2020 demand)	
1	Umbadda New T/S	• Design capacity = 900 ton/day • Minimum three discharge points	• Sorting area and drop-off area • Entry and exit weighbridges
2	Sharg El Nile New T/S (Combined)	• Design capacity = 1,050 ton/day • Minimum three discharge points	• Sorting area and drop-off area • Entry and exit weighbridges
3	Bahary New T/S Plan (Combined)	• Design capacity = 600 ton/day • Minimum two discharge points	• Drop-off area • Entry weighbridge
4	Omdurman South New T/S Plan	• Design capacity = 400 ton/day • Minimum two discharge points	• Drop-off area • Entry weighbridge
5	Soba New T/S Plan	• Design capacity = 1,350 ton/day • Minimum three discharge points	• Sorting area and drop-off area • Entry and exit weighbridges
6	Rehabilitated Khartoum T/S	• Design capacity = 1,190 ton/day • Minimum three discharge points	• Sorting area and drop-off area • Entry and exit weighbridges
7	Rehabilitated Omdurman T/S	• Design capacity = 1,050 ton/day • Minimum three discharge points	• Sorting area and drop-off area • Entry and exit weighbridges

The design standards will also influence the numbers of equipment that will be needed at each transfer station. The required numbers of units for each are shown in Table 3-16.

Table 3-16 Equipment Requirements for the Improved Transfer Stations

SN	Transfer Station	B – Secondary Transport Equipment Requirements	
		Year 2020	Year 2025
1	Umbadda New T/S	Heads = 3 units, Trailers = 7 unit, Facility Head = 1 unit	Heads = 5 units, Trailers = 10 unit, Facility Head = 1 unit
2	Sharg El Nile New T/S	Heads = 5 units, Trailers = 9 unit, Facility Head = 1 unit	Heads = 6 units, Trailers = 11 unit, Facility Head = 1 unit
3	Bahary New T/S Plan	Heads = 3 units, Trailers = 5 unit, Facility Head = 1 unit	Heads = 4 units, Trailers = 7 unit, Facility Head = 1 unit
4	Omdurman South New T/S Plan	Heads = 2 units, Trailers = 4 unit, Facility Head = 1 unit	Heads = 3 units, Trailers = 5 unit, Facility Head = 1 unit
5	Soba New T/S Plan	Heads = 6 units, Trailers = 11 unit, Facility Head = 1 unit	Heads = 7 units, Trailers = 14 unit, Facility Head = 1 unit
6	Rehabilitation Khartoum T/S	Heads = 5 units, Trailers = 10 unit, Facility Head = 1 unit	Heads = 7 units, Trailers = 13 unit, Facility Head = 1 unit
7	Rehabilitation Omdurman T/S	Heads = 5 units, Trailers = 9 unit, Facility Head = 1 unit	Heads = 6 units, Trailers = 11 unit, Facility Head = 1 unit

3.4 Establishment of Call Center and Installation of GPS Tracking System

3.4.1 Call Center

KCC established a call center to receive complaints and requests on solid waste management from citizens in January 2016 as one of activities outside the Project. The number of call center "1965" was advertised through TV and radio and stickers of the call center with the number were put on the collection vehicles provided by Japanese grant aid. As KCC negotiated with major telecom companies, citizens can call the number at free of charge.

Call center at KCC

Sticker on waste collection vehicle

Fig. 3-12 Call Center at KCC

The Department of Cleaning Promotion and Information, which was newly established at KCC to do public awareness activities, is responsible to run the call center. Although KCC rented a room in a building in the town and contacted out development of a software for data input and analysis in the beginning, it become difficult to maintain them. KCC moved the call center inside the KCC office building. The call center has three operators each for two shifts. They receive about ten calls/day on average and input data of the calls in an excel file. Most of calls are complaints about non-coming collection vehicles. KCC has a plan to build an interlocking system between the tracking system explained in the next section and call center so that KCC or LCA can send a collection vehicle to a location where a complaint call is made immediately.

After the call center receiving a call, KCC contacts respective LCA, and then LCA give a direction to respective district cleaning office to solve the problem. The district cleaning office should report back to LCA after taking an action, and LCA reports back to KCC.

KCC prepares a monthly report of calls received at the call center. According to the reports, the call center sometimes receives the second call from the same citizens as LCA does not take actions and does not report back to KCC. KCC and LCA should try to communicate closely and share information.

The Project organized a study tour to the target area of FPFT collection, the transfer station and landfill for the operators since they do not have sufficient knowledge on solid waste management.

3.4.2 GPS Tracking System

In 2015, KCC entered into a contract with a European country to introduce GPS tracking system for the localities

collection trucks, KCC operated collection trucks and heavy equipment.

Up to November 2016, the tracking devices have been installed in 282 collection trucks and heavy equipment, including all the trucks procured under the Japan Grant Aid. KCC has a target to install the devices in 500 trucks and equipment and the installation works are ongoing.

The objective of the system is to determine at any fixed time whether the truck or equipment is in operation or idle, and where it is located. The system provides daily reports showing the activity of the equipment on the previous day. The devices have been installed in the trucks in reportedly such a manner as to prevent dismantling by the drivers or operators. Officers can track the trucks movements on their mobile phones or through computers where the required software has been installed. The main computer for this purpose is located in the Technical Department of KCC. The officer in charge provides daily reports to the department head.

JPT was not involved in the decision making behind the installation of the tracking system and it is therefore beyond the scope of this project to evaluate this system. We have noted however the following issues which may need to be addressed by KCC regarding the GPS tracking system.

- There is a need for the officers following the tracking system to understand the actual collection work on site and heavy equipment use at the landfills in order to correctly interpret the data generated by the tracking system
- A number of times the officers of KCC attempted to view the tracking system on their mobile phones or on the PC but could not succeed due to frequent problems with the internet connection
- Localities workshops and garages often change license plates of the trucks to avoid registration problems and this may affect the accuracy of the reporting on the tracking system
- The localities do not seem to be using the generated reports and it seems that the system is in place for KCC to monitor the localities. While the tracking system is an important monitoring tool, it should also be used to improve the operations by the localities.

3.5 Strengthening of Safe Diving and Vehicle Maintenance System

The related grant aid project had a soft component for enhancing capacity of maintenance of the equipment. The soft component prepared check sheet and manual for daily inspection by the drivers and periodical inspection in the central workshop, focusing on preventive maintenance which maintains and inspects the equipment before breakdown.

Table 3-17 Check sheet of daily and periodic inspection

Driver's check list for daily inspection

Truck No. Driver Name.

Place	Check item	No.	Contents	Check
Front	Front	1	Condition of lighting device	
		2	Condition of number plate, wiper and side mirror	
		3	Level of clutch oil	
		4	Level of coolant water	
	Bottom	5	Engine oil Brake oil leakage	
		6	Radiator water leakage	
Inside of engine room		7	Coolant water leakage	
		8	Oil leakage (Engine oil, Power steering oil)	
		9	Condition of fan belt	
		10	Level of power steering oil	
Side	Left	11	Condition of front left tire	
		12	Condition of fuel water separator	
		13	Transmission oil leakage	
		14	Condition of rear left tire	
Back	Back	15	Condition of lighting device	
		16	Condition of number plate	
	Bottom	17	Differential oil Brake oil leakage	
		18	Condition of hydraulic cylinder	
Side	Right	19	Condition of rear right tire	
		20	Battery condition	
		21	Level and leakage of brake oil	
		22	Draining air tanks	
		23	Condition of air cleaner indicator	
		24	Level of engine oil	
		25	Level of hydraulic oil	
		26	Condition of front right tire	
The important daily inspection point		1	Brake oil	
		2	Air tank water	
		3	Radiator coolant water	
		4	Engine oil	
		5	Bottom of truck (Front)	
		6	Bottom of truck (Rear)	

Periodic service check sheet

Date	Locality	Model	Reg. No.	Mileage	Checked by
				km	

✔	OK	×	Change	A	Adjust	C	Clean up	T	Tighten	L	Lubricant

Oil, Filter and water		Qty.
1	Engine oil	
2	Engine oil filter	
3	Fuel filter	
4	Air cleaner	
5	Brake oil	
6	Clutch oil	
7	Transmission oil	
8	Differential oil	
9	Hydraulic oil	
10	Hydraulic oil filter	
11	Power steering oil	
12	Radiator coolant water	
13	Battery water	
14	Greasing (Chassis and Body)	

Engine room	
15	Engine Idle RPM
16	Fan belt
17	Fan
18	Injector pump, Nozzle
19	Generator
20	Starter

Outside	
21	Brake air tank, piping
22	Brake air tank Drain valve
23	Front Brake hose, pipe
24	Front brake lining (Adjustment)
25	Rear Brake hose, pipe
26	Rear brake lining (Adjustment)
27	Parking brake
28	Clutch Free play (Adjustment)
29	PTO shaft
30	Hydraulic pump, cylinder
31	Compactor or Container carrier equipment
32	Tire
33	Wheel nut bolt
34	Frame, body
35	Lights / Miller

Driving	
36	Engine general (start, running sound, smoking)
37	Foot brake
38	Parking brake
39	Clutch / Transmission
40	Steering
41	Noise

Comments:

Source: Soft component of the related grant aid project

The preventive maintenance of the equipment has been developed as mentioned above, there are some unoperated waste collection vehicles due to breakdowns and accidents. 12 units of waste collection vehicle out of 80 vehicles procured by Lot-1 of the related grant aid project have faced breakdowns since March 2016. Responding to an accident in Karary LCA, KCC carried out an investigation of all 80 waste collection vehicles of Lot-1 from 15th to 22nd October 2016. The result of the investigation is:

- There are five broken vehicles caused by accidents out of 80 vehicles.
- There are twelve broken vehicles including five vehicles mentioned above in total. At present, nine vehicles are still not operational due to breakdown.
- Omdurman LCA, Karary LCA and Umbadda LCA have more broken vehicles than the other LCAs.

Table 3-18 Result of the Investigation

	Lot-1 Grant Aid Project	Accident vehicles	Breakdown vehicles including the accident	Rate of breakdown
Khartoum LCA	10 units	None	None	0%
Omdurman LCA	10 units	1 unit 2969 (CC)	4 units 2943 (CC)、2950 (CC) 2927 (CM)、2969 (CC)	40%
Bahary LCA	10 units	None	None	0%
Shareg Elneil LCA	12 units	None	1 unit 2960 (CC)	8%
Karary LCA	10 units	3 units 2902 (CM)、2904 (CM) 2911 (CM)	4 units 2906 (CM)、2911 (CM) 2904 (CM)、2966 (CC)	40%
Umbadda LCA	10 units	1 unit 2921 (CM)	2 units 2997(CM)、2921(CM)	20%
Jabal Aulia LCA	13 units	None	1 unit 2946 (CM)	8%
KCC	5 units	None	None	0%
Total	80 units	5 units	12 units	15%

4-digit figure: Registration Number of Vehicle, (CM): Compactor, (CC): Container Carrier

In consideration of the situation mentioned above, result of the investigation was included in the agenda of NSC (National Steering Committee) on 3rd November 2016. JPT requested KCC and LCAs to implement daily and periodical inspection and to provide some guidance on safe driving to the drivers.

JPT provided additional guidance for the operation staff to improve the work discipline for the central workshop which was authorized by the state government. Organization chart and the work discipline of the central workshop are shown below.

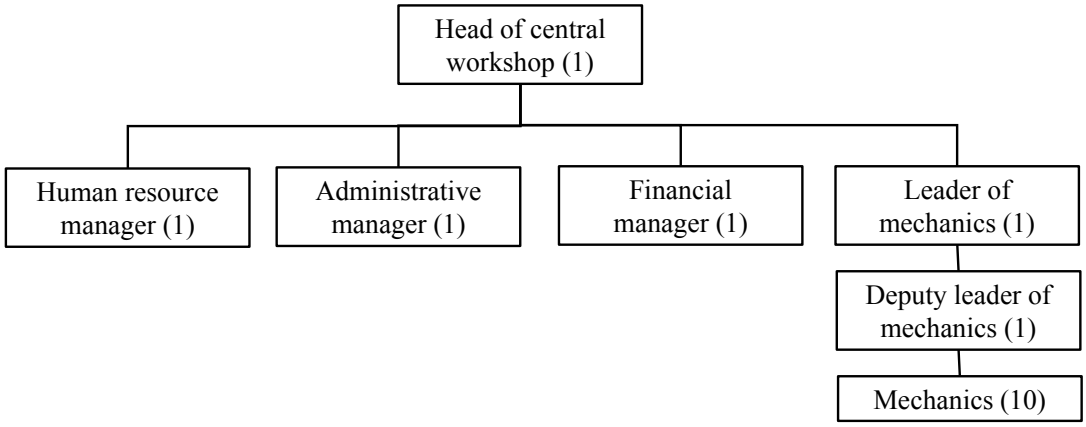


Fig. 3-13 Organization Chart of the Central Workshop

Table 3-19 Work Discipline for the Central Workshop

1. Organization of the central workshop	
2. Job description	
3. Rule of general affairs	
4. Work rule	
5. Rule on working time and holidays	
6. Guidelines for reporting system and forms	
7. Safety and sanitation standard	
8. Guidelines for safety and sanitary improvement	(1) General rule (2) Chief Manager of Safety and Sanitation (3) Safety and Sanitation Committee (4) Safety Gear (5) Medical Examination and Other Health Management Methods (6) Education and Training
9. Rule on Staff Training	

Chapter 4 Improvement of Operation and Maintenance of Landfill Site (Output 3)

4.1 Prevention from Illegal Dumping and Management of Waste Collection Amount

In 2013, the JICA expert instructed Sudanese C/P to record incoming waste amount at the landfill sites. Since then, recording the data has become usual work for the landfill sites. At present KCC has data management system shown in figure and table below. Operation staff of the transfer stations and the landfill sites record information of incoming vehicles ((a), (b), (c) and (d)) and report to the operation manager of KCC headquarters by mobile phone ((h) and (i)) every day. In particular, (e), (f) and (g) of figure below means feedback procedure to each LCA and transfer stations to prevent from open dumping and skipping collection work on working day, as follows: This feedback procedure was developed by Sudanese side without the support from JPT.

(e): When a waste collection vehicle arrives at the transfer stations, the operation staffs give a stamp on record book of the driver. And then the driver submits the record book to their supervisor of LCA.
(g): This procedure is only for JLCA which transports their waste directly to Khartoum landfill site and the drivers of JLCA get stamp in the landfill site instead of the transfer station.
(f): When a trailer arrives at the landfill site from the transfer stations, the driver gets stamp on the designated form and submits it to supervisor of the transfer stations.

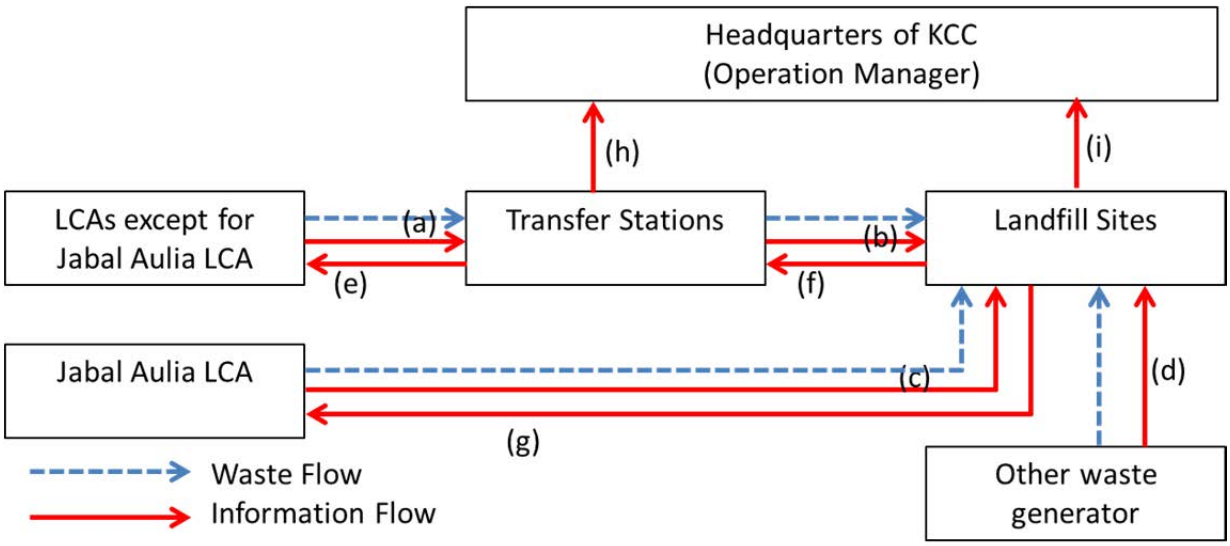


Fig. 4-1 Exiting Data Management System

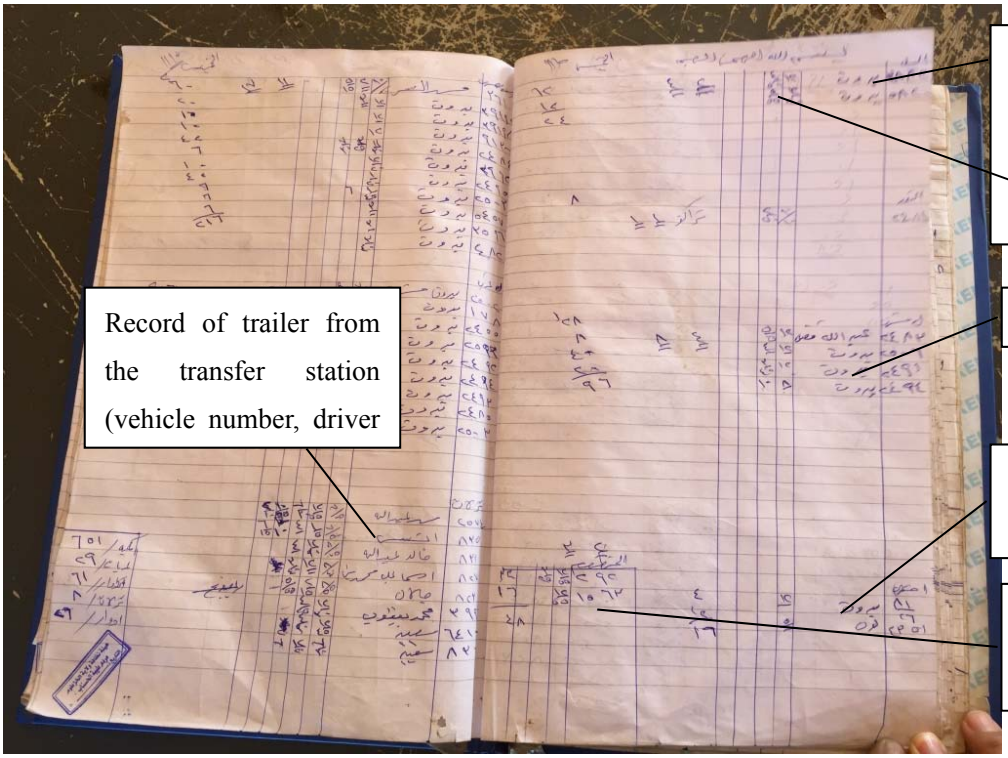
Table 4-1 Existing Data Management System

	Purpose	Description	Remark
(a)	To grasp number of incoming vehicles to the transfer stations	Collection area, vehicle registration number, driver's name, incoming time, number of trips, vehicle type etc.	Advice from JPT
(b)	To grasp number of trailers from the transfer stations to the landfill sites	Trailer registration number, incoming time and number of trips	Advice from JPT
(c)	To grasp number of vehicles from JLCA* to Khartoum landfill site	Collection area, vehicle registration number, supervisor's name, incoming time, number of trips, vehicle type etc.	Advice from JPT
(d)	To grasp number of incoming private vehicles to the landfill sites	Name of waste generator (in case of contracting), collection area (irregular case), incoming time, number of trips etc.	Advice from JPT
(e)	To feedback	Operation staff in the transfer stations gives a stamp to the record book and writes the arrival time. The driver submits the form to LCA	Sudanese side's own initiative
(f)	To feedback	Operation staff in the landfill site gives a stamp to the designated form and writes the incoming time. The driver submits the form to the supervisor of the transfer station.	Sudanese side's own initiative
(g)	To feedback	Operation staff in the landfill sites gives a stamp to the record book and writes the incoming time. The driver submits the form to LCA	Sudanese side's own initiative
(h)	To report to KCC HQ	Number of vehicles and trips	Advice from JPT
(i)	To report to KCC HQ	Number of vehicles and trips	Advice from JPT

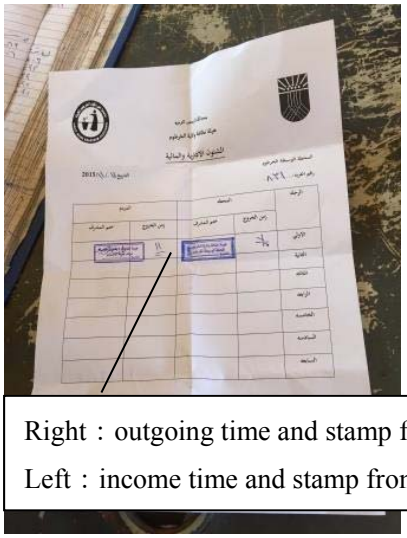
(a),(b) are corresponding to figure above

*: Waste from JLCA is transported to Khartoum landfill site directly.

Table 4-2 Record Form for Khartoum Landfill Site



Form for feedback to the transfer station

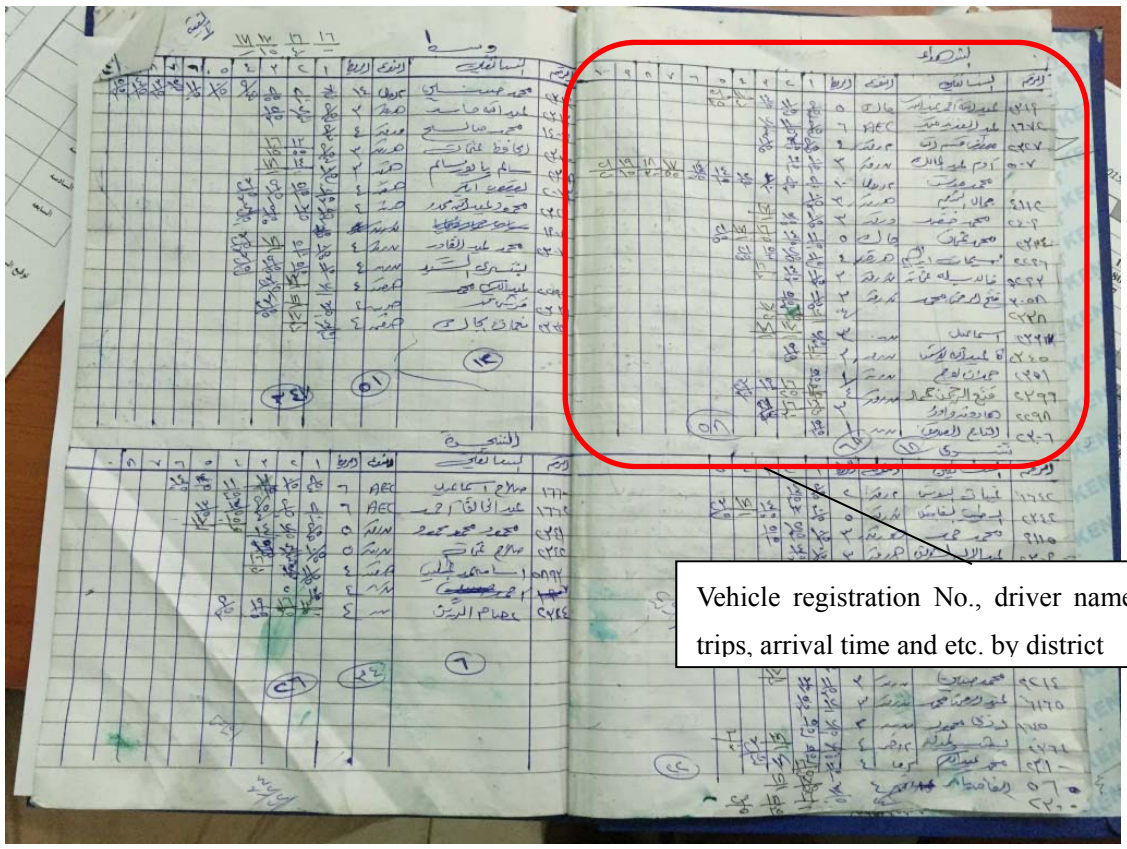


Right：outgoing time and stamp from TS
Left：income time and stamp from LFS

Record book for feedback to JLCA

Driver use a page per day and get a stamp each trip

Table 4-3 Record Form of Khartoum Transfer Station



There are no any functional weighbridges in the transfer stations and landfill sites in Khartoum state. Therefore, collection and disposal waste amounts are estimated by number of trips of waste collection vehicles and trailers. Methodology of the estimation is shown below.

Estimation of waste collection amount:
[Number of trip of waste collection vehicle from LCA to TS] × [Average unit weight by vehicle]

Estimation of waste disposal amount:
[Number of trip of trailer from TS to LFS] × [25 ton]
+ [Number of trip of waste collection vehicle from LCA to TS] × [Consisting unit weight])]

The amounts of waste collected and waste disposed theoretically shall be almost the same. There was large discrepancy between the two estimations; 3,800 ton/day of waste collection and 2,100 ton/day of waste disposal as of November 2016. JPT and C/P thought that the discrepancy was caused by the following reasons:

1. Consequent error due to the different estimation methods
2. Lack of record keeping at the landfill sites
3. Illegal dumping by trailers during transportation from the transfer stations to the landfill sites
4. Small amount of recyclables segregated by waste picker at transfer stations

JPT and C/P analyzed the record of incoming waste to Khartoum landfill site for two weeks from 25th February to 9th March 2016, and it was figured out that number of trips of 2nd week decreased by 20 % from the one of 1st week as shown below.

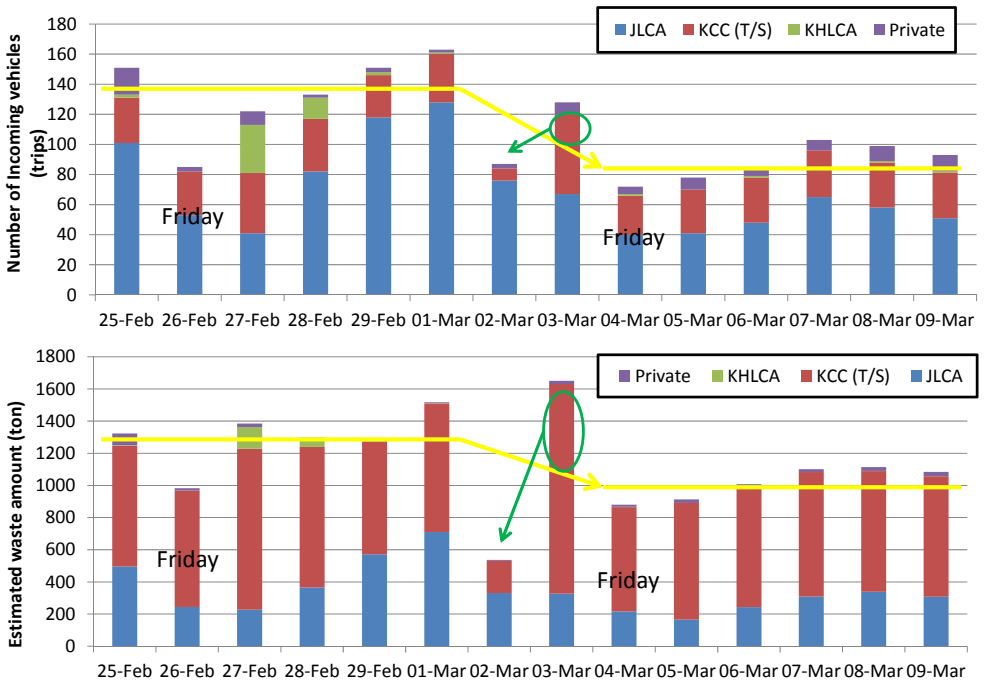


Fig. 4-2 Number of Trips and Estimated Waste Amount (Daily)

Furthermore, the number of trips by hour is shown below. The figure showed that there were hours during which no vehicle came to the landfill site for waste disposal and this was more in the 2nd week than in the 1st week. This shows a possibility that no record keeper was there.

Table 4-4 Number of Trips to Khartoum Landfill Site by Hour

	Friday						Friday							
Hour	25-Feb	26-Feb	27-Feb	28-Feb	29-Feb	01-Mar	02-Mar	03-Mar	04-Mar	05-Mar	06-Mar	07-Mar	08-Mar	09-Mar	Total
0	1	1		2		2			1		3		1		11
1	2			1	1	3	1	2	3		1	4	2	5	25
2	1		3	2			1	1		1			2	1	12
3	1		3		2	1	1	3	1			2			14
4	1	1		1		3		1	1		1	1		3	13
5	1	1		2	3	1	1						2	1	12
6					1	1									2
7	1	1	1	2	1	2					1	1			10
8	2		1	1	4	4	2	1			1	1			17
9	4	4	7	9	12	4	2	3	3	2	2	3	5	3	63
10	8	5	9	13	15	11	8	5	3	7	8	8	2	7	109
11	9	11	21	18	19	17	14	19	11	7	9	16	15	10	196
12	22	6	14	16	14	17	7	16	10	8	5	10	12	8	165
13	14	13	13	9	14	23	9	7	6	8	14	11	11	13	165
14	30	3	8	14	26	20	14	17	9	12	12	15	7	13	200
15	16	12	16	7	11	21	8	11	5	10	5	6	7	6	141
16	16	8	6	18	8	13	7	12	3	9	6	8	10	5	129
17	10	3	2	4	10	9	6	12	5	3	4	8	8	6	90
18	6	8	7	3	6	3	4	6	5	4	5	2	1	4	64
19			1	1		5		1		2	1	2	5	3	21
20	2	2	3	8	1	1	2	3	2	4	2	3	3	2	38
21		2	2		1			3	2	1	2		3		16
22	4	1	3	1		1		1	1		1	2	2	3	20
23		3	2	1	2	1		4	1		1		1		16
Total	151	85	122	133	151	163	87	128	72	78	84	103	99	93	1549

After March 2016, the discrepancy between the collection and disposal amounts decreased. It was observed that collection amount, disposal amount and the discrepancy were 4,058 ton/day, 3,739 ton/day and 319 ton/day respectively in May 2016. As the result, the consequent error due to different estimation methods which was at first assumed as one of the reasons of the discrepancy is not a major reason of the discrepancy. As a matter of fact, it can be justified that the waste collection amount and disposal amount are almost the same despite the different estimation methods.

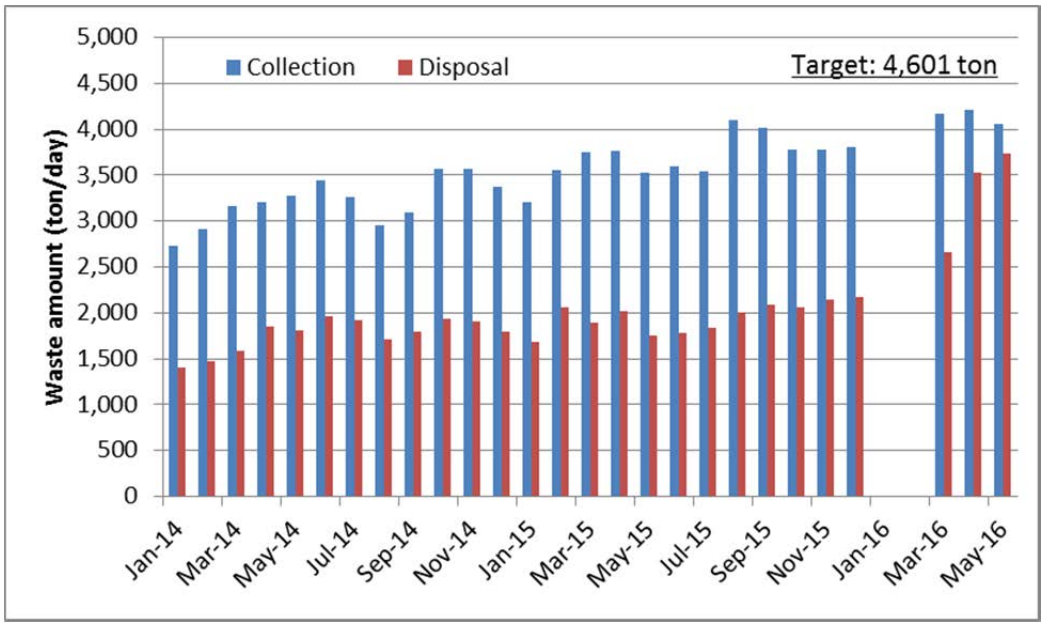


Fig. 4-3 Record of Estimated Waste Collection and Disposal Amount

KCC and LCA have introduced the feedback procedure of waste collection and transportation for preventing from illegal dumping of waste during transportation to the landfill sites. KCC enforced the feedback procedure rigidly from year 2016. Therefore, illegal dumping has decreased and operation staff in the landfill sites has kept the record accurately. As the result of these efforts, estimated waste disposal amount has been increased. However, there are still illegal dumping along the access road to the landfill sites, as shown below. KCC and LCAs shall make more effort to stop the illegal dumping through strict feedback procedure.


Fig. 4-4 Scattered and Accumulated Waste along the Access Road to Khartoum LFS

4.2 Preparation and implementation of Improvement Plan of Khartoum Landfill Management

JPT and C/P from KCC prepared Improvement Plan for Khartoum Landfill Site. Outline of the plan is shown in table below.

Table 4-5 Outline of the Improvement Plan

Chapter	Contents
1. Introduction	Objective and target level of improvement
2. Current situation	Analysis of current situation and problem
3. Operation and Management Conditions	Organization chart, working time etc.
4. Landfill development plan	Design of every phase and after landfilling, remaining capacity etc.
5. Disposal operation plan	Compaction work and cover soil work
6. Emergency plan	Countermeasure for emergency situation such as fire etc.
7.Environment management and social consideration plan	Predictable environmental affect and its countermeasures
8. Safety control	Safety guidelines for operation staff

Remaining capacity of Khartoum landfill site is estimated as 4.5 million m^3 as of June, 2015 based on topographic survey in June 2015. Conditions of the estimation of the capacity are;

- Excavation below ground level by 5 m
- Landfilling the waste up to 25m

With 1,920 ton/day of incoming waste to Khartoum landfill site, remaining lifetime of the landfill is 6.7 years as of June 2015, i.e. the landfill site will consume all disposal space in year 2021.

Table 4-6 Remaining Capacity of Khartoum Landfill Site

Item	Figure	Unit	Remarks
Remaining Capacity	4,490,130	m3	Height 25m, Excavation depth: 5m
Disposal waste amount	1,920	ton/day	
Disposal waste amount after compaction	1,920	m^3/day	
	642,400	m^3/year	for 11 months due to rainy season
Cover soil	32,120	m^3/year	5% (10 cm of cover soil each 2 m of waste)
Remaining year from June 2015	6.7	Year	
Estimated completion time	August 2021	-	

Khartoum landfill site is open to receive the waste 24 hours a day at present. During preparation of the plan, receiving waste at night and night time operation were one of the discussion points. Following figure shows average number of incoming vehicles to the landfill site by hour based on the record from February to March 2016. It revealed that around one vehicle per hour came to the landfill site between 11 PM and 9 AM. Night time operation in Khartoum landfill site which has no lighting system has caused accidents and disorganized waste unloading. JPT proposed KCC to stop the night time operation, however KCC decided to continue the night time operation due to waste collection in some area for night time and due to risk of theft.

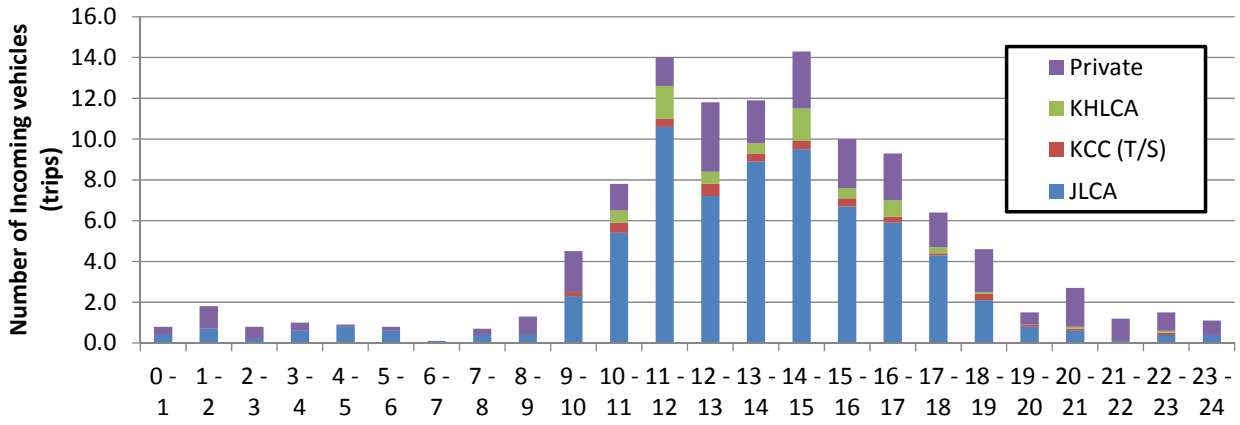


Fig. 4-5 Number of Incoming Vehicle to Khartoum Landfill Site by the Hour

4.3 Implementation of the Improvement Plan

4.3.1 Preparation of Operation Record and Analysis

Operation staff in Khartoum landfill site has kept record of the number of incoming vehicle. In addition, JPT and KCC prepared a form of operation record which includes 1) Operation Time and Fuel Consumption of Heavy Equipment, 2) Record of Soil Cover Work, Cleaning Work and Fire, 3) Repair and Maintenance of the Equipment, 4) Working Time of the Operation Staff. The first draft of form prepared by JPT did not include Operation Time and Fuel Consumption of Heavy Equipment, however KCC added them. KCC has started using the recording form in Khartoum landfill site since July 2016.

[Operation Record of Landfill Site]

بسم الله الرحمن الرحيم

Khartoum Cleaning Corporation

Operation Department

Landfill administration

Khartoum Landfill Site

Daily Operation Record

Date …./…./2016

Heavy equipment &vehicles

Name of the machine	No of Hours	Fuel consumption	K/h
Loader			
Bulldozer			
Excavator			
Truck 516			
Truck 974			
Truck 520			
Generator			
Tractor			

Daily inspection

Did the cover soil applied	Yes / No	Reason
Did the embankment applied		
Cleaning the waste around the Landfill		
Fire appearance		
Cause of the fire		
Situation of the fire		
Internal road		

Maintenance

Machine	Time of discovery	Time of repair	Routine checkup	Remark

Human recourse

Name	Absence	Absence with notice	Remark

Fuel consumptions of the heavy equipment were analyzed based on the operation record for three months from July 2016. There were 56 days' available data out of three months. Result of the analysis was summarized in table below. Compared to standard fuel consumption for construction equipment in Japan, fuel consumptions per working hour in Khartoum were higher than the respective value in Japan, although the operation condition and climate condition in Khartoum and Japan are different.

Table 4-7 Fuel Consumption and Operation Time of Landfill Management Equipment

Type	Available date (available data)		Average of available data		
			Working hour	Fuel consumption	Fuel consumption per working hour
Bulldozer	53	(53)	6.3 h	250.0 L	40 L/h
Wheel loader	9	(9)	4.8 h	160.0 L	33 L/h
Excavator	37	(37)	4.1 h	110.5 L	27 L/h
Truck 516	23	(22)	7.2 h	43.4 L	6 L/h
Truck 520	40	(38)	7.9 h	47.4 L	6 L/h
Service Truck 974	55	(7)	3.0 h	17.9 L	6 L/h
Pickup	6	(0)	-	-	-
Tractor	4	(0)	-	-	-
Generator	13	(0)	-	-	-

Operation time per day of the bulldozer in Khartoum landfill site was 5 – 7 hours and fuel consumption per operation time was around 40 L/h as shown following figure. Almost all available data of fuel consumption per hour are 40 L/h.

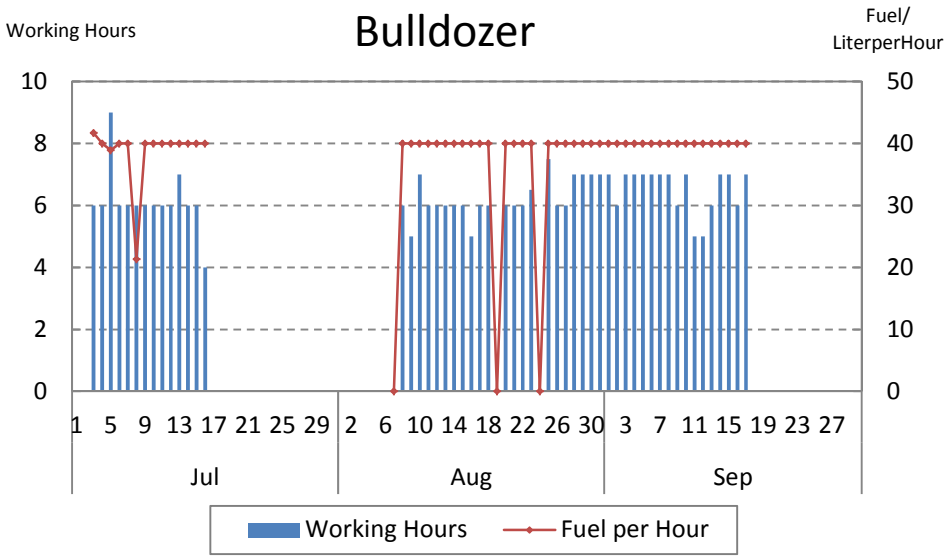


Fig. 4-6 Operation Time and Fuel Consumption per hour of the Bulldozer

Operation time per day of the excavator in Khartoum landfill site was 4 – 6 hours and fuel consumption per operation time was around 27 L/h. Unlike the bulldozer, fuel consumption of the excavator has small fluctuation. Fuel consumptions per working hour in Khartoum were higher than the respective values in Japan as mentioned above, and therefore management of fueling method is one of the issues for landfill management.

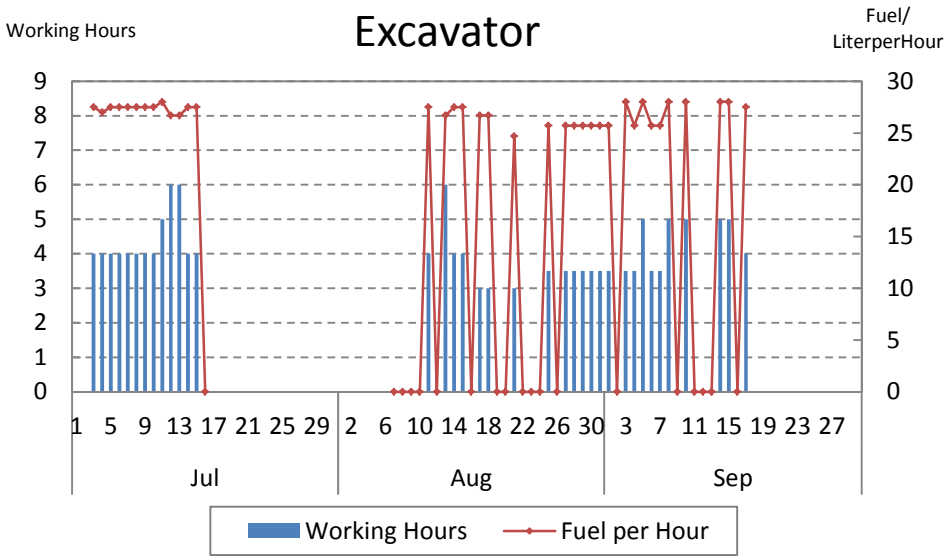
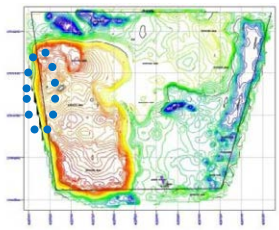


Fig. 4-7 Operation Time and Fuel Consumption per hour of the Excavator

4.3.2 Protection of Steep Slope of Landfill Area

There is steep slope whose incline is 1:1.5 at North-West part in Khartoum landfill site. To avoid the land slide of the steep slope, it shall be protected and covered by soil.





There is small embankment of dumped waste which was burned openly along the steep slope. JCC and JPT found out three countermeasures to protect the steep slope as shown below. Option 1 is the most suitable and practical method among the countermeasures, however the bottom area of the steep slope is located in the state government owned area which is beyond the landfill area. Option 3 is only countermeasure to protect the steep slope within the landfill area. In case of Option 1, land use approval by the state government is required and therefore KCC sent a request letter to utilize the government land.

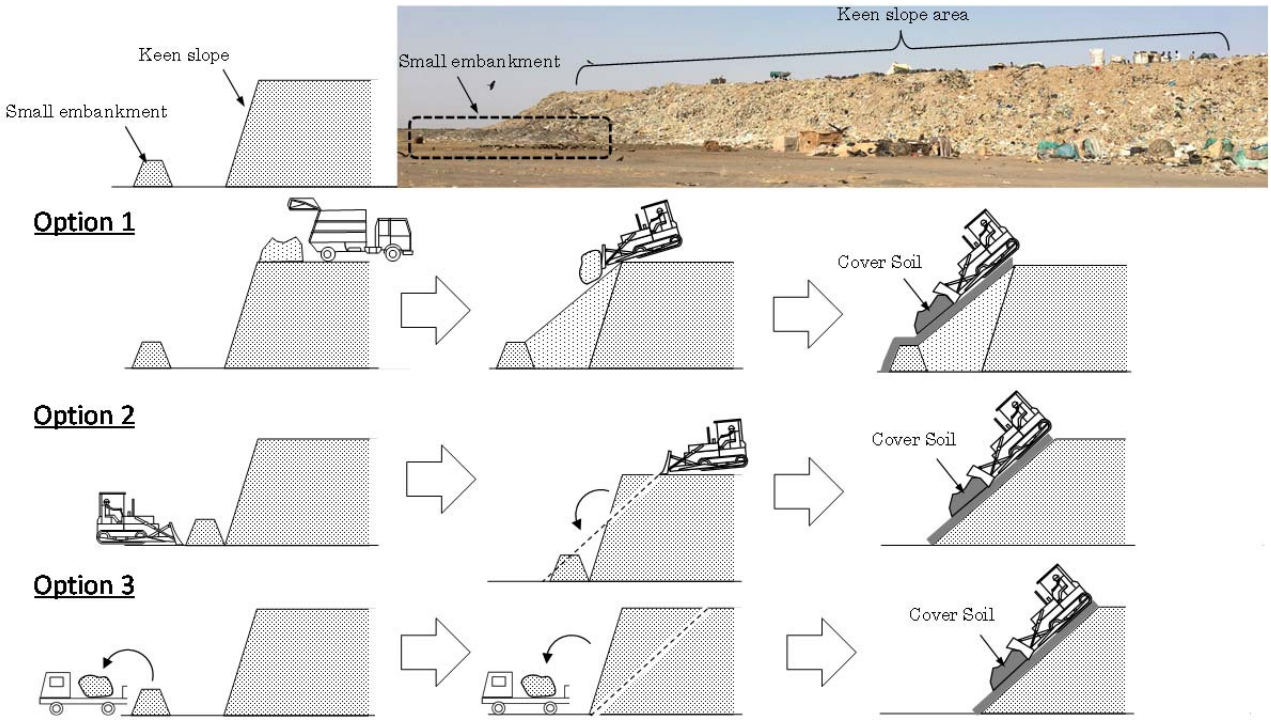


Fig. 4-8 Image of Countermeasures

Option1 :	Area between the small embankment and the steep slope will be landfilled by new waste and be finally covered by soil. An advantage of this option is to implement the countermeasure in line with the regular operation work and therefore no additional work. On the other hand, there is necessity of approval for land utilization of the government land.

Option2：	The small embankment will be moved toward the steep slope by bulldozer and part of the slope will be cut and shaped. And finally the shaped slope will be covered by soil. This option is a compromised countermeasure between Option 1 and 3.
Option3：	The small embankment will be removed and unloaded in the landfill site. Part of the slope will be cut and shaped, and then the shaped slope will be covered by soil. An advantage is to implement this countermeasure within the present boundary area and any approval for land utilization is not required. Disadvantages are that it requires heavy work load and high cost due to large civil works.

KCC implemented the protection work at part of the steep slope in area of the landfill site by their own budget in December 2016. The landfill staff cut the top the slope and disposed new waste on that area to mitigate the steep slope without soil cover.

Fig. 4-9 Improvement work of Option1

4.3.3 Other Improvement

(1) Secure of Expansion Area of Khartoum Landfill Site

Khartoum landfill site will be expired in around 2021, and therefore the revised M/P planned to construct a new landfill site. When KCC sent the letter on land allocation mentioned in 5.3.2, the state government discussed and decided that 20ha of private land nearby Khartoum landfill site would be procured for expansion area for the landfill site. As of January 2017, KCC had reached an agreement on the land acquisition. It is assumed that KCC can utilize the expansion area for around 20 years as landfill site, and therefore sustainability of solid waste management in Khartoum state shall be strengthened.

(2) Procurement of Office Equipment

Lighting of the administration office was required for record keeping during night time operation. KCC procured a generator and installed lighting of the administration office by its own budget.

Fig. 4-10 Generator and Light Equipped by KCC

The Project planned to construct boundary fence of Khartoum landfill site and a gate, however the facilities could not be constructed because the landfill site is beyond the landfill area authorized. In order to prevent from the scattered plastic waste and to control the access to the landfill site, it is recommended that the facility shall be constructed in future.

4.4 Safety and Sanitation Training

The Project held the safety and sanitary workshops for landfill staff as mentioned in 3.2.7. In addition, the second workshop was held in January 2017.

Explanation form KCC's executives

Safety gears provided

Fig. 4-11 Safety and Sanitary Workshops at Khartoum Landfill Site in January 2017

Chapter 5 Improvement Measures of Institutional Setting and Financial Status in SWM (Output 4)

5.1 Organization Status of KCC and LCA

5.1.1 Organizations of SWM in Khartoum

Organizations of solid waste management in Khartoum State are shown below. The organization shall fulfill their responsibility for solid waste management. AU was newly introduced as the lowest level organization. AU has responsibility for solid waste management and an AU covers 100,000 of population which is suitable level for solid waste management. Solid waste management shall be implemented with a central focus on AU.

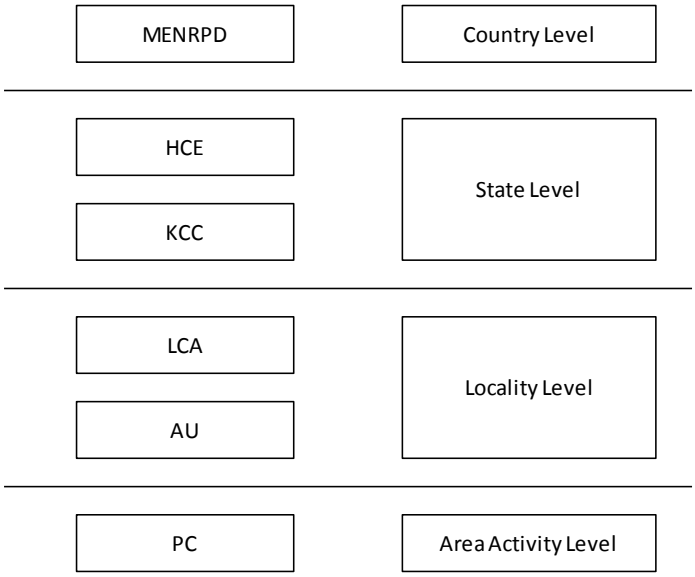


Fig. 5-1 Organization of Waste Management in Khartoum State

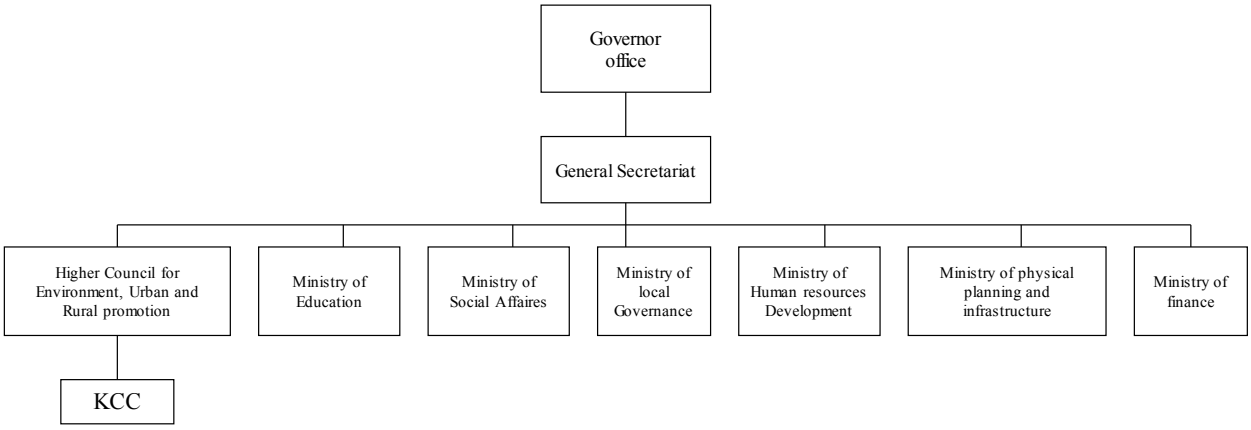


Fig. 5-2 Organization Chart of Khartoum State (as of January 2016)

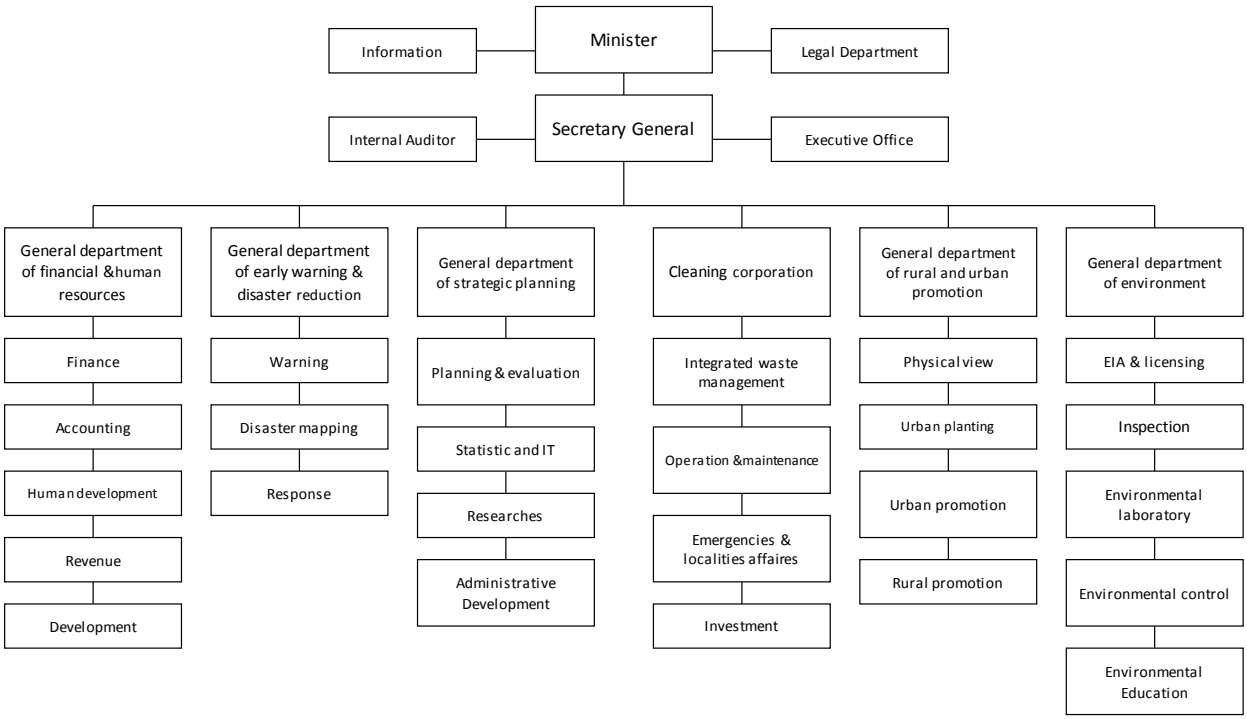


Fig. 5-3 Organization Chart of HCC (Higher Council of Environment) (as of January 2016)

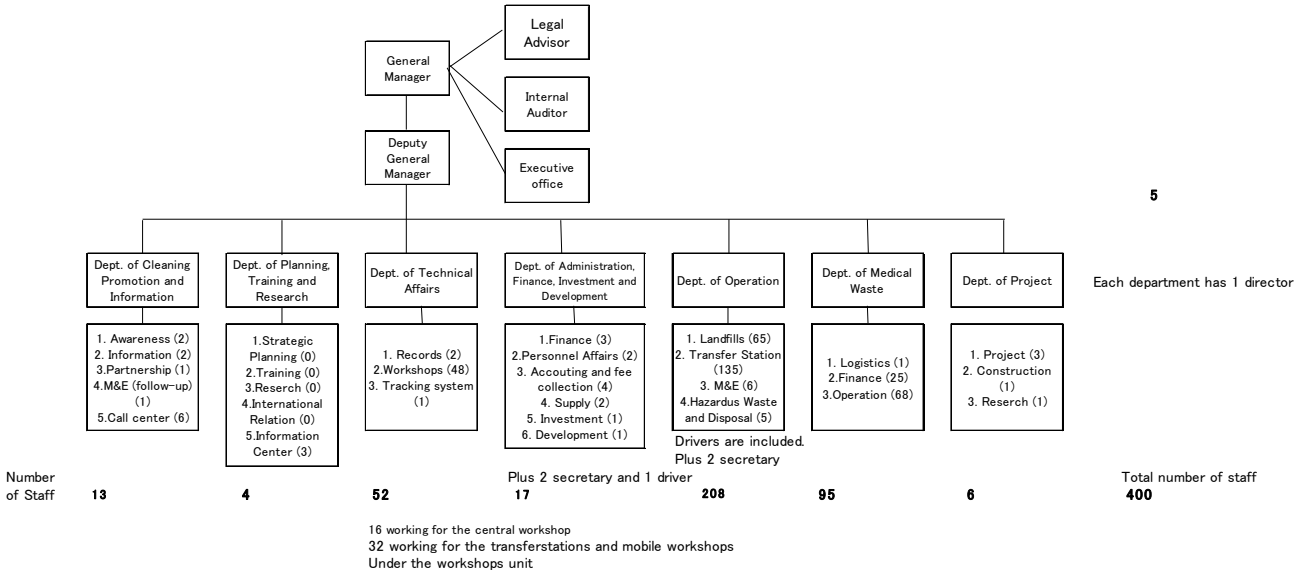


Fig. 5-4 Organization Chart of KCC (as of August 2016)

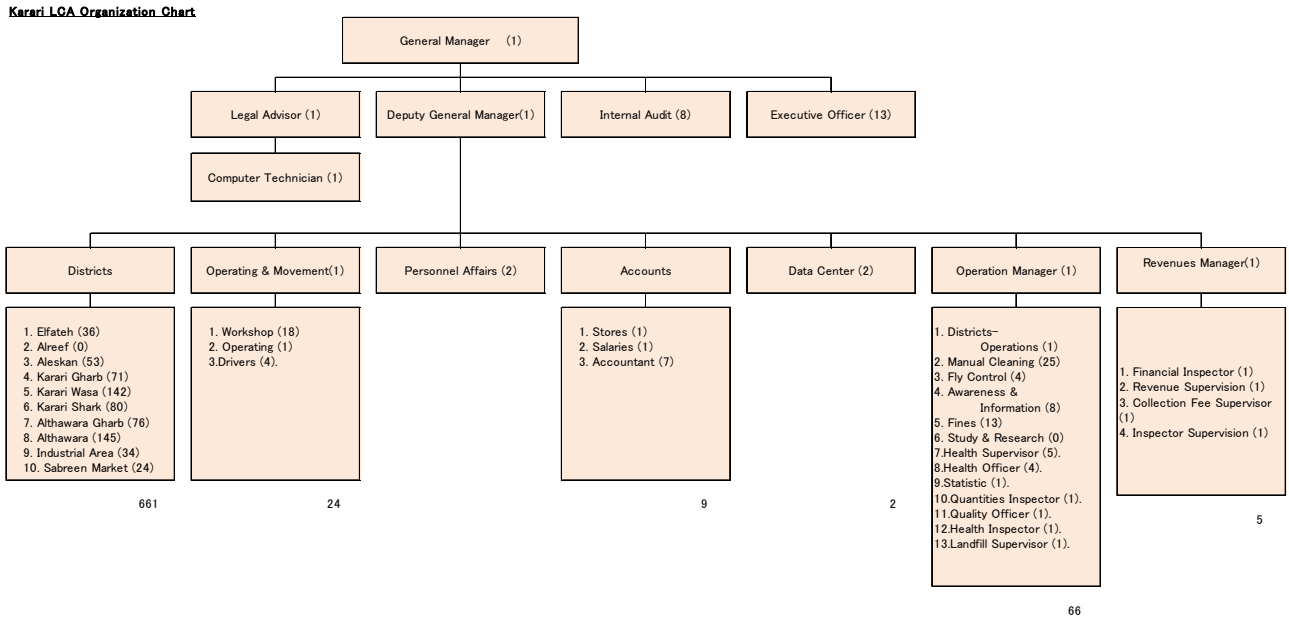


Fig. 5-5 Organization Chart of Karary LCA (as of August 2016)

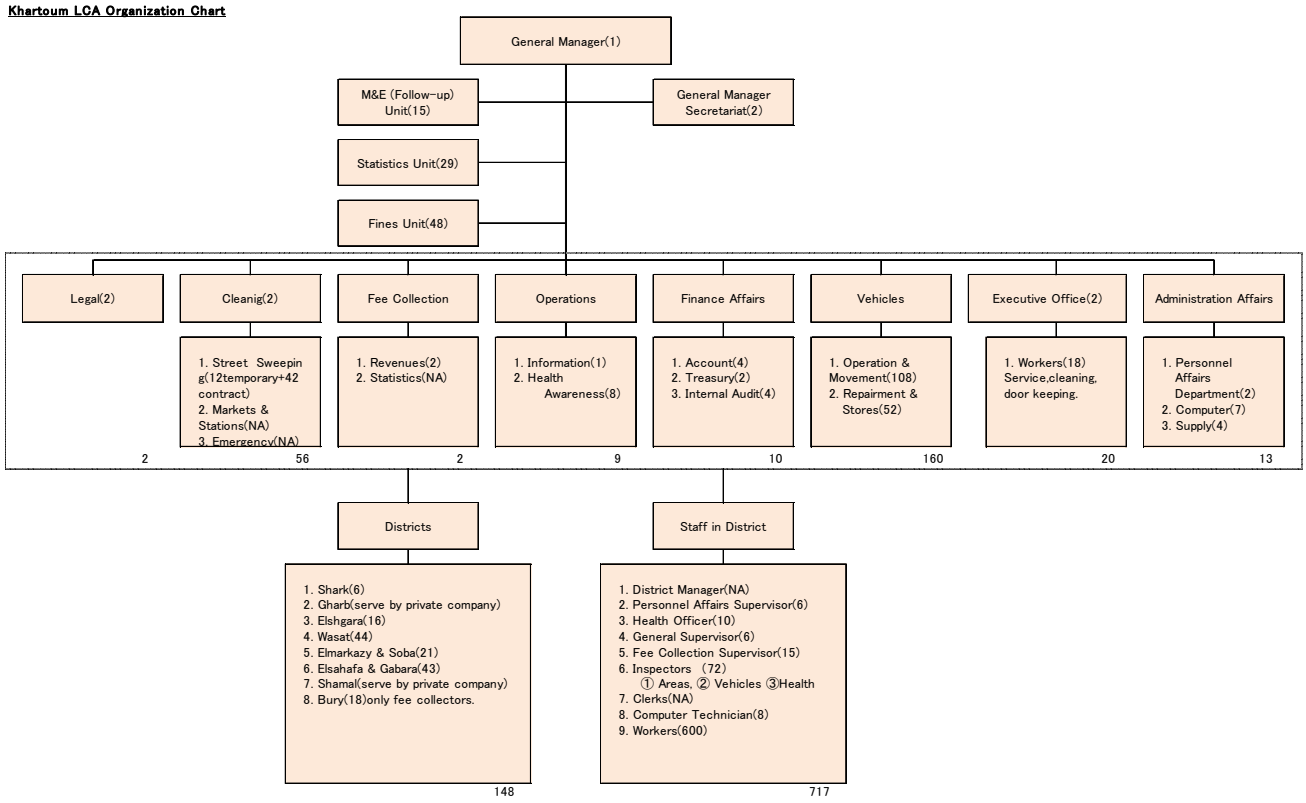


Fig. 5-6 Organization Chart of Khartoum LCA (as of August 2016)

Organizations and responsibilities of SWM are shown in the following figure. KCC mainly manages landfill sites and transfer stations, and LCA manages waste collection. Waste collection has been transferred from LCA to AU since 2015.

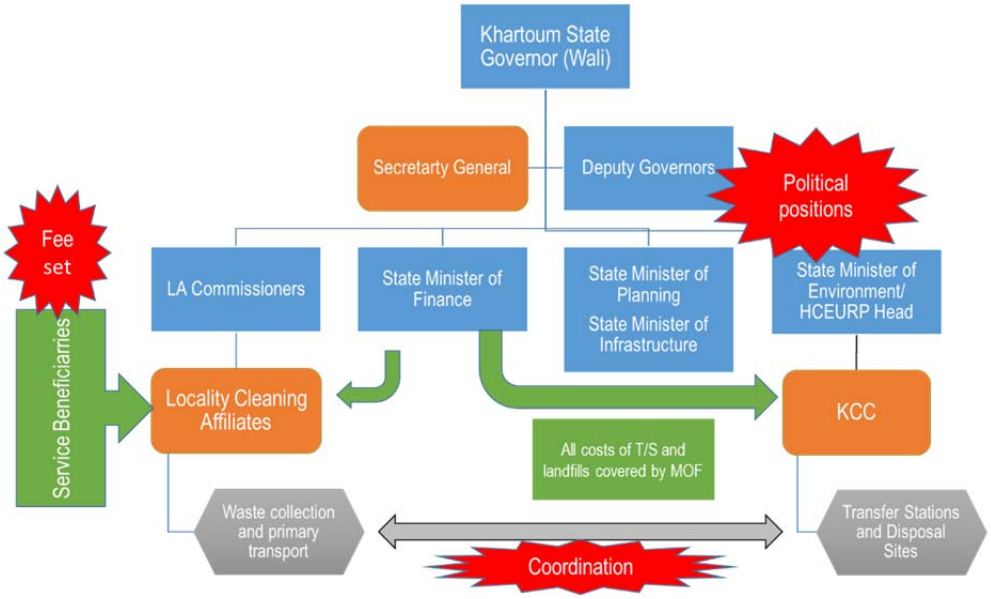


Fig. 5-7 Organizations related with Solid Waste Management (Cost and Responsibility)

Table 5-1 Organization and Responsibilities of SWM

Organization	SWM Responsibility
MENRPD (Ministry of Environment, Forestry and Physical Development)	- To develop a national environmental policy and plan - To implement environment (including waste) programs for the environment - To undertake and promote research and development - To coordinate overseas support to the Government of Sudan and the State governments in the field of SWM
HCE (Higher Council of Environment and Rural and Urban Development)	- To make a Waste Management policy for Khartoum state - To supervise Waste Management activities done by KCC, LCA and AU. - To implement Waste Management activities beyond the scope of KCC, LCA and AU, such as general environmental issues
KCC (Khartoum Cleaning Cooperation)	- To make detailed plan and operate transfer stations and landfills of solid waste management - To set standards for waste collection and evaluate and support the localities activities concerning collection - To train KCC and LCA staff - To coordinate with LCA - To strengthen coordination with the Waste Management stakeholder - To coordinate media - To produce explanatory materials, reports and information related to SWM
LCA (Locality Cleaning Affiliate)	- To collect municipal solid waste and implement cleaning operations in the respective localities - To implement Waste Collection activities for respective locality - To train LCA staff including district and District/ AU cleaning office staff - To coordinate with District/ AU cleaning office - To establish a good relationship with partners at the locality level - To develop materials for Waste Management raising in coordination with KCC
AU (Administration Unit)	- To participate in making Waste Management plan of KCC and LCA - To collect data of communities in AU and analyze them and share with LCA - To implement Waste Collection activities for respective AU - To coordinate with the Popular Committee
PC (Popular Committee)	- Number of 15 residents' committee representing the community. - Cooperate with LCA in SWM, in terms of designate fixed points and distribute

Organization	SWM Responsibility
	waste bins, preparing for lecture. - Facilitate LCA and AU to approach the community for Waste Management

5.2 Responsibility of AU and Construction of AU Office

5.2.1 Organization of AU

As the administrative organization of Khartoum State, offices of 7 Localities (corresponding to cities) are under the state government. Up to 2013, each Locality had several Districts, and each District had a district office as a branch of the locality office. In total, 7 Localities had 36 districts. However, this District system has been abolished since 2014. And Administration Unit (AU) system has been started instead of the District system. In total, Seven localities have actually 105 AUs (Total 119 AUs including 14 AUs of which are set in markets).

As the population of Khartoum state is around 7.39 million, unit population for each organization is shown below.

Table 5-2 Waste collection population for each organization

	Organization number in Khartoum state	Waste collection population (Average) (Population covered by each organization)
LCA	7	About1,000,000 people/LCA
DISTRICT (Now abolished)	36	About 200,000 people/DISTRICT
AU	105	About70,000 people/AU

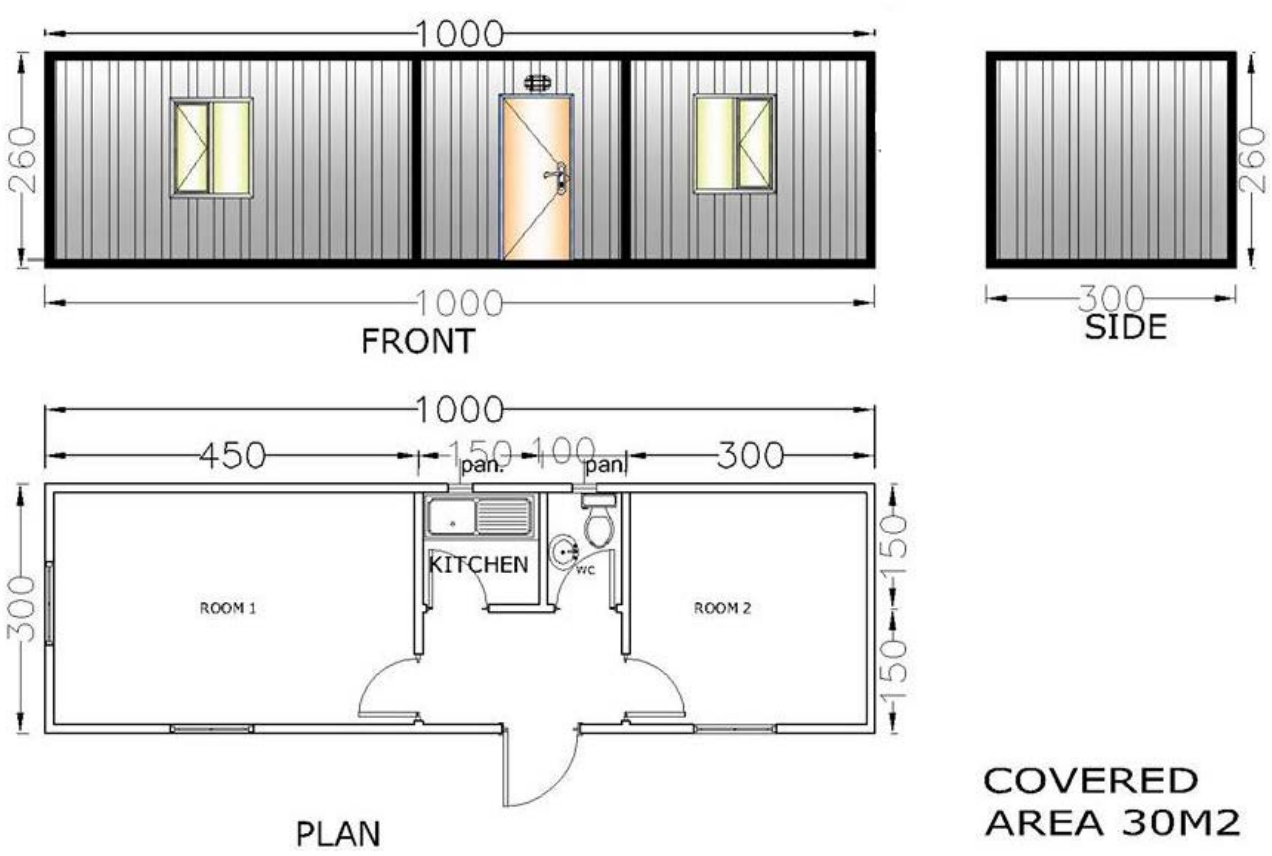
5.2.2 Responsibility of AU

AU' responsibilities are not only ''Waste management'' but also "Financial and economic development affairs", "Educational affairs", "Urban Planning", "Agriculture and Animal Livestock Affairs", "Health and environmental activities", and local administration will be mainly managed by AU.

At ''AU'' level, waste collection population is less than that of ''District'', so they will be able to manage much better waste management service.

5.2.3 Construction of AU SWM Office

AU SWM Container offices were constructed at Khartoum LCA and Karary LCA to be a hub of waste collection service at AU level in December 2016. Detail is shown below.



[Unit: centi-meter]

Fig. 5-8 Drawing of AU SWM Office

	
Foundation Work	AU SWM Office (After construction)

<table>
<tr><td>  </td><td> 
</td></tr>
<tr><td>Opening Ceremony</td><td>Signboard of AU SWM Office</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Weekly meeting inside of the AU SWM Office</td><td>Complaint handling from Resident
(It was not complaint of waste management but also drainage, so they introduced another authority.)</td></tr>
</table>

Fig. 5-9 Aspect of AU SWM Office in Karary

An opening ceremony was held at Khartoum LCA AU SWM office and Karary LCA AU office and KCC officer, LCA officer and residents were invited in December 2016. Purposes and responsibility of AU SWM office were announced at the ceremony.

Because AU Office was constructed in the end of this project period, it will take time for the AU Office to function well. The responsibilities of AU SWM Office were set as below and AU Offices started its function.

Table 5-3 Responsibility of AU SWM Office (Attached inside of AU SWM Office)

	Responsibility
1	To collect and analyze the collection data
2	To manage the collection workers
3	To hold the popular committee meeting
4	To hold the collection improvement weekly meeting
5	To be the information center for citizens
6	To manage collection vehicles
7	To receive complains on SWM from citizens

For waste management at AU SWM Office, AU SWM Office manager deals with followings

- Coordination with KCC and LCA
- Activities such as arrangement of waste collection vehicles
- Dealing with complains from residents

So JPT has done activities below to enhance motivation of AU SWM officers.

- Construction of AU SWM Office
- Attachment of Organization chart at AU SWM Office wall(such as below)
- To issue an official letter from KCC(The letter mentioned such as ‘’To appoint AU SWM Office manager’’.)

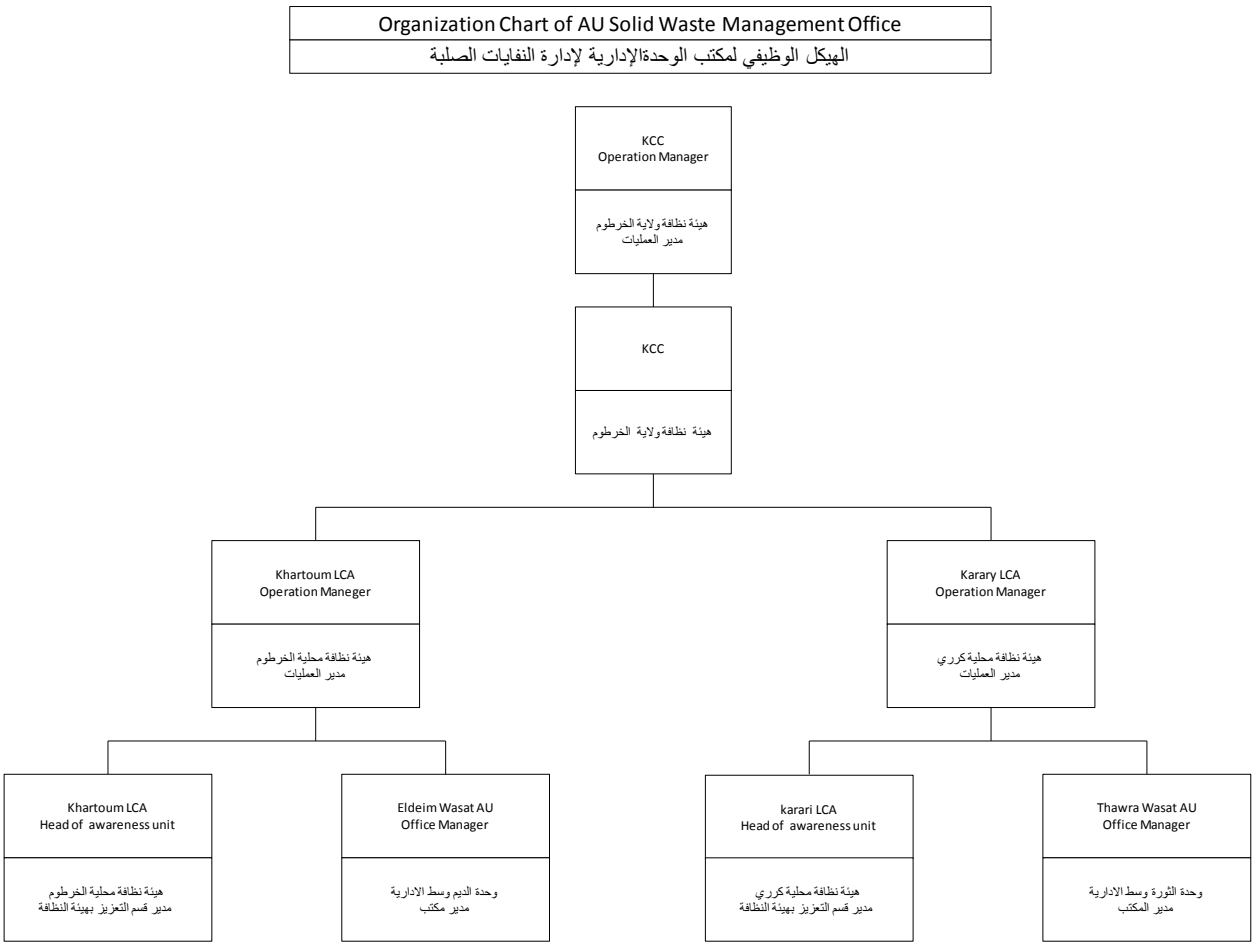


Fig. 5-10 Organization Chart of AU SWM Office (Khartoum, Karary)

The AU SWM office is expected to be utilized for waste collection and contact point to the residents. Sudanese side will construct further AU SWM offices in other areas.

5.3 Financial Analysis

The recent budget of waste management and the budget from the revised master plan are shown below.

5.3.1 Budget of KCC and LCAs

Budgets of KCC and LCAs are shown in following tables. The tables are the operation cost not including the capital cost.

Table 5-4 Budget of KCC

Item		Approved budget 2016	Proposed for the year 2017
Compensation of workers		11,309,517.00	15,821,690.00
	Wages and Salaries	4,337,800.00	5,484,575.00
	Other than wages and salaries	6,971,717.00	10,337,115.00
Purchasing of goods and services		66,879,570.00	104,834,573.40
	Goods	20,410,566.00	30,406,389.40
	Services	46,469,004.00	74,428,184.00
Total		78,189,087.00	120,656,263.40

Table 5-5 Income and Expenditure of each LCA

LCA	Income(SDG/year)			Expenditure(SDG/year)		
	SWM fee	Subsidy	total	Salary	Others	Total
KHLCA	46,266,554	0	46,265,284	18,389,300	34,996,712	53,386,012
BLCA	1,225,547	13,706,213	14,931,760	7,506,288	7,425,472	14,931,760
JLCA	7,471,928	2,807,846	10,279,774	3,414,141	6,735,525	10,149,666
KLCA	7,910,587	3,637,260	11,547,847	2,972,385	8,786,144	11,758,529
OLCA	12,990,517	0	12,990,517	7,840,876	3,149,932	10,990,808
SLCA	6,598,352	1,939,500	8,537,852	3,009,728	3,655,212	6,664,940
ULCA	15,445,538	0	15,445,538	11,182,914	1,609,413	12,792,327
Total	97,909,023	22,090,819	119,998,572	54,315,632	66,358,410	120,674,042
Source: LCA data (Annual Report 2015, etc)						

Budget scale of KCC and LCA is shown below. Budget scale for operation cost is almost 200 million SDG per year and its unit cost is around146 SDG/ton (budget is divided by waste amount). Budget scale for solid waste management including the capital cost for the equipment and the facility is 400 million SDG and its unit cost is around 303 SDG per ton.

Table 5-6 Budget Scale of KCC and LCA

		Annual budget or expenditure (SDG)	Unit cost (SDG/ton)
For operation cost	LCA (Expenditure in 2015 including 0.1 billion SDG of SWM fee)	120,674,042	146
	KCC (Budget in 2016)	78,189,087	
Capital cost for equipment and facility		214,163,332	157
Total		413,026,461	303

5.3.2 Required Budget of Revised Master Plan and Recommendation

Required budget of revised master plan is shown below. It's about 767 million SDG per year (without Incineration system).

Table 5-7 Required Budget of Revised Master Plan

SN	Component	Cost (SDG)
(1)	Management and administration	5,858,333
(2)	Waste collection and transport	511,130,468
(3)	Transfer stations	167,283,751
(4)	Final disposal	78,581,843
(5)	3Rs and Intermediate Treatment	1,172,718
(6)	PR and Public Awareness	3,557,250
Total Master Plan Cost		767,584,362
Unit cost per ton (SDG/ton)		377

5.4 Recommendation of Financial Issues

Budget scale of the revised master plan is almost 20% higher compared to the recent budget. So it will be necessary to secure the required budget through following actions:

- To strengthen fee collection from the residents through improvement of the fee collection rate, and through increase in tariff of the waste collection fee
- To strengthen fee collection from restaurants and offices as large waste generators
- To get subsidy from upper authority and to get financial support from donors

Sudanese side will seek an optimum action and good mix of the actions.

Financial data management at KCC and LCA is not sufficient. So it is difficult to collect financial data. It will be necessary for KCC and LCA to keep financial record (Budget and Expenditure) in a proper manner.

Chapter 6 Revised M/P of SWM in Khartoum State (Output 1)

6.1 Basic Framework of the Revised M/P

The basic framework of the revised M/P is shown below. The framework is basically same as the original M/P, however some parts of the framework have been revised depending on the current situation.

Table 6-1 Basic Framework of the Revised M/P

Item	Contents
Targeted year	Year 2028
Targeted waste	The plan covers domestic solid wastes generated in the jurisdiction of Khartoum State. Industrial waste, medical waste, and liquid and gaseous waste wastes are not included in the scope of the master plan.
Objectives	1. to expand collection service area and to prevent illegal dumping 2. to provide better service to meet demands in each residential area and commercial area based on their necessity 3. to increase collection ratio 4. to introduce more effective recycling system, source separation of recyclables and waste reduction system in corporation with the community 5. to provide collection service for construction waste and bulky waste 6. to collect the collection fee more effectively and to reduce subsidy from the state 7. to introduce privatization in the field of solid waste management

6.2 Revised Master Plan

6.2.1 Waste Collection and Transport and Transfer Stations

(1) Issues that are addressed in the Master Plan

The present issues related to the operation of waste collection and transfer stations that have been addressed in the revised master plan, are described as follows：

1. LCA staff needs to be given permanent staffing status and wages re-considered
2. Many collection trucks are unreliable due to old age and require difficult repair works
3. Collection trucks trip production rates are low
4. Collection work needs to be more efficient
5. Transfer stations lack sufficient number of trailers for secondary transport
6. Compaction facilities at the transfer stations are out of order
7. Omdurman Transfer Station has only one ramp and some waste is discharged on the ground
8. There are many waste pickers surrounding the transfer stations which is almost open dumping site with offensive environment

(2) Waste Collection and Transport Master Plan

The target collection rates are for the Khartoum State as a whole and the individual seven localities are shown in the table below

Table 6-2 Collection Service Rates Improvement Targets

Year	2016		2020		2025		2028	
Item	Generated waste (t/d)	Collection share (%)	Generated waste (t/d)	Collection target (%)	Generated waste (t/d)	Collection target (%)	Generated waste (t/d)	Collection target (%)
Khartoum State	5,752	65%	7,094	70%	9,208	76%	10,748	80%
Khartoum LA	1,364	65%	1,690	72%	2,207	80%	2,584	85%
Omdurman LA	801	68%	992	74%	1,295	81%	1,515	85%
Bahary LA	691	68%	855	74%	1,112	81%	1,299	85%
Umbadda LA	712	68%	873	74%	1,118	81%	1,295	85%
Jabel Aulia LA	946	53%	1,163	59%	1,504	67%	1,752	71%
Sharg En Nile LA	629	60%	775	64%	1,032	68%	1,220	71%
Karary LA	609	60%	745	64%	958	68%	1,112	71%

The forecast amounts of generated waste were calculated as follows:

= Projected population (in year n) x unit generation rate (in year n)

The population projections were estimated using past trends for Khartoum State as a whole. In distributing forecast population over the seven localities past trends were considered as well as the expected roles each locality will have in the future and present population densities in that locality. Population growth in inner localities; Khartoum, Omdurman and Bahary were expected to decrease slightly in favor of increased growth rates in outer localities of Jabel Aulia, Sharg En Nile, Karary and Umbadda in that order.

Unit generation rates (UGR) were estimated to grow by 1.5% annually for inner localities and 1.2% annually for outer localities, taking into consideration the present UGR in each locality and the income levels expected in the localities.

The plan is targeting to collect 80% of the total MSW generated in Khartoum State in 2028. For the inner localities of Khartoum, Omdurman and Bahary the target is set at 85%, while for the outer localities a lesser target has been adopted of 71%.

The improvement plan adopts a four-way approach. These are;

・Expansion of the fixed place and time system (FPFT) for waste discharge and collection and collection frequency of two days per week, through more efforts on public awareness and promotion of community participation,

・Improvement of the collection crews' employment and working conditions, and

・Improvement of the equipment maintenance and repair capabilities

・Expansion of the haulage capacity through annual plan for renewal of trucks and improvement of equipment maintenance and repairs.

The Improvement Plan has adopted the following trip numbers for each truck type as the ideal trip production rates (Table 6-3). These production rates can only be achieved when the improvements described in the four-way approach improvement plan are realized.

Table 6-3 Ideal Trip Production Rates by Truck Type

	Compactor		Dump Truck				Arm-roll	Tractor
Volume	16 m^3	12 m^3	14 m^3	8 m^3	6 m^3	2 m^3	12 m^3	6 m^3
Haul capacity (t/trip)	7.2 ton	5.4 ton	4.9 ton	2.8 ton	2.1 ton	0.7 ton	4.2 ton	2.1 ton
Trip/day	4 trips	4 trips	2 trips	4 trips	4 trips	8 trips	9 trips	4 trips

Table 6-4 shows the total trucks to be operated in a given year by type, and the trucks and containers procurement requirements are shown under that.

In 2017, the total operated trucks necessary are 660 trucks. By the end of the planning period, in 2028 the number will fall to 513 trucks. Although the collected waste amount will increase due to population growth and more collection service coverage, smaller trucks will be phased out with more reliance on compactors and arm-roll trucks. In addition, as the operational improvements are expanded and in turn trip production increases, the trucks will be able to make more trips and need for new trucks will be reduced.

Table 6-4 Procurement Plan for Trucks and Containers for all of Khartoum State

	Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
A. TRUCKS														
Compactor (16 m^3)	Total	48	43	47	38	39	42	59	65	72	77	84	95	--
	New	11	4	5	9	3	5	20	6	8	6	18	15	110
Compactor (12 m^3)	Total	158	158	157	155	154	154	123	116	107	111	119	105	--
	New	7	3	2	5	2	5	27	6	9	4	15	30	115
Dump truck (14 m^3)	Total	48	50	50	33	31	29	37	38	39	41	34	36	--
	New	8	2	0	2	1	9	10	1	4	2	3	4	46
Dump truck (8 m^3)	Total	80	83	63	63	63	68	69	69	57	44	55	63	--
	New	1	3	0	3	0	5	15	1	11	5	12	11	67
Dump truck (6 m^3)	Total	78	72	55	44	41	41	44	47	50	51	36	13	--
	New	0	2	0	1	0	0	4	3	3	1	0	1	15
Dump truck (2 m^3)	Total	81	81	81	81	81	81	81	81	84	91	10	10	--
	New	0	0	0	0	0	0	0	0	3	7	0	0	10
Arm-roll (12 m^3)	Total	73	78	82	90	90	98	98	107	111	114	113	108	--
	New	10	5	4	8	0	8	2	9	4	3	19	37	109
Tractor (6 m^3)	Total	94	94	94	94	90	90	73	79	81	78	80	83	--
	New	0	0	0	0	12	0	31	6	5	10	12	7	83
Annual Trucks	Total	660	659	629	598	589	603	584	602	601	607	531	513	--
	New	37	19	11	28	18	32	109	32	47	38	79	105	555
B. CONTAINER														
Container (12 m^3)	Total	730	780	820	900	900	980	980	1,070	1,110	1,140	1,130	1,080	--
	New	591	50	40	80	144	671	70	110	120	174	661	40	2,751
Container (2 m^3)	Total	2,791	2,710	2,762	2,591	2,595	2,644	2,517	2,524	2,522	2,652	2,867	2,863	--
	New	2,810	0	75	2,515	50	105	2,390	130	135	2,415	350	145	11,120
Annual Containers	Total	3,521	0	75	2,515	50	105	2,390	130	135	2,415	350	145	--
	New	3,401	50	115	2,595	194	776	2,460	240	255	2,589	1,011	185	13,871

During the master plan period of 2017 to 2028, it is necessary to procure a total of;

- 555 Trucks

- 2,751 arm-roll containers
- 11,120 compactor containers

The trucks and containers to be operated annually and new procurement requirements for each locality have also been estimated and are provided in the Master Plan.

(3) Transfer Stations

There is an urgent need to construct more transfer stations and procure secondary transfer equipment. Presently only two transfer stations are being operated, receiving about 1,300 ton/day of waste. KCC has prepared its 2016 and 2017 annual plans calling for construction of at least one transfer station in each locality, however the implementation has been lagging behind.

In discussions with KCC, their annual plans were re-considered based on the expected service area for each station and the priority, as shown in Table 6-5.

Table 6-5 Prioritization of KCC Transfer Stations Improvement Plans

SN	Activity	Service Area / Targeted Operation Year
1	Umbadda New T/S construction completion	• Serve Umbadda LA • Target operation year 2016 end
2-3	Combined Bahary and Sharg El Nile New T/S construction	• Serve Sharg El Nile LA and Bahary LA • Target operation year 2017
4	Omdurman South New T/S Plan	• Serve southern part of Omdurman LA • Target operation year 2018
5	Soba New T/S Plan	• Serve southern part of Khartoum LA and Jabel Aulia LA • Target operation year 2018
6-7	Rehabilitation of Existing Khartoum and Omdurman T/S	• Serves Khartoum and Omdurman LAs • Procurement of trailers in 2017
8	Karary New T/S FS	• Southern part of Karary LA will be served by Omdurman T/S and northern parts can proceed directly to landfill • Requirement for this T/S should be studied after 2018
9	Jabel Aulia New T/S FS	• Soba T/S will serve Jabel Aulia • Requirement for this T/S should be studied after 2018

Under the re-arranged program all the planned transfer stations should be completed by the year 2020. Sorting and processing equipment will be introduced to the transfer stations. A new transfer station in Jabel Aulia will transport solid waste to Khartoum landfill site which will be expanded. And in the case of the proposed Karary T/S, this may not be immediately required. Therefore, it is proposed that these two transfer station construction projects be re-studied after completion and operation of the other proposed four transfer station.

The implementation schedule for the plan, considering the required activities of land allocation and engineering works is shown in Fig. 6-1.

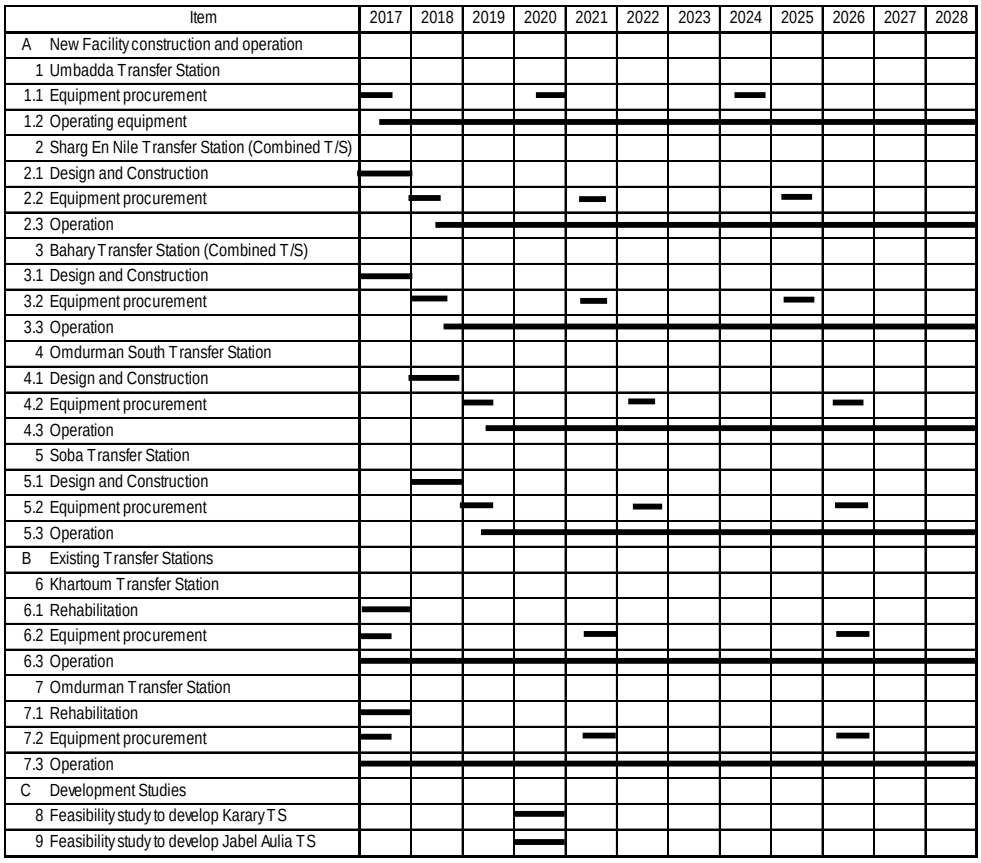


Fig. 6-1 Transfer Stations Improvement Plan Implementation Schedule

6.2.2 Final disposal

Solid waste disposal by landfill should be done in a sanitary manner to protect the public health and the environment. Master Plan categorizes sanitary landfill site into four levels in accordance with the facility as shown in table below.

Table 6-6 Proposed Sanitary Landfill Levels

Facility	Level 1	Level 2	Level 3	Level 4
Description	Controlled dumping	Sanitary Landfill with bund and daily cover	Sanitary Landfill with leachate re-circulation	Sanitary Landfill with Leachate Treatment facilities
(l) Soil cover	○ (Periodic)	○ (Daily)	○(Daily)	○(Daily)
(2) Administration office	○	○	○	○
(3) Access management facility (fence and gate)	○	○	○	○
(4) Embankment		○	○	○
(5) Drainage facility		○	○	○
(6) Gas removal facility		○	○	○
(7) Leachate collection			○	○
(8) Leachate recirculation			○	○
(9) Leachate treatment				○
(10) Liner				○

Khartoum state government started waste disposal at Bahary landfill site as open dumping site. The government has

tried to make the level of Bahary landfill to be controlled dumping (Level 1) since 2008. KCC plans to make the landfill site become "Sanitary Landfill with bund and daily cover (Level 2)" by Year 2021. And then considering low rainfall level, KCC will achieve sound "Sanitary Landfill with bund and daily cover" at aims to become level 2, Sanitary Landfill with bund and daily cover, until target year. Due to the low amounts of rainfall in Khartoum and deep groundwater table levels at the landfills, there is no fear of huge amounts of leachate water production or threat of leachate seepage to the groundwater. Therefore Level 2 was decided to be sufficient improvement target.

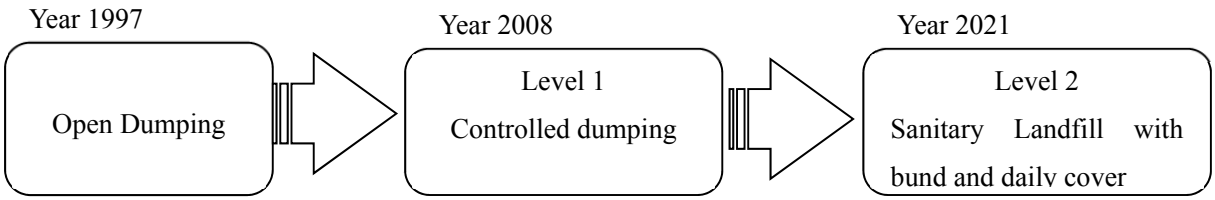


Fig. 6-2 Road Map of Developing Sanitary Landfill

Image of Level 2 Landfill Site is depicted in figure below. The landfill basically has Administration office, Access management facility (fence and gate), Embankment, Drainage facility and Gas removal facility.

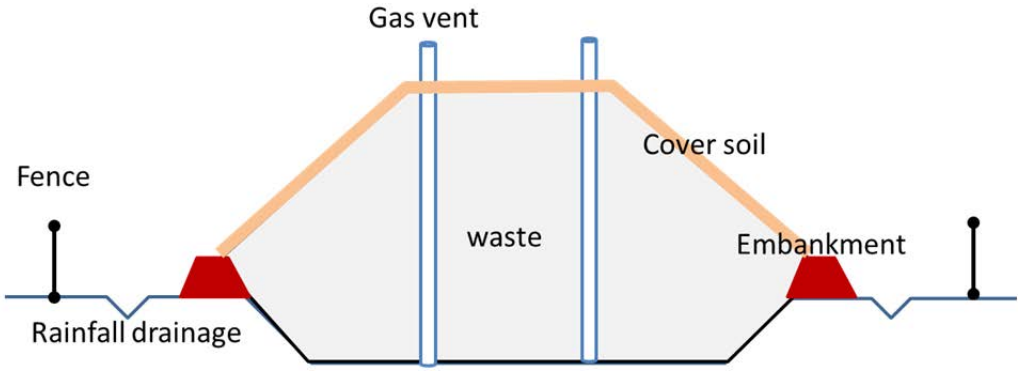


Fig. 6-3 Image of Level-2 Landfill Site

(1) Plan on Khartoum landfill site

Khartoum LFS will reach its capacity limit in 2021 so that the new landfill site should be constructed before that[9]. KCC shall start to select a candidate site for the new LFS in 2017. The new landfill site will be constructed as Level-2 landfill site.

[9] It was planned that a new landfill site would be constructed as replacement of Khartoum landfill site at that time of discussion of M/P. However, it was finally decided that the landfill site will be expanded.

Table 6-7 Timeline of Khartoum LFS and New LFS

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Khartoum LFS												
Fence and Weighbridge												
Procurement of one unit of Bulldozer												
Operation as level 1												
New LFS												
Site selection and land acquisition												
Design and EIA												
Construction of next cell (Capacity :12 million m^3)												
Procurement of two units of Bulldozer												
Operation as level 2												

(2) Plan on Omdurman landfill site

Omdurman landfill site has the total area of 550ha so it can be utilized continuously in the future. The dumping area of Omdurman landfill site will be developed in phases to utilize the area maximally. Each phase will be planned to have ten years of waste disposal capacity. As the phase 1, it will be constructed with 9 million m^3 of capacity and operated from 2020 as Level-2 landfill site.

Table 6-8 Timeline of Omdurman LFS

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Omdurman landfill site												
Operation as level 1												
Design of Phase 1												
Construction of Phase 1 (Capacity :9 million m^3)												
Procurement of three units of Bulldozer												
Operation as level 2												

(3) Plan in Bahary landfill site

Bahary landfill site has the total area of 750ha of area so it can be utilized continuously in the future. The dumping area of Bahary landfill site will be also developed in phases in order to utilize the area maximally. Each phase will be planned to have ten years of waste disposal capacity. As the phase 1, it will be constructed with 6 million m^3 of capacity and operated from 2020 as Level-2 landfill site.

Table 6-9 Timeline of Bahary LFS

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Bahary landfill site												
Operation as level 1												
Design of Phase 1												
Construction of Phase 1 (Capacity :6 million m^3)												
Procurement of one unit of Bulldozer												
Operation as level 2												

6.2.3 Recycle (Including 3R)

In principle, there is no formal intermediate treatment and recycling. The recycling facility complex set up at Omdurman has not been in operation since the last 2-3 years. On the other hand, KCC reported that there are some 37 small private processing plants for plastic wastes.

The main issue is the lack of information on the market demand and the informal nature of all the present waste sorting. In addition, there is hardly any source separation and separate collection or recyclable materials from the waste stream.

KCC has highlighted the importance of waste minimization in its Strategic Plan for SWM (2017 – 2030) through a number of conceptual projects. Based on the strategic plan, seven activities have been identified for inclusion in the master plan.

- Preparation of Recycling Study and Action Plan
- Setting up the institutional system for the 3Rs
- Introduction of Source Separation and Separate Collection
- Operation of Processing Facilities at the SWM Facilities
- Production of Compost from Organic Wastes
- Introduction of EfW (Energy from Waste) Intermediate Treatment Facility
- Public Awareness on 3Rs

The implementation schedule is shown in Fig. 6-4.

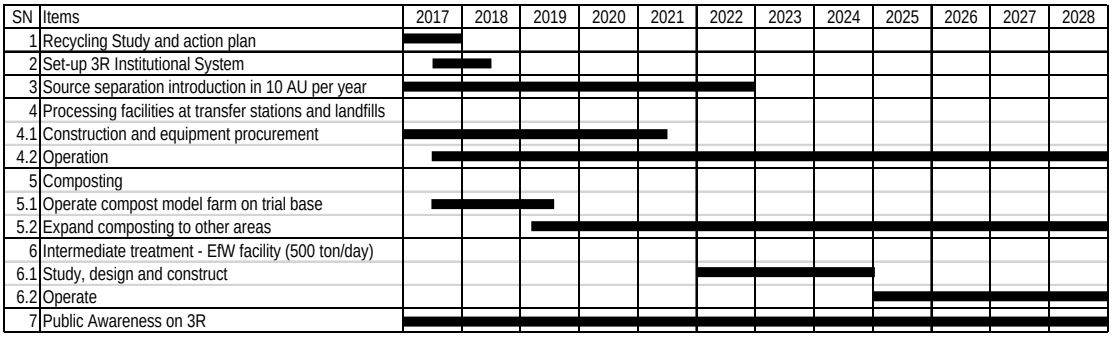


Fig. 6-4 3Rs and Intermediate Treatment Plan Implementation Schedule

Considering that this activity has not been dealt with directly by Khartoum State, the following are some recommendations that were put forward for smoother implementation.

(1) Develop the plan

The activities of the 3Rs should be based on a clear understanding of the present recycling activities, potential stakeholders and market demand. A fact-based plan is necessary.

(2) Work closely with stakeholders

Activities should incorporate as much of the present stakeholders as possible. The present waste pickers and "recycling shops" need to be gradually formalized in order to improve working conditions and raise the quality of processing and recycling. Dangerous practices, such as children waste pickers and melting of electric appliances parts and batteries should be eliminated.

(3) Enshrine 3Rs in the conscious of the public

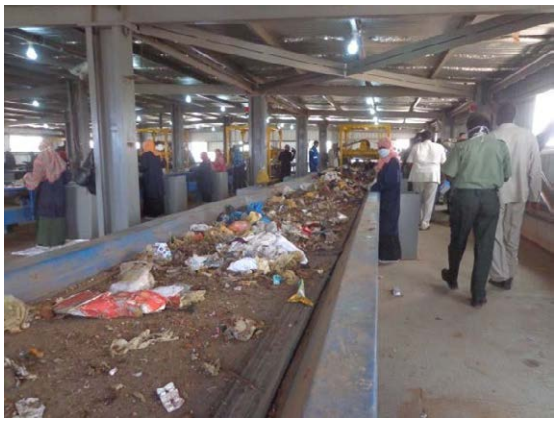
Efforts to commit the general public to recycling are paramount for the success of the 3Rs. The idea that recycling is important to generate income should be replaced by an understanding that recycling is important to manage solid waste more effectively and conserve the environment.

(4) Recycle system developed in Omdurman landfill site

A recycling facility complex including sorting plant, compost plant and PET pellet plant was constructed in Omdurman landfill in 2014. Omdurman landfill site was constructed by Petroleum Engineering Consultancy Service (PECS) in 2008. Construction costs of the recycling facilities were shared by as follows:

- Building and compost plan: Egyptian company
- Civil work: Local construction company
- Recycling equipment: Chinese and Indian companies

As of December 2016, the facilities, however, were not functional.

	
Manual sorting lines	Feeding conveyor of wastes

Waste to be recycled

Watering to organic waste for compost production

Fig. 6-5 Activity for Recycling by Private Company in Omdurman Landfill

6.2.4 Public Awareness

Public awareness is usually unvalued. Priority is put on purchase of machines, vehicles and equipment and there is not much budget left for awareness raising activities. Citizens tend to think that the government should be responsible and they do not understand their responsibilities or roles as a waste discharger. This master plan was prepared in a way to change the current situation.

Table 6-10 Implementation Schedule of Public Awareness

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
1	Awareness raising on SWM (General)												
2	Explanatory meeting with neighboring communities for construction of new transfer stations												
3	Awareness raising on 3R												
4	Awareness raising on FPFT												

(1) Awareness raising on SWM (General)

First of all, the government should give a permanent position to temporal staff and increase the number of staff at LCAs to carry out awareness raising activities on solid waste management.

- ✓ Staff at the Department of Cleaning Promotion and Inforamtion (13 members), KCC are now hired on a temporary basis, but they should be given a permanent staff status to give their efforts to curry out their tasks. This is because KCC should play a leadning role in public awarenss for solid waste management in Khartoum state.
- ✓ LCAs should hire adequate number of staff. In the future, each AU cleaning office should have at least one staff who in charge of public awareness and community participation and each LCA should have three staff at LCA office. The current number of staff in charge of public awareness is 44 at 7 LCAs and it should be increased to 123 in the future.

Following activities will be carried out to raise awareness of citizens on waste management.

- ✓ A room in the transfer stations, landfills as well as recycling facilities should be allocated as an environmental/waste management learning center for public awareness activities. Students and citizens who

have interest in the environment and waste management can visit the center and learn. KCC will prepare video program and exhibits and give talks or lectures for visitors.

- ✓ There has been a discussion that the environment education should be included in the school curriculum. This is a good chance that waste management will be included as a theme to raise awareness of school children. MENRPD is expected to contribute in producing a textbook to be used for environmental and waste management education.
- ✓ MENRPD, Higher Council of Environment, KCC should continue using traditional media and social media to send information to citizens. Oraganizing vents for waste management is also a good means to draw attnetion of citizens.

(2) Explanatory meeting for new transfer stations

KCC has already received complaints such as odor or scattered waste at the exsisting transfter stations from neighbors. KCC should explain the construction plans and mitigation plans to avoid contamination or odors to the neighboring communities. KCC will hold explanatory meetings for residents, if there is a need, for the new transfer stations to avoid complaints from neighboring communities in the future.

(3) Awareness raising on 3R

It is planned 3R and source separation will be introduced from 2017. How to separate waste at source and how separated waste will be reused or recycled should be informed to citizens. Public awareness is very important for 3R. Posters and brochures should be developed and awareness raising through media should be done by KCC. A demonstration kit also should be developed for citizens to have an idea how to segregate waste. This kind demonstration kit will be used at schools or community meetings. For the pilot areas where the source separation is introduced, LCA and AU staff should hold community meetings and pay house-to-house visits.

(4) Expantion of FPFT collection system

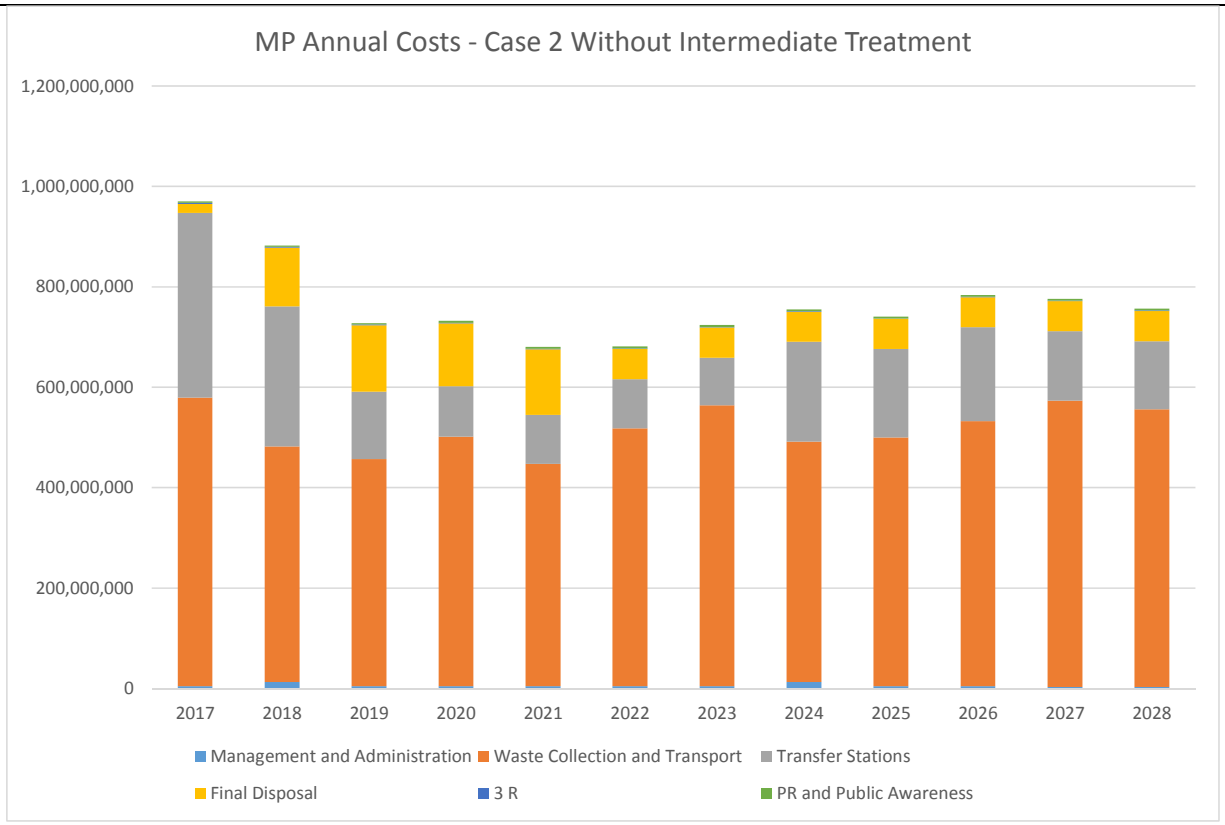
As for the expansion of FPFT, we have already had lessons from the pilot areas in Karary and Khartoum. A house-to house visit was the best way to encourage citizens to cooperate for FPFT along with community meetings, lectures, brochure. A study tour to the best performance area motivated residents in the other areas to work hard. How to motivate the popular committee in the target area is also key and there is a need to train them. These lessons can be adapted by the other LCAs to introduce FPFT.

6.2.5 Organization

The M/P planned to change the organization and clarified responsibility of each organization.

6.2.6 Financial Analysis for Master Plan

Master plan includes financial estimations of required cost for solid waste management from 2017 to 2028, and most realistic scenario which is not including the incineration plan is shown in following table.



Case 2 - Without Intermediate Treatement — SDG/y

Items	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average
1.Management and administration cost	4,825,000	12,825,000	4,825,000	4,825,000	4,825,000	4,825,000	4,825,000	12,825,000	4,825,000	4,825,000	3,025,000	3,025,000	5,858,333
2.Waste Collection	574,451,378	469,355,882	451,998,385	497,045,746	442,645,686	513,512,622	559,199,972	478,872,663	495,187,397	527,643,858	570,230,285	553,421,741	511,130,468
3.Transfer Station	367,931,008	278,835,874	134,497,232	100,205,912	97,558,412	97,760,912	94,760,912	198,793,381	176,316,134	186,881,743	138,431,743	135,431,743	167,283,751
4.Final Disposal	17,929,057	117,176,016	132,395,066	125,009,862	130,494,091	59,996,861	59,996,861	59,996,861	59,996,861	59,996,861	59,996,861	59,996,861	78,581,843
5.3R Activity	1,975,000	1,537,610	1,266,000	1,266,000	1,266,000	1,266,000	916,000	916,000	916,000	916,000	916,000	916,000	1,172,718
6.Awareness	3,113,000	2,577,200	2,914,400	4,051,600	3,598,800	3,822,000	4,435,000	3,635,000	3,635,000	3,635,000	3,635,000	3,635,000	3,557,250
7.Total	970,224,442	882,307,582	727,896,083	732,404,120	680,387,989	681,183,395	724,133,745	755,038,905	740,876,391	783,898,462	776,234,889	756,426,345	767,584,362

t/d

Items	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average
8.Waste Collection Amount	3,913	4,212	4,531	4,871	5,240	5,633	6,052	6,499	6,976	7,483	8,023	8,598	6,003

SDG/t

Items	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average
9.Unit Cost	679	574	440	412	356	331	328	318	291	287	265	241	377

Fig. 6-6 Annual Financial Plan of Master Plan (Scenario without Incineration Plant)

Required cost to realize M/P will be larger than current cost, and therefore cost sharing among the residents, the business entities and donors was considered in M/P. Cost sharing of the most realistic scenario among some scenarios is shown in following table, and cost to be borne by the residents will be monthly 3.1 SDG per person

Table 6-11 Cost Sharing Recommended by the Master Plan

	Share			Cost to be borne by the residents
	Residents	Business entity	Donor etc.	
The most realistic scenario	20%	50%	30%	3.1 SDG/person/month

Chapter 7 Input of the Project

7.1 Assignment Schedule of Japanese Experts

Original assignment schedule of the Japanese experts as of the commencement of the Project, May 2014, is shown figure below. In August 2015, the assignment schedule was revised as table below.

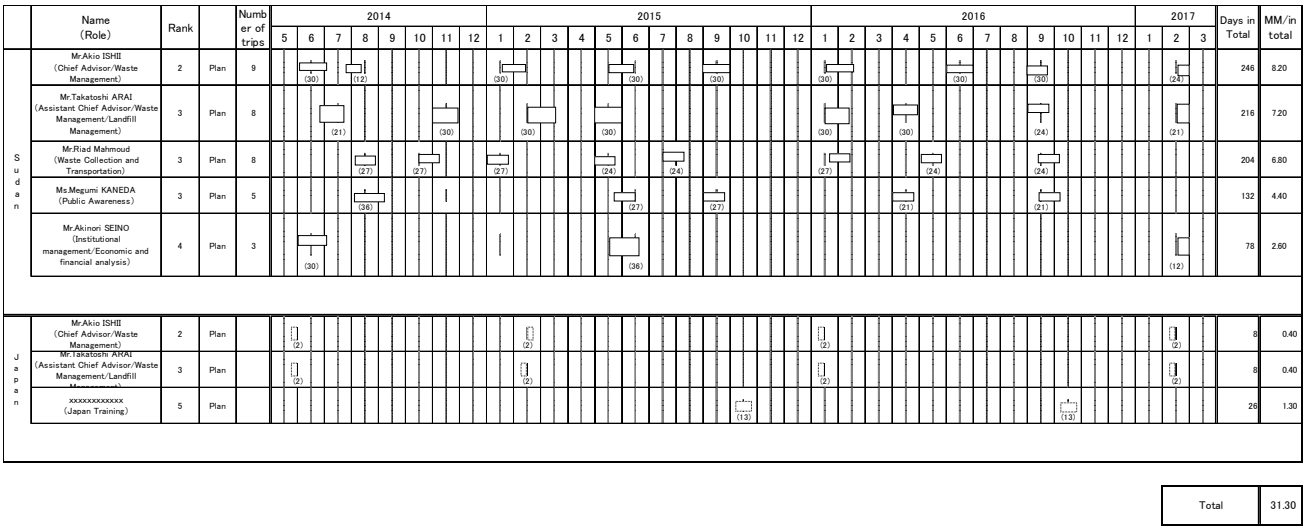


Fig. 7-1 Original Assignment Schedule of the Japanese Experts as of May 2014

Table 7-1 Review of the Assignment of the Japanese Expert

Title	Name	MM		Reason
		Original	After change	
Chief Advisor / Waste Management	Mr. Akio ISHII	8.20	9.20	To analyze the contents and background of Vision which indicates the direction for revision of the master plan.
Deputy Chief Advisor / Waste Management / Landfill Management	Mr. Takatoshi ARAI	7.20	8.20	To analyze the contents and background of Vision which indicates the direction for revision of the master plan.
Waste Collection and Transportation	Mr. Mahmoud RIAD	6.80	7.80	To study new transfer stations to be constructed by the state government
Public Awareness	Ms. Megumi KANEDA	4.40	5.40	To study the utilization of AU which was newly introduced as minimum administration body To incorporate the system of AU to revise SWM of the masterplan
Institutional management / Economic and financial analysis	Mr. Akinori SEINO	2.60	4.77	To study a method of waste collection improvement with utilization of AU

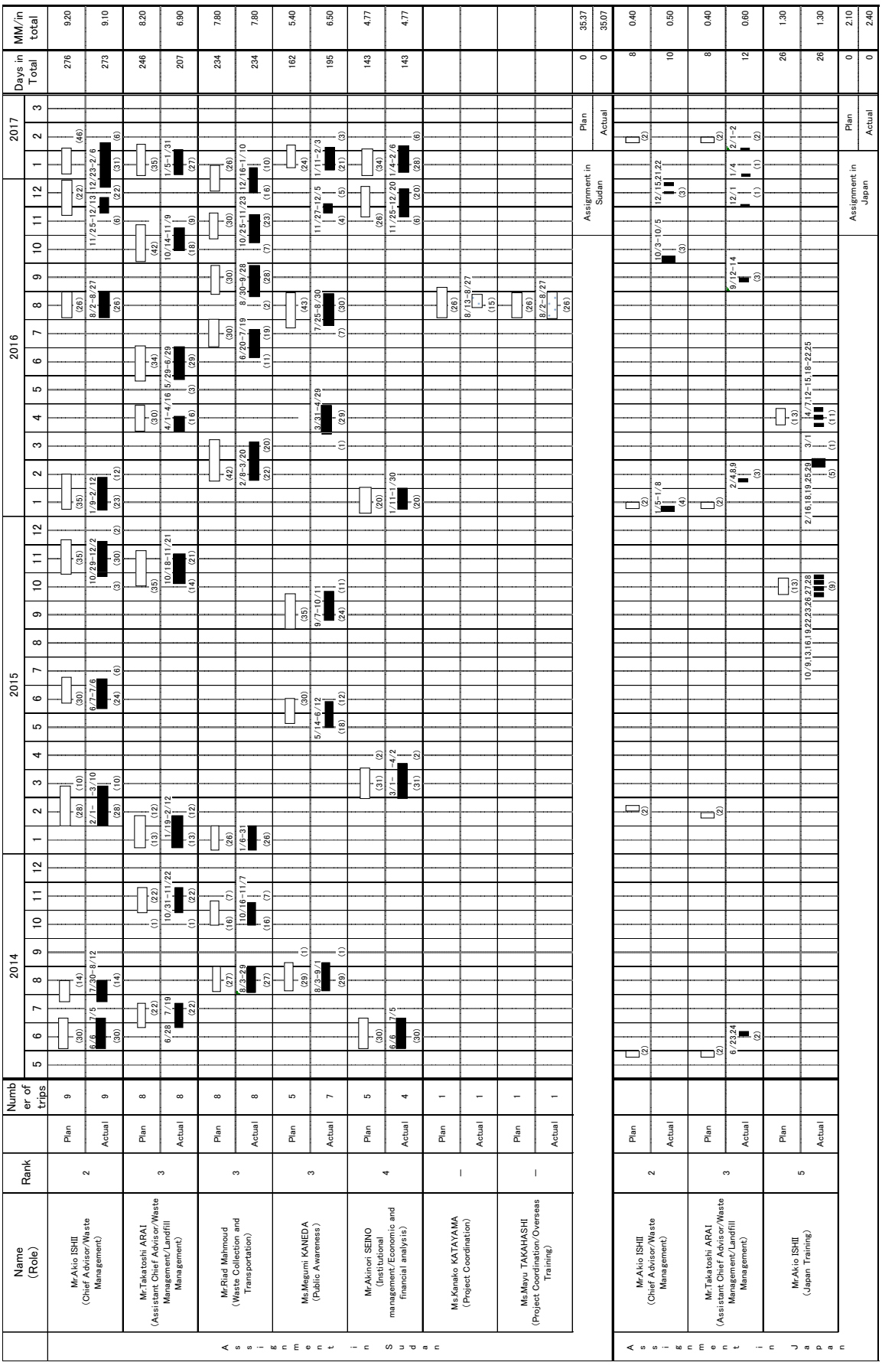


Fig. 7-2 Revised Assignment Schedule and Actual Schedule

7.2 Record of Training of Counterpart

7.2.1 Training in Japan

(1) Objective

The training in Japan was held twice in 2015 and 2016 to understand how the central and local government in Japan has developed SWM and to create the direction toward the sound SWM through lectures and site vising to SWM facilities in Japan.

(2) Trainee

Trainees of the training in Japan are shown in table below

Table 7-2 Trainee of 1st Training in Japan in 2015

	Name	Organization	Title
1	Mr.Jaafer Musa Mohammed Bakhit	Higher Supervisory Department for Cleaning for Technical Administration	Manager
2	Ms.Aisha Sedahmed Abdelgader Mohammed	Department of Environment Affairs/ Environmental Control, Ministry of Environment, Natural Resource and Physical Development	Inspector
3	Mr.Abdalazim Ali Abdalla Ali Alla	Khartoum Locality Cleaning Affiliates for Operation Management	Manager
4	Mr.Ahmed Elnoor Hassan Abdalla	Head of Afficate, Umbada Locality Cleaning Affiliates	General Manager
5	Mr.Elshazaly Obeid Mohamed Ahmed Mustafa	Karary Locality Cleaning Affiliates for Operation Management	Manager

Table 7-3 Trainee of 2nd Training in Japan in 2016

	Name	Organization	Title
1	Dr.Omer Mustafa Abdel Gadir Elkhidir	Ministry of Environment, Natural Resources & Physical Development (MENRPD) of Republic of Sudan	Under Secretary
2	Mr. Omer Ahmed Ibrahim	High Council of Environment, Khartoum State, Republic of Sudan	Minister
3	Dr. Mesap Berir Hajahmed	Khartoum Cleaning Corporation (KCC)	General Manager
4	Mr. Gosai Ahmed Mohammed	MENRPD	Project Coordinator
5	Mr.Altayeb Mohamed Ibrahim	KCC	Operation Manager

(3) Schedule

The training in Japan was held twice from 12th to 24th October 2015 and from 16th to 23rd April 2016, respectively. Detailed schedules of each training are shown in table below.

Table 7-4 Detailed Schedule of 1st Training in Japan in 2015

Date		Type	Contents	Lecture or Facility
12 Oct.			Arrival at Japan	
13 Oct.	10:00 ～ 12:30	―	Briefing on the rule	JICA Tokyo
	12:30 ～ 12:40	―	Courtesy call to JICA HQ JICA and Briefing (schedule, objective etc.)	JICA HQ
14 Oct.	10:00 ～ 12:00	Lecture	Operation of waste management and involvement of public section in Tokyo	Bureau of environment, Tokyo Metropolitan Government
	14:30 ～ 16:30	Lecture	Contents of JICA Technical Cooperation Project, and contents and progress of Grant Aid Project	Chief Advisor of the Project
15 Oct.	9:30 ～ 11:00	Lecture	M/P in Khartoum state	Chief Advisor of the Project
	13:00 ～ 14:30	Site visit	Outline of landfill in Tokyo Bay	Environmental business department, Tokyo Environmental Public Service Corporation.
16 Oct.	10:00 ～ 11:00	Site visit	Outline of transfer station	Department of environment and cleaning, Shinjuku City
	13:00 ～ 15:30	Site visit	Latest technology and operation of incineration plan	Shibuya cleaning center, Clean Authority of TOKYO
17 Oct.			Day off	
18 Oct.			Day off	
19 Oct.	9:00 ～ 11:00	―	Documentation	―
	13:30 ～ 17:00	Site visit	Recycling, operation of reginal landfill site, utilization of closed landfill site and environmental monitoring	Section of environment, Tokyo Tama Regional Association
20 Oct.	10:00 ～ 12:00	Site visit	Operation of field SWM office, waste transportation by ship	Cleaning center office, Department of living and environment, Kita City, Tokyo
	15:00 ～ 16:30	Lecture	Points of Training in Japan	Chief Advisor of the Project
21 Oct.	10:00 ～ 12:00	Lecture	Issues for realization of the Khartoum M/P	Chief Advisor of the Project
	13:30 ～ 16:30	Lecture	Documentation	Chief Advisor of the Project
22 Oct.	9:00 ～ 11:30	Site visit	Waste collection at Meguro City	Cleaning Center, Meguro City
	13:30 ～ 15:30	Site visit	Repair and maintenance of waste collection vehicles	Cleaning Center, Meguro City
23 Oct.	9:00 ～ 12:00	―	Documentation	―
	13:30 ～ 17:30	―	Reporting	JICA Tokyo
24 Oct.			Departure	

Table 7-5 Detailed Schedule of 2nd Training in Japan in 2016

Date		Type	Contents	Lecture or Facility
16 Apr.			Arrival at Japan	
17 Apr.	13:00 ～ 16:00		Briefing and preparation	
18 Apr.	10:00 ～ 11:30		Briefing	
	13:30 ～ 14:45	Site visit	Outline of Incineration plant	Shibuya incineration plant
	15:30 ～ 16:30	Site visit	Courtesy call to JICA HQ	JICA HQ
19 Apr.	9:30 ～ 11:00	Site visit	Outline of Incineration plant	Meguro incineration plant
	13:30 ～ 15:00	Site visit	Construction supervision and safety management of construction	Suginami incineration plant (under construction)
20 Apr.	10:00 ～ 11:30	Site visit	Transfer station and transfer system of solid waste	Katsushika City
	15:00 ～ 15:30		Courtesy call to Tokyo Metropolitan Government	Tokyo Metropolitan Government
21 Apr.	10:00 ～ 11:30	Site visit	Outline of field SWM office	Shinjuku field SWM office
	13:30 ～ 16:00	Site visit	Outline of landfill in Tokyo Bay	Tokyo Environmental Public Service Corporation.
22 Apr.	9:00 ～ 11:00	Site visit	Outline of waste collection	Meguro City
	13:30 ～ 15:30	Site visit	Repair and maintenance of waste collection vehicles	Cleaning Center, Meguro City
	16:30 ～ 17:30		Courtesy call to JICA HQ	JICA HQ
23 Apr.	11:00 ～ 16:20	Site visit	Utilization of closed dumping site	Tokyo bay
			Departure	

(4) Outcome

The trainees formulated action plan for improvement of solid waste management applicable to Sudan as outcome of the training in Japan through understanding solid waste management conducted by central and local governments. The outcomes would be made good use as follows:

- The trainees reported their outcomes at NSC and meeting on revision of the master plan. The outcome were part of the input of the revision.
- The outcomes were shared among stakeholders including counterparts
- The outcomes were applied into the daily works and better management was realized

	
Shinjuku Transfer Station and Recycling Center	Landfill site of Tokyo Tama Regional Association
	
Waste collection in Meguro City	Tokyo Metropolitan government
	
Landfill off Tokyo bay	Closing report

Fig. 7-3 Picture of 1st Training in Japan in 2015

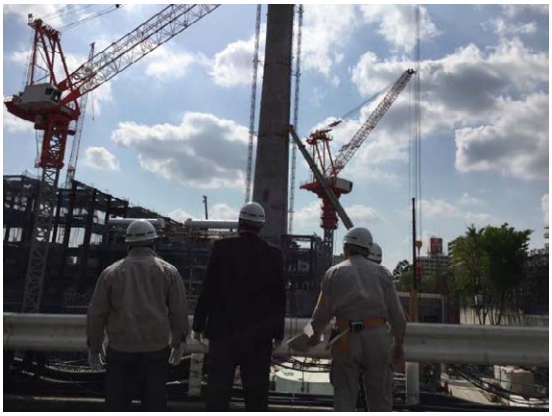
	
Katsushika Transfer Station	Courtesy call to JICA HQ
	
Landfill off Tokyo bay	Meguro Incineration Plant
	
Waste collection in Meguro City	Construction site of Suginami Incineration Plant

Fig. 7-4 Picture of 2nd Training in Japan in 2016

7.3 Equipment Procured by the Project

Equipment procured by the Project is listed as follows:

7.3.1 Equipment for the Project Office

Table 7-6 Equipment for the Project Office

	Equipment	Unit	Price (JPY)
1	Laptop computer	1	100,000
2	Printer	1	
3	Projector	1	90,000
4	Screen	1	

7.3.2 Equipment for the Pilot Project

Table 7-7 Equipment for the Pilot Project

	Items	Unit	Price (JPY)
1	Waste bins for waste collection improvement PP	1 set	1,250,000
2	Safety gears for waste collection Improvement and landfill site improvement PP	1 set	1,880,000
3	Signboard for waste collection improvement PP	1 set	220,000
4	Leaflet for waste collection improvement PP	1 set	280,000
5	AU SWM office (Container Office) for institution improvement PP	1 set	2,780,000

7.4 Local Expenditure

Local expenditure of the Project was summarized as follows:

Table 7-8 Local Expenditure (1/2)

Item	Cost (Japanese Yen)
Local Staff	12,915,000
Cost related with vehicles	2,144,000
Rental Fee	121,000
Consumable goods	510,000
Travel and transportation fee	171,000
Communication and haulage cost	114,000
Material and document cost	1,052,000
Other cost	360,000
Total	17,387,000

Table 7-9 Local Expenditure (2/2)

Item	Cost (Japanese Yen)
Topographic survey at landfill site	865,000
Waste amount and composition survey	4,097,000
Total	4,962,000

Chapter 8 Lessons Learned and Recommendations

8.1 Issues and Efforts on Implementation of the Project

8.1.1 Closed Communication with C/Ps through Weekly Meeting

The Project has mainly two Sudanese counterpart agencies, MENRPD and KCC. KCC had a few direct relationships with MENRPD due to an organization under the state government. It became apparent that information sharing and communication between MENRPD which has responsibility of overall management of the Project and KCC which has responsibility of implementation of the Project. Thus, the Project decided to hold weekly meeting among MENRPD, KCC and JPT to share and confirm the progress, issues, and plan of the activity.

8.1.2 Enhancement of Communication through Frequent NSC

The Project has many related organizations such as C/P organizations, state government and seven LCAs. The state government is carrying out their own activities for solid waste management in parallel with the Project and therefore closed communication and sharing information among the organizations is essential. The Project has frequently held NSC with attendance of PD and PM to enhance the communication since year 2015 when the Project activities became active. NSCs has been held to discuss the specific issues and plan practically as shown in following table rather than to report the progress of the Project conventionally.

Table 8-1 Main Agendas of NSCs

	Date	Main agenda
1	8th June, 2014	To discuss the work plan, To appoint the C/P personnel
2	3rd March, 2015	To clarify the roles among AU and the related organizations, To discuss the indicators of PDM
3	29th June, 2015	To replace the C/P personnel, To report the progress of the PP
4	15th November, 2015	To replace the C/P personnel , To discuss the indicators of PDM
5	3rd November, 2016	To confirm the activity during the project remaining period, To discuss the outline of M/P
6	29th December, 2016	To discuss the draft M/P
7	29th January, 2017	To explain project activity, To explain future recommendation

8.1.3 Participation of State Minister of Environment

KCC is an organization under Higher Council of Environmental, Urban and Rural Promotion headed by the state minister of environment. Although the chairman of the Higher Council holds a post of the state minister of environment, any member of the council including the state minister is not C/P of the Project. JPT has made effort to develop close relationship with the state minister through training in Japan etc. Decisions have been made smoothly by C/P organizations due to understanding of the Project by the state minister through the close communication.

8.1.4 Replacement of Counterpart Personnel

During the Project, key counterpart personnel such as Project director, Project manager, Collection and transportation manager, Landfill manager, Community participatory sold waste management manager, Institutional and finance manager and Administrative coordinator, were replaced. Even worse, change of Project Manager was not smoothly carried out due to some difficulties of Sudanese side. At that time, JPT requested the Sudanese side to replace Administrative coordinator at first and not to change C/P at once for consistency of the Project. And then the Administrative coordinator managed to change the other counterpart personnel gradually in consideration of the whole project activities. NSC authorized the replaced C/P personnel as the final step and the authorization raised their ownerships.

8.1.5 Replacement of LCA's Person in charge

General Managers of LCAs were frequently replaced during the Project and it caused the delay of the Project activities. In particularly, general managers of Khartoum LCA were replaced six times and JPT needed to explain the PP activities to the replaced general managers. On the other hand, PP has involved many stakeholders such as general manager and operation manager from LCA and popular committee members through weekly meeting so that they could continue the PP in the fields without instructions from the general managers. AU SWM offices were constructed for them to have an opportunity to work at field level.

8.1.6 Local Staff sent from Local Temp Agency

The rule to employ local people was changed because the so-called Labor Standards Act was strengthened in Sudan. As of June 2014, at that time of commencement of the Project, many other JICA's projects faced employment problems and some projects were at law. Accordingly, it was difficult for the Project to employ local staffs. The Project was recommended to employ only essential local staff and the Project employed only two persons; Interpreter/Coordinator and Driver for two years from the beginning of the Project, although the Project had budget for six local staff including three engineers. Hiring less local staff than planed caused some delay of the activities of the Project. JPT found a human resource agency and consulting company which could dispatch local staff, and then JPT has hired additional local staff from these companies since April 2016 to catch up the delay.

8.2 Lessons Learned through the Project Implementation.

Sudanese side has done their own activities for improving solid waste management, motivated by cooperation work with JPT in the Project. It is assumed that sustainability is being developed and strengthened. Main activities building sustainability implemented by Sudanese side are shown in table below.

Table 8-2 Main Activities Building Sustainability Implemented by Sudanese Side

Case	Activity
1	JPT advised Sudanese side to record the incoming waste amount to each facility to develop the SWM data management system. Beyond the advice, KCC, by themselves, developed the feedback procedure to LCA office and the transfer stations by aiming to avoid no waste collection by waste collection vehicle and to

	avoid open dumping by trailer on the way to the landfill sites.
2	The state government has established the technical committee, constructed related facilities, done procurement and awareness activities without support from JPT. In particular, the state government is proceeding construction of the three new transfer stations
3	Khartoum LCA has expanded FPFT collection system to the other area nearby the PP area as LCA realized efficiency of FPFT and residents living near the PP areas requested to introduce the system to their area.
4	Both LCAs and KCC have improved their capacity for data collection, analysis and reporting under the Project. The LCAs and KCC use simple Excel file formats to enter the data and develop graphical analysis of the services. Due to the absence of weighbridges, the methods to calculate the waste amounts, in terms of weight and volume were discussed with all the LCAs. The waste amount generated and collection rates in each locality were estimated by JPT and LCA operation managers based on data analyzed in the last two years.
5	KCC has been strengthened organizationally and number of KCC staff was increased 330 in year 2013 to 400 in year 2016. KCC has also established new sections within the organization such as call center.
6	Annual budget and income of LCAs has been increased form year to year and budget in 2015 was almost the double size of one in 2013. In particular, income from SWM fee from residents and business entities during the period was also doubled. LCAs have secured the budget by its own effort without further financial support from the state government.
7	KCC decided to acquire 20 ha of land nearby Khartoum landfill site for its expansion and reached an agreement of the land owner(s). KCC is going through the procedure for the payment of the land acquisition to the owner(s).

It is assumed that these activities building sustainability have been resulted by some factors and their interactions shown in below: In other ward, the factors can be lessons learned by the Project for other projects.

(1) Continuous Support from JICA over Last Five Years

JICA dispatched a solid waste management expert to improve solid waste management in the state for three year from JFY 2010 to 2012. And survey of the related grant aid project was conducted in JFY 2013, and then this project has been implemented since June 2014. It is assumed that capacity of the Sudanese officers including the counter parts has been gradually developed since JFY 2010. In addition, JPT and the C/P personnel have developed friendship and the long-term cooperation enabled smooth implementation of the Project.

(2) Utilization of Outcomes Produced by the JICA Expert

The Project has tried to utilize the outcomes produced by the JICA Expert dispatched in JFY 2010. Several activities were be implemented based on the outcomes.

Firstly, the administration offices in the landfill site were constructed as an activity of the JICA Expert. The administration offices have enabled KCC to keep record of incoming vehicles to the landfill site and develop the feed-back system mentioned in Table 8-2.

Secondly, when the JICA Expert was dispatched, permission was necessary from the police to hold a community meeting which KCC had hardly held in the past. Even though KCC held the community meetings, KCC and the residents tended to complain each other and were preoccupied in quarrels. The JICA Expert continued to hold the community meetings and atmosphere to exchange opinions was gradually created. PP on improvement of waste collection has been smoothly carried out based on the created relationship.

(3) Impact form the Related Grant Aid Project

It is sure that the related grant aid project in parallel with this technical corporation project and dispatching an expert gave many impacts to Sudanese side. Motivation and movement toward improving solid waste management have been arisen by the related grant aid project. Japanese side had several opportunities to explain the activities of JICA to the governor through this grand aid project. This is a possible cause that the governor has become interested in solid waste management.

(4) Synergistic Effect between the Project and the Related Grant Aid Project

JPT has implement the Project and the related grant aid project as one project rather than separate projects. JPT has positively discussed inspections, construction supervision and required arrangement of the related grant aid project at the weekly meetings with C/P. Moreover, JPT requested C/P to maintain the equipment procured by the related grant aid project and to provide trainings to their mechanics after the handing over. C/P was able to develop their capacity and the Project became functional.

(5) Coincidence with Social Need and Participation of the Decision Makers in the Project

The project invited decision makers, such as the governor and state minister of environment, to the bus tour and opening event at start of the Project and the pilot project. Solid waste management in Khartoum state has been one of the prioritized social problems and the Project meets the need from Sudanese side on improving solid waste management. As the result, the governor and the state minister of environment have participated in any activities to improve solid waste management and leaded the activities with strong leadership.

8.3 Recommendations to Achieve Overall Goal

The indicator of the overall goal is waste collection rate in 2020. Although the equipment of the grant aid project was handed over to Sudanese side in January 2016, the overall goal cannot be achieved only by the equipment. The Khartoum state government should procure additional waste collection vehicles, and construct and improve the transfer stations in line with their own plan with their own budget to achieve the overall goal. The state government completed construction of the Umbadda transfer station and started construction of the new Bahary transfer station. With regard to the procurement, the state government has planned to procure 220 waste collection vehicles and 30 out of 220 vehicles have been already purchased. In addition, the government consulted with Japan Bank for International Cooperation (JBIC) and an officer from JBIC visited Sudan to confirm requests for a loan to procure vehicles from Sudanese side in October 2015. As these movements show, it is believed that a possibility of the procurement and the construction to be implemented as planed is high.

For the overall goal, the federal and state government should understand the importance of master plan revised by the Project further and give financial and institutional supports to KCC and LCA the Project gives following recommendations under the conditions that the federal and state governments support KCC and LCA.

(1) To Prepare for Introduction of New Advanced Technology (MENRPD)

There is a dormant complex of recycling facilities in Omdurman landfill site which was constructed in 2014. Transfer stations to be constructed will have sorting lines for recyclables and Sudanese side wants to introduce advanced technology for recycling. M/P also includes a plan to introduce advanced technology such as a recycling facility and incineration plant. There are many difficulties to introduce the advanced technology even in developed countries such as source separation by residents, marketability of sorted recyclables, and operation skills for sustainable operation of the facilities. An incineration plant, particularly, requires consent from residents and skilled operators. MENRPD, therefore, shall conduct basic research, build consensus with residents and train engineers as a national strategy.

(2) To Create the Environment for Resident and Business entities to Participate (MENRPD)

As the consent from residents is mentions above, it is essential to cooperate among the governments, the residents, and business entities for better solid waste management. The residents and the business entities should recognize the importance of public health and environment conservation and be in the environment where they can change their mindsets and behaviors. MENRPD, therefore, shall implement environmental education, PR through mass media, and fosterage of opinion leaders and academic researchers for environment not only for solid waste management.

(3) To Do Priority Setting, De-centralization and De-politicization of SWM (MENRPD, KCC and LCAs)

KCC has prepared three documents to improve SWM, that are Vision, Strategic Plan from 2017 to 2030 and Annual Plan for 2017. Based on these documents, and arranging the priorities of SWM improvement from technical and financial viewpoints, The master plan has been revised. All these are documents that require ratification by Khartoum state government and starting implementation. And the implementation should not be obstructed by political changes in leadership positions. De-centralization should proceed at the AU level.

(4) To Have Financial Stability of SWM (State government)

The Vision has set clear financial policies to improve SWM financing. It is important that Khartoum state government reviews the fee setting for SWM based on actual expenses of all SWM operations, and not only collection at present. The fee setting presently includes too many categories and should be simplified in order to improve fee collection. The fee collection system is different from one LCA to another and it is advised that Khartoum state government should consider the optimum fee collection system for the whole state. The plan to include SWM fees collection in the water and electricity bills, as explained by KCC GM, is one method to improve revenue collection.

(5) To Involve Private Sector in SWM (State government, KCC and LCAs)

The KCC Vision has identified several cases for private sector involvement in SWM. Case C, where private sector is proposed to be involved in waste treatment is recommended as the best start. KCC, and the LCAs need to train their staff on how to prepare the contracts with the private companies, in terms of technical and general conditions, and how to monitor and evaluate the companies work. It should also be noted that even with the engagement of private companies, the ultimate responsibility for the health of the residents and the sanitation of Khartoum will always rest with Khartoum State.

(6) To Promote Community Based Solid Waste Management (KCC and LCAs)

The residents and the business entities have responsibility for solid waste management as a waste generator. When JICA Expert was dispatched in 2010, KCC was reluctant to hold the community meetings and to exchange opinions with the residents. KCC and LCAs shall enhance their communication skill which was developed in the Project and shall involve the residents to solid waste management as waste generators. KCC and LCAs shall strengthen their awareness units, secure the budget for PR and hold community meeting intensively.

(7) To Improve Work Environment and Motivation of the Workers (KCC and LCAs)

The workers of waste collection and landfill sites have engaged in field works under dangerous and insanitary conditions. The collection work is carried out in front of residents so that behavior of waste collection workers can affect the image of solid waste management. KCC and LCAs shall continue to hold safety and sanitary workshops and shall provide the safety gears for workers to make a safe and sanitary work environment for the workers as well as give better image of solid waste management. In addition, improvement of labor condition, compensation of work accident and salary shall be considered.

(8) To Secure a New Landfill Site (KCC)

A landfill site which is a final destination of solid waste is most important infrastructure of solid waste management. KCC needs to secure a new landfill site to replace the Khartoum landfill site with about five-year remaining capacity. The state government has decided to expand the existing landfill site to nearby south area which has 20ha and has reached an agreement on land acquisition with the land owner. The land acquisition shall make solid waste management in Khartoum state more sustainable. KCC shall go through procedure for the land acquisition without delay and shall secure the expansion area.

(9) To Maintain the Equipment (KCC)

The Project and the related grant aid project have introduced ‘preventive maintenance’ which maintains and inspects the equipment before breakdown. In addition, technical and organizational capacity of the workshop has been developed through preparation of work discipline, safety regulation, compensation of work accident and training system. Despite those efforts, there are still many vehicles breakdown. KCC shall respect and strictly fulfill the preventive maintenance.

(10) To Expand New Waste Collection System, FPFT, to Other Area (LCAs)

FPFT collection system with utilization of bins has been introduced by the Project with the aim to achieve the sanitary work condition for the collection workers and better image of solid waste management. The state government has decided to expand the system to 21 AUs. However, the expansion has not been going well as planned. Types of waste collection system shall be selected depending on the local condition. FPFT is a suitable system in residential area. LCAs shall improve the work efficiency and sanitary work environment through introduction of FPFT into some residential areas.