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Assessment of Environmental Sustainability of Solid Waste Collection and Transport Service of Micro and Small Enterprises, the Case of Bahir -Dar city, Ethiopia

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Abstract
Until recent years in Ethiopia, solid waste management (SWM) services were majorly the responsibilities of the municipalities, which resulted in inadequate service provision. Bahir Dar is among the major cities located at north-western Ethiopia in which the city primarily starts solid waste collection service by organizing Micro and Small Enterprises (MSEs). The focus of this study is hence to explore the environmental sustainability of solid waste collection and transport services by MSEs in Bahir Dar. The study assessed the environmental sustainability of waste collection and transport services of MSEs using indicators based on sustainable or integrated solid waste management frame work. Based on the assessment, the service is constrained by several factors and not environmentally sound or sustainable. This is because, absence of environmental policy, no waste separation at source which impacts reuse and recycling, waste is not timely collected and transported which can create favourable conditions for the breeding of microorganism's and pollution. The waste storage materials are not water proof and closed (rather exposed to rain and sun) which has resulted in bad odour and affects workers health. Moreover, since the waste transport vehicles are of a general purpose type, they are not convenient for loading and very risky for the health of MSEs workers and highly impedes the waste collection service. The collected waste is not safely disposed in the final dumping site which is not well protected; has no fence or any sound management options like regular compaction and sanitary land fill.
Keywords: Sustainable solid waste management, Microenterprises (MSEs), solid waste

1 INTRODUCTION

Population in urban areas is increasing at alarming rate, parallel most cities' waste quantity is increasing rapidly; an enormous volume of waste is generated every day and as a result it is impossible to solve this problem by the local governments alone. Previous studies show that 1.3 billion tons of solid waste per year has been generated from global cities with an annual cost of $205.4 billion (Hoornweg, D. & Tata, P., 2012). This large amount of solid waste generation has become one of the serious challenges for environment and public health; particularly it is more serious in developing countries/continents like Africa (UNEP, 2004).

Many authors have shown that SWM is not an easy task because it is complicated by interwoven challenges particularly in less developed countries. This is basically due to a lack of functional, integrated and appropriate policies and processes, poor adapted strategy and technology, insufficient funding, a lack of proper sanitary land-fill, illegal dumping and a lack of people's awareness in integrated WMS (Coffey and Coad,2010; Marshall, R. & Farahbakhsh, K., 2013; Achankeng, 2003). Different countries employ different approaches to manage waste in order to prevent its impacts on the environment. Involving the community at large is the basic option to employ effective SWM. Especially for developing countries MSEs can be one of the methods which can play a vital role in achieving the active participation of the population as a solution for problems associated with solid waste (Scheinberg, 2001).

Ethiopia has started to organize and participate MSEs in solid waste management activities. Bahir Dar is among the major cities located at north-western Ethiopia in which the city primarily starts solid waste collection service by MSEs and this study is focused on it. The city has almost 220,344 inhabitants including rural areas. The quantity of solid waste in Bahir Dar continues to increase and becomes unmanageable to the local government. According to Bahir Dar City (2010) solid waste characterization and quantification report, the Municipal solid waste composition generation rate in daily total tonnage is that from residential (54 tons/day), commercial (24.2), institutional (17) and from street sweeping (3.56) a total of 98.8 tons per day. Therefore, it is important to investigate the environmental sustainability of the service delivery through MSEs so as to solve the obstacles facing with regard to the waste management system of the city, to promote environmentally safe guard experiences and to indicate government mechanisms to support or stimulate sustainable service delivery of MSEs. The overall objective of this research was hence to explore the environmental sustainability of waste collection and transport services by MSEs in Bahir Dar and to propose possible solutions based on identified constraints.

2 MATERIALS AND METHODS

2.1 Literature review and developing conceptual frame work for the study

The conceptual frame work of this study was developed by reviewing the fundamental concepts of the integrated waste management frame work from which the study majorly focuses on the environmental suistanaibiliy of solid waste system elements of collection and transport, with MSEs as service providers in Bahir Dar city, the local government of the city as facilitator and citizens in the city as service users. The conceptual frame work is summarized in figure 1 below.

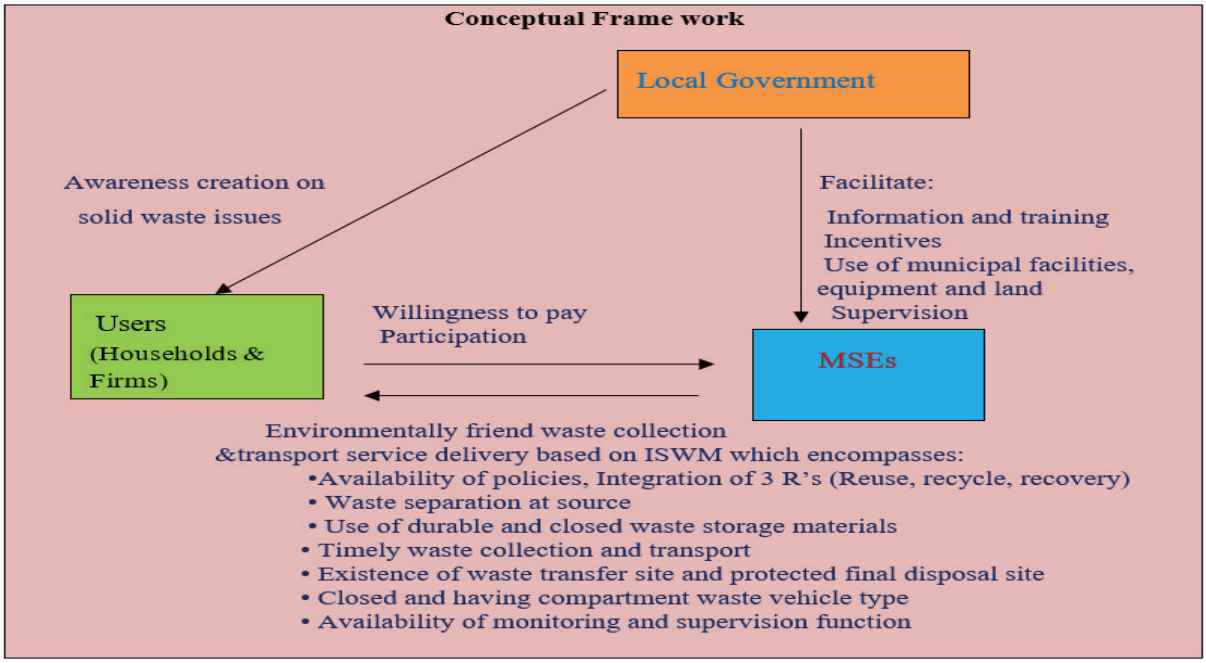

Figure 1: Conceptual frame work for sustainable MSEs solid waste collection &transport service delivery
Source: Developed by the Author based on ISWM frame work

2.2 Determining Study population and Sampling Techniques

The study area which is Bahir Dar city has 9 urban kebeles. In the city, 4 MSEs have started solid waste collection services. These MSEs deliver solid waste collection services through division of kebeles in equal proportion. From the 4 MSEs, 2 MSEs (Green vision MSE and Vision MSE) were randomly selected to collect data. In order to get better insight, 2 sample kebeles were also randomly selected from each of the 2 sample MSEs working area.

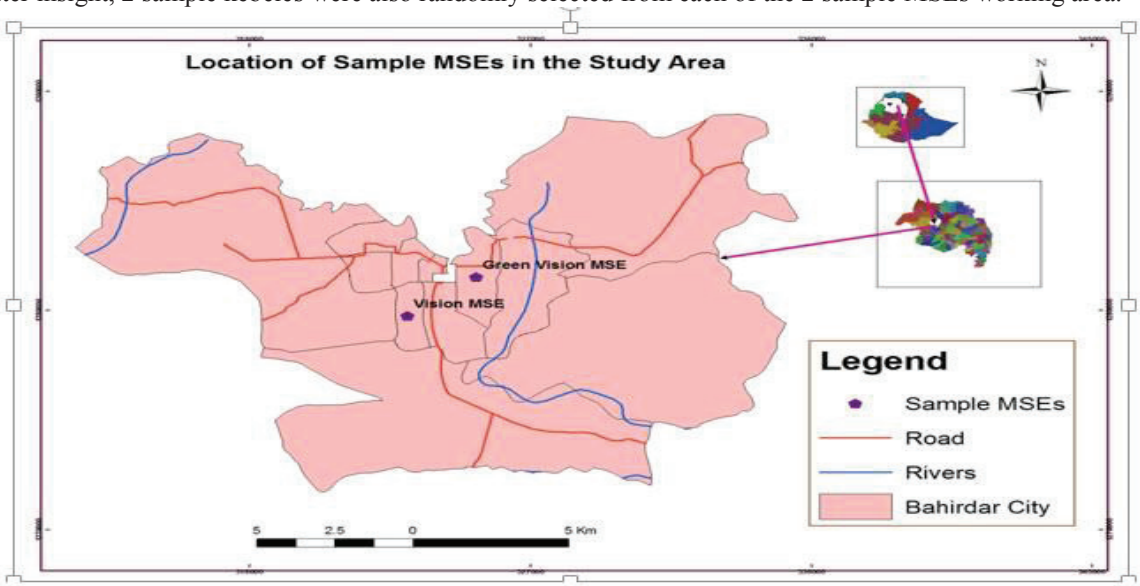

Figure 2: Location of sample MSEs in Bahir Dar

The main respondents were the MSEs managers and solid waste collection workers of MSEs, users and local government staffs including concerned experts. The selection of solid waste MSEs workers is done through a

convenience sampling technique. From each of the 2 sample MSEs 50 waste collection workers, that are 100 workers in total, were selected to collect data.

The selection of users for focus discussion was through purposive sampling technique. From each of the 2 sample kebeles (MSEs working area) 10 users per kebele, in total 20 users were selected for group discussion. Besides purposive sampling was also used to select 3 respondents from government officials and 2 from MSEs managers. Totally, from 125 respondents data was collected.

2.3 Data collection and Analysis methods

Data was collected in the study area using questionnaires, interview, observation and focus group discussion (FGD).The quantitative data was analyzed using SPSS software. Excel sheets were also used to analyze the collected data types. The findings from the analysis are presented by using tables and charts. Qualitative type data's were analyzed through a number of steps. The data was grouped under different themes and combining the themes in to larger categories. Having broader categories of themes helps the researcher to undertake creation of links between relevant categories of data. Besides, narration of qualitatively analyzed data's was also employed.

2.4 Determining Variables and indicators

Prior to field work the author identified the variables to be measured for assessing the suistanaibiliy factors of the waste collection service of MSEs in the study area. Based on the reviewed literatures relevant indicators were also identified. The research question with operationalized variables, indicators, data sources and analysis methods are summarized in table 1 below.

Table 1: Operationalization of sustainability variables and indicators with respective data sources & analysis

Environmental sustainability Factors of Waste collection and Transport Activity			
sub variables	**Indicators**	**Data source**	**Data analysis**
Integration of 3Rs	Environmental policies that enforces & promote 3 R's	Interview with Municipality & MSEs, Questionnaires	Qualitative/ quantitative
	MSEs practices towards the 3 R's (Collecting recycling materials, composting)	Interview,Questionnaires Observation	Qualitative/ quantitative
Frequency of waste collection &Transport	Time length of waste collection (days, weeks)	Interview,Questionnaires, Observation	Qualitative /quantitative
	Availability of sufficient waste transport vehicles		
Proper handling of waste by users(waste segregation)	waste separation at source & different storage bins	Interview, Questionnaires, Observation	Qualitative /quantitative
	Use of durable & closed storage material	Interview,Questionnaires, Observation, FGD users	Qualitative /quantitative
Safe collection & disposal of waste	Waste workers safety:(availability of protective cloths & regularly using of the cloths, medical check-up)	Interview	
	Use of closed type & having compartment containers in waste transport vehicles	Interview,Observation	Qualitative
	Availability of waste transfer sites	Interview, Observation	Qualitative
	Properly protected final disposal site (Ex. Fenced, compacted & lined with clay so as to prevent leachate effect)	Interview,Observation	Qualitative
Revenue generating mechanisms	Cost recovery mechanisms, incentives, credit access	Interview,Observation	Qualitative/ quanitative
Monitoring system	Availability of monitoring & supervision function	Interview, Observation	Qualitative

3 RESULT AND DISCUSSION

3.1 Environmental sustainability factors

3.1.1 Availability of environmental policies and enforcement mechanisms

The existence of environmental policies that guide activities of waste in line with the 3Rs is very crucial for the environment as well as to use waste materials for economic purpose. According to interview conducted with Mr. Getachew (regional environmental protection core process representative) there is no environmental policy particularly for the region (in the study area) but there is an environmental policy and the SWM proclamation at country level that advocates and emphasises for these 3Rs. However, according to the data analysed from respondents indicated that respectively 33% and 67% of the respondents replied the existence of these policies

have very low and low supportive functions with regard to waste management.

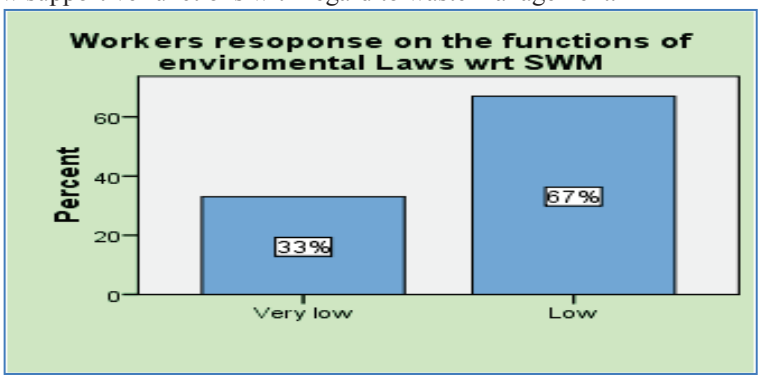

Figure 3: Workers response on the supportive functions of existing environmental laws

3.1.2 Availability of Monitoring and supervision function

According to Haan, Coad &Lardinois (1998), when enterprises are involved in delivering SWM services, at least four groups of supervisors should be organized from Municipality staff, independent inspectors, MSE supervisor and beneficiaries. However, the research findings in this study area revealed that 58% of the respondents have not been even supervised by the Municipality, others 29% and 13% of the respondents replied that there has been very rarely and sometimes supervisory function by the Municipality respectively.

3.1.3 Waste separation at source and conducting separate collection

The impact of waste on the environment will lessen and economic value of waste can increase if it is segregated at source and stored in separate storage materials. But based on workers day to day observation, the study findings indicated that 78% of the respondents replied that users have stored their waste without separation and 22% of the respondents confirm that users waste has been poorly handled/dispersed (see figure 4 below).

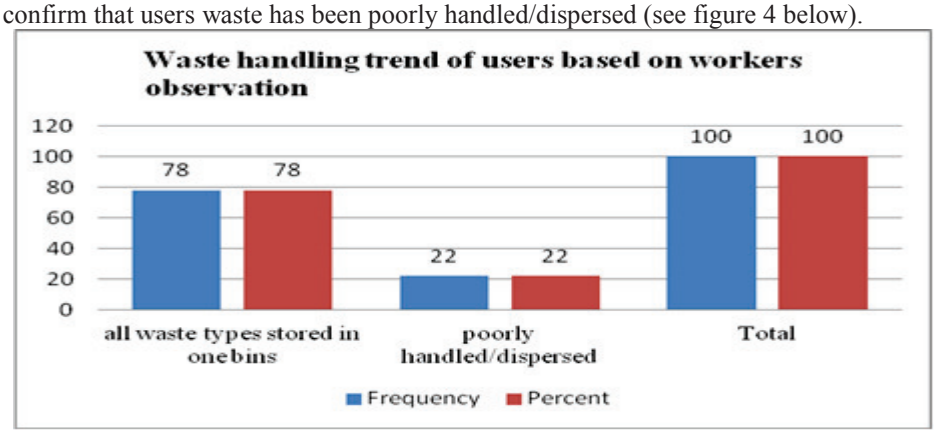

Figure 4: Waste handling trend of users based on workers observation

3.1.4 MSEs Practices towards the 3 R's

According to Moreno, Rios & Lardinois (1999), to make MSEs service environmentally sustainable, the MSEs have to implement and gear their activities towards environmentally sound practices. In this case, an important composting practice has been started by one of the sample MSEs (Green vision MSE). Since this MSE has small farm (supported from Municipality) workers have been using the compost for their fruit farm. However, according to the managers of Green vision MSE since the MSE have not their own trucks, it has been difficult to transport waste for this purpose (composting) and this limits the amount of compost to be produced. The second sample MSE (Vision MSE) is still practicing a collecting and dumping approach.

Another important observation was that MSEs workers have started to collect some recyclable materials like plastics and metallic substances. The data analysed from both MSEs respondents reveals that 42% of the respondents has been collecting those materials individually while doing their regular waste collection service.

Table 2: The response of waste workers about the collection of recyclable materials

The response of waste workers about the collection of recyclable materials					
		Frequency	Percent	Valid Percent	
Valid	Yes	42	42	42	
	No	58	58	58	
	Total	100	100	100	

However, according to the workers, since there is no separation of waste at source by the users, they have faced great difficulties to get the usable materials after the waste has been mixed.

3.1.5 Use of durable & closed storage materials by users

According to the data analysed from waste collector's observation, the widely used waste storage materials of households are sacks (89%) and card boxes (11%), which are water porous materials during the rainy season. No respondents replied the availability of plastics and metallic storages. Unfortunately this investigation was conducted during rainy season and the respondents of waste collectors said that "since the storage materials used by users are open, exposed to rain and easily permeable to water, it highly increases the weight of waste. Besides, the addition of moisture (rain water) in the waste creates a bad smell which seriously affects our health. It has exposed us for coughing and asthmatic diseases."

3.1.6 Frequency of waste collection

As Coffey & Coad, 2010 waste should be collected more frequently, at least twice a week to avoid unpleasant air pollution. The frequency of waste collection from sample respondents revealed that 46% of the respondents have been collecting users waste in two weeks interval. While respectively 37%, 3% and 14% of the respondents has conducted waste collection service once a week, twice a week and daily.

Table 3: Workers response on the frequency of waste collection schedule

Workers response on the frequency of waste collection schedule		Count		
		Name of MSEs		Total
		Green Vision MSE	Vision MSE	
Workers response on the frequency of waste collection schedule	Daily	8	6	14
	Twice a week	3	0	3
	Once a week	37	0	37
	Every two weeks & above	2	44	46
Total		50	50	100

According to FGD held with users the frequency of waste collection was their main issue as it is not satisfactory. Users complain the service because of their waste has not been collected on time. The participants said that "We are already paying for the service but the problem is the collectors have come once in two weeks and sometimes they have come in three weeks interval" which is disappointing.

Further one of the waste collectors explains as follows:

> *"There are big hotels where we have collected their waste daily. The problem is very serious during Saturday and Sunday since the offices are closed and the driver of the truck is also not available on these days. At this time we have faced a great challenge where to put the collected waste from hotels. When we tried to store somewhere until Monday, few illegal scavengers have scattered the waste on the asphalt during night. This creates additional burden on us since the dispersed waste has to be collected again". (MSE waste collector).*

3.1.7 Availability of waste transfer site

The study findings show that there is no temporary transfer site prior to final disposal and instead the MSEs workers simply collect in any free space until the waste is transported to its final disposal site. The problem is when the vehicles are not available; the waste may stay there for a week resulting in unpleasant smelling around the area. According to the interview held with the two MSE managers this causes a consequent or even conflict between waste workers and inhabitants of the area. As per site observation workers have collected the waste from users and stored almost on the foot path (exposed to rain and sun), which is really creating difficulties for the people to pass along the road. This is because no specific site or temporary stations are delineated in the city to collect the waste until its final disposal.

Photograph 1: waste collected on the foot path

Source: author field observation

Coffey & Coad (2010) suggested that specifying and implementing an adequate number of small transfer stations is more useful than a single large one. Improper transfer arrangements can cause inefficiencies and scattered waste. In the research area there are no large and small transfer sites. Rather waste is collected in any free space and leads to bad smelling in the area as well as a conflict between collectors and inhabitants.

3.1.8 Waste vehicles Type & its convenience for loading

The existence of compartment containers in the vehicle is helpful for separate collection and transport Hoornweg & Tata (2012). Based on field observation the trucks that are currently used to transport waste do not have separate containers. They are general purpose trucks which transport and dump all types of waste materials together. In addition, they are not convenient for workers during loading since not Lift dump trucks. Workers are loading with the waste (See the picture below).

Photograph 2: Vision MSE workers while loading waste on General purpose truck

The study conducted by Hoornweg & Tata (2012) justified that using general purpose vehicles for waste service is a great mistake since they are inefficient. More similarly, the study findings of this research in Bahir Dar indicated that the MSEs are still using the general purpose trucks and they are not conducive for the waste workers during loading; transport and to separate the waste. Vehicles are open types without any cover, this will lead to dropping of waste during transportation. While, Moreno, Rios & Lardinois (1999) findings in Guatemala showed that 30% of the waste transport trucks are closed vehicles. This technology responds to lessen the health risks to the workers.

3.1.9 Waste workers safety

Waste workers safety is another decisive factor. Workers should have enough protective equipment like foot wear, gloves and masks for safety. Based on workers responses in the sample area, 92% have protective clothing while the remaining 8% have no protective clothing.

Table 4: Workers response on availability of protective clothing

Workers response on availability of protective clothing			
		Frequency	Valid Percent
	Yes	92	92
	No	8	8
	Total	100	100

Though a large number of the respondents have responded that they have safety clothes, the author (during

field study) observed that a considerable number of waste workers were actively engaged without wearing even hand-gloves.

Photograph 3: Waste workers without hand Gloves during waste collection

The author observed that from the above three waste workers, only the lady one wear hand gloves, the remaining two workers did not use gloves. Further investigations on the safety of workers indicated that 36% of the respondents have faced either contact with hazardous materials or injury while rendering the waste collection service.

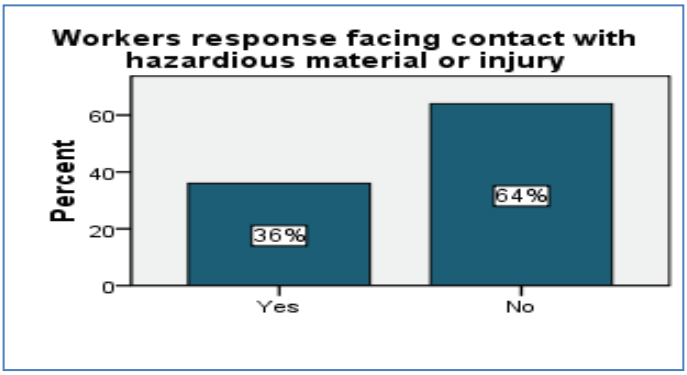

Figure 5: Workers response on facing contact with hazardous material or injury during waste collection

Quotes from MSEs workers:

"Since there is no waste separation at source, hidden materials like broken bottles and needles highly injured our hands even through penetrating the glove during collection. Besides, especially the hand gloves are worn out frequently since it has high load on it, at this time there is no fast response on supplying the glove and sometimes we decided to buy gloves from our own pocket." (Interview with Waste worker)

"The problem is further aggravated by the absence of any medical support for the workers.
During door to door collection for instance, one of our friends was bitten by someone's dog and she has been treated at her own expense with a great problem.
Some of us have families, if we have faced a health problem and stay at home without work, the whole family will be endangered. Hence, our health care should be considered."

Photograph 4: personal interview with waste worker

As per UN-Habitat (2010), sound waste management contributes a lot to the healthiness of the inhabitants as well as workers involved in waste collection. But the findings in the study area show that there is no medical check-up or support for waste collectors and they face contact with hazardous materials or injuries.

3.1.10 Availability of proper final disposal site

According to UN-Habitat (2010) a final waste disposal site should be properly selected and fenced so as to protect the entrance of stray animals and to reduce the impact of waste on the surrounding environment as a whole.

In the study area, the final dumping site is not well protected, it has no fence and compaction. During field observations animals like cattle simply entered to the disposal site and according to inhabitants their cattle and sheep are affected by plastics while grazing. Due to this impact, farmers around the area highly complain over the site.

Photograph 5: Dumping site of the study area without any protective measure (fence)

Source: author field observation

3.1.11 Cost recovery and revenue generating mechanisms

According to Moreno, Rios & Lardinois (1999), the MSEs can be sustainable since they could support themselves with the payment received from citizens and covering the cost of the service. However in the study area the MSEs financial contract with the Municipality is very minimum and highly limited for salary of workers.

The service payment of the MSEs is calculated and paid from the Municipality based on workers salary with very little administration budget. According to the manager of Vision MSE there are 71 workers in their MSE; out of these 5 management bodies have a monthly salary of 1500.00 Ethiopia birr ($ 88.25 US dollar) and the remaining 66 workers have a monthly salary of 500.00 Ethiopia birr ($ 29.40 US dollar).

Then, the total contract budget released from the Municipality to MSEs service payment will be 5*1500.00+ 66*500.00 = 40,500.00 Ethiopia birr or $ 2382.35 in US dollar (which is for the monthly salary of the workers); and only 5000.00 Ethiopia birr or $292.15 in US dollar for administrative costs like for maintenance of hand carts, to buy hand gloves, telephone expense, etc. This shows that almost their total budget is not more than salary.

The same financial contract system (service payment) has also been applied to Green vision MSE. The absence of any revenue mechanism other than this fixed service payment from the Municipality is another challenge for MSEs development. The findings from both MSEs respondents indicated that from the total 100 respondent's waste workers, 93 respondents are not satisfied due to very low payment rate.

Based on the interview conducted with the two sample MSES Managers there is no financial incentive except covering the cost of fuel and salary of the vehicle driver (the driver is employed in the Municipality). Besides, due to long bureaucracy of the financial institutions they did not still get financial credit.

On the other hand (as per the interview conducted with the managers of MSEs) many people who live in rented housing still do not pay for the service. Some individuals have even more than 15 dormitories, and are considered as a single household or user and pay same rate as a single household. Besides there is no extra payment system when users generate more waste on special days like ceremonies.

The Green vision MSE managers said "The existing payment of workers is very minimum as compared to the challenge that we have faced. If the payment is improved, the workers are interested and committed to the work."

> *"We have delivered the service in a condition that a kind of worm from the waste drops on our body; we are doing this because we have convinced ourselves for the work. And believing and hoping that the payment will be improved, but not yet; while the living cost has been increased."(Waste worker, July, 2013)*

4 CONCLUSION

The environmental sustainability of the service is highly influenced or affected by a number of factors. Mainly, a serious shortage of waste transport vehicles which has a great impact on the frequency of waste collection, poorly designed waste vehicles, absence of waste separation at source, unsafe waste collection and disposal methods which still relays on a collecting and dumping approach, insufficient funding systems, inadequate monitoring and

supervision and low enforcement of rules to implement activities as per the local context. Because of these challenges the current waste service delivery of MSEs is environmentally unsustainable. But this does not mean that the service delivery of MSEs cannot be improved. In order to improve and make the enterprises service delivery more environmentally compatible and sustainable in the future the following recommendations are proposed.

There should be an environmental policy /law which guides and enforces activities in line with ecological sustainability. Since it is a prerequisite for the whole range of activities, the existing federal environmental law should be broken down in to a regional law so as to implement according to the local context.

The city administration in collaboration with the MSEs workers should encourage and promote waste separation at source. The Municipality should have a plan in the short run to minimize the current impact of the final dumping site at least through enclosing/fencing the site and regular compaction. In the long run, the local government have to take joint actions with interested stakeholders (NGOs) on finding long term measures and funding possibilities in order to upgrade the final dumping site to sanitary land fill. The Municipality should monitor and supervise regularly whether the waste is safely managed or collected by the MSEs. The provision of convenience waste transport vehicle should be given priority in order to deliver frequent waste collection service.

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