Strategic Factor Analysis of Solid Waste Management in Southwestern Ethiopia: The Case of Jimma Metropolitan City

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ABSTRACT

Background: *Solid waste management is a cosmopolitan environmental problem confronting humanities and metropolitan authorities by contributing 80% of all diseases and related mortality. With mean annual growth of 5.54%, Ethiopia is fostering a highest urban population growth rate in Africa. In contrast, there is low commitment in managing urban environmental issues. Consequently, Solid waste disposal is an important environmental and area of concern since information is barely available in the study area.*

Objective: *To measure solid waste management by using IFAS-EFAS-SFAS matrix, and explore how the system is organized*

Method: *descriptive cross-sectional surveys were conducted at household level where respondents were selected by using multistage-mixed sampling technique. Then IFAS-EFAS-SFAS analytical tool and interview schedule was employed to take data on advantage of existing opportunities and menaces towards minimizing weaknesses and threats.*

Result: *IFAS-EFAS-SFAS matrix showed strength and weaknesses of 1.16 and -1.42, respectively; with a difference of -0.26. Similarly, summary of opportunity and threats was 1.33 and 1.35 respectively; with a difference of -0.2. The overall result indicated; solid waste management was at inferior efficiency. Congruently, females were more committed to dispose of solid wastes than their counterparts at 10% significant level. Households with large number of female households were also better off in managing solid wastes. Regardless of economic status, better educational entitlement facilitated willingness to pay. Distance from main road brought significant effect on solid waste management. Private collectors didn't have adequate facilities to serve each household; and therefore, households at distant location to waste collecting bins were disposing their wastes in illegal sites.*

Conclusion and Recommendation*: Participatory institutional support should be in place to ensure sustainable solid waste management. Similarly, further decentralization should be in place to empower local administrations since households were willing to pay if they got services, and community-based organizations should take part in service deliveries. Environmental NGOs should also play role in solving waste management issues by capping landfills and capacitating pre-collectors.*

Key words: *EFAS-IFAS-SFAS, Household, Jimma, Solid Waste*

1. INTRODUCTION

1.1. Background and Justification

Solid waste disposal is one of the major environmental problems confronting humanities and municipal authorities. It is an important challenge and area of concern in the era of increasing population and rapid urbanization (Gallardo *et al*., 2015; Minoglou and Komilis, 2013). The problem is often magnified in cities where dense concentration of people is generating substantial amount of solid wastes; causing a heap of 1.3 billion tons of solid waste, and resulting in to annual cost of 205.4 billion USD (Wagner and Bilitewski, 2009; Zerbock, 2003). Inappropriate dumping in illegal sites has aggravated spread of anthropogenic diseases and in turn has accounted for 80% of all diseases and related mortality (Bayu and Mahlet, 2011; Kebede, 2004).

According to UNEP (2016), poor urban waste management accounted to five percent of total global greenhouse gas emissions and 12 percent of world's methane emissions (i.e. greenhouse gas that is affecting more than 20 times than that of carbon dioxide). Thus, solid waste management is a global problem demanding full and continuing coordination between different stakeholders of scientists, economists, technicians, politicians, private organizations and citizens (Ramachandra and Bachamanda, 2007; UN-Habitat, 2010). Events of 21st century indicated wastes have become a major consequence of modernization and economic development (WoldeGiorgis, 2002). However, in the quest for 'Western-styled' development, developing countries didn't budget enough for managing solid wastes. As a result, cities are suffering from solid wastes, inadequate water supply, sanitation and air pollution (Pacione, 2005; Pokhrel and Viraraghavan, 2005). The problems have disproportionately affected the urban poor than rural ones (Bartone, 2000; Jeswani and Smith, 2003).

Rate of urbanization in Africa, which is estimated at 3.5% per annum, is highest compared to developed and developing nations who exhibited average urban population growth of 0.5 and 2.6 percent, respectively. In spite of this rapid urban growth, there seems to be a mismatch in managing urban environmental issues (Bayu and Mahlet, 2011). This is also true in Ethiopia, where influx of people is moving to urban centres with a projected urban growth rate of 4.79%. This growth is the highest amongst most developing countries (Montgomery, 2008; World Bank, 2019). Hence, solid waste management in Ethiopia is getting better attention in last few years. Nevertheless, the efforts, environmental and public health challenges are increasing (UNEP, 2016).

Despite the challenges, there was limited information that describes the actual practice of solid wastes handling in the study areas. Similarly, technical knowhow, financial capacity, culture, and understanding of community are not well studied to forward preventive measure and remedial actions on solid wastes. Therefore, this research is conducted to fill the gap on households' solid waste disposal alternatives, and context specific factors of the study area.

1.2. Problem Statement

Reliable waste management data provides an all-inclusive resource for comprehensive, critical and informative evaluation of waste management options in all waste management programs

(Chang and Davila, 2008). Data on municipal solid waste generation and composition are available in few selected cities, most of which are over a decade old. Solid waste is not well managed since people dispose garbage wherever possible and this led to huge environmental pollution deteriorating the health of humankind and other living beings. Due to lack of knowledge of disposing wastages, people trash the garbage in a way they want. The information on amount of waste collected and segregated by the informal waste workers has not been shared to the public, and nor the government has its record. As a result, they are mistreated and their role is undermined despite the fact that they are actually cleaning Jimma city. Despite increasing population and rate of urbanization, technology, technical knowhow, financial capacity, culture and understanding of the community are not well identified. With more and more people moving to Jimma city, the waste management sector is suffering from dearth of information. As *Awetu* River is running through Jimma and its skirts, there is temptation to use water bodies as quick and easy waste removal solution. However, their consequence is not well identified. Despite immensity of the problem, very little research has been carried out on subject in Jimma City.

1.3. Objective of the Study

1.3.1. General objective

The general objective of this study is to analyse determinants of solid waste management practices at household level in Jimma City

1.3.2. Objective of the Study

- To measure current solid waste management by using IFAS-EFAS-SFAS matrix
- To explore how waste management system is organized in the study area

2. MATERIALS AND METHODS

2.1. Description of the study area

Jimma is one of the oldest modern cities in south-western Ethiopia, which is recently recovering from its deep sleep. As the city is experiencing rapid urbanization, waste generation is flattering to leave piles of solid wastes along roads, drainage channels and open spaces. Yet, the amount, type and composition of generated waste were unknown. Therefore, characterization of waste stream and its generation rate per capita is not well known. Accordingly, this research is intended to fill current literature gap on solid waste management in Jimma city.

Jimma city is one of the special zones of Oromia Regional States, which is surrounded by Jimma Zone. The city has 17 Kebele[1] Administrations with population size of 205,163. Among this total population, 49.72% are female and the rest are male. The average number of persons per household in Jimma city was 4.8 person/HH (JZHD, 2018). With an area of 50.52 square kilometers, Jimma city is geographically located with latitude and longitude of 7°40′N and 36°50′E. During 19th century, the city owed its importance in as a caravan route between Shewa and Kingdom of Kaffa, and Jimma.

2.2. Study design

[1] Kebele Administration is smallest division of local government structure

2.2.1. Sampling Procedure and Sample size

Multistage-mixed sampling technique was employed to select sample respondents from the total population. But, at first stage, purposive sampling is employed to select Jimma City, since Jimma is one of the largest cities in south-western Ethiopia. Then by using simple random sampling, four Kebele Administrations: namely '*Bosa Kito' and 'Hirmata'* are selected from Woreda 1; and *Mentina'*, and *'Mendara Kochi'* were selected from Woreda 2, respectively. Subsequently, by using Cochran sample size determination formula, the sample size is resolved with 90 percent confidence level.

Cochran Sample size determination formula

$n = \frac{N}{1+Ne^2}$ Where n= required sample size

N= Total population size (205,165 i.e. total population size of Jimma city)

e= margin of error (i.e. 10% tolerable error for selection)

$= \frac{205,165}{1+205,165\ (0.01)^2} = \mathbf{99}$ This made up the total sample number of actual respondents, 99

Subsequently, by using probability proportional to size, proportional sample size for each Kebele was set accordingly. As result, 28, 18,22 and 31 Households selected from *'Bosa Kito'*, 'Hirmata', *'Mentina'*, and '*Mendara Kochi'* KAs, respectively. Then by using sampling frame collected from each Kebele Administrations, sampling interval was determined where n^{th} term signified the actual participating household respondent.

2.2.2. Data Collection procedure

Data Collection for Obj. 1

A preliminary survey was first conducted before exploratory survey to develop a workable hypothesis. For this, three focus group discussions were held with 19 group members. Similarly, 18 key informants were interviewed by using open-ended checklists; and these were composed of two municipality officials; three Kebele administrations, five pre-collectors, three pre-collecting crewmembers, three *korealwes* and 2 *Luwachs*.

Then a semi-structured interview schedule is prepared to obtain information from selected households. But, before the formal survey, pre-testing was made to ascertain reaction of respondents and to revise lists of important issues that had not been left out. The pre-testing has also given opportunity for certain pertinent issues, which would have been missed in draft interview schedule. Then, the interview schedule was modified accordingly to serve the purpose.

Data Collection for Obj. 2 (IFAS-EFAS-SFAS analysis)

Data were collected from FGD participants by using questionnaires; and then analysis is done through qualitative approach to diagnose strengths, weaknesses, opportunities and threats on solid waste management. Subsequently six important items were abstracted for each section i.e. strength, weaknesses, opportunity and threats for IFAS-EFAS matrix through pairwise ranking.

2.3. Method of Data Analysis

2.3.1. Analysis of objective 1

Statistical Package for Social Sciences (SPSS) Version 20 was used to determine Chi-square, t-test and Pearson correlation to test respondents' level of awareness, knowledge and practices

on solid waste management. Descriptive statistics of frequency, percentage, mean and standard deviation. The data were processed into statistical tables and charts for interpretation and discussion. Data analyse were disaggregated into various classes of residential areas in the Metropolis (Afon and Okewole, 2007). Statistical analysis of relationship between waste generation rate, household income, waste generation and household size were performed using regression analysis.

2.3.2. Analysis for obj. 2 (IFAS-EFAS-SFAS analysis)

IFAS-EFAS-SFAS analytical matrix is adopted to disclose preliminary decision of maximizing strengths and opportunities; to minimize threats and to turn weaknesses into strength towards taking advantage of existing opportunities and minimizing weaknesses and threats.

IFAS-EFAS-SFAS matrix represents table with appropriate factors (external or internal) which will be listed in first column; and other columns will contain weights assigned to factors (ranging from zero to 1; where sum of all weights should equal to one). Similarly, rating of each factor will be assigned basing on efficiency of solid waste management response. For each factor, weighted score is calculated by multiplying rate by weight. Sum of all weighted scores represented value showing how well solid management is operating in its internal or external environment. This value will range from one to three, with 3 being very important, and 1 and 2 were important and 2=important, respectively (Hunger and Wheelen, 2007).

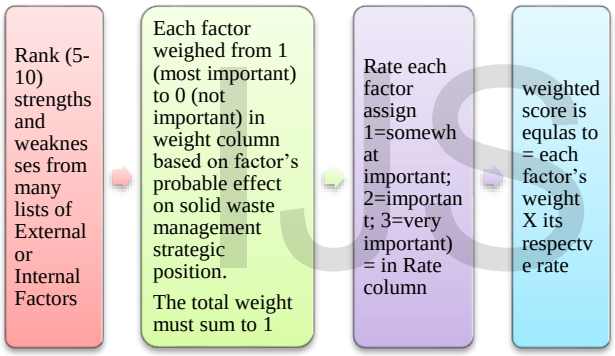

Figure 1. Summary of Steps in analysis of IFAS-EFAS evaluation

3. RESULT

3.1. Demographic Characteristics

Demographic analysis which was concerned with family size, age, sex composition and education exhibited the following different responses accordingly.

3.1.1. Age

Households age, which was a continuous variable measured in years, affected solid waste management significantly at 5 percent (Mean= 48.73 SD of 12.94). Similarly, the difference in household age was statistically significant at 5 percent (t=8.56, p=0.031). The larger households' standard deviation indicated that, the values in the data set were farther from the mean by $\pm$12.9 years of age; and the data set were not well concentrated around the mean i.e. 48.73 Years. As proxy measure of experience, older household heads (beyond 48 years of age) showed better awareness on waste management than older ones. A dependency ratio of 129.9 is reported where 100 economically active household groups supported 129 dependent households. The result indicated that, large proportion households were dependent on family labour to dispose of wastes. This implied that, the reality can create a wide opportunity of creating revenue generation for jobless youths from the sector. The result was in line to Bartone

(2000) and Kebede (2004) who reported most older households showed better attention for environment than the literate youngsters since they consider solid waste management is not the sole responsibility of municipalities, but it should be shared by the community and community based organizations at large.

3.1.2. Sex of Respondents

Females were committed to clean their houses and dispose of solid wastes than their counterparts do (26.8%). This result was well supported by chi-square outcome, which showed female-headed households were more involved in solid waste management practices at 10% significant level. Similarly, households with large number of female households were better off in Managing Solid Wastes. The association between solid waste management practices and sex was positive and significant ($r = 0.149$, $p < 0.05$).

This result agrees with Cleaver (1993) and Pokhrel and Viraraghavan (2005) who lamented female residents showed positive concern for solid waste management practices than their counterparts. This was plausible because most female households in developing countries perform cleaning and sweeping by themselves. Correspondingly, females were customarily considered as part of the household for such household activities than their counterparts were.

Table 1. Demographic characteristics in the study areas

Characteristics	**Total (N=99)**			
	Mean	**SD**	**t-test**	**P value**
Age of HHH	48.73	12.94	8.56	0.031**
Family size (no.)	7.34	5.42	5.63	0.076*
Experience	6.74	8.45	-25.60	0.002 ***
Education level	**MHH (N=73)**	**FHH (N=26)**		
Illiterate	7.56	24.32	15.94	p=0.003***
Read and write	25.82	39.26	32.54	$\chi 2$=15.952
Primary school	36.97	21.55	29.26	
Post primary	29.65	14.87	22.26	
Total	100	100	100	

*** Significant at 5% ($P \leq 0.05$), ** Significant at 5% ($P \leq 0.05$), * Significant at 10% ($P \leq 0.1$);
Source: Computed from the field survey data

3.1.3. Educational Position

About 7.56 percent of households were illiterate leaving the rest to literates, who were composed of 25.82%; 36.97 and 26.65 percent with elementary, high school and tertiary school education entitlements, respectively. Correspondingly, positive and strong relationship of educational privilege had supported solid wastes management at household level.

This result was in accordance with Solomon (2011) who stated education had significantly and positively affected quantity of milk marketed in Ethiopia. Cleaver (1993) also asserted educated households were more productive than uneducated ones, and educational status of farmers was positively related to their demand for new technologies. They also pointed-out literate households tends to pay better for waste disposal better than their counterparts do.

3.1.4. Family Size

With an average family size of 5.5, majority of sample respondents (79.02%) had less than the average family size of the study area. However, this average family size was higher than the National average; which is five. The result implied, better availability of active labour force.

However, this opportunity didn't help much since households were managing solid wastes in defectively manner when compared to households of smaller family size (4.38) who were dwelling best.

The result was in line to Wube (2015) who reported households with large family size paid more than others for solid waste management, as the former generated more solid wastes. The study by Wolday (1994) also showed household size had significant positive effect on quantity of waste generated.

3.2. Socio-Economic Characteristics of Respondents

3.2.1. Monthly Income of Households vs. Willingness to Pay

The study indicated 25.12% of respondents had better income (>1700 Eth. Birr/month i.e. 1.97 USD[2]/day), while 42.12 of respondents reported as they often collect a monthly income between 851 to 1700 Eth. Birr r (i.e. 1 to 1.97 USD per day). However, 32.76% of respondents were collecting a monthly income of <850 Br, which was less than one USD per day. Hence, the meagre monthly income of households deterred their willingness to pay for SWM delivery services.

However, the amount of money that beneficiaries paid for the services differed at large. Similarly, all households were price takers who were getting a door-to-door waste collection service with a flat fee price of 10 to 20 birr/ polyethylene bag/service. However, 76.4% of households didn't have bargaining power and 12.2% of households of them were willing but unable to pay for the services due to their lowest monthly income. But 11.4% of households refrained to pay for any waste collection services since they assumed waste collection is the sole responsibility of local administration.

Mazzanti *et al*., (2008) and Kassim and Ali (2006) argued that, there was a direct and negative correlation between income and municipal waste generation in Italy.

3.2.2. Waste generation by households

Despite increasing solid waste generation, Jimma municipality collected 19.19% of generated waste; which is below the national average (21.6%). Yet, the rest 17.23; 13.24 and 9.52% solid waste were casted off at open spaces, nearby collecting bins, and by roadsides, respectively. Similarly, open burning wastes was also one of the disposal systems for 5 percent of households. In addition, 6.27% of households dumped solid waste by riversides.

About 80.81% of respondents claimed that the city's solid waste was not properly managed by the municipality. Hence, they argue efficiency of solid waste management by is so weak compared to the National Average, which is 21.6 per cent (Birke, 1999). As a result, it was common to see piles of wastes, smelly gutters, polluted streams, and choked gutters stink. This implied that there was a growing concern on impact of public health and the environment.

[2] 1USD=28.6969 Ethiopian Birr March 15, 2019

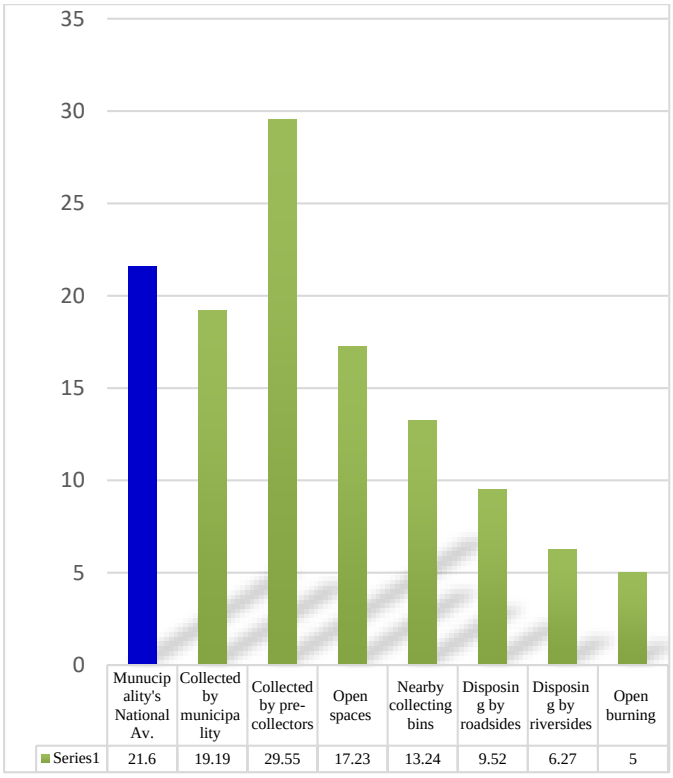

Figure 2. Waste collection by participants and disposal site
Source: Computed from the field survey data

3.2.3. Awareness of Households on Solid Waste Collection

The analysis showed 92% of respondents have agreed that, clean and healthy environment is vital for life. This indicated they have better knowledge to safe and clean environment. However, 74.99 % of respondents of respondents were not interested to participate in SWM training. This was because, 35% of them thought their educational background that they already have is better to understand about the subject matter, and 15% of respondents reported, they don't have time to participate. Similarly, 12% of respondent were unwilling to participate in training due to language barrier and the rest reported; they are not totally interested to take part in such training 38%.

3.2.4. Source Reduction and Reuse

Exchanging and selling of old clothing, fabric scraps and electronics were familiar source reduction activities where 4.03% of used materials were donated for the neediest. Similarly, 28.29% of respondents had reused durable containers like bottles, boxes and bags. About 22.13% '*Luwachs'* were important source reductionists since they bartered clothing and shoes with new household utensils. Similarly, using papers for soft tissue were popular reusing method for 20.12% of households. Similarly papers and plastics were used as igniting material to catch fire by 13.67% of respondents. Likewise, selling of casted-off materials for '*Koralews'* was also accustomed by 10.76 % of households.

This result agrees with Gaurav (2014) and USEPA (2009) who reported segregation at source is completely missing. Similarly, and Sufian and Bala (2007) reported special care for site selection, refuse compaction, cover application, leachate collection and treatment, and site monitoring were prerequisites at ultimate waste disposal sites.

3.2.5. Valorization Chain of Households' solid waste management in Jimma

About 74.7% of households responded, they never tried to collect garbage scattered anywhere in the town, because 45.28% of them thought that was the responsibility of SWM service, while 29.92 and 34.10% of respondents said they were not aware of the problem and by the time they saw the garbage, they may not get sufficient material to collect the garbage.

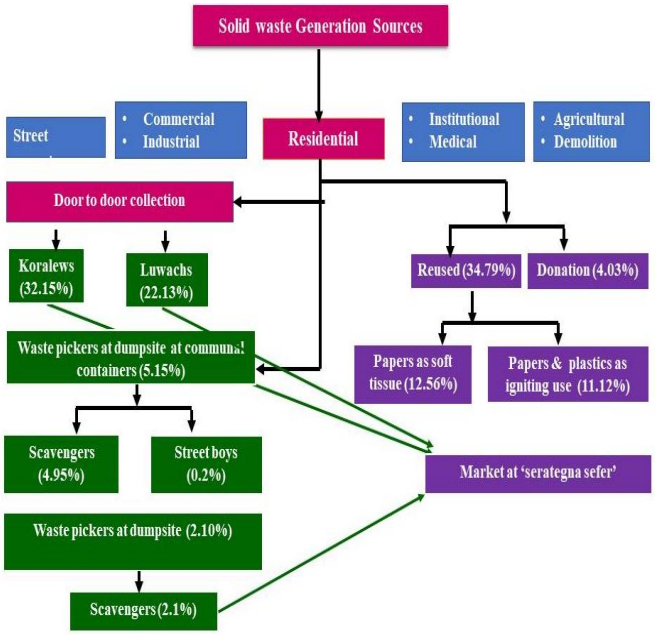

Figure 4. Valorization chain of Household solid waste management, Jimma City
Source: Computed from the field survey data

3.3. Institutional Characteristics

3.3.1. Waste Collecting Materials and Facilities

About 42.32% of respondents replied the available number of storage bins were few in number; while 75.27% of them reported the collecting-bins were kept far apart. As a result, the waste is always seen spilled over and scattered around the bins.

3.3.2. Accessibility to Roads

Households which were residing in 100-meter radius form main road accessed pre-collecting delivery services (65.38%) better than those who were living in radius of 100-500 meters (24.46%) and far off (10.16%). The chi-square result showed significant but negative relationship at 1% level. As a result, the highest the distance in meter, the lower was the chance of getting easy access to pre-collecting delivery services. Similarly, 68.65% households who were residing on smoothest road have accessed pre-collecting services better than their counterparts did. This was due to pre-collectors were not motivated to reach households if they are residing in farthest and roughest roadside. As result, pre-collectors were not able to push their carts to farthest distance and rugged roads since it requires their extra human labour and costs to repair carts in case of breakage. Hence, door-to-door waste collection services were heavily hampered by farthest distance and roughest road.

This result agrees with Gaurav *et al*., (2014) and Tchobanoglous (1993) who reported, if disposal site is too far from the city, it may be uneconomical to use collection carts and therefore convenient locations should be established to transfer wastes to disposal site. Similarly, inadequacy of waste storage containers near to households has negatively contributed disposal of wastes in unauthorized places. Hence, inhabitants who failed to access

pre-collecting services at nearby sites were forced to dispose of wastes on free spaces, roadsides, streamlines and inconvenient places.

3.3.3. Enforcement of Rules and Regulations

About 54.6% of respondents said enforceability was not entirely practiced despite solid waste regulations (Proclamation NO. 513/2007), and thus they did not hear about any person who has been penalized for violation of illegal solid waste disposal. Nevertheless, 23.7% of respondents stated regulation is strong and active; and local administration is taking action for disrupting deeds. Yet, 11.7% of households responded they were not aware of enforceability regulations at all. Hence, low awareness and poor commitments of local administrations made enforceability unproductive, and thus it was one of the serious constraints in solid waste management.

This finding coincides with Kaseva and Mbuligwe (2003) and Tadele (2012) who stated lack of awareness and enforcement of existing legislation are the main constraints to solid waste collection services.

3.3.4. Transporting Waste

The nearest collection site took 5-10 minutes for 36.47% of respondents; and 11 to 20 minutes for 43.22% of households. Hence, 28.8% of respondents were forced to carry single-use synesthetic bags and came back to home empty handed. Nevertheless, 72.2% of the residents returned the emptied container after throwing litters. On the other hand, when waste disposal service was handled by crewmembers of pre-collectors, the chance of getting back of emptied containers was total absent. *Abjiffar* pre-collecting association provided service for 3.5% of respondents and it gave services once in every week. The association regularly transported solid wastes in open lorry, which often and unintentionally contributed litters on streets. 15% of households were accessing house-to house collection services by using animal pull carts and 43.21% of respondents said waste collection frequency has dropped from once a week to once every two weeks. Hence, by the time pre-collectors reached to homes with irregular collection times, households were often persuaded to miss collectors.

3.4. IFAS-EFAS-SFAS Result

Developing solid waste management scheme is often concerned in analysing internal and external environments. Hence, this chapter is aimed at identifying strategic factors in ways that are more systematic, and negative impacts of waste can be minimized to some extent by identifying strengths and deficiencies in current management practices.

However, recent review of Allesch and Brunner (2014) showed there were limited studies that focused on application of analysis in waste management, while it could be effective tool to identify gaps in existing SWM management practices and to improve them.

3.4.1. Internal Factor Assessment Summary (IFAS)

The following internal and external factors were identified as strength and weakness of solid waste management in the study areas.

IFAS- EFAS matrix showed specific factors affecting SWM and revealed their weights; and therefore, the recapitulated result of this qualitative study showed a gross strength and weaknesses of 1.16 and -1.42, respectively; and their gross differences was -0.26. Similarly, summary of opportunity and threats was 1.33 and 1.35 respectively; and their difference was -0.2. This indicated Jimma city's solid waste management is weaker instead of its strength.

Table 2. IFAS scores on identified internal factors of solid waste management

Attribute	Internal Factors analysis (Strength + Weakness)	Weight	Rate/ value	Score
S1	Waste separation at source (for *korealew* and *luwach*	0.15	2	0.30
S2	Good attitude to clean environment	0.04	1	0.04
S3	Labour availability	0.1	3	0.30
S4	High proportion of education capacity	0.08	2	0.16
S5	Public-Private Partnerships	0.03	2	0.06
S6	Willingness to pay	0.10	3	0.30
	Sub-Total	**0.50**		**1.16**
W1	Separation of biodegradable wastes	0.08	3	-0.24
W2	Waste as a resource for revenue generation	0.07	3	-0.21
W3	Willingness to pay	0.03	2	-0.06
W4	Participation in community meetings	0.05	2	-0.10
W5	Illegal disposal	0.15	3	-0.45
W6	Low awareness	0.12	3	-0.36
	Sub-Total	**0.50**		**- 1.42**
	Grand total	**1**		

Source: Computed from the field survey data

Among six identified items prioritized by pairwise ranking and IFAS matrix, respondents accepted three of the six items as important strength in the community, and they were considered as partially sustainable at minimum level. These identified strong items were: waste separation at source (for *korealew* and *luwach*); labour availability and willingness to pay. Nonetheless, the rest of items including attitude to clean environment, ratio of education capacity and Public-Private-Partnership were considered as inconsequential and thereby needs extra attention from Jimma community. This was mainly due to lack of consistency and coordination between local/district municipalities to improve waste management service delivery. Based on FGDs with the community in the division and relevant stakeholders of government departments, following weaknesses were identified

3.4.2. External Factor Assessment Summary (EFAS)

Derived from consultations with the community in the division and relevant stakeholders of government departments, following opportunities were identified (Table 3).

Table 3. EFAS scores on identified internal factors of solid waste management

Attribute	External Factors Analysis (Opportunity + Threats)	Rate/ Value	Weight	Score
O1	Growth in demand for service	0.09	2	0.18
O2	Door to door waste collection services	0.13	3	0.39
O3	Regular collection of wastes	0.03	2	0.06
O4	High potential labour source	0.11	3	0.33
O5	Involvement of private sector	0.09	3	0.27
O6	Green consciousness in residents	0.05	2	0.1
Sub-Total		**0.5**		**1.33**
T1	Inadequate resource (budget, facility, vehicle)	0.12	3	-0.36

T2	Enforceability	0.11	3	-0.33
T3	Poor waste management (reckless landfill)	0.05	2	-0.10
T4	Lack of bio-methanation/ composting	0.06	2	-0.12
T5	Lack of decentralized management	0.12	3	-0.36
T6	Defective transportation (litter disposal	0.04	2	-0.08
Sub-Total		**0.5**		**-1.35**
	Grand total	**1**		

Source: Computed from the field survey data

3.4.3. Strategic Factors Analysis Summary (SFAS)

The summarized SFAS Matrix was calculated by combining external factors from EFAS table and internal factors from IFAS Table. Hence, this recapitulated SFAS summary is a compilation of IFAS and EFAS with weighted score, where each three dominant factors from strengths, weaknesses, opportunities and threats are combined to find prioritized strategy within short-term, intermediate and long-term implementation, respectively (Table).

Solid waste management position in IFAS-EFAS quadrant was determined by calculating values on x-axis (abscissa) and y-axis (ordinate) referred to total value of each factor. Based on calculations with IFAS and EFAS score above, it could be seen value of X and Y was:

X = Strength + Weakness = 1.16 + (-1.42) = (-0.26)
Y = Opportunity + Threat = 1.33 + (-1.35) = (-0.2)

Table 4. SFAS result

Attribute	Strategic Factors Analysis Summary	Rate/ Value	Weight	Score
S1	Waste separation at source (*korealew* and *luwach*)	0.15	2	0.30
S3	Labour availability	0.1	3	0.30
S3	Willingness to pay	0.1	3	0.30
W1	Separation of biodegradable wastes	0.08	-2	-0.24
W2	Illegal disposal	0.15	-3	-0.45
W3	Low awareness	0.12	-3	-0.36
O1	Door to door waste collection services	0.13	3	0.39
O2	High potential labour source	0.11	3	0.33
O3	Involvement of private sector	0.09	3	0.27
T1	Inadequate resource (budget, facility, vehicle)	0.12	-3	-0.36
T2	Enforceability	0.11	-3	-0.33
T3	Lack of decentralized management system	0.12	-3	-0.36
			0	**-0.21**

Source: Computed from the field survey data

Based on IFAS-EFAS matrix result, Jimma city's waste management current position was in third quadrant (i.e. turnaround quadrant) where the overall solid waste management actions were suffering from huge fragile internal weaknesses. This in turn is wrecking the cost on environmental sustainability of the study area.

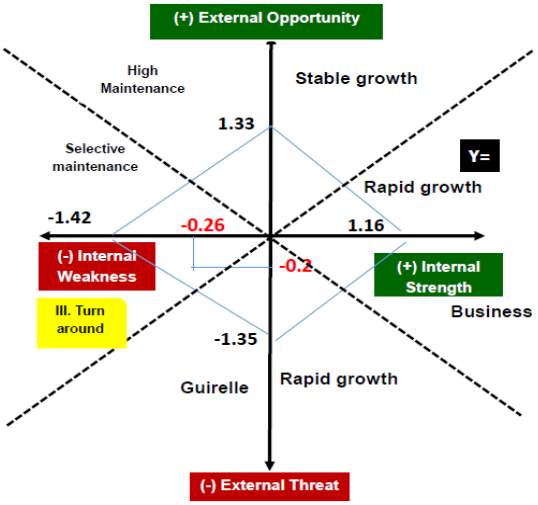

Figure 5. IFAS-EFAS Matrix Diagram
Source: Computed from the field survey data

As the result, major bottlenecks mentioned in SFAS result should be resolved towards strengthening revenue generation from wastes, arresting illegal waste disposals, strengthening households' willingness to pay and augmenting participation of households in community meetings.

3.4.4. Identified Strategic Factors Implementation Period

The highest score of SFAS was regarded as important to be implemented within long term strategy (three years and beyond), while medium and lowest scores were considered for mid and short-term strategies, respectively; where the mid-term would be implemented in one to three years, and the short-term strategy would be considered within a year.

Based on the recapped result of SFAS analysis result, four factors with highest score is to be resolved fully through **long-term strategy**. These include illegal disposal, door-to-door waste collection services, inadequate resource (budget, facility, and vehicle) and lack of decentralized management system (Table 5)

Medium Term Strategies

Three major factors with middle score marked to be resolved in medium term strategy based on SFAS analysis. These factors are regarded to be resolved in medium term, including low awareness, high potential labour source, and involvement of private sector and enforceability

Short Term Strategies

The factor that needs to be resolved in short-term strategy will include four major factors. These include Waste separation at source (for *korealew* and *luwach*), Labour availability Willingness to pay, Separation of biodegradable wastes

Table 5. Strategy implementation period according to SFAS result

Attribute	Strategic Factors Analysis Summary	Weight	Rate/ Value	Score	Strategy		
					Short Term	Medium Term	Long Term

S1	Waste separation at source (for *korealew* and *luwach*)	2	0.15	0.3	X		
S3	Labour availability	3	0.1	0.3	X		
S3	Willingness to pay	3	0.1	0.3	X		
W1	Separation of biodegradable wastes	-2	0.08	0.24	X		
W2	Illegal disposal	-3	0.15	0.45			X
W3	Low awareness	-3	0.12	0.36			X
O1	Door to door waste collection services	3	0.13	0.39			X
O2	High potential labour source	3	0.11	0.33		X	
O3	Involvement of private sector	3	0.09	0.27		X	
T1	Inadequate resource (budget, facility, vehicle)	-3	0.12	0.36			X
T2	Enforceability	-3	0.11	0.33		X	
T3	Lack of decentralized management	-3	0.12	0.36		X	
		0		**3.99**			

Source: Computed from the field survey data

4. CONCLUSION AND RECOMMENDATION

4.1. Summary and Conclusion

Solid waste management is a serious agenda and a major cause for environmental. The result also supported that, inadequate collection, storage and uncontrolled disposal of solid wastes in open dumps and unauthorized sites have created serious problems. From demographic variables, educated household heads were better in solid waste management than illiterates, indicating that education supported to raise level of understanding. Likewise, female-headed households were better in solid waste management than their counterparts were, since they were customarily left for females. Among socio-cultural factors, distance of residential house from main road have brought significant effect since the municipality did not assign sufficient waste container in different parts of the city and private waste collectors didn't have adequate facilities to serve households equally. Hence, households who are living far from the centre were wrongly encouraged to dispose their wastes in unauthorized sites.

In relation increasing population size in the city, limited facilities of its municipality of container, vehicle service, waste gown, glove and carts, illegal dumping was highly practiced in the study area. Due to limited awareness, solid waste was simply disposed of giving lower chance for waste reduction.

4.2. Recommendation

- Efforts need to be made to make planning and implementation process participatory, all-inclusive and collaborative towards maintaining sustainability
- Monitoring and evaluation should be in place to respond to the emerging and evolving challenges of solid wastes management in Jimma city
- The municipality should better assign adequate annual budget to improve inadequacy of vehicle service and related solid wastes management facilities.

- Local administrations should encourage and support private sectors (such as by organizing jobless youths) and participate them in solid waste management since households were willing to pay if they can get a regular door to door collection services.
- Community based organizations (CBOs) should take part in strengthening public awareness, financial support, and co-providing facilities to waste collectors.
- Sufficient number of waste bins should be put in vital locations and it should be emptied before wastes are spilled out of it.
- NGOs should play their role in resolving waste management issues by supporting construction of lined and capped landfills
- Measures should be to safe disposal of biodegradable materials
- Community engagement structures should be promoted

5. DECLARATIONS

Ethics approval and consent to participate

- All authors agree that no modification to the author list can be made without the formal approval of the Editor-in-Chief, and all authors accept that the Editor-in-Chief's decisions over acceptance or rejection of any breach of the Principles of Ethical Publishing in the Journal

Conflict of interest

- We have no conflict of interest to declare

Consent for publication

- I hereby affirm that the contents of the manuscript are original and it has never been published in any language fully or partly, nor it is under review for publication elsewhere.

Availability of data and materials

- Additional Supporting Information may be found online in supporting information tab for this article

Competing interests

- We have no competing interest to declare

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Authors' contributions

- Berhanu Megerssa: Conceptualization, Methodology, Formal analysis, Investigation, Writing - Review and Editing

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