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Sustainable solid waste management practices and perceived cleanliness in a low income city

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ABSTRACT

Waste reduction and waste separation are two preferred practices in sustainable solid waste management (SSWM). These two methods are seemingly impossible to implement without high awareness within the communities as well as a strong commitment and support from the city authorities. Despite the limited extent of these practices, this study attempts to analyze the current SSWM practices in Makassar City, Indonesia. The SSWM practices focused on waste separation and waste recycling. Assessing waste separation and recycling practices were carried out by field observations, focus group discussions, interviews with the actors, and a questionnaire survey. To avoid significant bias in the responses on perceived cleanliness of the city, we classified the respondents into three groups. Group 1 consists of all eligible members of local communities involved in daily solid waste management activities – common households. Group 2 consists of those actively involved in waste separation activities – SSWM households. Group 3 was composed of those institutionally responsible for conducting solid waste management. The primary result of this study shows that the presence of community practices on waste reduction and waste separation was strongly correlated to a sense of cleanliness in the community. This result implicitly indicates that by a using positive environmental image and performance within a locality, the community can become enthusiastically involved and push for sustainable SWM practices.

1. Introduction

Sustainable solid waste management puts waste reduction and waste separation practices as the most preferred elements in the waste hierarchy (EPA South Australia, 2014; Sustainable Facility Tools, 2014; US EPA, 2013). It is realistic that these two elements in the hierarchy significantly influence the end-products of the overall solid waste management process. Otherwise, public attitudes become lax and persistent solid waste management problems develop. Yang, Zhou, and Xu (2014) asserted that carbon emissions from municipal solid waste (MSW) treatment is one of the anthropogenic sources of climate change and accounts for 3–5% of global greenhouse gas emissions. Cities face chronic archetypal problems of developing countries in solid waste management. They turn to openning disposal sites despite having limited land, increasing waste generation while management capacity remains constant, reduced rates of waste processing, and crumbling solid waste management infrastructure. This study attempts to analyze the relationship between waste reduction and waste separation practices by a number of individuals within a community and the sense of cleanliness perceived by the community at large. These individuals can be change agents to promote a waste reduction and waste separation movement with the goal of sustainable solid waste management. We conducted this study in a developing city in Indonesia, where the sole solid waste management authority faced persistent problems in coping with the continuous increase of waste generation. Concurrently, the capacity to manage solid waste was practically constant. Thus, it always lagged behind in meeting its needs for appropriate solid waste management. This is in agreement with the findings by Guerrero, Maas, and Hogland (2012). They delineated that solid waste management is a challenge for city authorities in developing countries mainly due to increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated with its management, the lack of understanding of a variety of factors that affect the

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different stages of waste management and linkages necessary to enable the entire system to function.

Minghua et al. (2009) identified that increasing population, economic growth, increased well-being, and rapid urbanization are significant factors that increase waste generation. This is true regardless of the nation's development status or whether it is a developed or developing country. Burntley (2007) identified additional variables including lack of organizational capacity, insufficient financial resources, complexity of the problems and multi-dimensionality of the management system. However, developing countries are in particular the most suitable model for this cause and effect correlation. This analysis is sometimes beyond the capability of developing countries to handle (Sujauddin, Huda, & Rafiqul Hoque, 2008; UN Habitat, 2010). These observations signify the necessity of sustainable solid waste management. Zurbrügg, Gfrerer, Ashadi, Brenner, and Küper (2012) asserted that integrated and sustainable solid waste management should not only be given top priority, but must go beyond technical aspects to include several key elements of sustainability to ensure success of any solid waste project. The overall enabling environment can also be a key feature determining performance and success of an integrated and affordable solid waste system. Zurbrugg et al. (2012) argued that the drivers of success or failure can be linked to (1) elements that include the issue of social mobilization and acceptance (2) institutional elements such as stakeholders, legal and institutional arrangements comprising roles, responsibilities, and management functions, and (3) economic elements covering financial and operational requirements as well as cost recovery mechanisms. In the different tone, Lohri, Camenzind, and Zurbrügg (2014) highlighted that the financial sustainability in municipal solid waste management continues to be a major challenge in cities of developing countries. Through these drivers, the roles of communities as change agents must be stimulated and endorsed despite insufficient capability of local authorities. This is one of the reasons waste reduction and waste separation efforts carried out by the community needs to be strengthened regardless the extent of these good practices at present.

Good practices in waste reduction and waste separation in some cities in Indonesia are ubiquitous but intermittent. This depends on the presence of external agents and stimulants such as financial and technical sponsorships. One of the cities in Indonesia, where the communities are undertaking waste separation, is Makassar City (formerly Ujungpandang). The city is approximately located between 5^{O} 06′ 40″ S, 119^{O} 24′25″ E and 5^{O} 13′ 06″ S, 119^{O}30′10″ E. We conducted a study to understand the correlation between the extents of waste reduction and waste separation practices and the sense of cleanliness as perceived by members of the communities. In this study, we define the “sense of cleanliness” as what the community perceive, feel and experience on their surroundings with respect to waste and the impacts on cleanliness. Waste reduction and waste separation activities are presently done in a simple manner in this city. Thus, it is interesting to see the activities of the pioneers of waste reduction and waste separation work towards sustainable solid waste management practices and their contributions to the clean and green city of Makassar. Although the study was undertaken in Makassar City, the results may reflect the situation in many cities in Indonesia.

2. Sustainable solid waste management practices in Makassar

Sustainable solid waste management practices involve decisions at strategic, tactical, and operational levels. Considerations include selection of waste treatment sites and landfills (Wang, Qin, Li, & Chen, 2009), capacity expansion strategies for allocating transformation facilities and landfills (He, Huang, Zeng, & Lu, 2009), service zoning (Mourão, Nunes, & Prins, 2009), and the need for collection days in each zone and for each waste type (Chu, Labadi, & Prins, 2006). A holistic approach to waste management will lead to positive consequences for the reduction of GHG emissions (UNEP, 2010). However, holistic approaches cannot always be implemented smoothly. Difficulties can arise due to institutional, technical and financial constraints at national and local government levels, as well as in the private sector (Ababio, Ernesto, Arguello, & Gabbay, 2013; Abderrahmane, Okkacha, & Hassibaa, 2014; UN Habitat, 2010), lack of capacity to handle waste management demands on the part of urban authorities and where services are poor or nonexistent (Okot-Okumu & Nyenje, 2011).

There are a set of Acts and Government Regulations associated with solid waste management in place at the national level. For example, Act 18/2008 regarding Solid Waste Management (UURI: 18/2008), Government Regulation 81/2012 on Municipal Solid Waste (PP: 81/2012), and Minister of Environment's Regulation 13/2012 on 3Rs have been enacted. We argue that these legal products are actually adequate to implement sustainable solid waste management. Our proof is that while some cities such as Surabaya, Palembang and Tangerang are able to implement the sustainable solid waste management by employing the same legal products, the majority cities failed. These three cities are declared as the cleanest cities in Indonesia (Tribun-Timur, 2015). Problems remain at the local level. Solid waste management in Makassar City reflects the typical traditional municipal solid waste management in a developing city. There are business-as-usual characteristics. Household solid waste is dumped at the roadside, and waste trucks collect it and directly transport it to landfill site. Alternately, waste carts will collect the waste from roadside waste bins and move it to a designated transfer station. Then, waste trucks collect the waste from transfer stations and move it to a landfill site. In this process, waste separation, 3Rs, composting, waste to energy programs, and zero waste are absent. City authorities having a concept of sustainable solid waste management reflected in a program called Makassar Clean and Green. It was only partially implemented because of technical and financial constraints. Lack of basic infrastructure for implementing sustainable solid waste management is also a severe constraint. As a result, traditional management solid waste practices persist.

In Makassar City, all the municipal wastes are dumped into a single disposal site at the Tamangapa landfill. The Tamangapa landfill became operational in 1993. It was expected to remain in use until 2018 (25 years). However, the landfill site was already full in 2014 because of higher-than-projected increases in waste generation. At the same time, the municipal solid waste management by the city authority made no significant changes in terms of its sustainable solid waste management (SSWM) practices. To a limited extent, waste recycling, waste banks and waste separation practices were initiated.

An NGO initiated these practices with limited support from the solid waste management authority. The NGO adopted a local government program called Makassar Clean and Green and employed existing legal framework, as discussed above. They engaged in pilot programs in communities to instigate the beginnings of sustainable solid waste management. Despite operating on a small scale and being clustered, the program covers two essential elements of sustainable solid waste management. These are waste banks and waste separation at the household level. This is important because households are a large waste generator in Makassar City (MCDPC, 2010; MSO, 2014) as shown in Table 1.

Considering the limited waste handling capacity of the waste management authority of Makassar City, which is presently 88% utilized, the focus of solid waste management in Makassar is currently on residential areas, commercial area, tourist areas and

Table 1
Waste generators and transported waste, Makassar City 2014.

Waste sources	Daily waste generation (m3/day)	Percentage	Transported waste (m3/day)
Residential/Household	2136	51.0	1807(89%)
Commercial areas	1466	35.0	1210(87%)
Industrial areas	84	2.0	60(72%)
Open spaces/Water body	314	7.5	265(89%)
Tourist coastal areas	42	1.0	40(100%)
Street	117	2.8	110(96%)
Others	29	0.7	22(84%)
Total	4188	100.0	3514(88%)

Source: Estimated from Data 2014 of the Makassar City Department of Park and Cleanliness.

on-street wastes. The percentage of generated waste transported out these areas is higher than for other areas such as industrial areas and open space, which is in total accounted for only about 9.5%. On-street cleanliness seems mandatory for the city as the street is a show window of the city. Moreover, effectiveness of the clean city program is mainly assessed from the cleanliness of city streets. This is why the solid waste management authority of the city gives priority to this area. The handling capacity of the waste management authority may do a level of SWM, but it does not do sustainable solid waste management, as these practices are rare in Makassar. This is why the landfill was filled faster than expected. Limited land availability and NIMBY issues generated hardships in many cities in Indonesia, including Makassar. These issues are persistent.

Despite efforts being scattered, operating on a small scale and lacking government support, waste separation at the household level, waste recycling, waste banks and waste reduction, have been practiced for years. The practices were pioneered by an NGO, *Yayasan Peduli Negeri* (Peduli Negeri Foundation), as agent of change to promote sustainable SWM in Makassar. The impacts of practices on overall performance of solid waste management, however, depend on waste composition. In Makassar City, the waste composition is predominantly organic as shown in Table 2.

Based on the waste composition reflected in Table 2, waste recycling and waste bank practices will not have significant impacts on the quantity of waste disposed in the landfill. Rather, the practices can promote awareness for communities facing radical changes in waste composition, i.e., when inorganic waste takes precedence over organic waste in terms of quantity. Alternatively, waste composting and waste-to-energy programs can be good alternatives in Makassar since organic waste is currently predominant. The path to sustainable solid waste management in Makassar City should therefore begin with waste composting and waste to energy programs. In the next phase, recycling industries can be promoted to absorb increasing quantity of recyclable wastes. Waste reduction must be conducted continuously as it is a fundamental concept in sustainable solid waste management.

Table 2
Municipal waste composition in Makassar city 2014.

Waste type	Quantity of waste generated (m3/day)	Percentage[a]
Organic waste	2998.0	71.5
Inorganic waste:		
Paper	429.0	10.0
Plastic materials	401.0	9.6
Metal, Tin, Iron, Aluminum	164.0	4.0
Rubber materials	123.0	3.0
Glass materials	39.0	0.1
Lumber	32.0	0.1
Others i.e. incl. hazardous wastes	2.0	0.1
Total	4188.0	100.0

[a] Based on average percentage of random samples at source level i.e. households, stores, markets, etc.

In this study, we attempt to measure the practices with respect to two most visible performance indices of solid waste management. They are (1) the cleanliness of the locality, and (2) the lifespan of the landfill. Cleanliness was based on the perceptions of the community, i.e., people's sense of cleanliness. The lifespan of the landfill, on the other hand, was measured by the reduction of waste put in the landfill site as a result of waste recycling, waste separation and waste reduction practices done by the citizens.

3. Methodology

The study was carried out by acquiring primary information about the perception of communities and relevant secondary information available from various agencies in Makassar City. The perceptions of cleanliness as well as views about the implementation of the present solid waste management by the city authority were acquired by employing a questionnaire. Some respondents were directly interviewed to ensure the clarity of the questionnaire. This was to avoid respondents incorrectly interpreting the questions. The eligible respondents in this study is practically all heads (men or women) of households who are currently living in Makassar City.

Since the study was about exploring citizens' sense of cleanliness and it association with sustainable solid waste management practices in their immediate locality, the respondents were classified into two groups. This was to avoid bias in the responses. For example, responses tend to be biased towards the positive when one must evaluate one's own work. The first group of respondents (Group 1) was selected randomly among all eligible households in the study area, excluding those households actively engaged in sustainable solid waste management practices, hereafter referred to as SSWM households. The exclusion of SSWM households was to avoid this bias. The main purpose of this group was to ascertain perceptions about cleanliness a locality that implemented solid waste management by through city authorities and SSWM households. The second group of respondents (Group 2) was selected among the SSWM households. The information acquired from this group is about their contributions to managing solid waste in the city, their constraints, support received and expectations to improve their performance in implementing sustainable solid waste management practices.

In the first group respondents, the number of individual selected in each district was in their proportion to their presence in the total population in that district. The process of random selection was similar to Permana, Aziz, and Siong (2015). Random selection of the respondents was done using Google Maps (http://maps.google.com) and field checking in each district in the following way. In a district, we formed sub-districts based on the lowest level of city administration and further subdivided to the smallest manageable residential plot. Then, plots were assigns number 1 to N for each of the N households within the plot. After that, random numbers were generated to select the desired number of respondents in a particular residential plot. Finally, the process was repeated in other districts until the whole city was covered. The process of household selection is schematically shown in Fig. 1. We did a pre-survey to distinguish residential buildings and non-residential buildings by undertaking a field check prior to distributing the questionnaire. The same process was done for the second group, which consisted of 2105 SSWM households. Opinions from the

solid waste management authority were also acquired as a check-and-balance vis-à-vis the respondent's perception.

The sample size was determined according to formula n = N/(1 + N × eN×e^2), where N is number of population and e is expected error. The number of Group 1 households in the city was 320,655 (Table 3). The required sample size was 384. In Group 2, the required sample size was 350. The response rate was such that there were 412 Group 1 respondents and 379 Group 2 respondents. The questionnaire was distributed manually and collected within a week. Interviews were done with 40 selected Group 1 respondents. Key persons within the City Department of Cleanliness and Park were interviewed to obtain their opinions about solid waste management.

The sense of cleanliness was using an easily understood question: How do you feel about the cleanliness of your locality. The responses were given on a 5 point scale as follows: (1) I feel the surrounding are very dirty and messy (2) I feel dirty in the surroundings (3) I feel neither clean nor dirty in the locality (4) It is clean in the surroundings (5) I feel very clean in the surroundings. The level of sustainable solid waste management practices was measured by the proportion of households that actively practiced SSWM (SSWM Households) per 1000 population. The assumption of this measure was that SSWM households where enthusiastically practicing and actively promoting sustainable solid waste management in their locality. Their opinions about solid waste management done by waste management authorities and solid waste management activists were acquired separately.

4. Results and discussions

4.1. Socio-economic profile of the respondents

Socio-economic profile of the respondents was acquired through a questionnaire. One of the primary intentions of acquiring the profile was to understand the correlation between level of involvement in SSWM practices and the profile of the respondents. Among 500 questionnaires distributed to randomly selected Group 1 respondents, 412 returned completed questionnaires. From the respondents' data, their socio–economic profile is shown in Table 4.

Table 5 shows that majority of Group 1 households (70.6%) do very basic activities in solid waste management, i.e., put household waste in waste containers and dispose/place them at roadside collection points. However, the majority of Group 2 households (89.7%) did an intermediate level of solid waste management. Group 1 reflects a lower level of community involvement in municipal solid waste management compared to Group 2 households. It is notable that were three different levels of involvement in solid waste management within the community. Lower income people, i.e., those with monthly incomes equivalent to 201-300 USD, were the most active in both groups. Lower income people are usually more focused on subsistence matters. Thus, perhaps their involvement in SSWM is economically motivated.

The involvement of high income households in intermediate level waste management activities was low. Those with higher incomes who did participate did so due to their consciousness of social responsibility within the community. It is common in urban areas across Indonesia, that higher income people allocate little time to mingle with their community. Their social engagement is lower compared to low income people. They avoid significant involvement in community activities, including waste management. Thus, this finding is not surprising. Several studies of psychological behavior discuss this phenomenon (Aronson, Wilson, & Akert, 2009; Brewers, 1999; McLeod, 2008; Tajfel, 1974; Tajfel, 1982).

4.2. SSWM practices

Sustainable solid waste management practices in the study area were limited to waste separation, waste recycling, and waste banking, and to some extent, waste reduction. Although the practices were present in every district in Makassar City, the level of these practices varied in each district. We defined the number of households (those actively engaging in and fostering waste separation and waste recycling in the community) for every 1000 population as an indicator of the level of SSWM. By this definition, it was expected that the larger number of households engaged in SSWM in a community, the cleaner the neighborhood would be perceived by its residents.

Group 2 respondents, or SSWM Household, indicted that their predominant motive for engaging in SSWM was to earn money from recyclable wastes. This was true of 86.8% of respondents, while the remaining 13.2% cited social responsibility as their motive. As the data in Table 6 show, we can safely say that recycling businesses promoting sustainable solid waste management is quite feasible and profitable.

When we assessed the motives of SSWM household respondents according to their total household income, we found four different households patterns in supports for sustainable solid waste management. These patterns are shown in four quadrants in Table 7.

The involvement of lower income households in SSWM due to their social responsibility (Quadrant 3) provides strongest support for sustainable solid waste management. This is because

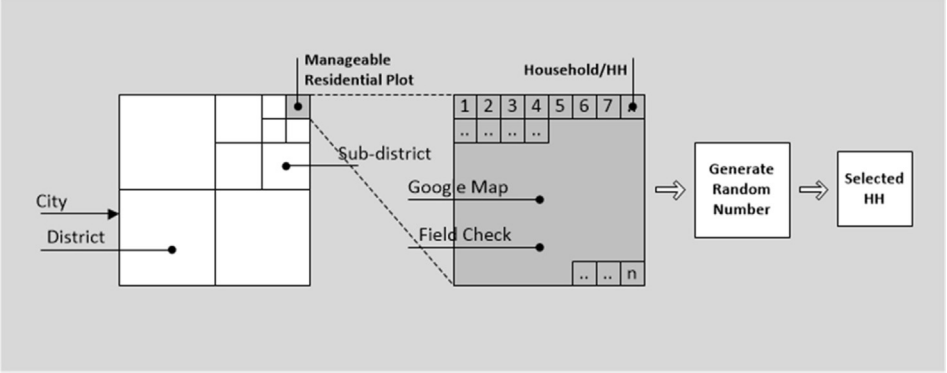

Fig. 1. Random selection processes of the respondents (after Permana et al., 2015).

Table 3
Population and households practicing SSWM.

No.	Districts/Townships	No of population	No of house-holds	Number of households actively practicing SSWM (SSWM households)	Level of SSWM practices[a]	Group 1 respondent		Group 2 respondent	
						Min. Sample	Acquired sample	Min. Sample	Acquired sample
1	Biringkanaya	195,906	42,458	106	2.50	51	54	18	22
2	Bontoala	52,631	11,405	50	4.38	14	17	8	10
3	Makassar	81,054	17,565	108	6.17	21	21	18	19
4	Mamajang	58,087	13,365	90	6.77	16	16	15	16
5	Manggala	130,943	27,247	110	4.04	33	37	18	20
6	Mariso	56,578	12,457	66	5.32	15	18	11	18
7	Panakukang	144,997	34,791	340	9.77	42	42	57	59
8	Rappocini	156,665	35,449	392	11.07	42	45	65	66
9	Tallo	138,419	28,253	516	18.30	34	35	86	87
10	Tamalanrea	108,984	32,292	70	2.17	39	40	12	13
11	Tamalate	182,939	43,788	174	3.97	52	55	29	30
12	Ujung Pandang	26,477	5791	20	3.44	7	10	3	5
13	Ujung Tanah	46,836	9673	40	4.12	12	12	7	9
14	Wajo	27,556	6121	23	3.76	7	10	4	5
	Total	1,408,072	320,655	2105	6.58	384	412	350	379

Note.
[a] Level of SWM practice was measured as the number of Household (HH), which are actively practiced SSWM, per 1000 of population in the respective townships.
Source: Makassar Facts and Figure 2014 (MSO, 2014) http://makassarkota.bps.go.id/?hal=publikasi_detil&id=37 and authors' analysis.

households, while of lower income, are motivated by their social responsibility rather than economics. Social motives can be valid for people in any economic condition. However, economic motives may not be workable without economic incentives. In the same way, the community in quadrant 4 provides limited support for SSWM because higher income people are in the minority. The weakest support is seen in quadrant 1. This group is very unstable without economic incentives because their income is very low. Without economic enticement, the present implementation of SSWM in Makassar City is fragile.

Table 4
Socio-economic profile of group 1 and 2 respondents.

No	Attributes	Group 1 (Common HH)		Group 2 (SSWM HH)	
		Frequency	Percentage	Frequency	Percentage
A	**Domicile of Respondents:**				
	1. Biringkanaya	54	13.1	22	5.8
	2. Bontoala	17	4.1	10	2.6
	3. Makassar	21	5.1	19	5.0
	4. Mamajang	16	3.9	16	4.2
	5. Manggala	37	9.0	20	5.3
	6. Mariso	18	4.4	18	4.7
	7. Panakukang	42	10.2	59	15.6
	8. Rappocini	45	10.9	66	17.4
	9. Tallo	35	8.5	87	23.0
	10. Tamalanrea	40	9.7	13	3.4
	11. Tamalate	55	13.3	30	7.9
	12. Ujungpandang	10	2.4	5	1.3
	13. Ujung Tanah	12	2.9	9	2.4
	14. Wajo	10	2.4	5	1.3
	Total	412	100.0	379	100.0
B	**Total Monthly household income in equivalent USD:**				
	1. <200	36	8.7	214	56.5
	2. 201–300	178	43.2	127	33.5
	3. 301–400	105	25.5	38	10.0
	4. 401–500	46	11.2	0	0.0
	5. 501–600	26	6.3	0	0.0
	6. 601–700	19	4.6	0	0.0
	7. >700	2	0.5	0	0.0
	Total	412	100.0	379	100.0
C	**Occupation:**				
	1. Public Sector Employee	152	36.9	29	7.7
	2. Private Sector Employee	203	49.3	28	7.4
	3. Self-employed	56	13.6	322	85.0
	4. Others, unemployed	1	0.2	0	0
	Total	412	100.0	379	100.0
D	**Involvement in SWM activities in the community:**				
	1. Basic: Disposed HH Waste to collecting points	291	70.6	39	10.3
	2. Intermediate: Separate Waste and Disposed HH Waste to collecting points	112	27.2	340	89.7
	3. Advance: HHW Separation and Community Engagement	9	2.2	0	0
	Total	412	100.0	379	100.0
E	**Average household size**	4.1		4.5	

Table 5
Cross-tabulation of level of SWM involvement across household income.

			Monthly household income (USD eq.)							Total
			<200	201–300	301–400	401–500	501–600	601–700	>700	
Involvement in SWM in the community	**Basic:** Disposed HH waste to collecting point	Count	22	124	76	33	19	16	1	291
		% within involvement in SWM in the community	7.6%	42.6%	26.1%	11.3%	6.5%	5.5%	0.3%	
	Intermediate: Separate waste and disposed HH waste to collection points	Count	14	48	29	10	7	3	1	112
		% within involvement in SWM in the community	12.5%	42.9%	25.9%	8.9%	6.2%	2.7%	0.9%	
	Advance: HHW separation and community engagement	Count	0	6	0	3	0	0	0	9
		% within involvement in SWM in the community	0.0%	66.7%	0.0%	33.3%	0.0%	0.0%	0.0%	
Total		Count	36	178	105	46	26	19	2	412
		% within involvement in SWM in the community	8.7%	43.2%	25.5%	11.2%	6.3%	4.6%	0.5%	

Table 6
Number of SSWM household generating recyclables.

Recyclable production (kg/month)	Total household income USD/Month equivalent					
	<200	201–300	301–400	401–500	501–600	601–700
1–5	93	63	20	0	0	0
6–10	74	41	10	0	0	0
11–15	31	18	4	0	0	0
16–20	13	4	4	0	0	0
21–25	0	0	0	0	0	0
26–30	3	1	0	0	0	0
>30	0	0	0	0	0	0
Total	214	127	38	0	0	0

4.3. The sense of cleanliness and level of SSWM practices

Cleanliness of the community is the most visible and easily interpreted by common people as a measure the level of solid waste management practices in the community. Respondents' perception about the cleanliness of their immediate environment is summarized in Table 8.

Table 8 reveals that Panakukang, Rappocini and Tallo are perceived by respondents as the three cleanest townships. About 82% of the respondents perceived their environment clean in Rappocini, 62% in Tallo and 71% in Panakukang. These three towns are in fact the townships with the top-three highest numbers of SSWM households, i.e., 11.06, 18.26, and 9.77 per 1000, for Rappocini, Tallo and Panakukang respectively. Visually, the cleanest community as perceived by the respondents is shown in Fig. 2. In contrary, a dirtier community is shown in Fig. 3. However, visual proof must be supported by statistical analysis. For this purpose, we conducted a statistical analysis on the correlation between perception of cleanliness and level of sustainable solid waste management practices. A partial correlation analysis on three variables, i.e., perceived cleanliness vis-a-vis perceived quality of SSWM and level of SSWM was undertaken, as shown in Table 9.

Table 9 reveals significance correlation between perceived cleanliness, and perceived quality of sustainable solid waste management (SSWM) with level of SSWM practices. The correlation coefficients were 0.457 and 0.553 which are greater than 0.000 (2-tailed significance). It can be concluded that one's sense of cleanliness and solid waste management practices in a locality are associated.

SSWM households were small in number, i.e. only 2105 out of 320,655 households, or 0.65% (Table 3). Although few, they have been able to show impact in promoting the fundamental practices

Table 7
Four levels of community support for SSWM among group 2 respondents.

	Lower HH Income	Higher HH Income
Economics Motivation	Common support of the community towards SSWM **Quadrant 2: 80.5%***	Weakest support (less desirable) **Quadrant 1: 6.3%***
Social Responsibility Motivation	Strongest support of the community (more desirable) **Quadrant 3: 9.5%***	Limited support of the community **Quadrant 4: 3.7%***

*Note: the percentage shows present conditions in the study area.

Table 8
Perceived cleanliness by township.

Township	Item	Perceived cleanliness (1 = Dirties, 5 = Cleanest)					Level of SSWM[a]	Perceived quality of SSWM		
		1	2	3	4	5		Bad	Neutral	Good
Biringkanaya	Count	9	34	11	0	0	2.50	21	27	6
	%	16.7%	63.0%	20.4%	0.0%	0.0%		38.9%	50.0%	11.1%
Bontoala	Count	3	6	8	0	0	4.38	0	6	11
	%	17.6%	35.3%	47.1%	0.0%	0.0%		0.0%	35.3%	64.7%
Makassar	Count	2	3	14	2	0	6.15	0	2	19
	%	9.5%	14.3%	66.7%	9.5%	0.0%		0.0%	9.5%	90.5%
Mamajang	Count	2	3	7	4	0	6.73	0	1	15
	%	12.5%	18.8%	43.8%	25.0%	0.0%		0.0%	6.2%	93.8%
Manggala	Count	2	4	20	11	0	4.04	4	11	22
	%	5.4%	10.8%	54.1%	29.7%	0.0%		10.8%	29.7%	59.5%
Mariso	Count	1	4	8	5	0	5.30	0	6	12
	%	5.6%	22.2%	44.4%	27.8%	0.0%		0.0%	33.3%	66.7%
Panakukang	Count	1	2	9	28	2	9.77	1	6	35
	%	2.4%	4.8%	21.4%	66.7%	4.8%		2.4%	14.3%	83.3%
Rappocini	Count	0	0	8	26	11	11.06	1	2	42
	%	0.0%	0.0%	17.8%	57.8%	24.4%		2.2%	4.4%	93.3%
Tallo	Count	0	0	13	14	8	18.26	4	8	23
	%	0.0%	0.0%	37.1%	40.0%	22.9%		11.4%	22.9%	65.7%
Tamalanrea	Count	8	17	13	2	0	2.17	27	10	3
	%	20.0%	42.5%	32.5%	5.0%	0.0%		67.5%	25.0%	7.5%
Tamalate	Count	0	12	32	11	0	3.97	13	18	24
	%	0.0%	21.8%	58.2%	20.0%	0.0%		23.6%	32.7%	43.6%
Ujungpandang	Count	0	5	5	0	0	3.45	5	2	3
	%	0.0%	50.0%	50.0%	0.0%	0.0%		50.0%	20.0%	30.0%
Ujungtanah	Count	0	5	6	1	0	4.14	0	3	9
	%	0.0%	41.7%	50.0%	8.3%	0.0%		0.0%	25.0%	75.0%
Wajo	Count	0	3	7	0	0	3.76	3	2	5
	%	0.0%	30.0%	70.0%	0.0%	0.0%		30.0%	20.0%	50.0%
TOTAL	Count	28	98	161	104	21		79	104	229
	%	6.8%	23.8%	39.1%	25.2%	5.1%		19.2%	25.2%	55.6%

Note.
[a] Number of SSWM Household for every 1000 Household (the larger the number, the cleaner surroundings are expected).

of sustainable solid waste management to the community in their locality. Their presence was appreciated by the community as their work was positively perceived. The total quantity of recyclables was 3118.50 kg/month based on the samples, or approximately 17,320 kg/month for the whole Makassar city. The total potential generation of recyclable wastes in Makassar City is approximately 897,000 kg/month and the extent of sustainable solid waste management in Makassar is very small i.e., only 1.93% on average. Therefore, the effect of waste segregation was insufficient to enable the Tamangapa Landfill to remain open for its designed lifespan. On the other hand, the potential generation of organic wastes is 71%. It is left untouched and often burdens solid waste management, as the Tamangapa landfill site comes to an end. Based on our observations, interviews with the local and national SWM experts, and findings of this study, we recommended that the solid waste management authority in Makassar must revisit their strategies with a more suitable and effective implementation towards sustainable solid waste management. The strategies of the present solid waste management of the city must be focused on how to exploit organic waste through various ways. The city needs to reduce the volume of organic waste disposed in the landfill site. Considering the present condition of the waste management authority of Makassar City, a feasible option to deal with the organic waste in Makassar City is by extensive composting. This is an attractive option because of the extensive agricultural activities in areas adjacent to Makassar are a potential market of compost products. Also, community based composting activities presently exist.

Fig. 2. Image of an alley in a Panakukang housing area (perceived clean community).

Fig. 3. A Roadside in Biringkanaya (perceived dirty community).

Table 9
Perceived cleanliness vis-à-vis perceived quality of SSWM and level of SSWM practice.

Variables	Correlation	Variables		
		Perceived cleanliness	Perceived quality of SSWM	Level of SSWM practices
Perceived cleanliness	Correlation	1.000	0.457	0.553
	Significance (2-tailed)	–	0.000	0.000
	df	0	409	409
Perceived quality of SSWM	Correlation	0.457	1.000	0.327
	Significance (2-tailed)	0.000	–	0.000
	df	409	0	409
Level of SSWM practices	Correlation	0.553	0.327	1.000
	Significance (2-tailed)	0.000	0.000	–
	df	409	409	0

4.4. Failure factors

We acquired the information from the waste management authority of Makassar City by interviewing some key persons in the Makassar City Department of Parks and Cleanliness (MCDPC). They generally admitted that waste management in Makassar City is presently not satisfactory, as the present capacity of the waste authority is only 88% (refer to Table 1). This view has also been verified by the respondents' perceptions on the performance of the authority in managing municipal waste. Ninety-three percent of respondents perceived insufficient performance (refer to Table 10). According to them, there are three primary failure factors, namely (1) insufficient budget allocated to handle municipal waste (2) insufficient waste management infrastructure and (3) insufficient quantity and technical capacity of personnel. These factors are pervasive and omnipresent elements of the public services in most cities in Indonesia, not only waste management. Thus, the reasons of failure in managing municipal waste, as stated by the authority, are not plausible because some cities successfully contended with these factors. Balikpapan has been recognized as the cleanest city in Southeast Asian region (Roswati, 2014).

Based on observation and opinions of the citizens, this study finds that success is actually due to non-conventional approaches. Our observation found that most cities in Indonesia did a business-as-usual conventional approach of solid waste management, which is “collect, transport, dispose and forget”, without at all think about sustainability. On the other hand, the non-conventional approach thinks more sustainably and future-oriented. If the authority insists on a business-as-usual style, little progress would be expected. This study suggests generating a snow-ball effect initiated by encouraging more community involvement in doing waste separation at source, waste reduction and recycling. In the local government, the city authority facilitates this activity by providing bins to segregate wastes, establishing waste banks and recycling factories. We believed that such things must happen towards sustainable solid waste management. The embryos are actually in place.

5. Conclusions and recommendations

This study reveals three essential findings. First, the presence of SSWM households actively engaging in sustainable solid waste management practices through waste separation and recycling has been viewed favorably by their community, as the connection between their presence and the sense of cleanliness in the locality is perceived as strong. Second, although the extent of sustainable solid waste management practices by SSWM households is relatively small, the potential influence of these households in the community is large. Inactive citizens in the community, most of them are represented by Group 1 respondents, can be easily and positively inspired by SSWM households to participate in sustainable solid waste management practices. Last, the quantity of organic waste is still large, i.e., 71%, and is left unmanaged. The solid waste management authority must focus on utilizing this organic waste through composting and waste-to-energy programs. For this purpose, we recommend the local government establish a community-based waste composting as an initial step towards more extensive and capital-intensive waste composting and waste-to-energy businesses. Our another research shows that a smallest unit in the community – the so called *Rukun Warga* – can be a potential actor in the program, without the necessity of extensive investment by the local authority. However, appropriate policies must be in place prior to the establishment of this program.

Present national and local policies on solid waste management seem adequate to push the implementation of solid waste management towards sustainability. Thus, it is not necessary to revisit or revise the current policies. However, about 93.0% of the respondents reported that the performance of the solid waste management authority in implementing waste management is unsatisfactory, as perceived by Group 1 respondents (Table 10). At the same time, Group 2 respondents (SSWM Households) reported that 95% of them received insufficient support from the authority. This shows that SSWM households are engaged in sustainable solid waste management solely through their own initiatives and efforts.

When discussing this situation with the waste management authority, a nominal response was received. The authority blamed insufficient budget, infrastructure and personnel handling waste management for unsatisfactory municipal waste management. Our opinion rather focuses upon an inability of the authority to prioritize their solid waste management program. The authority failed to pose the strategies within their limited budget, infrastructure and

Table 10
Perception on waste authority's efforts on SSWM.

Perception	Frequency	Percent	Statistics	
Extremely insufficient	11	2.7	Mean	2.48 (between insufficient and neutral)
Insufficient	222	53.9	Mode	2 (insufficient)
Neither sufficient nor insufficient	151	36.7	Std. Dev	0.685
Sufficient	25	6.1		
Extremely sufficient	3	0.7		
Total	412	100.0		

personnel constraints. With these constraints, their strategy must prioritize currently in-place waste separation, waste recycling and waste banking practices and increase them to their maximum utility. The authority must increase the proportion SSWM households, which are presently only 0.65% of the total households in Makassar up to 30% (the present quantity of recyclable wastes). In the meantime, local government can also develop recycling centers and material recovery facilities. Based on this study and lessons from the success of other cities such as Surabaya and Palembang, local government should exercise its power to promote community-based recycling businesses as a fundamental step towards a more comprehensive sustainable solid waste management.

We found that currently organic waste is predominant, i.e. 71%, we recommend the SWM authority in Makassar City to promote waste composting and waste-to-energy programs considering the present capability of the local government. However, the program must be all-inclusive upstream to downstream. Waste composting, for instance, must deliberately market its composting products. Experience in a zero waste project in the Mekong Region (http://eep3r091.wordpress.com/) shows that marketing of composted products, i.e., fertilizer is difficult since conventional methods are better adapted to chemical fertilizers. Thus, it is a potential treat to sustainability. Similarly, waste to energy programs must ensure a smooth and continuous supply of organic wastes.

Looking at current persistent problems of SWM in Makassar City as reflected in the previous discussions, we recommend the municipal waste authority must think strategically and innovatively to offer suitable strategies to cope with municipal solid waste management in Makassar City. Otherwise problems will persist. Traditional approaches to waste management in Makassar have proven unsuccessful in moving to handling municipal waste in more sustainable way. As researchers, we must constantly provide inputs to the decision makers and policy implementers for the improvement of their city. One of the objectives of this study is providing that feedback.

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