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Public Perception and Approach on the Municipal Solid Waste Management in Bandung city, Indonesia.

Master's Thesis

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Declaration

I hereby declare that this Thesis entitled “Public Perception and Approach on the Municipal Solid Waste Management in Bandung, Indonesia” is my own work and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of FTA.

In Prague, 26. 4. 2019

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Denisa Beňová

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Abstract

This Thesis examined public perception and approach on the municipal solid waste management (MSWM) in Bandung city, Indonesia. Increasing amount of waste becoming a serious topic in developing countries due to aspects as health related issues, environmental issues and others. In Indonesia, government implemented in past decades several laws and regulations dedicated to MSWM, unfortunately, thus are not well communicated to the public sector. Moreover, the set tax's level is inadequate with regard to MSWM financial needs in Bandung. Also, previous studies determined public and its interest in MSWM as one of the key factor of sustainable MSWM, however this aspect is not well considered. The results of conducted questionnaire survey in the study area showed that over 97% of respondents are not satisfied with MSWM practices and over 83% of respondents consider MSWM services as insufficient. Available sufficient awareness about the important operations such as waste handling and recycling was is at low level. On the other hand, over 67% of citizens (respondents) are interested in MSWM in connection to the environmental issues and also familiar with 3R concept. However, personal interviews showed the contrasts among respondents from government sector, officers of MSWM organizations and citizens of Bandung. Using a binary probit model it was found that age, education level, locality and satisfaction with MSWM practices played significant role in respondent's interest in MSWM. Applying the Chi-square test of independence suggested that age, level of education and average monthly income was strongly associated with willingness to pay different taxes for sufficient MSWM. Above mentioned results bring a whole new perspective on the public perception and approach on the MSWM that could be considered in the planning and implementation of sustainable MSWM, since this issue has not been deeply examined in Bandung.

Key words: governmental regulations, interest, public awareness, waste generation, landfilling, questionnaire survey, willingness to pay, binary probit model, chi-square test

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3R	Reduce Reuse Recycle concept
ASEAN	Association of Southeast Asian Nations
GHG	Greenhouse gases
LCA	Life Cycle Assessment
MSW	Municipal solid waste
MSWG	Municipal solid waste generation
MSWM	Municipal solid waste management
MSWT	Municipal solid waste treatment
PDK	PD Kebersihan/ Regional cleaning service
TPA	Tempat Pembuangan Akhir/ Final disposal site
TPS	Fasilitas Pengolahan Sampah/ Temporary disposal site
SWM	Solid waste management
WMS	Waste management system
WtE	Waste-to-energy

1. Introduction

Increasing population and economic growth in Indonesia has created poor environment condition in cities and rural areas. The most common problem for both is improper waste management system (WMS). Waste management services in urban areas are not clearly developed and fast accumulation of huge amount of waste leads to a quick get rid-off solution as open dumping sites for both rural and urban areas (Damanhuri et al. 2009; Alberdi et al. 2018). Nowadays, Indonesia produces over 64 million tonnes of municipal solid waste (MSW) yearly and collection rate varies between 50-70% (UNEP 2017). Bandung city produces over 1,600 tonnes of MSW per day with collection rate only 61%, rest of the MSW stays on the streets, rivers or is burned. Thus, Bandung is in urgent need for sufficient municipal solid waste management MSWM solution (Barnadi 2010).

In Indonesia, MSWM is responsibility of municipalities and local governments. Numbers of policies and regulations regarding MSWM have been set up in Indonesia (PD Kebersihan 2016; Indartik et al. 2018). Unfortunately, they are not well introduced to a public sector and their compliance is limited by many factors namely lack of financial sources, inadequate infrastructure, lack of manpower and others (Dethier 2017; Susmono et al. 2017).

Previous studies (Al-Rabaani & Al-Mekhlafi 2009; Barnadi 2010; Asmawati et al. 2012 Triguero et al. 2016; De Gisi et al. 2017; Hunter et al. 2017) determined that an aspect of public perception and approach on MSWM plays essential role to establish sufficient MSWM. Nevertheless, this aspect has been poorly investigated in Bandung city (Barnadi 2010). The main aim of this Thesis was to determine public perception and approach on MSWM in Bandung, Indonesia. Interest of MSWM in connection to the environmental issues and factors likely to influence this factor were investigated. As well as willingness assessment of inhabitants to pay taxes for sufficient MSWM services, in terms that higher taxes could results in better MSWM services and financial background for investments to awareness or education. Moreover, evaluation of perception and approach on MSWM divided by districts of Bandung city and metropolitan area, was

provided. Since, there is no evidence about complex examination of public perception and approach on MSWM in Bandung city.

2. Literature review

2.1. Municipal solid waste

Waste is a leftover material that is not desirable after the end of a production/ consumption process, but in a natural process, the term waste is not known. Natural processes are related to each other in a cycle, where the output of one process becomes an input for another process. Waste is a material that has no value or is not valuable for ordinary or primary purposes in fabrication, use of goods that are damaged or defective in manufacturing, excessive or rejected materials (Barnadi 2010). According to the Intergovernmental Panel on Climate Change (IPCC 2006), municipal solid waste (MSW) refers to waste streams that are generated in urban areas and which are collected and treated by, or for, municipalities or other local authorities. The IPCC definition includes the following waste streams as a part of MSW: food waste, garden and park waste, paper and cardboard, wood, textiles, nappies (disposable diapers), rubber and leather, plastics, metal, glass, and others (e.g. ash, dirt, dust, soil, electronic waste). Waste from construction and demolition activities is usually excluded from MSW definitions, as well as industrial and liquid wastes from municipal sewage networks (Aleluia&Ferrão 2016). MSW from developing countries is generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others (Miezah et al. 2015). MSW is term applied to a heterogenous waste generation and can be subdivided into two major groups: organic and inorganic (Sudibyo et al. 2017).

MSW has become a major concern in these days. Due to the rapid urbanization, population growth, industrialization and improved lifestyle, amount of MSW uncontrollably and rapidly increasing (UNEP 2017). The amount of MSW is linearly related to GDP growth while its composition is a matter of socio-economic situation and seasonal conditions. Indonesian GDP steady grow and generation of MSW with it (Mu´min et al. 2017). Strong domestic demand, especially private consumption and investment drive economic growth while exports play a less important role. Indonesia is

projected to reach a growth rate of 6.4% over the annual period (UNEP 2017). Indonesia generates the highest quantity of municipal waste from ASEAN countries, with population circa 267 million inhabitants, the amount of MSW generation is almost 200,000 tons per day that is equivalent to about 64 million tons per year and this number is increasing by 2-4% annually. Producers of MSW are residential area (48%), traditional market (24%) followed by commercial area (19%) and public facilities (9%) (Gandidi et al. 2017; UNEP 2017). As developing country, Indonesia produces mainly organic waste that influence choice of appropriate technology for MSW treatment (Sudibyo et al. 2017).

2.1.1 Municipal solid waste composition

The composition of MSW varies significantly from one municipality to another. Such variation depends mainly on the life style, economic situation, waste management regulations, industrial structure, seasonal conditions and heterogeneity of waste (Mu´min et al. 2017; Sudibyo et al. 2017; Abdel-Shafy&Mansour 2018). The heterogeneity of the generated waste is a major setback in its utilization as a raw material. The quantity and the composition of the MSW are critical for the determination of the appropriate handling and management of these wastes, also, such information is valuable for the technology decision making (Abdel-Shafy&Mansour 2018). There is therefore the need for separation of the waste before they can be subjected to any appropriate treatment process (Miezah et al. 2015). Indonesia, as developing country, produces mainly organic waste with range up to 70% according to Sudibyo et al. (2017) or up to 60% according to UNEP (2017) from total amount of MSW. However, in recent years generation of plastic waste has increased due to packaging materials and change in lifestyle (Chaerul et al. 2014; Sudibyo et al. 2017). Composition of waste in Indonesia is shown on Figure 1.

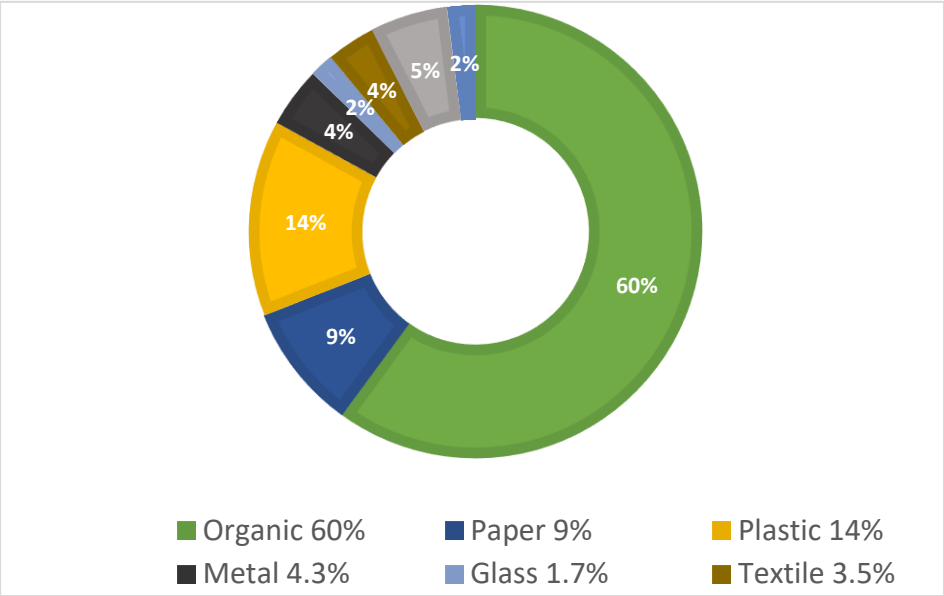

Figure 1. Municipal solid waste composition in Indonesia.
Source: UNEP (2017)

Composition and characteristics of MSW are very important for waste management planning, meaning implementation of appropriate system in different places, and influence choice of technology as well as waste management infrastructure (Sudibyo et al. 2017; Raharjo et al. 2018). Moreover, the important physical components of MSW, such as plastics and chemical fibres, may be harmful in some contexts (either they are potentially toxic themselves or they absorb other pollutants) and are suspected of being carcinogenic to human health (Gu et al. 2017).

Meanwhile, the time has a great impact on the composition of MSW. Biodegradation of such MSW during the time is an important factor that affects the amount of recyclable material particularly the organic contents (Abdel-Shafy&Mansour 2018). Total amount of produced waste and its potential to be recycled depends on a waste composition. Table 1 shows percentage share of the total volume of produced waste that is possible to recycle.

Table 1 Recycling potential of MSW

Type of waste	**Recyclable waste (%)**	
	Recyclable part	**Non-recyclable part**
Wet garbage	69.9	30.1
Paper waste	74.9	25.1
Plastic waste	79.8	20.2
Glass waste	85.6	14.4
Ferrous metal waste	71.5	28.5
Average	**79.4**	**20.6**

Source: Raharjo et al. (2017)

2.1.2. Municipal solid waste generation

Municipal solid waste generation (MSWG) is problematic and it is an issue of concern everywhere in the world, particularly in all urban centres and especially in developing countries (Abdel-Shafy&Mansour 2018). Waste generation is a consequence of using raw material and energy losses that generate different wastes, thus leading to additional costs to society for collection, treatment and disposal (Ghinea et al. 2016). MSWG is considered as a huge challenge for developing countries that suffer from environmental pollution problems caused by increasing volume of generated waste (Abdel-Shafy&Mansour 2018). Also, MSWG and its composition is influenced by socioeconomic factors including household size, monthly income, employment status, and education level (Sankoh et al. 2012; Abdel-Shafy&Mansour 2018). Other factors that influence both, MSWG and waste composition, are change in the source-sorting behaviour and consumption of goods affected by lifestyle. Especially in Indonesia where people became interested in westernized their consumption behaviour, while the country and its WMS are not prepared for it (Abdel-Shafy&Mansour 2018).

Living conditions in developing countries, with emerging economies, and its cities are getting worse and health issues are rising as well as environmental conditions are getting worse. Problems such as polluted rivers, groundwater, air and water born bacteria and viruses are arising from cities polluted by increasing MSWG. These sub sequences of

polluted environment influence human health and causes different disease and deaths since less wealthy inhabitants have not afforded appropriate health care (Sasaki et al. 2014).

For an adequate and sustainable planning of WMS, the accurate forecast of waste generation is an essential step that should be count, since various factors can affect waste trends and generation (Ghinea et al. 2016; Sun & Chungpaibulpatana 2017). MSWG is still growing and this trend will continue in next years as it is shown on Figure 2 and Figure 3. Increase of MSWG is linearly related to the population growth that often comes with impacts on the environment (Ayeleru et al. 2018).

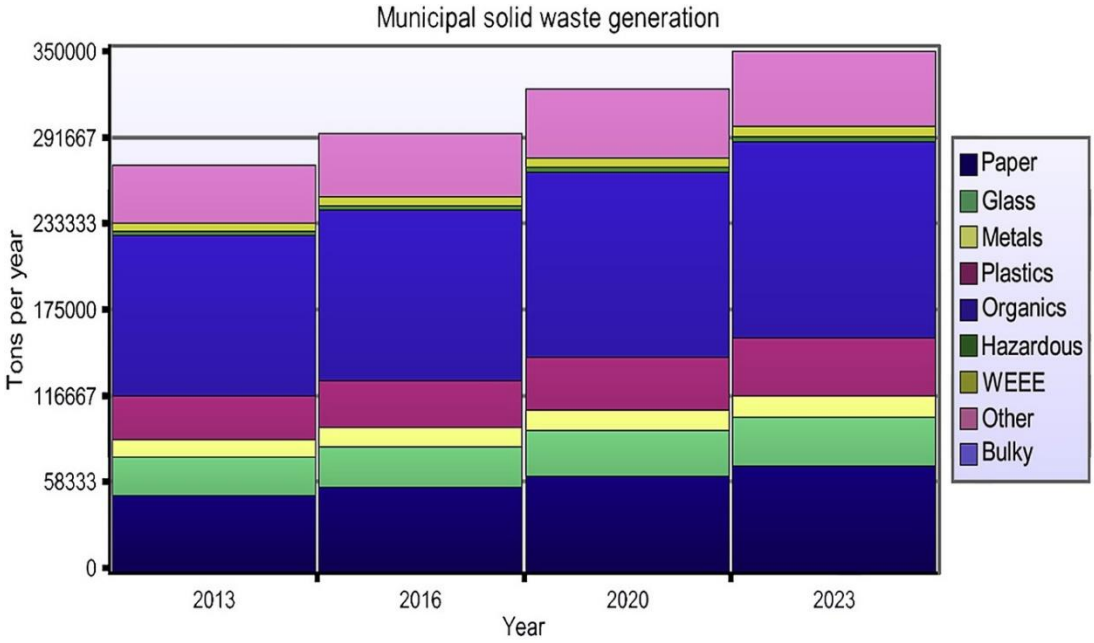

Figure 2. MSW generation worldwide.
Source: Ghinea et al. (2016)

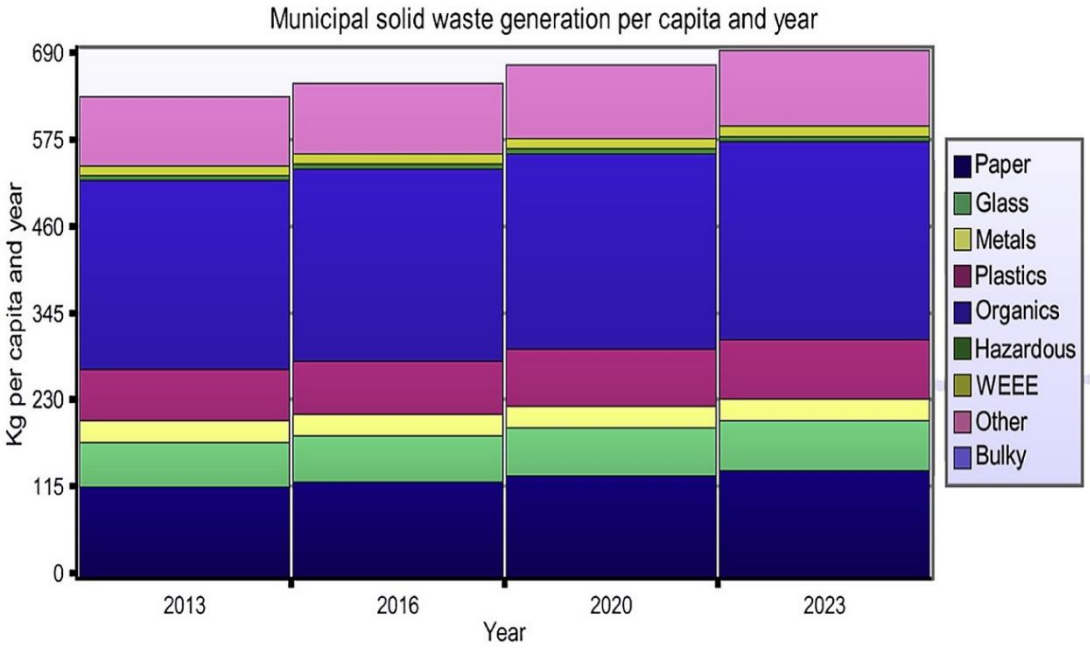

Figure 3. MSW generation per capita worldwide.
Source: Ghinea et al. (2016)

Proper modelling of WMS is also essential for the simulation of various environmental impact scenarios (Adamović et al. 2017). Waste management and MSWG itself is becoming an emerging problem for national and local governments, since the manners in which the growing amount of solid waste are managed do influence the human health and the environment and could contribute significantly to resources conservations (Ghinea et al. 2016).

2.2. Municipal solid waste management

Conventionally, municipal solid waste management (MSWM) includes the process of collection, transportation, and treatment methods and technologies for MSW (Chaerul et al. 2014). United Nations Development Goal 11 – Sustainable cities and communities and Goal 12 – Responsible consumption and production, are arising attention for sustainable consumption, production and save MSW disposal, especially, in developing countries where just minimum of MSW is safely disposed (Colombijn & Morbidini 2017; UN 2019). The MSWM is also multidimensional set of activities that engaged different actors, processes and policies (laws and regulations) interacting with each other (Aleluia & Ferrão 2016). In addition, MSWM seems to be crucial topic for environmental

protection in present and also in future (Karak et al. 2012). With increase of MSWG rate, as mentioned in previous chapter, whole MSWM and its steps should also increase equally. MSW collection efficiency especially in developing countries is only about 40%, whereas efficiency in developed countries is up to 90% (Yadav & Samadder 2018). A typical MSWM in developing countries displays an array of problems, including low collection coverage and irregular collection services, inappropriate infrastructure, financial budget shortages, crude open dumping and burning without any air and water pollution control, breeding of flies and vermin, and uncontroll of informal waste picking or scavenging activities (Manaf et al. 2009). Uncontrolled open dumping, open burning and unsanitary landfill are common waste disposal practises of MSW not only in Indonesia, but also in other developing countries like India, Nepal, Cameroon and many others (Yadav & Samadder 2018a). These options of MSWT are improper to practise in terms of human and animal health, environment problems such as global warming, ozone depletion, ecosystem damages abiotic resource depletion, and well-being of inhabitants at all (Susibyo et al. 2017; Yadav & Samadder 2018a; Khandelwal et al. 2019).

In Indonesia, country that consist of more than seventeen thousand islands, implementation of unified WMS is impossible (Susmono 2017). MSWM here include handling trash and operating landfills that is a responsibility of the local government of towns and districts. MSWM for these authorities is not a priority because of budget shortages, poorly educated local officials and lack of political willingness, thus, MSWM in Indonesia decline (Dethier 2017).

To find out the appropriate solution of MSW disposal with minimal impact on environment and health conditions is one of the biggest developmental challenge for Indonesia and other developing countries (Yadav & Samadder 2018a). The decision making in MSWM industry requires an assessment to prevention and minimization of the hazards associated with all above mentioned issues. Developed countries in Europe and Asia use life cycle assessment (LCA) for quantification of environmental impacts of MSWM (Yadav & Samadder 2018a; Khandelwal et al. 2019).

2.2.1. Life cycle assessment of municipal solid waste

Life Cycle Assessment in MSW is a tool (computer-based) that has the ability to assess and compare environmental impacts of a product, process or activity through its life cycle. In case of MSWT, methods and technologies are investigated to determine the most environmentally, economically and socially sustainable management option. Also, LCA assess the benefits associated with a product through its life from raw material acquisition to production, use, and final disposal (Yadav & Samadder 2018b; Khandelwal et al. 2019). LCA can measure or analyse different impacts from environmental point of view like global warming, greenhouse gases (GHG) emissions, GHG mitigation potential and others. Moreover, from other point of view LCA can measure for example energy use of disposed MSW (Zhao et al. 2018). In the last decades, LCA was used in many studies concerning waste management from different viewpoints. Edwards & Schelling (1999) used LCA methodology on municipal waste with special emphasis on transportation and recycling plant, Cherubini et al. (2008) used LCA analysis to provide transparent and comprehensive environmental evaluation of a range of waste management strategies for dealing with mixed waste fractions of city waste stream, Liu et al. (2017) evaluated impact of MSW emission by integrating emergy analysis and LCA. There are several studies that used LCA in connection with MSWM. These studies have shown that MSWM is a complex and multidisciplinary field thus its evaluation needs holistic approach (Laurent et al. 2014; De Feo et al. 2017).

However, LCA could be very helpful tool, it also has limitations. The LCA outcomes are dependent on the system boundaries and by author chosen baseline scenarios that are difficult for cross comparison. The other limitation comes from evaluating waste to energy and several extension methods have been proposed for further development (Fan et al. 2018).

2.2.2. Municipal solid waste management in Bandung city

In Bandung, the MSW and its management that has been taking place is established on the notion that waste is not a resource and relies on the approach to disposing of garbage in the location of waste disposal sites. Waste management with a new paradigm aims to reduce the volume of waste disposed of to Tempat Pembuangan Akhir (TPA) (final disposal site) through the development of treating waste by reducing, reusing and

recycling (3R). Waste management with a new paradigm also emphasizes that waste management is a public service that aims to control the waste generated by the community through community empowerment supported by the implementation of waste management policies (Barnadi 2010; Indartik et al. 2018). The new paradigm views waste as a resource that has economic value in different forms such as energy, compost, fertilizer or industrial raw materials. Waste management with the new paradigm can be done with waste management activities that apply the 3R concept and applies empowerment of the community. Waste management includes reduction activities, reusing of materials, and recycle materials that has this potential, whereas community empowerment in the form of activities of sorting, collecting, transporting, processing, and final processing (Barnadi 2010; Dethier 2017). Nowadays Bandung city produces about 1,600 tons of MSW per day (Opendata 2018), from this volume only 61% is handled or collected by municipality services (Tarigan et al. 2016).

Municipality services consist of trucks that are directly collecting waste, if the infrastructure allows, from households, buildings and markets on an irregular basis to more than 200 Fasilitas Pengolahan Sampah (TPS) (temporary disposal sites). These TPS are distributed to various locations in the city often in close proximity of households (Tarigan et al. 2016; Dethier 2017). Waste collected to TPS is taken afterwards to the TPA. However, one to two third of collected MSW do not leave these TPS. This fact negatively influences environment conditions straight in the city, well-being of inhabitants and booster born of bacteria and viruses, breed of insects and rodent vectors (Siyaranamual 2013). On the other hand, some of the TPS have established compost sites and use organic material for small scale biogas stations that supplies TPS with cooking gas (Hijau Lestari 2019).

TPAs are another waste related issue in Bandung due to improper management. The tragical termination of Leuwigajah final disposal site operations in 2005, has imposed direct impacts on the Bandung metropolitan area. For the purpose of an alternative landfill or dumping site in Bandung there was established emergency TPA in Sarimukti (Damanhuri et al. 2009). TPA Sarimukti is located about 40 km from Bandung city, to run its services related to solid waste collection and management is complicated (Randhami et al. 2018). This so-called temporary TPA starts in 2006 and till nowadays it is still

operating despite the fact that in 2012 it was considered as overloaded and incompetent to further operations. TPA Sarimukti seize area about 25 ha, receives about 1,200 tons of MSW per day and nearly 75% is from Bandung city (Damanhuri et al. 2009; Randhami et al. 2018). Figure 4 shows the fluctuation of the monthly volume of MSW from Bandung that is entering TPA Sarimukti. Average volume of this MSW is 26, 400 tons per month. Since 2012, TPA Sarimukti, has been expanded due to increasing MSWG and was projected to be able to accommodate MSW until 2018. However, operations at Sarimukti are not well accepted among inhabitants. In December 2010, due to the unpaid compensation problem neighbourhoods who live in close surrounding of this TPA created a road blockade at the site entrance for three days. As the result, Bandung city was flooded by its own MSW, about three tons of solid waste was cumulated at TPS in the city and trickled-out to the streets (Siyaranamual 2013). Nevertheless, establishment of landfills are only a plan of government of Bandung city and West Java region. Newly planned site for TPA is Legok Nangka that should start in 2018 and meet technological standards of sanitary landfill (Yundiandika et al. 2013).

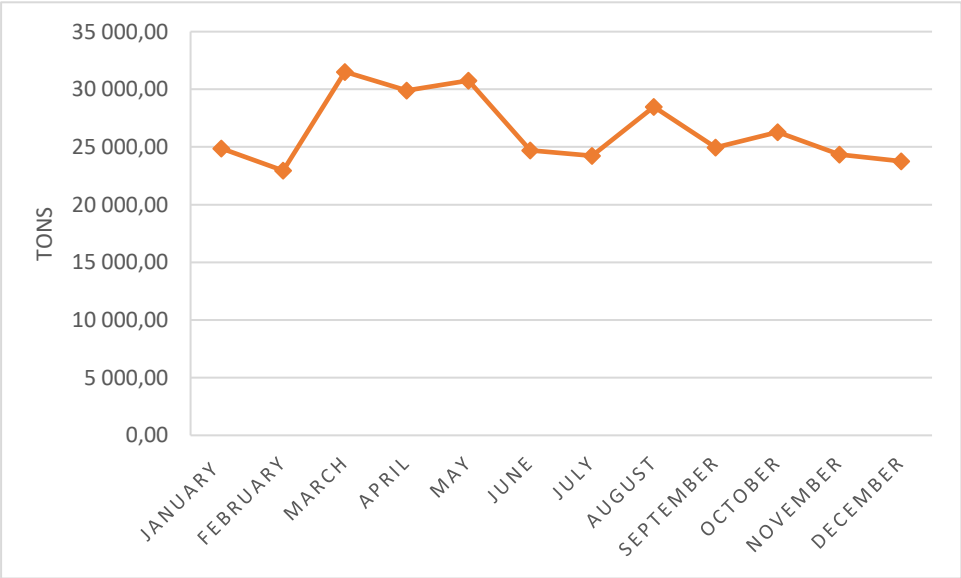

Figure 4. Fluctuation of MSW volume entered TPA Sarimukti from Bandung during a year 2016.
Source: PD Kebersihan (2018)

MSW volume is predicted to increase 1-5% per year in Bandung city. Increasing MSWG in Bandung is caused primary by inhabitants' lifestyle that becoming increasingly

consumptive and citizens' awareness of proper waste disposal, despite promoted campaigns, is very low (Indartik et al. 2018).

The role of the community in handling the waste in the city of Bandung is positioned only as an object of income sources. Waste originating from households is managed by municipal-owned cleaning service company – Perusahaan Daerah Kebersihan (PDK) at the citizen association level, and then taken to a TPS managed by PDK or informal agencies (Barnadi 2010). The regional government of Bandung city is required to formulate an urban waste management policy in overcoming the problem of garbage, especially garbage originating from households by giving the largest contribution to MSW in the Bandung (PD Kebersihan 2018). There is a need that household waste management can be integrated between all relevant institutions and become an important instrument in implementing the policy of urban waste management (Barnadi 2010).

Waste management in the city is inseparable from public policies issued by the regional government. In general, according to Barnadi (2010), public policy is influenced by four important aspects in implementing the policy:

- Communication
- Resources
- Disposition
- Bureaucracy

Efforts to establish the municipal solid waste management policy on the communication aspects of the Bandung city government are mostly carried out in terms of internal communication between government agencies related to the waste management. External communication with the community is at low level. Due to wanting means of communication (Indartik et al. 2018).

In the aspect of resources, especially in terms of funding sources and manpower, the government of Bandung city applies waste retribution as one of the sources of locally-generated revenue and funding sources for the implementation of waste management services. Citizens have to pay for services by monthly fees. These fees are financial source for municipal-owned cleaning service company – PD Kebersihan (PDK) (Barnadi

2010). This company ensure MSWM services in the form of collection, street cleansing, disposal and transporting waste from TPS to TPA. PDK cannot cover most of the collection service for the residential area, despite the fees, this company faces lack of finances and labour (Barnadi 2010; Siyaranamual 2013). The manpower became an issue due to infrastructure of the city. Many residential areas in Bandung are located in a narrow alley, hence the garbage trucks are not able to reach them and handcrafts are used as the only means to collect the waste. To overcome this problem, residential areas organize own informal collection services that are funded by monthly additional communal fees or directly levied on the households in time of collection (Siyaranamual 2013).

In the disposition aspect, the Bandung city government is required to have an agreement among implementers to establish a municipal waste management policy. Crucial regulation concerning MSWM is the law No. 18/2008 (Susmono et al. 2017). Bandung city also engaged multiple stakeholders to the creation of a regulation on MSWM. These will be mentioned in chapter 2.4 in more details.

Whereas in the approach of bureaucracy, the city government of Bandung places PDK as the only stakeholder that carries out waste management in Bandung. However, urban waste management carried out by PDK is just focused on waste management in terms of transporting waste from TPS to TPA. According to the law No. 18/2008 Bandung city and its MSWM have to develop community participation in waste management which is poorly developed till nowadays and brings its consequences in form of unsustainable waste generation, negative environmental impact and more (Barnadi 2010; Indartik et al. 2018)

2.3. Municipal solid waste treatment

Municipal solid waste treatment (MSWT) is the major and the last part of MSWM. The treatment of MSW is complicated due to its heterogeneous and variable composition, increasing generation, and most important – life habits of the residents which are changing from place to place all over the world (Nixon et al. 2013; Wang et al. 2018a). Decision making of choosing appropriate technology or method depends on multiple stakeholders, and especially, government and public acceptance have the major role

(Alberdi et al. 2018; Wang et al. 2018a). Figure 5 displays MSWM treatment methods and technologies.

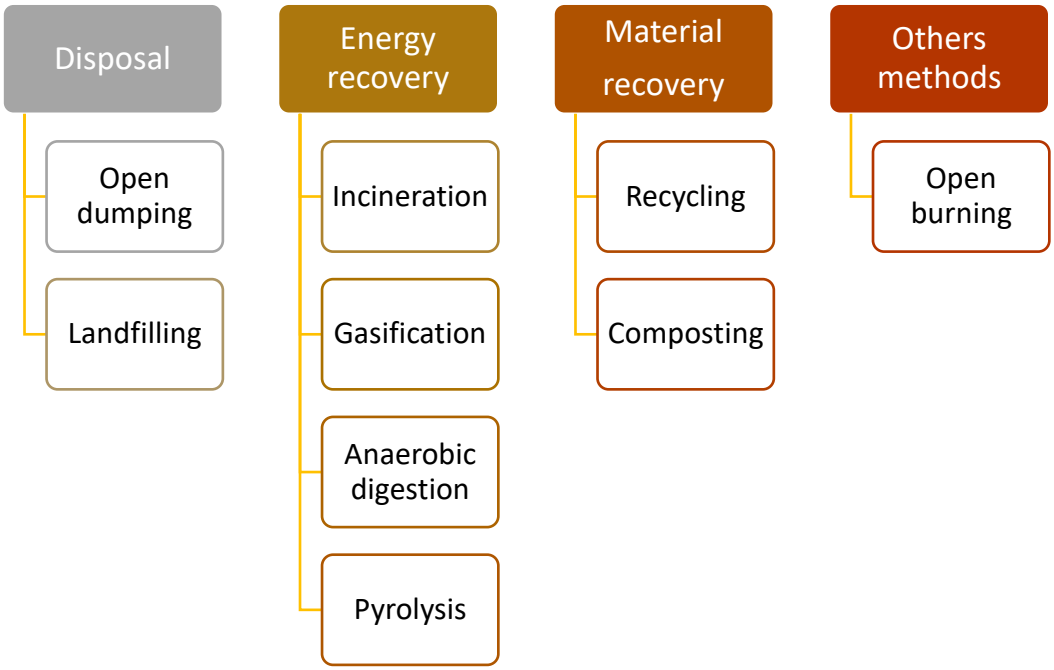

Figure 5. MSWT methods and technologies.
Source: Nixon et al. (2013); Chaerul et al. (2014); Vaverková et al. (2018); Wang et al. (2018a)

2.3.1. Disposal of municipal solid waste

Disposal of MSW composes of two main alternatives – open dumping and landfilling. Open dumping is still most common waste disposal methods mainly in developing countries followed by unsanitary landfills (Mishra et al. 2018).

Landfilling is the simplest, inexpensive and the most economical way as well as least environmentally friendly method of MSWM (Ogunlaja et al. 2019). Even though, this method continues to be widely used in many countries, including above all developing countries either highly developed ones (Behrooznia et al. 2018; Vaverková et al. 2018). Landfills are a potential threat to human health and the environment, it is necessary that they be constantly monitored, and their composition and types of waste at different stages of their use controlled (Vaverková et al. 2018).

Sanitary landfill is a method of controlled disposal of MSW on land. Waste is disposed in thin layers up to 1 metre and compacted by heavy machines as bulldozers. Several layers are placed and then compacted on top of each other to form a stabile refuse cell up to

3 metres. Every day these cells are covered with a layer of compacted soil to prevent odours and windblown debris (Britannica 2018). Also, a bottom liner and surface cover of landfill are playing the main role to avoid generation of leachate from disposed waste. The bottom liner is constructed at the beginning of landfill operation; final surface layer in the end of landfill operation and systems that are commonly used as these layers are evapotranspiration cover, capillary barrier, and compacted soil (Rahardjo et al. 2017).

Unsanitary or uncontrolled landfilling is still applied by more than half of the global population and the highest accumulation of this method can be seen in developing countries (Cossu, 2010). Unsanitary landfills operate below acceptable standards, wastes are typically not appropriately sorted, and therefore toxic gases and leachates are freely released to surrounding environment (Ogunlaja et al. 2019). These types of landfills without energy recovery or emission control systems could cause irreversible impact on the environment, namely air, soil and groundwater pollution as well as negatively affected human health (Behrooznia et al. 2018). Unsanitary landfill air pollution is caused by degradation of organic matter. Compounds like methane, carbon dioxide and nitrogen dioxide are the major emission pollutants and, in the case of methane, can cause explosion (Gollapalli & Kota 2018).

Open dumping is unsanitary waste disposal highly widespread in developing countries where about 40% of waste volume is disposed by this method or by illegal sites (Alam et al. 2017; Yadav & Samadder 2018b). These are usually shallow or open piles, generally poorly or not compacted at all. There is no control of any generated pollutant and scavenging of different types of material by animals and people occurs often as well (Alam et al. 2017).

2.3.2. Energy recovery of municipal solid waste

Energy recovery or waste-to-energy (WtE) systems describes a process that generates energy from different types of MSW. The most widespread technology is waste incineration, also, there are others like waste pyrolysis, gasification and anaerobic digestions. Each mentioned technology is able to provide energy in form of heat, electricity or gas (Nixon et al. 2013; Consonni 2015).

WtE incineration plants are complex and industrial installations that offers energy profit, sensible waste treatment method and rapid decrease of waste volume. On the other hand, waste incineration plants are expensive to build and operate. In these plants combustible material is burn in combustion chamber and generated heat is used to steam turbine generator (Breeze 2017). Modern waste incineration plants could obtain energy from waste with very low impact on the environment (Consonni 2015).

Pyrolysis and gasification are more advanced methods of waste energy recovery. Both requires high temperature, special combustion chambers and high financial input. Also, both ensure destruction of waste complex (Breeze 2017). Pyrolysis is thermochemical process that is conducted in the absence of oxygen and is not only energy recovery system but also produce by-products that have possible use as valuable feedstock. In case of pyrolysis the by-products are gaseous or solid, liquid that can be burnt to generate electricity or used in other process (Breeze 2017; Ding et al. 2018; Till et al. 2018). Gasification in comparison to pyrolysis requires limited oxygen amount during the process. This technology normally generates a low energy content gas which can be burnt to generate energy for instance in conventional steam generating boiler or fuel for piston engine (Breeze 2017; Ding et al. 2018).

Anaerobic digestion process of waste is decomposition of organic matter into gas, digestate and fugate in the absence of oxygen. Gas is consisted primary from methane and carbon dioxide (Ding et al. 2018). Anaerobic digestion of MSW is relatively new, challenging and still in development (Fan et al. 2018).

2.3.3. Material recovery of municipal solid waste

Material recovery of MSW coveres two options: recycling and composting. These methods require MSW pre-treatment and sufficient collection, thus are well developed in developed countries and poorly or not at all in developing countries (Kofoworola 2007; Zink & Geyer 2018). This method insists involvement of public sector, respectively separation of recyclable or compostable material starts at household level (Farrell & Jones 2009). Material recovery of MSW can save energy, resources, reduce emissions and reduce volume of waste imported to landfills (Oduro-Kwarteng 2016).

Recycling of MSW is crucial step to sustainable society where MSWM strategies should promote effective development of waste recycling and stimulate reuse of different materials (Expósito & Velasco 2018). Well-known valuable materials suitable for recycling are plastics, paper, glass and metal. Also, materials like textiles, oils, and tonners could be recycled. In environmental assessment methodologies such as LCA it is assumed that recycling of these materials prevents production, source extraction and therefore impact of similar materials from raw inputs. On the other hand, recycling can delay the time till final disposal of this material but not prevent any existing end-of-life material (Zink & Geyer 2018).

Composting is biological degradation of organic matter under controlled conditions to form humus-like material. The process is carried out by diverse population of microbes that vary both temporally and spatially. The temperature changes over the time with microbes' activity. Generally thermophilic temperatures are involved as a result of biologically produced heat (Farrell & Jones 2009). The matured compost can serve as soil conditioner in agriculture as bio-fertilizer or for gardening purposes. The matured compost is characterized by diverse parameters such as pH value, electrical conductivity, C/N ratio and others (Kazemi et al. 2016). Composting represents an important component for advanced MSWM. As landfilling is still the most widespread MSWT method, extraction of organic matter and following composting process can significantly reduce odour, methane production and leachate pollution (Ball et al. 2017). There are three main methods suitable for composting of MSW and commonly used in developed countries: aerated static-pile; enclosed and windrow (Kumar 2011).

2.3.4. Other municipal solid waste treatment methods

These methods are considered as illegal in developed countries. However about one billion ton of waste is open burnt mainly in developing countries. Open burning refers to combustion of any matter in such a manner that products of burning are emitted directly into environment without passing through an adequate filter or equipment (Kumari et al. 2017). Open burning takes place not only at household level but also at dump sites or TPAs due to the lack of technology and efficient MSWM. Open burning at dump sites causes high environmental pollution and explosion of methane occurs frequently (Forbid et al. 2011). Besides of open burning, there are others similar

methods widespread in developing countries. Dumping of waste on roadsides, abandoned lands, rivers or small channels are unfortunately common methods of MSW treatment practised in both remoted and municipal areas in developing countries (Pansuk et al. 2017).

2.3.5. Municipal solid waste treatment in Indonesia

In Indonesia, the MSWM and its treatment is majority represented by two options: open dumping or landfill. Inhabitants and government of Indonesia follow paradigm of collecting-transferring-dumping method that can be used if open dumping is excluded and if the landfills are sanitary and there is no problem increase of land providing for final disposal sites (Susmono 2017). The current general method of MSWM in Indonesia is collect-transport-dispose. The authorities of waste management transport waste from TPS to TPA and most of the local authorities try to undergo changes from open dumping to sanitary landfill (Lokahita, 2018). Furthermore, there are attempts to implement waste-to-energy technologies. Material recovery methods in the case of composting are quite known, however recycling of different wastes is still challenge for Indonesia. Other methods of MSWT as open burning are still widespread across the whole country, especially villages and small islands use this method as sole solution of MSWT. Figure 6 shows MSWT methods and technologies in Indonesia and its percentage representation (Yadav & Samadder 2018b).

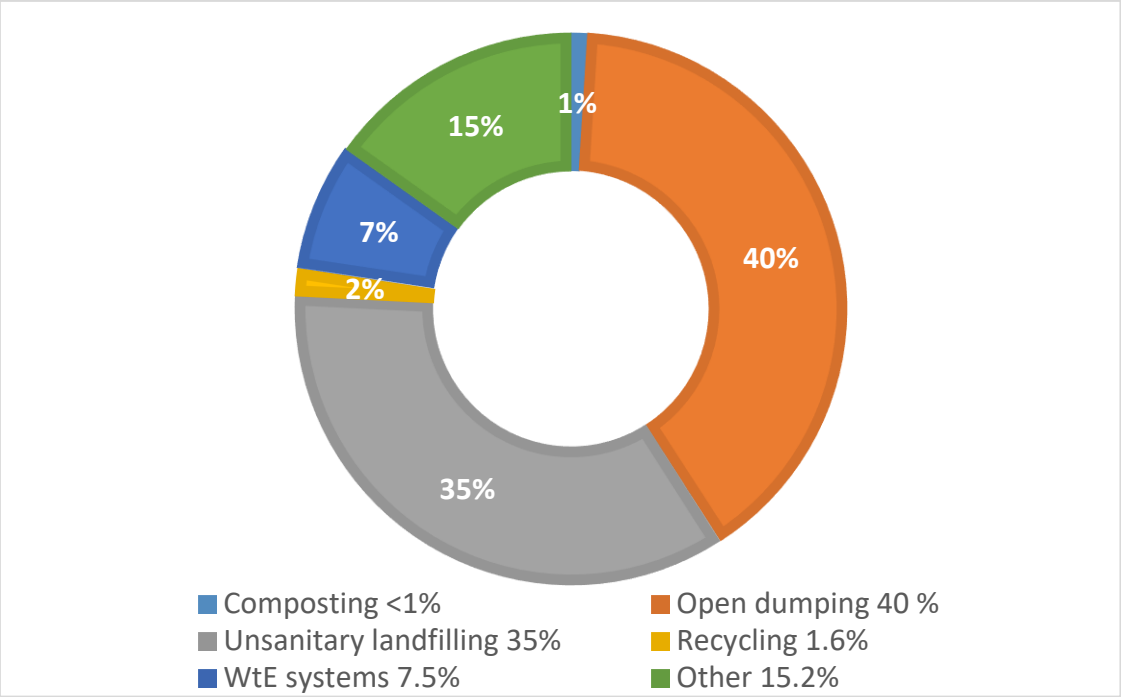

Figure 6. MSWT methods and technologies in Indonesia.
Source: Yadav & Samadder (2018b).

In Indonesia, small scale open dump sites are established in almost every village throughout the country, especially at small islands. In municipalities MSW is firstly collected and transferred to temporary disposal sites called TPS. Across Indonesia there are about 59 thousand of these sites, basically they are open dump site areas inside the municipality sometimes equipped by storage containers. These sites are often overwhelmed with rotting organic matter, flies and rodents. Valuable wastes, like plastics, glass, paper and metal, are removed by waste pickers or scavengers (Dethier 2017).

In Indonesia, it is common to find unsanitary landfills rather than sanitary and these landfills are called dumpsites (Chaerul et al. 2014; Dethier 2017). Collected waste is transported to one of the 537 official TPA. Almost every municipality operate own dumpsite within the city boundaries. Most of these dumpsites lack a lining or other soil and groundwater protection, thereby causing a direct pollution to the environment. (Dethier 2017). Furthermore, the leachates generated from landfills can pollute ground and surface waters, raising lots of public health concerns especially among communities located nearby MSW landfills. These communities using groundwater for irrigation of fields for food crops, thus polluted water has direct impact on the crops' consumers

(Ogunlaja et al. 2019). About 40% of the dumpsites have some kind of leachate monitoring, collection, and treatment system, mainly through basic sand filtration technologies. Landfill gas treatment is hardly applied all over the country. As a result, solid waste dumpsites throughout Indonesia emit an estimated 900 tons of methane each year that have a potential to be used as energy at proper handling (Dethier 2017).

Stability of landfills or dumpsites is one of the major geotechnical issue in MSWM. Events like disastrous solid waste slides or waste avalanches have been documented. The second deadliest event in the history took place 21st February 2005 at the Leuwigajah dumpsite, near Bandung city, Java, Indonesia. The waste slide buried 71 houses and killed 143 people (Lavigne et al. 2014). Luwigajah landfill has been operated since 1986 till above mentioned waste slide, during this period the total volume of dispose waste was 25,550 metric tons. The waste came from Bandung city, Bandung district and Cimahi city. Leuwigajah dumpsite was rather open dumping method of waste disposal, which did not have any facilities such as fences and liners. Despite the investigation between years 1990 and 1992 concluded Leuwigajah dumpsite as not suitable for landfilling in terms of security and environment point of view (Aryanti et al. 2017).

Except waste disposal methods Indonesia tries to apply WtE technology and other alternatives to decrease waste volume and negative impact on the environment. Unfortunately, there is only 3 incineration plants and no further replication happened (UNEP 2017). Several authors (Nixon et al. 2013, Susmono 2017; Sudibyo et al. 2017) mentioned that at multiple stakeholders from governments to municipality inhabitants raise the spectre of this technology and they are rejecting plans and programmes to implement waste incineration plant. Good example is the project: PTCPS – Medan Waste Incineration Power Plant – at Sumatra, Indonesia. In the first quartile of 2015 the project was announced and from this time it is still administratively prepared and edited. Last check-up took place on April 2018 and there was not any shift to implementation (Timetric 2018). Moreover, Indonesia tries to apply process of anaerobic digestion and biogas power plants. Several development projects have been implemented in this field since 1970 with engagement of international organization, e.g. government of Indonesia established biogas power plant using waste from dump sites (Alberdi et al. 2018).

According to UNEP (2017) and Alberdi et al. (2018) biogas stations are widespread across Indonesia in small-scale units and currently rarely used for MSWM.

Energy recovery technology of MSWT in Indonesia are not well developed or are not implemented at all. That fact affected several reasons as lack of government support (Dethier 2017; Susmono 2017), low public awareness (Nixon et al. 2013; Susmono 2017; Sudibyo et al. 2017; Alberdi et al. 2018), lack of financial resources (Dethier 2017; Breeze 2017). In addition, these technologies are complex system of MSWM comprises infrastructure, collection, separation and pre-treatment of MSW, thus are not adequate developed in Indonesia (UNEP 2017; Wang et al. 2018a; Yadav & Samadder 2018b).

Recycling of MSW in Indonesia is primary carried out by informal sector and handful of formal government services. Lack of public awareness about MSW handling, poor infrastructure lead to the formation of scavengers or waste pickers communities. In Indonesia, activities of informal sector are not considered as illegal. This sector consists of unregistered individuals, communities or small businesses (Sasaki 2014). Scavengers collect valuable waste as plastics, glass or metals disposed from streets, TPSs, and TPAs. This sector is not controlled by government, thus evades rules and regulations e.g., minimum wages, work place safety and children labour. Also, government relies on waste pickers' activities (Chaerul et al. 2014). Living and working conditions of scavengers are dangerous due to different causes of health risks, especially those who live directly on TPAs (Sasaki et al. 2014). Waste picker´s activities bring some benefits to individuals as time flexibility, immediate cash and others. Valuable garbage that is collected by waste pickers are sold to waste banks or businesses to processing and recycling (Chaerul et al. 2014). Waste banks in Indonesia, buy back valuable waste. In Bandung there is several waste banks e.g., Hijau Lestari, that buys back materials from waste pickers and contracted households. Hijau Lestari also provides demonstration field, gallery with reused waste, awareness of 3R but only at its place (Hijau Lestari 2019).

Composting is widespread in Indonesia mainly in small-scale units and at individual level. Composting is not so common in Bandung city core, on the other hand in metropolitan area of Bandung, especially in Cimahi, composting is more widespread. Nowadays, the

municipal government of Bandung initiating and controlling small-scale composting sites mainly at places as TPS. Still, the estimated waste recycling and composting by stakeholders have not yet achieved 10% (wet weight) of the total waste generated (Damanhuri et al. 2009).

Issues as open burning, open dumping to the rivers and streets are not exceptional for MSWMT methods in Indonesia. Generally, in the rural areas, inhabitants burn agriculture waste, while at the metropolitan area occurs phenomenon of open burning, and open dumping of MSW to rivers or streets and this highly correlated with unavailable or insufficient MSWM practices and services (Andarani et al. 2018).

2.4. Policies and regulation in Indonesia

Indonesia is administratively divided into 34 provinces and more than 460 municipalities. MSWM is responsibility of these municipalities or so-called local governments (Sudibyo et al. 2017). In Indonesia, two ministries carry the major responsibility for waste management: Ministry of Environment - responsible for solid waste handling regulations and Ministry of Public Works - responsible for urban infrastructure development (Susmono 2017). Introducing a law, act No. 18/2008 concerning municipal solid waste management was a new milestone for waste management policies in Indonesia. This brings legal consequences that the government is the authorized and responsible party in the field of MSWM even though operationally the management itself can partnering with business entities. This law also direct waste management policies to the zero-waste concept by emphasizing the high importance of the role of the community and its engagement in MSWM activities (Barnadi 2010). Most of local governments struggle with MSWM decision making because so many aspects and complexity of this issue such as choosing appropriate technology, finding suitable location for solid waste transfer station and dumping sites or landfills, developing waste management itself, limitation of affordability and shortage of budgets (Susmono 2017). Several authors and studies also concur that last but not least rather challenge than struggle is changing people behaviour and involving them into the process of MSWM to achieve positive outcomes (Nixon et al. 2013; Chearul et al. 2014; Susmono 2017; Wang et al. 2018a; Khandelwal et al. 2019).

Indonesia has set up major policies, programmes and strategy/plans for MSWM. Unfortunately, these are not well implemented and enforced at all governmental levels as well as awareness of public sector faces the lack of initiative from government (UNEP 2017). Since the act No. 18/2008 has been implemented, above mentioned stakeholders have started to change their paradigms about MSWM which consisted of collecting-transferring-dumping system to that in municipal waste handling is essentially to reduce waste as soon as possible (Susmono 2017). Simply put, act No. 18/2008 introduces MSWM by reduction and handling. Reduction include 3R concept and handling include waste separation, collection, transportation, and appropriate waste treatment solution (Raharjo et al. 2017). In addition, every municipality is responsible for MSWM and often engage additional regulations from different governors. The MSWM policy in the city of Bandung is aimed on improving public health and environmental quality and making waste as a resource (Barnadi 2010). Bandung city follow regulations at national, provincial and municipal level (Indartik et al. 2018). MSWM is a subject of interest of 13 regulations that are shown in Table 2.

Table 2. Regulation on waste management in Bandung city.

	Regulation	Level	Related to
1	Ministry of the Environment, Act No. 18/2008	National	Municipal solid waste management
2	Ministry of the Environment, Act No. 32/2009	National	Management of the environment
3	Ministry of the Environment, Regulation No. 81/2012	National	Household waste management
4	Minister of Home Affairs Regulation No. 33/2010	National	Guidelines for waste management
5	Minister of Public Work Regulation No. 03/2013	National	Garbage infrastructure and facilities in household waste handling and household waste.
6	Government Regulation No 18/2016	National	Local government
7	West Java Regional Regulation No. 12/2010	Provincial	Municipal solid waste management in West Java.
8	Regulation of Bandung City No. 11/2005	Municipal	Order, cleanliness and beauty *(Ketertiban, Kebersihan dan Keindahan (3K))*
9	Regulation of Bandung City No. 8/2008	Municipal	Regional long term development plan 2005 – 2025
10	Regional Regulation of Bandung City No. 14/2011	Municipal	Bandung city cleaning company
11	Regional Regulation of Bandung City Number 09/2011	Municipal	Municipal solid waste management in Bandung city
12	Municipal Regulation of Bandung No 316/2013	Municipal	Waste management service rates
13	Regional Regulation of Bandung City No. 8/ 2016	Municipal	Formation and composition of regional government of Bandung city

Source: PD Kebersihan (2016); Indartik et al. (2018).

In addition, attention, besides the regulations and policies, must be given to proper budget for local governments. Average annual fee for MSWM services in Bandung city is 2.5 USD per capita, while average annual cost of MSWM services per capita is 4 USD. Increase of fees prices could results in higher sufficiency of MSWM services as well as raise of different awareness campaign, workshops and investments to education either (Munawar et al. 2018).

2.5. Public perception and approach on the municipal solid waste management in Bandung

Regarding MSW, public and people themselves are the main factor that has significant role in MSW generation amount. To determine a public perception and approach on MSWM is a mean to understand the way of people's thoughts about MSWM practices and MSWM services. Therefore, learning public perception and approach is an essential source of information to find possible influential factors that affect MSW as well as to find out appropriate and suitable solution for MSWM (Sukholthaman et al. 2017). Successful MSW minimization and handling require public interaction in the decision-making process. This interaction could steer towards different point of view, e.g. municipal solid waste management services (available containers and bins, awareness campaign and workshops, demonstration field), technology or method for MSWT accepted by society in particular place, and others.

The aspect of public interaction has been acknowledged to play essential role in the MSWM planning in several studies (Barnadi 2010; Triguero et al. 2016; De Gisi et al. 2017; Hunter et al. 2017). However, this aspect has been poorly investigated in Bandung city even whole Indonesia either (Siyaranamual 2013). In addition, regional regulation on waste management in Bandung has referred to article 5 and article 6 of the law No. 18, year 2008 also mandates that public sector, waste management organizations, and community groups engaged should be included in MSWM activities (Barnadi 2010).

Formation and change of public perception and approach on MSWM are interwoven. People are adopting, modifying and resign to fit the ever-changing needs and interests. Attitude cannot be changed by simple education because acceptance of new approach and perception depend on who is presenting the knowledge, how is it presented, what is the position of the person or organization, the credibility of the communicator, and the conditions by which the knowledge was received. With an increase in knowledge of MSWM, there may be a change in attitude to this issue. However, change in perception and approach or behavioural change take long time (Al-Rabaani & Al-Mekhlafi 2009; Asmawati et al. 2012).

Despite all these facts mentioned above, external communication to the community in Bandung is only at the appeal of the installation of billboards in certain places such as "Dispose trash here", "Throwing garbage is prohibited", "Keep clean", and "Do not throw trash into the river". The Bandung city government does not have a special program that intensively handles the dissemination of urban waste management policies in the form of waste management (Barnadi 2010).

3. Aims of the thesis

The Master's Thesis was focused on evaluation of waste management situation in Bandung city. Special emphasis was put on the perspective of satisfaction of the city inhabitants, public's perception and attitude to this issue. The main objective of this Thesis was to analyse the public perception and approach of inhabitants to MSWM and determine the factors that influence a behaviour in Bandung city, Indonesia.

Specific objectives:

- To analyze factors likely to influence an interest of inhabitants in MSWM in Bandung
- To assess a willingness of inhabitants to pay for sufficient MSWM services in Bandung.
- To describe a public perception and approach on MSWM in different districts of Bandung city and metropolitan area.

4. Methodology

4.1. Study area description

The research was conducted in the city of Bandung located in the area of West Java and is the capital of West Java Province, Indonesia (see the Figure 7). In addition, in this Thesis the study was divided into four districts of the city, namely: Timur, Utara, Selatan, Barat, and metropolitan area. The total area of urban core is 167.67 km^2 and the total metropolitan area, which includes Cimahi city, Bandung Regency and West Bandung Regency, is 3,280 km^2 (see Figure 8). The urban area in 2017 had over 2.5 million inhabitants and metropolitan area of Bandung had over 8 million of inhabitants (BPS Kota Bandung 2018). After Indonesia independence declaration in 1945, Bandung city experienced rapid urbanization and development, mainly in economic and technology sector, and transformed the small town into a dense 16,500 people/km^2 metropolitan area. Natural resources have been extremely exploited and destroyed, particularly by conversion of protected areas to buildings plats. Also, the city has many problems, the most discussed issue today is insufficient MSWM followed by complicated traffic system resulting from a lack of road infrastructure (Tarigan et al. 2015).

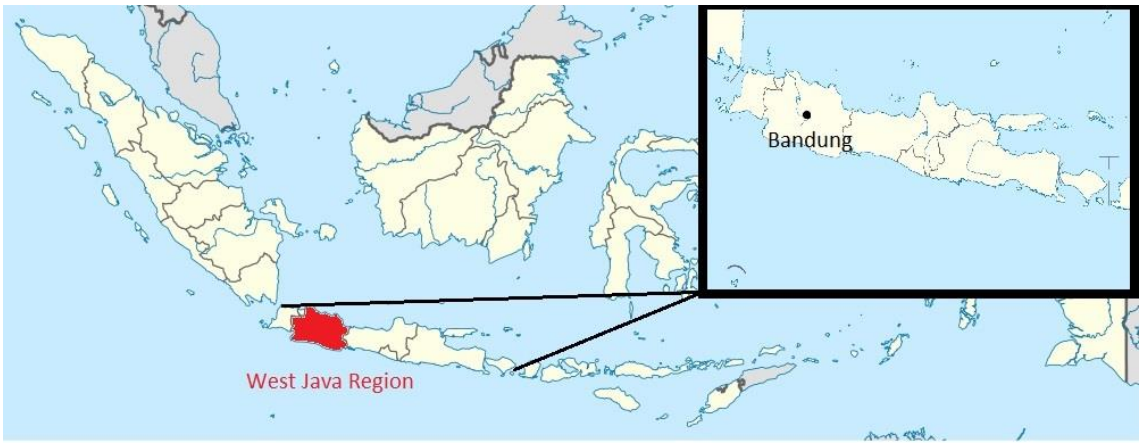

Figure 7. Map of Indonesia with highlighted West Java Region and Bandung city.

Source: ResearchGate (2019), adjusted by author

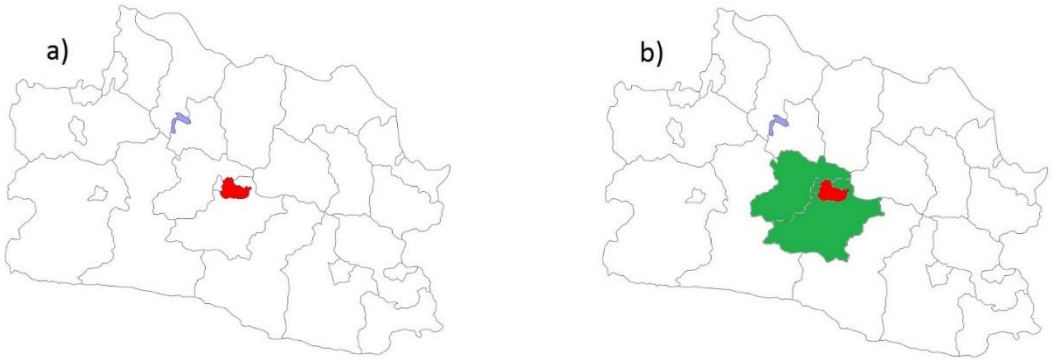

Figure 8. a) Representation of Bandung urban area in West Java Region;
b) Representation of Bandung metropolitan area in West Java Region.

Source: ResearchGate (2019), adjusted by author.

Bandung faced environmental disaster in 2005, when the landfill in Leuwigajah has collapsed, buried a village, Kampung Gajah, and killed more than 140 people, as it was mentioned above (Lavigne et al. 2014). Accumulation of MSW causes air pollution by open burning, the spread of disease and water contamination due to improper municipal solid waste handling. The provincial government so far, has not succeeded in resolving the issue of adequate MSWM system and involving public sector. Nowadays Bandung city faces urgent need to involve public sector through awareness of waste reducing and proper handling to decrease MSW volume produced in the city (Tarigan et al. 2015).

4.2. Data source

In this Thesis were used two types of data sources. Secondary data sources contributed and broadened understanding of the issue before the field research. Primary data were collected through application of several methods and were used as a base for the further study.

4.2.1. Secondary data sources

The main sources for secondary data were available scientific journals such as: Waste Management, Journal of Cleaner Production, Journal of Material Cycles and Waste Management, Journal of Environmental production. Moreover, secondary data sources include overviews, governmental reports and UNEP reports. Secondary data were searched in scientific databases as Web of Science, ScienceDirect, EBSCO and Google

Scholar. Keywords as municipal solid waste, regulations and awareness were used. Furthermore, additional important data was obtained through official website of PD Kebersihan cleaning service company and Hijau Lestari waste bank. Sources used for literature review were in English and Indonesian (Bahasa) languages.

4.2.2. Primary data sources

For more accurate information several data collection methods were used. Structured questionnaire, and interviews with inhabitants of Bandung, several officers from the government, landfill and waste banks. In addition, direct observation and photo documentation were used as a source for primary data collection methods that resulted to a better understanding of this issue. In the Appendix 4 are included photos from survey and study area.

Structured Questionnaire

As the tool for collection of primary data was chosen structured questionnaire. It was assessed as the most appropriate research instrument for data collection in aspect of short time period allowed for gathering information from target group, and high number of respondents.

Questionnaire was conceived in Indonesian (Bahasa) language and included 26 questions of various forms: single response with nominal categories, single response, multiple-choice responses and open-ended questions (see Appendix 2 questionnaire in English). Contained questions were divided into several sections:

0. **Demographic indicators** – gender, age, locality, education level and average monthly income
I. **Waste management indicators** – satisfaction with waste management services, waste handling, waste separation possibility, availability of waste management services, sufficiency of waste management services, percentage composition of waste.
II. **Public perception and approach on MSWM** – awareness of 3R concept, interest in waste management, willingness to take part in workshops, importance of education, and sufficient available awareness of waste management.

III. **Municipal feasibility of WM services** – duty to pay taxes, willingness to pay for services, waste management by government.

IV. **Municipal solid waste treatment** – usage of waste, knowledge of different method and technologies, acceptance of different method and technologies.

Inconvenient sampling method and snowball method were used to select respondents. More than half of questionnaires (182) were collected face to face, rest of questionnaires (152) were collected through social media. The questionnaire was shared with my colleague. For purposes of this Thesis were used sections I., II. and III.

Pilot testing

Pilot testing of questionnaires was held during first days of survey in Bandung with cooperation of consultant Dr. Yayan Satiakti from Padjadjaran University, Centre for Economic and Development Studies. Questionnaire was tested by 10 respondents in the Bandung municipality. Consequently, there was a modification of questionnaire after pilot testing in combination with observation of the study area, and the final set of questions was composed.

Interviews

Beside the questionnaire survey, three types of a personal interview were carried out (see Appendix 3). First type of interview was designed for officers from the local government (n=2). Second type of interviews engaged several officers from TPS, TPA Sarimukti, waste banks and Bandung Resik (n=5). Third type of interview was carried out with several inhabitants of Bandung (n=5). Every type of interview contained 4 questions, leaded in Indonesian (Bahasa) language and translated by Dr. Yayan Satiakti to English. Types of interviews:

I. **First type** – services of WM provided to inhabitants, rising of awareness, barriers for implementation of different MSW treatment methods and technologies, priorities in MSWM planning.

II. **Second type** – Functioning of service, sufficient awareness about operations, place adequation, opinion of changes.

III. **Third type** – description of MSW services, sufficiency of MSW services, adequacy of provided MSW services, opinion of changes.

Observation

For more complete picture of the study area, formal observation was undertaken through Bandung municipality, TPSs, waste banks and TPA Sarimukti. Information obtained from observation completed understanding of MSW handling and available awareness for public sector in Bandung.

4.3. Time frame

Total time period for whole Thesis writing (from reading for literature review till final submission of the Thesis) lasted from March 2018 to April 2019. Phases of this Thesis are shown in Table 3. The first phase of the Thesis was theoretical preparation when objectives and methodology were determined. Second phase was the direct primary data collection process in the study area in Bandung, Indonesia. The third phase included data processing, coding and analysis. For data analysis and interpretation were used statistical software Statistical Package for the Social Sciences (SPSS) and econometric software Stata 13.

Table 3. Time frame of the Thesis.

	March 2018 - July 2018	August 2018 - October 2018	October 2018 - January 2019	February 2019 - April 2019
First phase				
Secondary data analysis				
Formulation of objecticves				
Formulation of methods				
Questionnaire design				
Second phase (in Bandung)				
Pilot testing				
Questionnaire data collection				
Interviews				
Observation				
Third phase				
Data processing and coding				
Data analysis				
Data interpretation				

Source: Author (2019).

4.4. Target group

In this Thesis, I focused on inhabitants living in Bandung city. Respondents for questionnaire survey were chosen based on the following criteria:

I. To have age of 18 or more
II. To have Indonesian citizenship
III. To live in one of four districts of Bandung or metropolitan area
IV. To not be working in any government sector

Respondents for interview were chosen on the same base except criterion number IV. The total number of questionnaire survey respondents was 334. The total number of respondents for interviews was 12. Descriptive statistics of the target group divided by locality regarding public perception and approach on MSWM are presented in Appendix 1.

4.5. Data analysis methods

Primary data were analysed by two types of methods. For the first specific objective of this Thesis, public interest in MSWM in connection to the environmental issues, were modelled as binary choice (inhabitants were either interested or not in MSWM). For this specific objective analysis I decided to apply a binary probit model that has been introduced in several statistical journals and econometrics textbooks (Borooah 2002; Greene 2012; Feddag 2014). For the second specific objective to assess willingness of inhabitants to pay for sufficient MSWM services was applied a Pearson´s Chi-square test to determine factors of dependence. The third specific objective, description of public awareness and approach in four districts and metropolitan area, was analysed by descriptive statistics.

4.5.1. Chi-square test of independence

The Chi-square test of independence was used to determine whether there is a statistical independence or association between two or more categorical variables. The Chi-square test of independence can compare categorical variables. According to Babucea (2017), the Chi-square test of independence was used as follow:

$$\chi^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(o_{ij} - e_{ij})^2}{e_{ij}}$$

Where, o_{ij} is the observed cell count in the ith row and jth column of the table, e_{ij} is the expected cell count in the ith row and jth column of the table, computed as:

$$e_{ij} = \frac{row\ i\ total\ \times col\ i\ total}{grand\ total}$$

Also, in this this Thesis was used Fisher's exact test. This test is variant of Chi-square test and is used when number of observation in the sample are less than five. Following Good (2006) the Fisher's exact test was used in this form:

$$p = \frac{(\,(\,a\,+\,b\,)!\,(\,c\,+\,d\,)!\,(\,a\,+\,c\,)!\,(\,b\,+\,d\,)!\,)}{a\,!\,b\,!\,c\,!\,d\,!\,N\,!}$$

Where *a,b,c* and *d* are the individual frequencies of the 2x2 contingency table and *N* is the total frequency.

In the case of this thesis, I assessed associations between willingness to pay for sufficient MSWM services and other variables, namely: gender, age, years spent in Bandung, level of education, monthly income, satisfaction with MSWM practices, interest in MSWM, sufficient awareness about waste handling and recycling. Prices of hypothetical taxes were divided into 3 groups:

- Less than 30,000 IDR
- 30-50,000 IDR
- More than 50,000 IDR[1]

Yeung and Chung (2018) applied Chi-square test of independence to determine relationship of willingness to pay for MSWM services and variables such as knowledge, income, education etc. in Hong Kong.

4.5.2. Binary probit model

The binary probit model is a regression model in which the dependent variable is a binary random variable taking values zero or one (Horowitz & Savin 2001). The probit analysis provides statistically significant finding of which factors are likely to increase or decrease influence of the dependent variable (Uzunoz & Akcay 2012).

Several studies (Tadesse 2009; Afroz & Masud 2011; Agovino et al. 2016; Loan et al. 2019; Zhang & Zhao 2019) concerning municipal solid waste management used binary probit model.

The binary probit model in this thesis was used to analyze factors likely to influence interest in MSWM in connection to the environmental issues of public sector in Bandung city as it was mentioned above. Public interest was described as binary variable with the value 1 if the respondent is interested and value 0 If the respondent is not interested.

According to Winkelmann and Boes (2006) the binary probit model in following form was used.

$$Yik = \beta 1Xi + \epsilon i$$

[1] 100,000 IDR is approx. 7 USD.

Where *Xi* represent a set of all explanatory variables, *β1* is a vector of estimated parameters and *εi* is an error term. *Yik* is a dependent variable where *k* denotes if the respondent is interested in MSWM.

The system of equitation describing binary choices of respondents of questionnaire is following:

$$y_i^* = \begin{cases} 1 if y_i^* > 0 \\ 0 if y_i^* \leq 0 \end{cases}$$

or, more compactly:

$$y_i^* = I(Y_i^* \geq O)$$

Where *I* is an indicator function that returns 1 if the argument is true or 0 if the argument is false.

Multicollinearity

Multicollinearity refers to the linear relationship among two or more variables that indicates near dependence. This is a condition of deficient data that cause difficulties in binary probit model between response variable *y* and explanatory variable *X* (Alin, 2010). Presence of this phenomenon was tested by variance inflation factor (VIF).

The right VIF value is frequently discussed topic among scientific community. According to Curto and Pinto (2010) the VIF value should be less than 10. Kalnins (2018) stated that if the VIF value is less than 10, 8 or 5 the multicollinearity is not likely to exist.

VIF was tested by equation according to Greene (2007):

$$VIF_k = \frac{1}{1 - R_k^2}$$

Where R_k^2 is the R^2 - value obtained by regressing the k^{th} predictor on the other specified explanatory variables. Variance inflation factor is calculated for each of the *k* predictors included in binary probit model.

In addition to estimation probabilities, for better understanding of possible changes marginal effect was used. Marginal effect determinates how the dependent variable

changes if an explanatory variable change. Following Hasebe (2013), the marginal effect for binary variables was calculated by following equation:

$$Prob[y_n = 1|x_n, d_n = 1] - Prob[y_n = 1|x_n, d_n = 0]$$

Where x_n is computed at sample mean valuables.

4.5.2.1. Description of explanatory variables

Explanatory variables expected to influence public interest in MSWM are presented in Table 4. The variables include socio-economic characteristics of respondents, waste management indicators and waste management awareness. Particular explanatory variables were: gender, age, education level, locality, and satisfaction with MSWM, sufficiency of awareness about waste handling and sufficiency of awareness about waste recycling. Each variable and reason for its inclusion into the model is described below.

Gender: it is nominal variable taking value 1 for female and 0 for male respondent. Gender of the respondent was included to see possibility of different perception of interest in waste management between male and female respondents. Gender influences perception of interest in waste management in the aspect regarded to environmental issues (UNDP 2003; Al-Khatib et al. 2009).

Age: it is nominal variable divided into three groups. First group, coded as 1, including respondents in age (years) interval 18-24, second group, coded as 2, age interval is 25-39, and last group, coded as 3, is 40 and more. According to several studies (Lee &Paik, 2011; Talalaj & Walery 2015) age of respondent is important factor influencing interest in waste management. Generally, younger respondents tend to be interest in waste management due to new trends and recent increasing interest in protection of environment. While the older respondents tended to follow customs of previous generation with low interest in environment, on the other hand, nowadays older generation show increase of interest in MSWM (Babaei et al. 2015).

***Education level*:** it is nominal variable divided into three groups from primary education till university degree. According to Han et al. (2018), generally, higher education enhance public to be interested in waste management.

***Locality*:** is nominal variable covers four districts of Bandung city and metropolitan area. According to Guerrero et al. (2013), interest in municipal solid waste management could be associated with specific locality of the city or country.

Satisfaction with MSWM: it is nominal variable taking the value 1 for satisfied respondents and value 0 for unsatisfied respondents. Requirement of satisfaction from public sector is nowadays increasing mainly due to increasing interest in environment issue and waste management practices in general (López-Toro et al. 2016).

Sufficient awareness about MSW handling: The study results of Pakpour et al. (2014), showed that sufficient awareness about waste handling has important effects on public approach, interest in MSWM, as well as their intentions, moral obligations and participation in waste management.

Sufficient awareness about MSWM recycling: The study results of De Feo and De Gisi (2010), showed that low awareness about MSW recycling is connected with limited interest in municipal solid waste management. In general, the higher the awareness of waste recycling, the greater is the interest in waste management.

Table 4. Variables included in binary probit model

Variables	Definition	Type of variable
	Dependent variable	
Interest in MSWM	Public approach to interest in MSWM in connection with environment	Binary variable (1 = yes; 0 = no)
	Explanatory variables	
Gender	Gender of respondent	Binary variable (1 = female; 0 = male)
Age	Age of respondent (years)	Nominal variable (1 = 18-24; 2 = 25 – 39; 3 = 40+)
Education	The highest educational attainment	Nominal variable (1 = primary education; 2 = higher education; 3 = university degree)
Locality	Respondent's place of live	Nominal variable
Satisfaction with MSWM	Perception of respondent satisfaction with MSWM	Binary variable (1 = satisfied; 0 = unsatisfied)
Sufficient awareness – MSWM handling	Respondent's perception of sufficiency of available awareness about MSWM handling	Binary variable (1 = Yes; 0 = No)
Sufficient awareness – MSWM recycling	Respondent's perception of sufficiency of available awareness about MSMW recycling	Binary variable (1 = Yes; 0 = No)

Source: Author (2019)

5. Results and discussion

5.1. Descriptive statistics results

Demographic indicators

The result on the demographic backgrounds of respondents in study area are presented in Table 5. The results show that composition of gender was almost even with a slight predominance of female respondents. Almost half of respondents is in the age range between 25-39 years, this range is considered to be the age of employed population in Indonesia. Approximately 1/8 of respondents were in age range 40 and more. Majority of respondents had university education, while only less than 5% of respondents had primary education. The proportion of respondents in each city district is quite even, the least respondents are from Barat district and less than 15% are from the metropolitan area of Bandung. Over half of respondents spent in Bandung more than 2/3 of their lifetime, for 84% of respondents, from this category, it was whole life. Majority of respondents had average monthly income range between 2 – 5 million IDR. The least respondents are in category below 2 million IDR average monthly income that is considered as living minimum in Bandung city.

Table 5. Demographic background of respondents.

Variable	Description	Percentage (%)
Gender	Male	47.01
	Female	52.99
Age (years)	18 – 24	38.32
	25 – 39	49.4
	40+	12.28
Education level	Primary	4.49
	Higher	41.92
	University	53.59
Location	Timur	23.05
	Utara	27.70
	Selatan	20.35
	Barat	14.35
	Tengah (metropolitan)	14.65
Years in Bandung	< 1/3 of lifetime	26.05
	1/3 – 2/3 of lifetime	17.37
	> 2/3 of lifetime	56.58
Average monthly income	< 2 mil. IDR	21.86
	2 – 5 mil. IDR	51.79
	> 5 mil. IDR	26.35

Waste management indicators

Majority of respondents (97.6%) were not satisfied with provided waste management practices at all. Disposing of waste was realized mainly (66.5%) through different bins and containers, followed by disposing of waste in plastic bags in front of houses (26%). Even in the city, the waste burning occurred (5.7%). There were other possibilities for waste disposing as direct open dumping to rivers and streets, represented by 1.8% of respondents. Possibility for waste separation from public perception is limited. Through Bandung there are few places that is possible to separate waste to organic / inorganic waste. Other waste separation is available only at waste banks, located at three places in Bandung (see Figure 9). Majority of respondents (87%) would appreciate the possibility to separate MSW to different containers placed on the streets. Availability of waste management services for inhabitants was limited too. Available waste management services showed 21.3% of respondents, while 78.7% of respondents determined waste management services as not available. This result is closely related to waste management services sufficiency evaluation. Majority (83.3%) of respondents

evaluated these services as insufficient, while 16.7% of respondent evaluated services as sufficient.

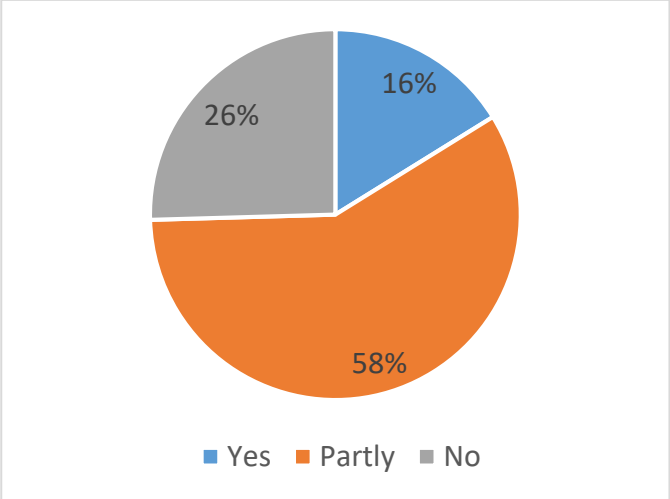

Figure 9. Available possibility of waste separation based on its origin.

Public perception and approach to MSWM

According to the questionnaire survey and interviews, knowledge of 3R concept was well spread among public sector in Bandung city. On the other hand, majority (74%) of respondents evaluated available awareness about waste handling as insufficient. Awareness availability of waste recycling was evaluated by (66.1%) respondents as insufficient as well. Figure 10 reflected respondents' perception of provided awareness of 3R concept, waste recycling and waste handling. Interviews of citizens' and officers' support the questionnaire results.

"I know 3R concept, it was promoted few years ago. Nowadays there is no available awareness about this issue, except few billboards alongside river." (Citizen interviewee).

"At this waste bank, we are promoting awareness, mainly about waste handling, but we are not able to expand this awareness through the town. Main reason is the lack of finances and the government actually prefer awareness about negative impact of corruption." (Officer interviewee).

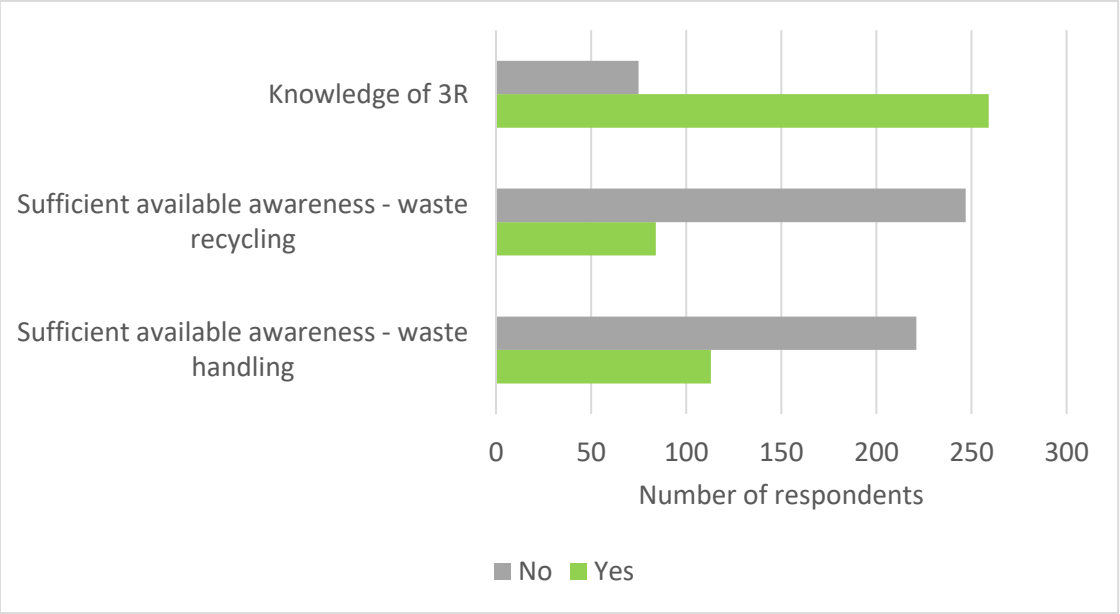

Figure 10. Data analysis results of awareness about MSWM

Questionnaire survey shows that 69.1 % of respondents behave partly according to 3R concept mainly due to low available possibility of waste separation based on waste origin as was mentioned above. Interview from citizen interviewee supported questionnaire results.

"Government provided us only awareness about 3R concept in past few years, nothing more. Nowadays there is problem with waste separation. I know the principle of this concept, but we don't have the opportunity to separate plastics, except to pay to waste bank to collect it or bring it by myself to this organization." (Citizen Interviewee).

On the other hand, government interviewee also claimed providing of other campaigns.

"There was huge campaign of promoting 3R as well as other campaigns about waste handling, recycling and waste treatment methods to improve MSW situation." (Government interviewee).

The results of the data analysis showed that division of respondents who would implemented education about MSWM to primary schools and those who would not was almost equal, e.g. percentage of respondent who answered yes to implement education of MSWM to primary schools was 53.3%, while those who would not implement this type of education was 46.7%. On the other hand, majority (92.8%) of respondents

consider education about MSWM issue as important for sufficient and smooth operation of MSWM activities. Large proportion (93.7%) of respondents would like to participate in workshops or some demonstration field to see effective approach to MSWM. From the study it could be also inferred that 67.1% of respondents are interested in MSWM in connection to environment and their well-being. Figure 11 reflected public approach to MSWM among the respondents.

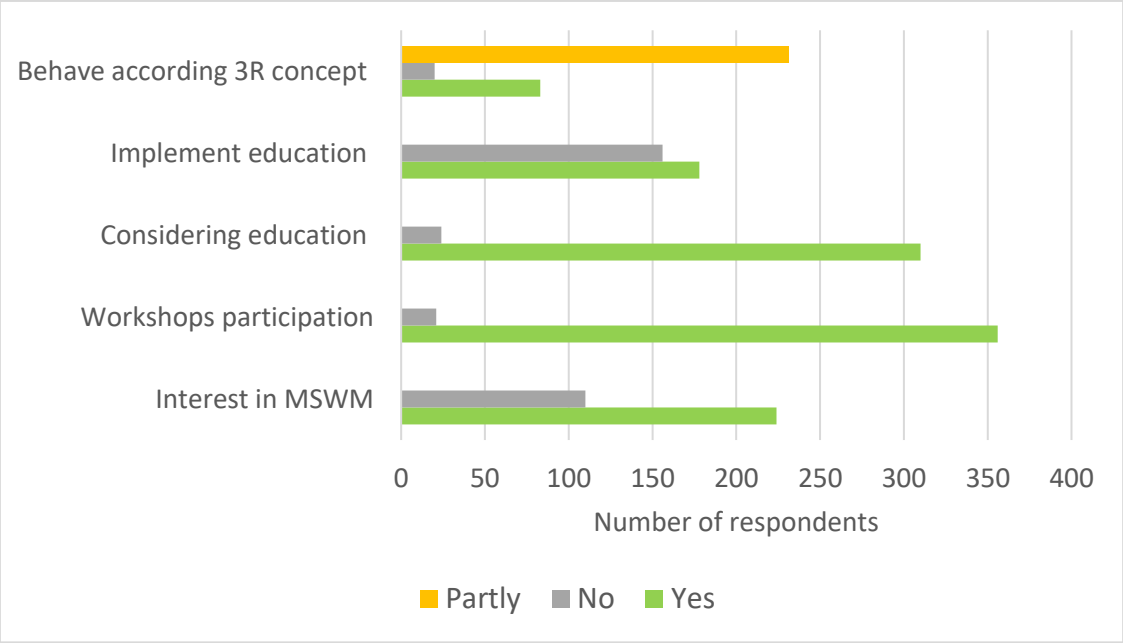

Figure 11. Public approach to MSWM

Municipal feasibility of WM services

The study findings showed that majority of respondents (93.7%) preferred if formal sector (government) take care of MSWM, while only 6.3% of respondents preferred handling of MSWM by informal sector as scavengers, waste pickers, private companies and so on. Also, the study findings showed dominance of respondents (88%) who paid certain taxes to municipality for waste management services. In addition, respondents (59.3%) were willing to pay for sufficient waste management services up to 30 thousand IDR per month, followed by those who were willing to pay in range between 30-50 thousand IDR in above 30%. Minority of respondents (7.5%) were willing to pay more than 50 thousand IDR. Figure 12 visually reflected willingness of respondents to pay certain taxes for sufficient MSWM services.

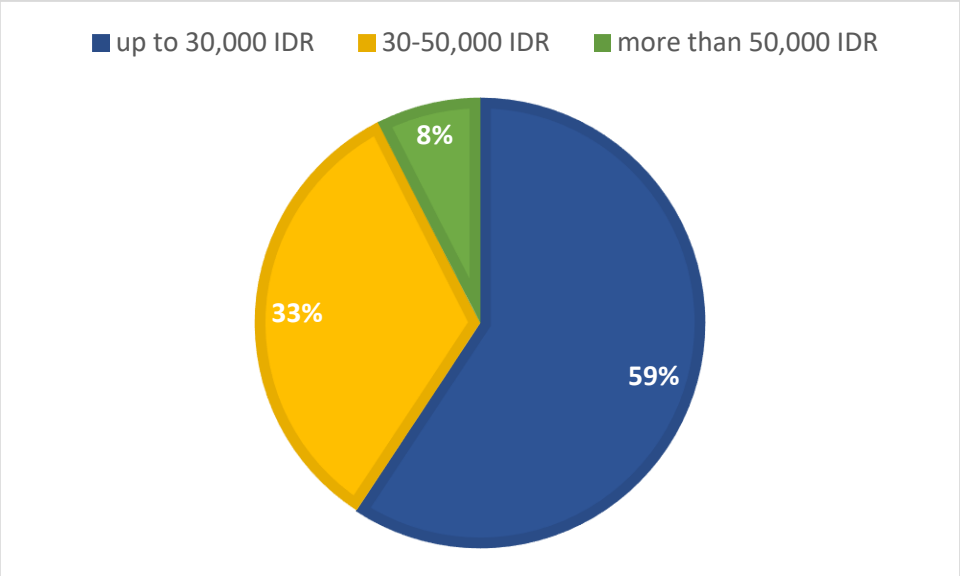

Figure 12. Respondent´s willingness to pay certain taxes for sufficient MSWM services

5.2. Results of Chi-square test to assess willingness of inhabitants to pay for sufficient MSWM services in Bandung.

Chi-square test of independence was used to assess relationship between respondents' willingness to pay certain taxes and other variables at 5% level of significance. Table 6 displays results of Person's Chi-square test and Fisher's exact test that is used when number of observations in the sample is less than 10, analysis that expressed relationships between respondent's willingness to pay certain taxes for sufficient MSWM services and several variables. According to Chi-square test, factors that were associated with respondent's willingness to pay were as follow:

Age was strong associated with willingness to pay. Results suggested that respondents in age range 40 years and more were the most willing to pay higher prices, while respondents in age range 18-24 years inclined to pay lower prices. Middle age category (25-39 years) of respondents tended to a middle category of price (30-50,000 IDR). A matter of age relationship with willingness to pay certain taxes or fees for sufficient waste management practices has been examined in several studies (Dadson et al. 2013; Song et al. 2016; Wang et al. 2018b; Yeung & Chung 2018; Han et al. 2019). According to Wang et al. (2018b) with an increase of age people are not willing to pay higher taxes, probably because older people are more sensitive to fees and tend on their present habits to pay minimum taxes. Based on the results of my study, the older a respondent, the more he/she is willing to pay taxes for sufficient waste management. The same

results were presented in the study from Ghana of Dadson et al. (2013), their findings showed that older respondents are willing to pay higher taxes for sufficient MSWM, which can be affected by higher income or they tend to understand the need of cleaner environment for future generations.

Other factor that was strong associated with willingness to pay was level of education. Respondents with university education were willing to pay higher prices, while respondents with primary education tended to pay lower prices. Also, respondents with higher education tended to lower prices but to a lesser extent than those with primary education. Such findings correspond with study results of Ezebilo (2013) from Nigeria, the study determined that the higher the level of education, the more the respondent is willing to pay. This could be possibly explained by the fact that respondents gain more information during studies regarding the costs and benefits of improved MSWM practices. Similar results showed also Yusuf et al. (2007) and Boateng et al. (2019).

Last factor that was strong associated with willingness to pay was income. Generally, there was a direct relationship between the factors. The higher the income, the more was respondent willing to pay. The study results of Pham et al. (2017) from Vietnam determined relationship between monthly income and willingness to pay for improved MSWM services. Results indicated that respondents with higher income are willing to pay higher taxes for MSWM than those with lower monthly income. My results showed the same pattern. Also, study findings from Oyawole et al. (2016) from Nigeria, resulted in the same relationship. The authors suggested that respondents with higher income may be willing to pay more for improved MSWM because these respondents may place more value on their health as well as the aesthetic quality of the environment. Similar results can be found in studies from Yeung & Chung (2018) and Han et al. (2019).

The rest of factors (gender, years spent in Bandung, waste management satisfaction, interest in MSWM, sufficient awareness about waste handling and recycling) were not associated with respondent's willingness to pay for sufficient MSWM services.

Table 6. Results of Chi-square and Fisher's exact test

Variable		Mean		Coef.	p-value
Age	18-24	25-39	40+		
	1.37	**1.48**	**1.82**	**21.76**	**<0.0001[2]**
Years in Bandung	>1/3 lifetime	1/3 -2/3 lifetime	>2/3 lifetime		
	1.48	1.66	1.43	6.31	0.178 [2]
Education	Primary	Higher	University		
	1.13	**1.32**	**1.64**	**24.61**	**<0.0001[2]**
Monthly income	<2 mil. IDR	2-5 mil. IDR	>5 mil. IDR		
	1.19	**1.45**	**1.78**	**47.88**	**<0.0001[2]**
WM satisfaction	Yes	No			
	1.63	1.48		4.43	0.123[2]
Interest in MSWM	Yes	No			
	1.46	1.56		3.90	0.214[1]
Sufficient awareness - waste handling	Yes	No			
	1.54	1.45		1.96	0.376[1]
Sufficient awareness - waste recycling	Yes	No			
	1.57	1.45		0.27	0.872[1]
Gender	Male	Female			
	1.46	1.49		0.53	0.77[1]

Note: 1– Chi-square test,2 – Fisher exact test. Source: Author (2019)

5.3. Analytical results of binary probit model of factors likely to influence interest of inhabitants in MSWM in Bandung

This chapter represent the results on the factors likely to affect the respondent's interest in MSWM in connection to the environmental issues. Results of the binary probit model were presented in Table 7. The variance inflation factors (VIF) of all explanatory variables were below three, with an average of 1.73. Thus, multicollinearity is not a concern. Results showed that age, education, satisfaction with MSWM practises and partly locality played important role in respondent's interest in MSWM in connection to the environmental issues.

The coefficient of young (18-24) and middle (25-39) age groups were positive and indicated that respondents in this age categories tended to be more interested in MSWM than respondents who were older than forty. This coefficient was statistically significant at 1% level. The results of the marginal effects demonstrated that an increase in the number of respondents in the age category 18-24 in the sample increases interest

in MSWM by almost 47 percentage points. Simultaneously, marginal effect showed that an increases of respondents in the age category 25-39 in the sample increase interest in MSWM by 43 percentage points. The results of age influence on interest in MSWM in connection to environmental issues brought in different results in following studies. The study results of Al-Khatib et al. (2015), showed that age of respondent had statistically significant influence on interest in MSWM in connection to the environmental issues. The young adult age category of respondent (25-34) and middle age category (35-44) tended to be more interest in MSWM than those respondents from young (18-24) and older (45+) category. Babaei et al. (2015) determined in their study that older respondents (45+) showed higher interest in MSWM than other age category. According to Ifegbesan et al. (2017), respondents in age category (18-24) were more interested in MSWM than other age categories. The results of my study correspond with results of Babei et al. (2015) and also Ifegbesan et al. (2017), young (18-24) and middle age (25-39) respondents were more interested in MSWM in connection with the environmental issues. This could be possibly explained by several reasons. Today in Indonesia, young people use social media and they are more in connection with worldwide information and situation, this can affect their increased interest. Also, people in middle age category often in Indonesia running their own business and are also in connection with social media that nowadays set up trend like zero-waste activities which bring attractive and new changes in their business for their clients.

The result of education showed that coefficient for respondents who had primary and higher education level was negative. This indicated that respondents with primary and higher education tended to be less interested in MSWM than those with university education. This coefficient was statistically significant at 1% level. The marginal effect demonstrated that increase of respondents with primary and higher education in the sample decrease interest in MSWM by almost 22 percentage points. Another statistically significant coefficient of satisfaction with MSWM services was positive and indicated that satisfied respondents tended to be interested in MSWM. Founded results was significant at level 5%. Besides, marginal effect showed that an increase of respondents that are satisfied with MSWM practices in Bandung city, increases interest in MSWM by 30 percentage points. The results from Ghana (Yoada et al. 2014), showed

that people with the highest education level are more interested in MSWM from different point of view, e.g. waste generation, environment and health issues. While, people with low education level or without education considered these factors at very low level. The research from Palestina (Al-Khateeb et al. 2017) determined that respondents with higher (university) education are supposed to be interested when it comes to environmental issues in connection with MSWM, as well as their role in social responsibility. Similar results were found in Malaysia (Afroz & Masud 2011) where people with university education were more environmentally consciousness in connection to MSWM than those with low or non-education level. Results of my study also indicated that respondents with university education were more interested in MSWM in connection to the environmental issues than those with primary or secondary education level. Probably, Tthis could be explained that the higher the level of education of the respondent, the more available information from different fields they obtain, also, openness to perceiving global problems is higher for respondents with university education level.

The coefficient of satisfaction with MSWM practices was statistically significant and was positive. This indicated that satisfied respondents were more interested in MSWM in connection to the environmental issues than those who were unsatisfied. This coefficient was significant at level 5%. Marginal effect showed that an increase in satisfied respondent increases interest in MSWM in the sample by 30 percentage points. According to De Young (2000) it was determined that respondent's satisfaction resulted in pro-environmental behaviour and also higher interest in this issue. Also, Corral-Verdugo (2012) affirms that satisfaction is a variable associated with sustainable behaviour and with infrastructural and economic conditions, and satisfaction in turn has an impact on the interest in MSWM in connection to the environmental issues. On the other hand, according to Cobbinah et al. (2017), respondent's dissatisfaction led to higher interest due to consideration of poor MSWM practices as a top-most socio-economic and environmental issue, which affects their health, livelihoods and general standards of living. Results of my study determined that satisfied respondents were more interested in MSWM in connection to the environmental issues than unsatisfied ones. This could be possibly explained that if the respondents are satisfied, they want to

hold their standards and act the way that has little some positive impact on the surrounding environment in connection to MSWM and try to find out helpful information about this issue.

The results also demonstrated that Selatan district in Bandung city had statistically significant influence on respondent's interest in MSWM in comparison with metropolitan area. The coefficient was positive and showed that respondents who lived in Selatan district tended to be more interest in MSWM than respondents from metropolitan area. This coefficient was significant at level 5%. Concurrently, marginal effect demonstrated that an increase of respondents from Selatan district increases interest in MSWM in the sample by almost 20 percentage points. According to research from Spain (Tabernero et al. 2015), locality had significant impact on interest in MSWM in connection to the environmental issues. This result should could be explained that inhabitants of different localities in the city or country have different access to information, communities promoting importance of interest in the environment, geographical area and also different distribution of inhabitants with different socio-economic background. This fact was found also in the study from India (Lalneihzovi & Lalchhuanawma 2017). The results of my study showed statistically significant influence among localities. This should be more probably caused exactly by different distribution of respondents, especially for Selatan district where the interest in MSWM in connection to the environment was the highest from all districts and more than 70% of respondents had university education.

Results of my study also suggested that gender, rest of the districts, available awareness about waste handling and recycling had no statistically significant impact on respondent's interest in MSWM in connection to environmental issues in my sample.

Table 7. Results of binary probit model.

	Coef.	Standard error	p-value	95% Conf. Interval		Marginal effect
Gender	0.102	0.156	0.513	-0.203	0.407	0.036
Reference (Locality of respondent is metropolitan area)						
Timur	0.351	0.246	0.153	-0.130	0.833	0.116
Utara	0.136	0.250	0.587	-0.354	0.626	0.047
Selatan	**0.630**	**0.265**	**0.018**	**0.110**	**1.149**	**0.195**
Barat	0.284	0.284	0.318	-0.273	0.840	0.094
Reference (Age of respondent is 40 and more)						
Young	**1.576**	**0.283**	**0.000**	**1.022**	**2.130**	**0.468**
Middle	**1.301**	**0.256**	**0.000**	**0.799**	**1.803**	**0.432**
Reference (Education level of respondent is university)						
Primary and higher	**-0.613**	**0.172**	**0.000**	**-0.950**	**-0.276**	**-0.217**
Public perception						
Satisfaction WM	**1.645**	**0.751**	**0.028**	**0.173**	**3.117**	**0.302**
Awareness - handling	-0.235	0.181	0.194	-0.590	0.119	-0.084
Awareness – Recycling	-0.135	0.191	0.482	-0.510	0.241	-0.048
Constant	-0.739	0.311	0.017	-1.348	-0.131	
Number of obs.	334					
LR Chi2	67.57					
Prob > Chi2	0.000					
Pseudo R2	0.159					

Source: Author (2019)

6. Conclusion

Public perception and approach on MSWM were analysed through the interest in MSWM in connection to the environmental issues, willingness to pay for sufficient MSWM services and factors as satisfaction with MSWM practices, sufficient available awareness about waste handling and recycling as well as knowledge of 3R concept, sufficiency of MSWM services and others.

The results of questionnaire survey conducted in the frame of this Master's Thesis showed that age, education level, locality and satisfaction had significant influence on public approach to interest in MSWM in connection to the environmental issue. Younger and middle age respondents tended to be more interested in this issue than respondents in older age category. It was suggested that respondents with university education were more interested than those with primary or secondary education level. Also, respondents from Selatan district were more interested in MSWM than those who lived in metropolitan area of Bandung city. Satisfaction with MSWM practices played important role in interest, satisfied responded tended to be more interested than those who were unsatisfied.

Public perception and approach were also examined through willingness to pay taxes for sufficient MSWM. There was significant relationship among willingness to pay, age, education and monthly income. Respondents with university education were willing to pay higher taxes as well as respondents with the highest income. In addition, respondents in older age category were willing to pay more than young and middle age category.

Descriptive statistic results of public perception and approach on MSWM divided by districts of Bandung city and metropolitan area showed that most of respondents are not satisfied with MSWM practices in their locality and assessed MSWM services in their locality as insufficient. Also, respondents faced lack of available sufficient awareness about waste handling and recycling. On the other hand, majority of respondents had knowledge about 3R concept in their localities. The vast majority of respondents was willing to participate in different workshops covering issues of MSWM and considered education about waste management as very important. On the other hand, just little

over half respondents would implement this education to primary schools. In addition, over half of respondents was interested in MSWM in connection to environment issues except Selatan district where majority of respondents were interested.

The results indicated that public perception and approach on MSWM in Bandung city should be enhanced by better education, providing of sufficient awareness and workshops. Consider public sector's needs and opinion in MSWM planning and decision making could result in more sustainable MSWM in Bandung. Also, public is willing to pay higher taxes for sufficient MSWM that should be taken into account at governmental level, surplus in taxes could be used as source for awareness campaign and overcoming of other barriers.

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Appendices

List of appendices

Appendix 1: Descriptive statistics results of waste management indicators and public perception and approach on MSWM divided by districts.

	District				
	Timur	Utara	Selatan	Barat	Metropolitan area
Waste management indicators					
Satisfaction (no) %	97.4	95.7	100	97.9	97.9
WM sufficiency (no) %	81.8	84.9	86.6	85.4	75.5
Public perception and approach on MSWM					
3R knowledge (yes) %	70.1	83.9	79.1	75	77.6
Awareness h (no) %	63.6	69.9	68.7	64.6	61.2
Awareness R (no) %	72.7	69.9	79.1	81.2	69.4
Interest WM	67.5	64.5	80.6	60.4	59.2
WS (yes)%	92.2	91.4	95.5	100	91.8
Consider education (yes) %	90.9	90.3	95.5	97.9	91.8
Implement education (yes) %	55.8	50.5	53.7	52.1	55.1

Appendix 2: Questionnaire for inhabitants of Bandung.

Declaration:

Dear respondent, this questionnaire is anonymous, and results will be used to Diploma Thesis data collection and writing at Czech University of Life Science (CULS), Faculty of Tropical AgriSciences, Kamýcká 129, 165 00 Prague, Czech Republic, Europe. Also, questionnaire will serve both to CULS and Universitas Padjadjaran, Center for Economic and Development Studies, Jl. Raya Bandung KM.21, Indonesia as base for further research.

Thank you for your time!

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Demographic information

Gender:		Male	Female
Age:	18 – 24	25-39	40+

Location:

Bandung Timur (Margahayu Raya, Riung Bandung, Ujung Berung, Antapani, Cibiru)

Bandung Utara (Setiabudi, Dago, Pasteur, Cihampelas)

Bandung Selatan (Kopo, Soreang, M.Toha, Baleendah, Cibaduyut)

Bandung Barat (Kab. Bandung Barat dan Sekitarnya)

Bandung Tengah (Bandung Kota yang tidak termasuk pada wilayah di atas)

How long have you been living in the city of Bandung?

Education level:	None	Primary	Higher	University
Average monthly income:		< 2 mil. IDR	2-5 mil. IDR	>5 mil.IDR

Section 1

1) **Are you satisfied with waste management system in your location?**

Satisfied Unsatisfied

2) **How do you handle waste on daily basis?**
   - Bins, Containers, etc.
   - Put the waste in plastics bags in front of house
   - Burning
   - Other: (specify)
3) **a) Do you have the possibility to separate the waste you dispose of, based on paper, plastic, glass, biology, organic, and non-organic?**
   - Yes
   - Only part of waste
   - No

   b) If there is no possibility to separate waste, would you appreciate the possibility to separate waste to different bins according to its origin?

   Yes No
4) **Which type of waste do you separate?**
   Whole waste
   PARTLY: Paper Plastics Glass Bio
5) **Is in your location available service for waste management?**
   Yes No
6) **Please describe waste management services in your location:**
7) **Does WM services sufficient?**
   Yes No
8) **Percentage division of daily produced waste:**
   Biological Plastic Paper Glass Others

<u>Section 2:</u>

9) **Do you know 3R (Reduce, Reuse, Recycle) concept?**
   Yes No (If no, please continue to Q7)
10) **Do you act according to this concept?**
   Yes Partly No
11) **Are you interested in WM and its solution in terms of decreasing negative impact to environment?**
   Yes No
12) **Would you be willing to take part in workshop/campaign/demonstration field about waste management handling?**
   Yes No
13) **Do you consider education of WM important from your point of view?**
   Yes No

14) Do you agree with integration of WM education at primary schools?

Yes No

15) Do you think there is sufficient awareness in your location of waste handling?

Yes No

16) Do you think there is sufficient awareness in your location of waste recycling?

Yes No

Section 3:

17) Do you currently have to pay certain taxes or fees for waste management services at your place?

Yes No

18) Do you want waste management to be carried out by the government?

Yes No

19) How much is your willingness to pay for waste management per month?

Less than 30,000 IDR 30,000-50,000 IDR More than 50,000 IDR

Section 4:

20) Would you like to use waste as source of:

a) Material Yes No

b) Energy Yes No

21) Do you know following technologies of waste management treatment?

Technology	**Yes**	**No**
Composting		
Incineration		
Landfills		
Recycling		
Biogas station		

22) Which technology would you prefer in your locality?

Composting Incineration Landfills Recycling Centre Biogas station

23) Would you be willing to take action in community-based waste management solution?

(for example: Separate waste, collect biological waste at one place to composting for benefit of whole community etc.)

Yes No

24) It is acceptable for you to use toilet savages for biodigestor feeding and obtain gas for cooking?

Yes No

25) Is it acceptable for you to use landfill gas for energy production?

Yes No

26) Is it acceptable for you to use compostable waste as source of fertilizer?

Yes No

Appendix 3: Interview questions.

Interview questions for citizens	**Interview questions for organization officers**	**Interview questions for government officers**
How the MSWM services work here?	How is this organization running?	How do you provide/handle MSWM services and who is responsible for it?
Do government arising any kind of awareness about MSWM?	From you point of view, do you obtain sufficient awareness about waste handling/recycling?	Do you arise any type of awareness campaign?
Does the government provide MSWM services in accordance to your vision?	Is this place adequate (in terms of location, waste amount…) to operate?	What are the main barriers to implement other final disposal solution than open dumping?
What should be done differently from your point of view?	Is there something that should be done differently to make operations smoother?	What are the set-up priorities in MSWM in Bandung?

Appendix 4: Photo-documentation of questionnaire survey and study area.

Note: collecting of questionnaires.

Note: Available bins for organic and non-organic waste, Bandung.

Note: information board for waste separation at MSWM organization, Bandung.

Note: Contents of organic and non-organic bins, Bandung.

Note: Temporary waste disposal site, Bandung.

Note: demonstration of composting at MSWM organization, Bandung

Note: waste dumped on the street, Bandung.