

## Development Strategy of Kawatuna Landfill Management in Palu City

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### Abstract

Kawatuna landfill serves the end processing of waste in Palu city region. Kawatuna landfill has actually been completed with various facilities like liquor processing, compost processing, and biogas catch, but its implementation is still like an open dumping. This research aims to set out a development strategy of Kawatuna landfill in Palu city. This was a descriptive qualitative method by comparing Kepanjen Edu-tourism landfill in Malang district and Kawatuna landfill in Palu city. This research focuses on the assessment parameter of sustainable solid waste management in a developing country. Data were collected through observation, documentation, and interview. The data of the research results of Kepanjeng Edu-tourism landfill and Kawatuna landfill management was then compared to determine its management gap, be analyzed, and be served as a material to develop a strategy of Kawatuna landfill development. Development strategy of Kawatuna landfill is as follows (a) operational technique aspect with the fulfillment of all feasibility standards; (b) legality aspect with the elaboration of regulation technique of waste management; (c) institutional aspect by separating the role of regulatory and operator institution, SOP and SPM (*Standar Pelayanan Minimal or Minimum Service Standards*) setting, as well as coordination strengthening among stakeholders; (d) financing and economics aspect by optimizing APBN (State Budget) and APBD (Local Budget) Provincial/District/City Government, finance source development from outside parties and retribution; (e) health and environmental aspect by providing health insurance for community and environment around the landfill; and (f) social aspect by empowering society around the landfill.

**Keywords:** Strategy, Development, Landfill, Waste, Sustainable

### INTRODUCTION

The existence of landfill as one way the Local Government's effort to provide facilities and infrastructure for waste management. Landfill management through an open dumping method is not allowed anymore. It must switch to the controlled landfill and sanitary landfill method. Landfill activity generates 3 three) types of waste, i.e. solid, gas, and liquid waste which if managed not well will have a potential to pollute environment around the landfill.

One of the landfills having the best service by awarding Reward Top 25 Public Service from the Ministry of Administrative and Bureaucratic Reform (PANRB) of the Republic of Indonesia in 2015 was Kepanjen Edu-tourism Landfill, Malang District. This landfill has also been served as an Edu-tourism landfill, Smart Practice Documentation, Knowledge center by Development Planning of the Republic of

Indonesia (BAPPENAS) in 2016. This management of Kepanjen Edu-tourism Landfill, Malang District tries to dig up and apply at other regions in case of protecting the environment and improving service.

Palu city region as the capital city of central Sulawesi is served by the one and only landfill, which is Kawatuna landfill. This landfill has been completed with several facilities, i.e. liquor processing management, compost processing, and biogas catch gradually switched to the electrical energy. Actually, waste management operations at Kawatuna landfill like an open dumping by which waste is left without land cover for days, and then buried and stockpiled not systematically. This reality has a very big potential to decrease human's health and harm environment, especially around the landfill.

Therefore, it needs a comparative study of a management of Kepanjen edu-tourism in Malang district and Kawatuna landfill in Palu city. This comparison is expected able to show the aspect from Kawatuna landfill management which needs to improve and develop. This research aims to set out a development strategy of Kawatuna landfill in Palu city.

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## **MATERIAL AND METHOD**

The objective of this research is to get a descriptive, insight and scientific picture about mangement in two landfills, i.e. Kepanjen edu-tourism landfill in Malang district and Kawatuna landfill in Palu city. To ease the researcher in obtaining that picture is employed a qualitative descriptive approach.

This research compares management at Kepanjen edu-tourism landfill, Malang district and Kawatuna landfill in Palu city. Management gaps collected was then analyzed and acted as material to adopt development strategy of kawatuna landfill in Palu city region.

### **Data Collection**

Data required in this research is a primary and secondary data. The secondary data was obtained from Malang Environmental Agency, Kepanjen edu-tourism landfill, Malang district, Palu Environmental Agency, Kawatuna landfill and deriving from the previous studies. Primary data was collected through a triangulation technique, which is a combination of several techniques among others observation, documentation, and interview [1].

The focus of this research uses a parameter basic of sustainable solid waste management assessment in a developing country [2] consisting:

#### **1) Operational Technique Aspect**

- Amenity, facility, infrastructure, and data are collected from observation using operating guidelines and the maintenance of the end disposal of control landfill and sanitary landfill system [3].
- Technological relevance to be operated depends on the physical and/local infrastructure condition.
- The opportunity of proper local knowledge and experience (skill) aims to design, build, operate, and maintenance technology, and ideally with the existing local material source.
- The availability of supply and service chain can be done timely and the price is affordable.
- The technology is easy to overcome and apply to the conditional changes.
- The technology used is either cheap or expensive

#### **2) Legality aspect**

- Policy and laws

- The relevance to the service quality standard/product as defined by laws, standard and regulation.

#### **3) Institutional Aspect**

- Manager Organizational Chart
- Standard Operating Procedure
- Employee's competence
- Cooperation amongs stakeholder
- Evaluation and monitoring

#### **4) Financing and Economics Aspect**

- Finance source
- Adequacy and financing effectivity
- Landfill activity which generates income and is used to the operational activity.

#### **5) Health and Environmental Aspect**

- Landfill ability to overcome disturbance like foul odor, dust, noise and insects/animals.
- Guarantee for welfare security and employee's health.
- Recovery impact and waste recycling.
- Landfill operational minimizes the use of natural resources and rare energy and pollutes the environment.
- It has been conducted liquor infiltration check using the existing observation well.

#### **6) Social Aspect**

- Acceptance, support, and benefits from and for community or the local authorities socially.
- Local structure empowerment and local work opportunity provision directly or indirectly.
- Service or product which fulfills the needs and potential of marginalized community group.
- Participation/involvement of society is considered and applied in a project

## **RESULT AND DISCUSSION**

Landfill management has to fulfill several aspects, i.e. operational aspect technique, legality aspect, institutional aspect, financing and economics aspect, health and environmental aspect, and social aspect.

### **Operational Technique Aspect**

Landfill operational implementation includes waste closure, liquor management, biogas control, and the implementation of reduce, reuse, and recycle (3R).

**Table 1 Operational Activity of Kepanjen Edu-tourism Landfill and Kawatuna Landfill**

No	Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
1	Daily closure	Waste closure is carried out every day using tarpaulin.	There is soil closure but its time is not certain, even it leaves blank even until 7 days.
2	Liquor control	It comprises shelter, processing through Liquor Processing Installment (IPL) and liquor recirculation into the landfill active cell to help waste spoilage process.	Liquor from the landfill is accommodated and neutralized at IPL, but there is no recirculation of liquor to landfill.
3	Biogas control	Developing gas purification method to reduce CO <sub>2</sub> , H <sub>2</sub> S dan O <sub>2</sub> . The result of this biogas processing reduces foul odor level and also generate benefits for society around the landfill as gas fuel of LPG substitute [5].	Using a technology of cooperation with Boras Stad Municipality Government, SWEDIA. However, this kind of technology only operated for 3 months and during at that time it successfully produced electricity, after 3 months this technology was broken and to date, it cannot be functioned anymore. Biogas from landfill are released into the air.
4	3R activity	Landfill develops Air and Hydro Waste Separation tool with a working system of separating organic and non-organic waste by which the organic one was degraded and pumped into the sludge drying bed facility to be composed (Bappenas' Knowledge Center Team, 2016) Aside from is also the involvement of the low-income community to be the certified-waste sorter (having an ID card) at the landfill, the result of this sorting activity is put into the waste banks available at the landfill.	There is a facility to apply 3R and composting activity, but the obstacles are none of the landfill personnel conducting the 3R activity and the poor community around the landfill tends to choose to be a common scavenger.
5	Landfill safety depends on the existence of access door and round fence.	The access door is only through the main fence which can be opened and closed. Landfill fence combines artificial fence in the form of wall and natural fence in the form of trees.	It is not completed with round fence, both artificial fence or natural fence, the access door to the landfill is exactly free since the entrance gate is only in the form of a gate without a fence with a very poor condition.

Kepanjen edu-tourism landfill is not dealing with difficulty in the land provision of daily closure, however, daily waste closure using tarpaulins are allowed by regulation that permits to use a biodegradable liner, compost, and tarpaulin [4]. It is different from Kawatuna landfill by which land cover is available but its implementation is not certain even the garbage is opened up until 7 days. It is caused by the age of soil transport truck which has been old and the lack of oil fuel (BBM) for vehicles and heavy equipment, as information gathered from information that *"...the waste is a bit difficult to burry with an old truck and if rain comes (closure) hards to do, moreover the limitation of BBM for vehicles operational.."* (Informant 4, 2018)

Liquor management at Kepanjen edu-tourism landfill comprises holding, processing through Liquor Processing Installment (IPL) and recirculation of liquor to the landfill active cell. IPL is also available at Kawatuna landfill in which the liquor from the landfill is collected and neutralized but there is no recirculation of liquor to landfill.

*"..the existing liquor only goes through the settlement pool and there is no liquor circulation yet to the landfill, even sometimes the liquor is overflowing during the rainy season. Last year's liquor circulation had time to run but this year (2018) is not conducted anymore because there is no budget.."* (Informant 4, 2018)

To manage and control biogas, Kepanjen edu-tourism landfill develops a gas purification method which is a local innovation result from the landfill manager and the Government of Malang District.

*"Technology are all from [our] friend innovation, Pak Koderi, Pak Rudi and friends. ...We try to [use] local technology, we suggest the staff at landfill to innovate gradually and how far they can..."* (Informant 3, 2018).

Gas control at Kawatuna landfill does not run well since the biogas management technology is broken. Biogas from the landfill is released to the air through a ventilation pipe.

*"...Actually, the gas catcher technology still runs but it experiences a problem on O<sub>2</sub> sensor which is broken so we are afraid to run it, if unconditionally O<sub>2</sub> goes up, it will be dangerous*

because there is no caution, hence, to avoid engine damage, we just heat it but do not function it to catch gas. The sensor cannot be repaired, it has been leaked out, if want to buy the new one, it is only sold in Swedia...” (Informant 6, 2018).

Releasing biogas into the air is really not suggested since it still contains dangerous gases. Biogas control, aside from purification can also be conducted by flaring, which is burning gas resulted by landfill to control the emission of dangerous gasses [6].

To conduct 3R activity, Kepanjen edu-tourism landfill is assisted by the existence of Air and Hydro Waster Separation tool deriving from the landfill manager innovation and poor community empowerment around the landfill as the registered-waste shorter (having ID card) at landfill. Meanwhile, at Kawatuna landfill, there is a facility to apply 3R and perform composting activity but the obstacle is there is no special personnel to conduct operational composting

and the community around the landfill is not interested yet in joining the 3R activity.

“...today’s society wants [to achieve something] instantly, they argue that it takes longer time if taught how to process waste, meanwhile scavenging at landfill takes shorter time, weighed and directly earn money...” (Informant 6, 2018).

Kepanjen edu-tourism landfill location is set as it is to ease people to come and go to the landfill without being known by the staff. While Kawatuna landfill is accessible for all even animals stock whose number reaches hundreds. This is very risky to the animal stock because it will be exposed by pollutant substance especially the dangers of heavy metal [7];[8];

Kawatuna landfill is not completed by weighbridge, hence there is no real data of the garbage dump goes to the landfill. Accurate data for waste becomes a heavy challenge in developing countries [9].

**Table 2. The Gaps of Amenity, Facility and Infrastructure at Kepanjen Edu-tourism Landfill and Kawatuna Landfill**

No	Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
1	Land area	2.5 Ha	5 Ha
2	Signboard	Clear signboard	Signboards is not clear and almost broken by age
3	Gateway	Very good and majestic condition	There is no gateway, only a signboard, so entrance and the exit door are accessible.
4	Landfill Office	An office is available and completed with computerization	An office is available but not maintained, not complited with computer.
5	Heavy Equipment	1 Excavator	1 Excavator, 1 Loader, 1 Buldozer, 1 Mini buldozer (broken)
6	Heavy Equipment’s Garage	Enough available	Available and large
7	Fuel Stock	Available	Available, but limited so that the heavy equipment can not operate every day.
8	Insecticide Stock	Available	Not available
9	Unloading and manuver equipment	Available, the existing maneuver room is not large, the dump fleet has to line up.	There is a very large space
10	Main operational street	Asphalt road	Asphalt road and dirt road
11	Operational path within the area	Asphalt road	Dirt road
12	Weighbridge	Available	Not available
13	Registration room : Required, digital	Registration room uses a digital system and recorded by CCTV	Manual registration room
14	Warehouse	Enough available	Available and large
15	Workshop and equipments	Enough available	Enough available
16	Fireman	Available for 2 units	Not available
17	Special area for recycling	Exists and functions	Available but not functioned
18	Transit area of household’s B3 (hazardous waste)	B3 does not go to landfill	There is no area for B3 transit, Garbage and B3 enter to the landfill
19	Praying room	Small mosque	There is no special prayer room

This reality truly complicates to estimate an accurate age for landfill. Landfill age estimation only can be known by projecting an individual's garbage dump or calculating it based on the number of dump fleet rites with the assumption that every fleet of garbage should be filled.

One of the key informants explain that *"We actually have no weighbridge, the existing fleets conduct three rites per day, so the estimation of garbage dump is calculated from the recording of fleet rites with volume estimation of every dump truck fleets going to the landfill is multiplied by three"* (Informant 5, 2018).

Palu city has a population of 374,020 inhabitants [10], based on the Government Regulation No. 26 of 2008 regarding National Spatial Plan, it is categorized as a Medium City. Based on SNI 19-3983-1995, individual's garbage dump for a medium city is 2.75 -3.25 L/person/day. Landfill capacity is calculated using the following formula [11].

Landfill capacity =  $L \times T$  =

Where,  $L$  = landfill area = 5Ha = 50,000 m<sup>2</sup>

$T$  = Dump of garbage's height = 10 m

Hence, the capacity of Kawatuna landfill is = 500,00 m<sup>3</sup>

1. Kawatuna landfill's age estimation based on the projection of an individual's garbage dump is:

Total population of Palu city = 374,020 inhabitants

Individual's garbage dump = 3 liters/day

Palu city's garbage dump per day

= 1,22,060 liters/day or 1,122 m<sup>3</sup>/day

Palu city's garbage dump during a year

= 1,122 m<sup>3</sup>/day x 365 day

= 409,530 m<sup>3</sup>/year

If the assumption of compaction level is 70% with details of 60% is waste and 10 is land cover, so Palu city's garbage dump in a year is = 409,530 m<sup>3</sup>/year x 70%

= 285,671 m<sup>3</sup>/year

The Percentage of Palu city's Garbage Dump to the Capacity of Landfill Capacity is:

$$\frac{285,671 \text{ m}^3/\text{year}}{500,00 \text{ m}^3} \times 100\% = 57.1/\text{year}$$

This indicates that Kawatuna landfill's age will no longer than 2 years.

2. Kawatuna landfill prediction based on the number of dump fleet rites with the assumption that every dump fleet is fully charged:

Total dump fleet = 39 units

Volume of each fleet = 6 m<sup>3</sup>

Total rites/day of each fleet = 3 times

Therefore, daily garbage dump in Palu City is

$$= 39 \times 6 \text{ m}^3 \times 3 = 702 \text{ m}^3/\text{day}$$

garbage dump per year in Palu City

$$= 702 \text{ m}^3/\text{day} \times 365 \text{ days}$$

$$= 256.230 \text{ m}^3/\text{tahun}$$

with assumption that compaction level is 70%

Palu city's garbage dump during a year

$$= 256.230 \text{ m}^3/\text{year} \times 70\%$$

$$= 179.361 \text{ m}^3/\text{year}$$

The percentage of Palu city's garbage dump to the capacity of landfill capacity is:

$$\frac{179.361 \text{ m}^3/\text{year}}{500,00 \text{ m}^3} \times 100\% = 35.9\% / \text{year}$$

This indicates that Kawatuna landfill's age is more or less 2 years 9 months.

Those two estimations above do not calculate population rate. As Sucipto said [12] that the amount of waste produced by a region is directly proportional to the population density, consumption level to the goods and types of its population activity.

#### **Legality Aspect**

The implementation of waste management in Malang Distrit and Palu City is regulated by each regulation as table 3.

It has been conducted a review on Malang Local Regulation Number 10 of 2012 Regarding Waste Management.

"...that suggestion is from DLH (Environmental Agency) and all stakeholders. Its compilation starts since 2015 facilitated by East Java Province, processed in 2017, and today is waiting for the result..." (Informant 3, 2018).

Waste management implementation in Palu city is explained as below:

"...In addition to the Local Regulation number 3 of 2016 regarding Waste Management, there is also Palu Mayor Regulation number 3 of 2017 on Cleanliness Implementation, which regulates tasks of all parties including Agency, Head of Village, head of Sub-district, etc, whose emphasis on the cultural penalty and sanction imposing..." (Informant 5, 2018)

Today's law does not regulate solid waste management specifically [13]. For that matter, it needs to compile a supporting regulation that can be served as a technical guidance of the existing regulation implementation. The intended technical guidelines have to clearly explain the process of reduction, handling, transporting, and waste-end processing.

**Table 3 Local Regulation in Malang District and Palu City**

Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
Regulation related to the waste	<ul style="list-style-type: none"> <li>Local Regulation of Malang District Number 10 of 2012 Regarding Waste Management.</li> <li>Malang Local Regulation Number 4 of 2014 regarding the Second Amendment of Malang Local Regulation Number 10 of 2010 Concerning General Service Retribution.</li> </ul>	<ul style="list-style-type: none"> <li>Palu Local Regional Government Number 3 of 2016 on the Amendment of Palu Local Regulation Number 11 of 2013 Regarding Waste Management.</li> <li>Palu Local Regulation Number 8 of 2011 Regarding General Service Retribution.</li> <li>Palu Mayor Regulation Number 37 of 2017 Regarding Cleanliness Implementation.</li> </ul>

**Table 4 Institutional of Kepanjen Edu-tourism Landfill and Kawatuna Landfill**

No	Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
1	The Role of Regulator and Operator	Separating institution as a regulator, which is DLH and institution as an operator in the form of UPTD (Regional Technical Implementation Unit) for waste service.	There is no separation between institution as a regulator and institution as an operator.
2	Organizational Chart	In the form of UPTD	Landfill management becomes one of the duties of a certain Division
3	Standard Operating Procedure (SOP)	There are four SOPs: SOP for landfill visitor, SOP for landfill manager, SOP for biogas utilization monitoring for the community around the landfill and SOP for turning on/turning off of biogas stove at home [6]	There is no SOP
4	Personnel	15 persons, consisting of 1 landfill head, 1 night security and 13 operational employees	13 persons, consisting of 1 field coordinator, 7 administrators, 4 operators of heavy equipment and 1 dump truck driver

**Table 5. Financing for Kepanjen Edu-tourism Landfill and Kawatuna Landfill**

No	Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
1	Source of Finance	APBD Malang, grants from a donor and CSR, and community self-reliance	APBD Palu and Grants from a donor
2	Use of expenses	(1) Study (detail creation of engineering design, environmental management scheme, and environmental monitoring scheme (UKL-UPL); (2) Landfill development; (3) equipment settlements; (4) Landfill Operational and Maintenance; (5) methane control and utilization, and (6) further development.	Landfill operational financing includes employee expenditure, service, and expenditure.
3	The amount of the APBD 2018 for Landfill operational	Landfill operational budget of the 2018 budget year is Rp 492.397.100,00 Total Budget for Waste Operational in Malang District is Rp 13.107.469.000,00 (US\$ 34.493)	Landfill operational budget for budget year 2018 is Rp. 426.440.000,00. Total Waste Operational Budget of Palu City is Rp. 13.025.831.340,00

In addition, it also needs regulation support that technically regulates the organizational formation of waste management like TPS (Temporary Storage), TPST 3R (temporary disposal site in operation), waste bank and the implementation of waste management at every organization.

#### **Institutional Aspect**

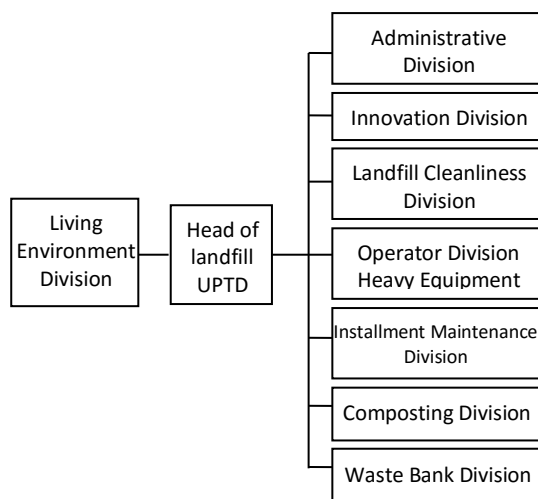
Management institutional of Kepanjen Edu-Tourism Landfill and Kawatuna Landfill is explained as table 4. Organizational chart of Kepanjen Edu-tourism Landfill is arranged simply including basic functions in landfill management.

Landfill employee is generally primary school graduate, through a training provided by landfill manager and DLH of Malang District, all

employees have a similar ability from driving to operating technology and computer.

*"..All employees have to be able to operate all types of equipment including to explain because visitors frequently come here, so it has not always been Pak Rudi (Head of the landfill) [who does it]" (Informant 1, 2018).*

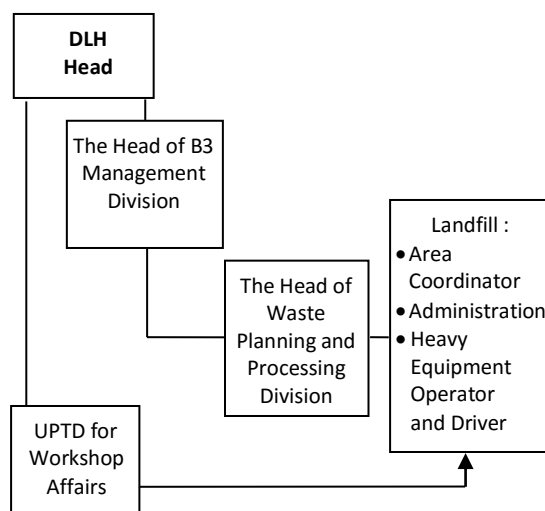
Waste management in Malang District is served by 4 landfills, i.e. Randuagung landfill (5.35 Ha), Kepanjen edu-tourism Landfill (2.4 Ha), Paras Landfill (1.2 Ha), and rejosari Bantur landfill (2.0 ha), also there is 15 community-based TPS 3R (s). Waste management implementation is also supported by 215 yellow personnels or cleanliness staff with 25 fleets consisting of 12 dump trucks and 13 Arm-Roll Trucks.



**Figure 1.** Organizational Structure of Kepanjen Edu-tourism, Malang District

Sources: Koderi, 2016

Landfill organizational structure is part of Palu Environmental Agency and becomes one of the Division Head duties, i.e. Planning and Waste Management Division.



**Figure 2.** Organizational Structure of Kepanjen Edu-tourism, Malang District

The number of landfill personnel composition at administrative division much more 7 persons shows that there is no analysis yet of workload so that there is an over employee at a certain position.

Rotation of structural officials frequently happens so that the adaptation to the new position as well as its duties and functions need longer time. Based on the interview result with the officials who handle landfill at Palu Environmental Agency, the head of Division who is also the head of the landfill just got the

position during a year and the Head of B3 Management even just made his position for 7 months.

Palu city with a land area of 395.06 km<sup>2</sup> and a total population of 374,020 inhabitants [10] consists of 8 Sub-districts and 46 villages. Waste implementation is supported by 12 TPS at ward level, 1 TPS at a market, and 8 TPS 3R, so there are 21 TPSs and TPS 3Rs in total, so there are still 25 wards having no TPS. This means there is still more than half of wards which are not served. Total dump truck fleet is 23 units and arm roll truck is 17 units so the total is 40 units, with details of 1 dump truck operates as TPA operational to transport garbage dump and 39 units as dump truck fleet.

### Financing and Economics Aspect

Operational financing for Kepanjen Edu-tourism Landfill and Kawatuna Landfill is as table 6.

The activity at Kepanjen Edu-tourism landfill that generates income is retribution for dump fleet that throws the dump at Edu-tourism Landfill, the details of retribution are as follows:

**Table 6.** The charge for dump truck which enters Kepanjen Edu-tourism landfill

No	Type of Fleet	The amount of Retribution (Rp)
1	Cart	75,000.00
2	Tosa	100,000.00 to 150,000.00
3	Pick Up	200,000.00

That result of retribution is reported to Malang Environmental Agency on 10th monthly. The data is then returned to the landfill in the form of landfill operational cost. While at Kawatuna Landfill of Palu city, there is no activity yet intended to earn money. Waste retribution withdrawal is directly handled by Palu Environmental Agency.

### Health and Environmental Aspect

“Law Number 18 of 2008 regarding Waste Management, article 4 states that waste management aims to increase a community’s health and the quality of the environment and creates waste as resources”.

Kepanjen Edu-tourism landfill activity protects the environment from the air pollutant in the form of ungodly smell and dangerous gas emission handled by making green buffer path and biogas catch.

**Table 7 Protection Facility to the Environment at Kepanjen Edu-tourism Landfill and Kawatuna Landfill**

No	Parameter	Kepanjen Edu-tourism Landfill	Kawatuna Landfill
1	Drainage/round dyke	Good condition	Broken/not maintained, covered by waste
2	Local drainage	Good condition	Broken/not maintained, covered by waste
3	Liquor recirculation	Recirculation system works well	There is no liquor recirculation
4	Liquor processor	IPL is available	Liquor management only reaches storage pool
5	Observation well:	There are 6 observation wells at landfill and community's well out of the landfill	There is no one observation well, covered by waste
6	Gas ventilation is connected to the gas recovery piping	Gas ventilation is connected to the recovery gas piping and gas purification	Gas ventilation is connected to the recovery gas piping, but the equipment of biogas processing does not work, so gas is released directly to the air.
7	Green buffer line	Green buffer line is available	There is no green buffer line
8	Daily soil cover	Soil cover is changed with tarpaulins	Daily cover soil is available
9	Final cover system: Integrated system with an impermeable layer of gas catcher is ended with topsoil minimum.	Integrated final cover system with an impermeable layer of gas catcher and ended with topsoil	Direct cover system uses top soil
10	Vector and odor control	Vector and odor control are conducted with a timely waste cover routine	There is no vector and soil control since the waste is not covered

Groundwater pollutant with liquor management from the landfill is streamed to the storage pool, neutralized biologically and recirculated to the landfill. Round drainage construction around the landfill area aims to prevent rainfall enters into landfill.

"...to monitor liquor pollution, the landfill is completed by 6 observation wells and Environmental Agency cooperates with jasa Tirta to test the water either polluted or not..." (Informant 1, 2018).

Management activity of Kawatuna landfill in Palu city is not optimal yet in preventing environmental pollution. Several risks and a real impact happen is as follows:

1. Biogas catch that does not work will increase biogas contribution in the form of methane (CH<sub>4</sub>), carbon dioxide (CO<sub>2</sub>), hydrogen sulfide and other pollutant gasses to the atmosphere that becomes one of the effects of glass effect and ungodly smell. The biggest production of greenhouse gas emissions is obtained from the results of landfill [14]. A conclusive evidence of biogas handle which is not optimal yet is frequent fire happens around the landfill are with newest accident on August 7, 2018.
2. Liquor recirculation not working causes storage pool easily full even overflowing to the out of the pool. This is truly risky for the groundwater quality around the landfill;

Landfill management conducts composting activity to utilize organic waste. Fertilizer produced from this activity is temporarily used to landfill needs. Community interest to this fertilizer is still low even it is free.

All community's health of those who are active at Kepanjen Edu-tourism landfill including employee and dump truck driver get a free health check every two months from a local public health center.

3. There is no observation well around the landfill so that can be known to what extent the seepage of liquor pollutes the environment and there is no routine examination yet to the risk of this pollution.
4. The environmental aesthetics goes down because of the rundown scenery, many vectors of a disease like odor, spy, and rates. This becomes a picture of a landfill which is far from the impression of being clean, calm, beautiful, and comfortable;
5. There is no health insurance yet for the manager and those who directly active around the landfill location, excludes the manager who is a civil servant who can utilize the Healthcare and Social Security Agency (BPJS Kesehatan). From 13 personnels of landfill, only 3 persons who are an ASN.  
*"health insurance is not available yet but safety compliment like glove, boot, and mask"*



*are provided by the manager. The employees with PNS status can utilize BPJS" (Informant 4, 2018)*

### **Social Aspect**

Landfill development into an edu-tourism landfill opens a great chance for society to actively participate based on the role distribution and function in a system of waste management. To make landfill have a continuous benefit, the community should involve treating landfill, methane facility and educational facility that encourage awareness to maintain landfill. Poor community group is involved in the waste shorting or also as a scavenger that will earn money from it [15].

An effort to change community's behavior and paradigm that is initially negative into positive is conducted in a community empowerment like below [15]:

- a. Community as a cadre of environment is a community around the landfill served as a voluntair, provided by a training from TPA manager so can take a role in operating and maintaining landfill.
- b. The Involvement of Community Self-reliance Group (KSM). KSM establishment aims to support landfill manager consisted of a community of villager/ward around the landfill area.
- c. Landfill waste shorter, TPST3R and waste bank worker. Poor community or low-income society are recruited to be a registered-waste shorter (having an ID card) at the landfill, a worker at TPS 3R and part of waste banks manager.

The form of education provided by Kepanjen Edu-tourism landfill to the society and visitors are as follows:

*"...The form of education to the society and visitor depends on the visitors, if the visitors are pre-school students, we explain and introduce them to what rubbish looks like, while for elementary school students, we made a bit more complex, for junior and senior high students, we let them to make compost and waste processing, but if the visitors are university students or from the local government, the activity depends on what interested them, the most frequent request is about the gas, liquor, and compost processing...." (Informant 1, 2018)*

*"...an invitation to sort out and manage waste to move together because the local government cannot work alone. Retribution problem, if you are served, you must pay retribution, but if it is*

*not, you must pay dues in return. Waste producer have to be responsible for their own waste, waste is not free, it is actually has a value but waste is not money, it will be if processed well. If the you want to get free, please process it by yourself. Do not burn your waste and do not throw everywhere. If you ask other people to process waste you produce, pay them properly... The conclusion is how to invite those who come here to process waste..." (Informant 3, 2018)*

The good and integrated solid waste management system provides economic and social benefits, therefore urban waste management is a crucial part of sustainable development [16].

The existence of Kawatuna landfill in Palu city gets no reaction from the local community. This is caused by social impact felt by community around the landfill. The intended social impacts are:

1. Job vacancy are opened for society around the landfill especially Kawatuna wards.

*"Local community involvement to work them as a worker/employee at landfill and dump fleet..." (Informant 4, 2018)*

2. Heredity habits of community at Palu valey is to raise livestock traditionally by grazing at nature [17]. A landfill not completed with round fence will ease the livestock to come and go to there. Educational background of the livestock farmer is primary school graduate by 48.8% followed by junior high graduate by 32.6% and senior high graduate by 18.6% [18]. Palu City community who becomes a livestock farmer is commonly those coming from the low-income community [19].

*"...community switches landfill as a place to release their livestock, graze at the landfill. I ever got information from an Agency Secretary that the previous departmen has ever prohibited livestock to enter the landfill but the society is angry because they consider that it was their land so to ignore the conflict they are allowed to graze their livestock there..." (Informant 4, 2018)*

3. A landfill is not able yet to give service of product to help society's need around the landfill.

*"There is no product and landfill service yet to help the most fragile society. Society tends to take benefits from the landfill as a scavenger" (Informant 4, 2018)*

Scavenger activity is able to get thousands kilogram of waste per day which is an

inorganic waste and hard to decompose [20]. This potential of scavenger needs an intensification effort of continuous education to make them involve to help landfill in a waste management

Based on the data, Palu city has no waste bank yet. Waste banks can be the solution to improve community role in processing waste. Waste bank managed by society gives a contribution to overcome waste problem in a developing country [21]. This can be educated by Palu City Government to be one of the solutions of waste management. Based on the study conducted by Hidayat *et al* [22], through an accompaniment, training, organizational improvement and the explanation of instructions/implementation guideline given by Malang City Government from 2011 to 2014 is able to turn Malang waste Bank into one of the icons of waste management with the 3R system.

#### **Development Strategy of Kawatuna Landfill in Palu City**

Development strategy of Kawatuna Landfill in Palu City can be applied based on the research result and gaps analysis between Kepanjen Edu-tourism landfill and Kawatuna landfill for management development is as follows :

##### **a) Operational Technique Aspect:**

1. Develops, completes and builds infrastructure, facilities and infrastructure of the landfill based on the applicable provision for management standard of sanitary landfill. Focuses on drainage improvement, liquor management system, observation wheel reconstruction, biogas management, daily waste cover, disease and odor vector control, green buffer line construction, weighbridge construction, entry fence and round fence construction and the development of main operational road and inside the landfill area;
2. Intensification of information socialization and education of 3R activity towards scavenger and makes them as a part of the 3R process of waste management at the landfill.
3. Creation and replication of Air and Hydro Waste Separation Equipment as a waste separation of organic and inorganic waste;
4. Providing transit area for B3 from household waste and its processing management.

##### **b) Legality Aspect:**

1. Technical guidelines of waste reductions and handling from the source until the end processing;
2. A guideline of compilation and application of organization/ waste manager institution, i.e. RT/RW, Ward, TPS, TPST 3R and Landfill;
3. Financing guideline of waste management;
4. Community role guidelines in managing waste;
5. Service guidelines for emergency condition;
6. Regulation and technical guidelines of livestock husbandry.

##### **c) Institutional Aspect:**

1. Strengthening and separation of regulator institution, in this case is Palu Environmental Agency and operator institution of landfill service in the form of UPTD;
2. A competent Human Resources placement in the waste management at UPTD to ensure UPTD can perform the duties and functions well;
3. Determining Standard Operating Procedure (SOP) of landfill management applied at each functional positions of manager and Minimum Service Standard of landfill;
4. Analyzing working load to determine the number of a certain personnel at every item of work to avoid the accumulation of personnel at a certain work which will decrease work effectivity and payment increase;
5. Coordination strengthening among stakeholder at Palu city government, UPTD, Sub-district, Ward, academics, private and community institutional;
6. Encouraging improvement and optimization of waste service unit especially TPST 3R;
7. Encouraging the establishment of community institutions as an operator of waste processing at the smaller area (RT/RW/ward).

##### **d) Financing and Economics Aspect:**

1. Optimization of main finance source deriving from the government (APBN), local government (ABPD Provincial/District/Municipality).
2. Finance sources development from external party through cooperation and partnership. The intended external party

is a cooperation between local government and cooperation/partnership with a business field or other donor institution;

3. Income improvement deriving from retribution by which a willingness to pay is influenced by service quality [23].

e) Health and Environmental Aspect:

1. A routine examination to those actively involved at the landfill can be conducted through a cooperation with Health Agency of Palu City;
2. Standard fulfillment of landfill health environment can be done by a routine examination to what extent pollutant factors pollute environment like liquor water distribution, odor, and disease vectors;
3. Environmental recovery exposed by pollution based on the standard of regulation.

f) Social Aspect:

1. Building communication to equalize perception between landfill manager and community around the landfill about waste management at the landfill. This effort is carried out through socialization intensification to deliver information about landfill activity opened to the society, the existence of landfill as an institution, not a location easily accessed by everyone. This socialization should also contain an education of benefits the society can gain from landfill activity through 3R activity and waste bank and information about the impact and the danger of neglectful landfill management;
2. Involving and accompanying society by establishing environmental cadre community;
3. Establishing and accompanying Community-Reliance Group to support landfill manager;
4. Recruiting low-income society so be the registered-waste sorter (having an ID card) at the landfill or TPST 3R;
5. Cooperating with an involved institution to provide training to an animal farmer around the landfill of ruminant feed processing deriving from leftover food waste, in which the result of this activity will be served as a source of additional feed for the livestock who will be able to avoid society to let their livestock to free to roam around the landfill.

## CONCLUSION

Development strategy of Kawatuna Landfill in Palu City is as follows: (a) operational technical aspect with the fulfillment of feasibility standard of landfill; (b) legality aspect by elaborating regulation technique of waste management; (c) institutional aspect by separating regulation institutional role and operator, SOP and SPM determination, and coordination strengthening among stakeholder; (d) financing and economics aspect by optimizing Provincial APBN/APBD, District/Municipal APBD, finance source development from external party and retribution increase; (e) health and environmental aspect by providing health guarantee for human and environment around the landfill; (f) social aspect by empowering society around the landfill.

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