EVALUATION OF THE IMPLEMENTATION OF WASTE GENERATION REDUCTION INTO COMPOST WITH WINDROW SYSTEM IN THE TALANG GULO FINAL PROCESSING, JAMBI CITY

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ABSTRACT

Talang Gulo Final Processing Site, Jami City will make efforts to reduce biodegradable waste consisting of leaf waste. The processing process that can be applied is by converting it into compost with an aerobic process with a windrow system. The purpose of this study was to evaluate the composting system and the results of existing waste processing. This research was conducted by direct observation and secondary data collection from the local management inventory. The composition of biodegradable waste in Jambi City consists of 47.4% food waste and 2.1% garden waste. However, the application of food waste is quite difficult to handle because of its characteristics, therefore garden waste is a priority for reduction by the government. The results of monitoring for one month in a row mean that the waste entering the compost facility is 4086 kg/day. The percentage of waste reduction from composting activities in total can be 0.986% of the total waste generation of Jambi City, or 45.426% of the total waste generation of Jambi City's gardens. The final measurement results of compost have met the quality standard of SNI 19-7030-2004 which has been set by the Indonesian government. The value of water content, pH, C – Organic, N – Total, C/N, P_2O_3, and K_2O Total is 13.64%; 7,12; 4.77%; 0.42%; 11.4% 45.01%; and 0.25%, respectively. It is hoped that even though the achievement of waste reduction from this activity is still low, if it is seen from the opportunities for sustainable management and social support from the community and the government, it will reduce waste generation in Jambi City.

EVALUASI PENERAPAN REDUKSI TIMBULAN SAMPAH MENJADI KOMPOS DENGAN SISTEM *WINDROW* DI TEMPAT PEMROSESAN AKHIR TALANG GULO KOTA JAMBI

Abstrak- Tempat Pemrosesan Akhir Talang Gulo, Kota Jami akan melakukan upaya reduksi sampah biodegradable yang terdiri dari sampah daun. Proses pengolahan yang dapat diaplikasikan yaitu dengan konversi menjadi kompos dengan proses aerob dengan sistem *windrow*. Tujuan dari penelitian ini adalah untuk mengevaluasi sistem pengomposan dan hasil pengolahan sampah yang dilakukan secara eksisting. Penelitian ini dilakukan dengan observasi langsung dan pengumpulan data sekunder dari inventarisasi pengelolaa setempat. Komposisi sampah biodegradable di Kota Jambi terdiri dari 47.4% sampah makanan dan 2.1% sampah kebun. Akan tetapi aplikasi sampah makanan cukup sulit untuk di tangani karena karakteristiknya, oleh karena itu sampah kebun menjadi prioritas reduksi yang dilakukan pemerintah. Hasil pemantauan selama satu bulan berturut-turut rata-rata sampah yang masuk ke fasilitas kompos adalah 4086 kg/hari. Persentase reduksi sampah dari kegiatan komposting secara total dapat yaitu 0.986% dari total timbulan sampah Kota Jambi, atau 45,426% dari total timbulan sampah kebun Kota Jambi. Hasil pengukuran akhir kompos sudah memenuhi baku mutu SNI 19-7030-2004 yang telah ditetapkan pemerintah Indonesia. Nilai water content, pH, C – Organic, N – Total, C/N, P2O3, dan K2O Total adalah13,64%; 7,12; 4,77%; 0,42%; 11,4% 45,01%; dan 0,25%, masing-masing. Diharapkan walupun

pencapain reduksi sampah dari kegiatan ini masih rendah, akan tetapi jika dilihat dari peluang pengelolaan yang berkelanjutan dan dukungan sosial masyarakat serta pemerintah akan menurunkan timbulan sampah di Kota Jambi.

Kata kunci : kompos, reduksi, sampah, *windrow*

INTRODUCTION

Jambi City, as well as other cities in Indonesia, is facing quite complicated waste problems such as environmental pollution due to uncontrolled burning and accumulation of garbage, dumping garbage into rivers resulting in flooding, and difficulty finding land for final processing sites (Edi, 2019). One of the efforts made is to minimize waste generation by processing waste into compost. Composting has an important role in waste recycling efforts, because of its ability to convert organic waste into compost organic fertilizer. The high percentage of biodegradable organic matter in municipal waste (Dianda, Mahidin and Munawar, 2018) makes municipal waste very prospective for composting. The results of financial and externality analysis concluded that composting decentralization is more efficient than composting centralization (Sahwan, 2016; Wahyono *et al*., 2016; Wahyono, 2018). By utilizing waste to become compost, the potential to waste reduction of waste disposed to landfill and reduce environmental impact (Rashid and Shahzad, 2021; Septiariva and Suryawan, 2021).

The urban internal area approach as the basis for compost supply-demand analysis is also used as the basis for the concept of organic waste management because the urban internal area has several potential compost consumers who can absorb compost production from municipal waste (Wahyono, 2016). If compost products are encouraged to be used in the internal areas of the city, then urban waste management will run sustainably, while creating a cycle of soil nutrients in urban ecosystems. One way to make this program work properly is to choose the right technology.

The windrow composting system is suitable for Indonesian conditions because of its flexibility (Kurnia, Sumiyati and Samudro, 2017). The advantages of the windrow composting system are that it is suitable for all types of organic waste, has a large loading capacity, and produces good quality compost (Lim *et al*., 2017). Therefore, the windrow composting method is suitable to be applied to treat compostable waste in the Talang Gulo Landfill. By utilizing waste into compost, another benefit that can be obtained is to help the city's waste management efforts. The problem of municipal waste is an inexhaustible problem faced by cities in Indonesia (Qonitan, Suryawan and Rahman, 2021; Sarwono *et al*., 2021; Suryawan *et al*., 2021; Iva Yenis Septiariva *et al*., 2022).

Processing of waste into compost is needed for agricultural development and can create jobs in Jambi City and can even increase the Jambi City Government's income. In addition, government support and policies are needed so that this effort can be successful in overcoming the waste problem in Jambi City (Edi, 2019). To support this, it is necessary to evaluate the existing conditions so that better planning can be carried out. The purpose of this study is to evaluate the biodegradable waste treatment system using windrowing compost technology at Talang Gulo Landfill, Jambi City in terms of reduction and final compost quality.

METHOD

At the research stage, in addition to finding information on literature studies and identifying problems, the process of taking research data is also carried out, namely primary data and secondary data. The existing condition is a review of the field conditions of the waste management system at the research location including waste generation and the waste composting process. Observations were carried out by taking documentation and observations at the research location, especially at the waste collection point. Waste generation obtained from existing conditions and evaluation of secondary data obtained from the landfill management.

RESULT AND DISCUSSION

Based on Figure 1 shows the composition of waste in Jambi City where biodegradable mostly consists of 47.4% food waste and relatively low garden waste, namely 2.1%. The reduction of biodegradable waste that is mostly done in Indonesia is by using a composting system. Composting is a method of processing organic waste by aerobic decomposition of biodegradable materials. The compost produced can be used in agricultural activities (Pergola *et al*., 2018). The type of biodegradable waste that is often processed using the composting method is garden waste because of the very high moisture content of food waste (Ghinea *et al*., 2019). Usually, food waste is more suitable to be processed with black soldier fly (Cheng, Chiu and Lo, 2017; da Silva and Hesselberg, 2020). In addition, the use of the black soldier fly also allows it to support the energy

supply (Raksasat *et al.*, 2021). However, composting has weaknesses such as the compost produced has a low nutrient content and takes a long time in the maturation process.

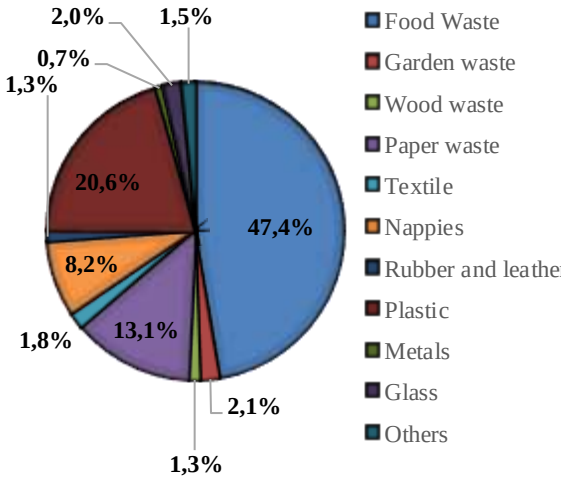

Figure 1. Waste generation composition in Jambi City (Hutagalung, Sakinah and Rinaldi, 2020)

The maximum amount of waste that enters the compost area is 15 tons/day. Leaf litter or garden waste will be collected at the entrance. After the waste is collected, the next 14 wastes will be put into the Shredder for enumeration. Leaf waste that has been chopped will be combined with food waste and fermented for 4-6 weeks or called Compost Turner type A. Composting at Talang Gulo Landfill uses the Windrow Mechanic Overturning system or mixing with heavy equipment. The width of the window is adjusted to the heavy equipment used, the minimum width is 1 meter, the height of the compost pile is about 1.75 meters, and the length is adjusted to the composting place. During the fermentation process, it is necessary to measure the humidity and temperature of the compost. Compost moisture needs to be maintained by regular watering and stirring every 3 days. After 6 weeks, the compost will be transferred to the Compost Turner type B area or ripening area with a duration of 6-8 weeks. Measurement of temperature and humidity, watering and stirring in this process also needs to be done. The ripe compost will be filtered using the Mobile Rotary Screen. Filtering is divided into 2 sizes, namely the size of 8 mm and more than or equal to 8 mm. Next, the compost will be packed according to the separation screen. The compost residue generated during the composting process will be disposed of in the Landfill. More details can be seen in Figure 2.

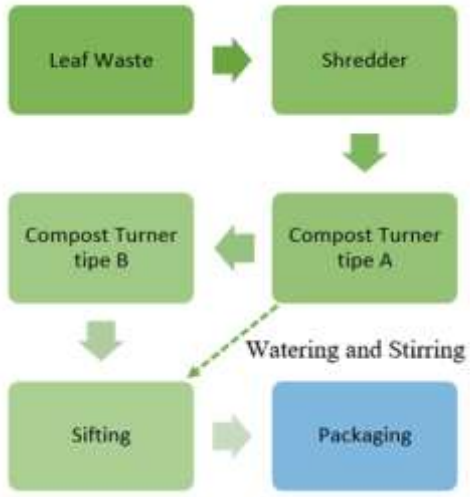

Figure 2. Waste Composite Process at Talang Gulo Landfill, Jambi City

The decrease in water content during the composting process is caused by evaporation into a gas (Koyama *et al.*, 2019; Yuan *et al.*, 2019). The higher the water content in the waste pile, the greater the shrinkage of the volume of waste. One of the key factors that show composting runs quickly is water content (Som, Lemée and Amblès, 2009). Moisture content is an important key in the composting process. The importance of water content is an important factor of maturity and quality of compost. The windrow composting system is a system that is suitable for Indonesian conditions because of its flexibility. Therefore, in the composting process, it is necessary to monitor the water content, if the waste is too dry then leachate recirculation (Balaganesh *et al.*, 2020) or additional water into the compost is required. Meanwhile, nitrogen has a critical role in composting engineering because of the decomposition of waste (Cayuela *et al.*, 2012).

There is a very small residue produced in the composting process, so composting is considered more effective in reducing waste that enters the Talang Gulo landfill compared to sorting. The amount of waste that is reduced in the composting process in one month is 100 tons. The compost produced has not yet been traded because it is still in the trial phase. Figure 3 shows data on waste entering the compost area with an average processed of 4.086 tons/day.

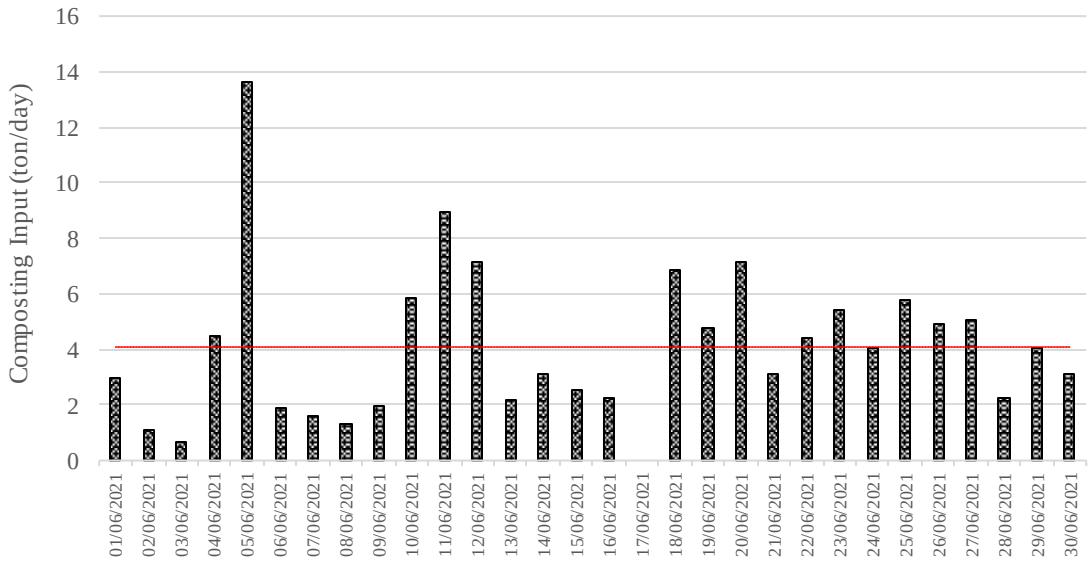

Figure 3. Composting Input Daily

In the composting process, 1/3 of the raw material (organic waste) will be obtained (Zahrina and Yenie, 2021). If this landfill consistently processes 4086 kg/day of waste, 1362 kg/day of compost will be obtained. The net profit obtained from the composting business is Rp. 60 – 1,060 per kg (Djaja, 2010), so the profit to be gained is Rp. 81720 –.1443720 daily.

Table 1. Composting Mass Balance Calculation in Jambi City

Waste Generation (ton/day)	Name Waste Processing Facilites[1]	Waste to the composting facility (ton/year)	Waste to the composting facility (ton/day)	Total Reduction with Compost (ton/day)	% Total Reduction with Compost
Total Waste Generation: 427.68	Komposting Mayang Mangurai	7.3[1]	0.02	0.11	0.026
	Komposting JL. Ki Bajuri	18.25[1]	0.05		
	Komposting Komp. Villa Kenali 1	7.3[1]	0.02		
	Komposting Jl. KH. Agus Salim	7.3[1]	0.02		
	Talang Gulo Landfill	1491.39	4.086	4.086	0.96
% Total Waste Reduction from Total Waste Generation with Composting in Jambi City					**0.986**
Total Garden Waste Generation: 9	Talang Gulo Landfill	1491.39	4.086	4.086	45.4
% Total Waste Reduction from Garden Waste Generation with Composting in Jambi City					**45.426**

[1] (Kementerian Lingkungan Hidup dan Kehutanan, 2019)

Along with the reshuffling process, C/N at the end incubation of 11.4 was good enough to be applied to the soil to improve its fertility level. The composting process in a closed state is more effective and can avoid the loss of nutrients due to rainwater washing. Compost that has a C/N ratio value above 20 is not recommended or should be avoided for use on agricultural land because it will have an unfavourable impact on plant growth. This is because compost that has a C/N ratio that is too high will cause nitrogen immobilization (Zhang and Pang, 2008). This immobilization occurs due to competition between plants and microbes to consume N so that plants only get a little nitrogen from the soil (Hosseini and Aziz, 2013). If the C/N ratio has reached 12-20, it means that the nutrients bound to the humus have been released through the mineralization process so that they can be used by

plants. However, a C/N ratio that has a value of 10 is recommended for ideal results (Peng *et al*., 2016).

Table 1. Physical properties of fruit waste

Parameters	Result	Criteria SNI 19-7030-2004	
		Min	Maks
Colour	Dark	-	Dark
Odour	Smell of earth	Smell of earth	
Water Content (%)	13.64		
pH	7.12	6.80	7.49
C – Organic (%)	4.77	9.80	32
N – Total (%)	0.42	0.40	-
C/N	11.4	10	20
P_2O_3 (%)	45.01	0.1	-
K_2O Total (%)	0.25	0.2	-

CONCLUSION

The composting process of leaf waste at Talang Gulo Landfill can process at least 4,086 tons/day or about 45.4% of the total waste generation in Jambi City. The result of compost processing has met the criteria set by SNI 19-7030-2004. The sustainability of this composting program must be supported by all levels of society and the government from source to disposal.

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REFERENCE

Balaganesh, P. *et al*. (2020) 'Improving Soil Fertility and Nutrient Dynamics with Leachate Attributes from Sewage Sludge by Impoundment and Co-Composting', *Clean - Soil, Air, Water*, 48(12), pp. 1–9. doi: 10.1002/clen.202000125.

Cayuela, M. L. *et al*. (2012) 'Biochemical changes and GHG emissions during composting of lignocellulosic residues with different N-rich by-products', *Chemosphere*, 88(2), pp. 196–203. doi: https://doi.org/10.1016/j.chemosphere.2012.03.001.

Cheng, J. Y. K., Chiu, S. L. H. and Lo, I. M. C. (2017) 'Effects of moisture content of food waste on residue separation, larval growth and larval survival in black soldier fly bioconversion', *Waste Management*, 67, pp. 315–323. doi: https://doi.org/10.1016/j.wasman.2017.05.046.

Dianda, P., Mahidin and Munawar, E. (2018) 'Production and characterization refuse derived fuel (RDF) from high organic and moisture contents of municipal solid waste (MSW)', *IOP Conference Series: Materials Science and Engineering*, 334, p. 12035. doi: 10.1088/1757-899x/334/1/012035.

Djaja, W. (2010) *Langkah Jitu Membuat Kompos dari Kotoran Ternak dan Sampah*. Jakarta: PT. Agromedia Pustaka.

Edi, R. P. dan S. (2019) 'Aleternatif Teknologi Pengomposan Berbahan Baku Sampah Perkotaan untuk Mendukung Pertanian Organik di Kota Jambi', *Journal of Chemical Information and Modeling*, 53(9), pp. 1689–1699.

Ghinea, C. *et al*. (2019) 'Development of a model for food waste composting', *Environmental Science and Pollution Research*, 26(4), pp. 4056–4069. doi: 10.1007/s11356-018-3939-1.

Hosseini, S. M. and Aziz, H. A. (2013) 'Evaluation of thermochemical pretreatment and continuous thermophilic condition in rice straw composting process enhancement', *Bioresource Technology*, 133, pp. 240–247. doi: https://doi.org/10.1016/j.biortech.2013.01.098.

Hutagalung, W. L. C., Sakinah, A. and Rinaldi, R. (2020) 'Estimasi Emisi Gas Rumah Kaca pada Pengelolaan Sampah Domestik dengan Metode IPCC 2006 di TPA Talang Gulo Kota Jambi', *Jurnal Teknik Sipil dan Lingkungan*, 5(1), pp. 59–68. doi: 10.29244/jsil.5.1.59-68.

Iva Yenis Septiariva *et al*. (2022) 'Municipal Infectious Waste during COVID-19 Pandemic: Trends, Impacts, and Management', *International Journal of Public Health Science (IJPHS)*.

Kementerian Lingkungan Hidup dan Kehutanan (2019) *Sistem informasi Pengelolaan Sampah Nasional*. Available at: http://sipsn.menlhk.go.id.

Koyama, M. *et al*. (2019) 'Effect of Ca(OH)2 dosing on thermophilic composting of anaerobic sludge to improve the NH3 recovery', *Science of The Total Environment*, 670, pp. 1133–1139. doi: https://doi.org/10.1016/j.scitotenv.2019.03.320.

Kurnia, V. C., Sumiyati, S. and Samudro, G. (2017) 'Pengaruh Kadar Air Terhadap Hasil Pengomposan Sampah Organik Dengan Metode Open Windrow', *Jurnal Teknik Mesin*, 6(2), p. 58. doi: 10.22441/jtm.v6i2.1191.

Lim, L. Y. *et al*. (2017) 'Review on the Current

Composting Practices and the Potential of Improvement using Two-Stage Composting ', *Chemical Engineering Transactions*, 61, pp. 1051-1056 SE-Research Articles. doi: 10.3303/CET1761173.

Peng, C. *et al*. (2016) 'Effects of long term rice straw application on the microbial communities of rapeseed rhizosphere in a paddy-upland rotation system', *Science of The Total Environment*, 557–558, pp. 231–239. doi: https://doi.org/10.1016/j.scitotenv.2016.02.184.

Pergola, M. *et al*. (2018) 'Composting: The way for a sustainable agriculture', *Applied Soil Ecology*, 123, pp. 744–750. doi: https://doi.org/10.1016/j.apsoil.2017.10.016.

Qonitan, F. D., Suryawan, I. W. K. and Rahman, A. (2021) 'Overview of Municipal Solid Waste Generation and Energy Utilization Potential in Major Cities of Indonesia', *Journal of Physics: Conference Series*, 1858(1). doi: 10.1088/1742-6596/1858/1/012064.

Raksasat, R. *et al*. (2021) 'Blended sewage sludge–palm kernel expeller to enhance the palatability of black soldier fly larvae for biodiesel production', *Processes*, 9(2), pp. 1–13. doi: 10.3390/pr9020297.

Rashid, M. I. and Shahzad, K. (2021) 'Food waste recycling for compost production and its economic and environmental assessment as circular economy indicators of solid waste management', *Journal of Cleaner Production*, 317, p. 128467. doi: https://doi.org/10.1016/j.jclepro.2021.128467.

Sahwan, F. L. (2016) 'Analisis Proses Komposting Pada Pengelolaan Sampah Berbasis Masyarakat Skala Kawasan (Studi Kasus Di Kota Depok)', *Jurnal Teknologi Lingkungan*, 13(3), p. 253. doi: 10.29122/jtl.v13i3.1394.

Sarwono, A. *et al*. (2021) 'Municipal Solid Waste Treatment for Energy Recovery Through Thermal Waste-To-Energy in Depok City, Indonesia', *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 85.

Septiariva, I. V. A. Y. and Suryawan, I. W. K. (2021) 'Development Of The Water Quality Index (Wqi) And Hydrogen Sulfide (H 2 S) For Assessments Around The Suwung Landfill , Bali Island', 16(4), pp. 137–148.

da Silva, G. D. P. and Hesselberg, T. (2020) 'A Review of the Use of Black Soldier Fly Larvae, Hermetia illucens (Diptera: Stratiomyidae), to Compost Organic Waste in Tropical Regions', *Neotropical Entomology*, 49(2), pp. 151–162. doi: 10.1007/s13744-019-00719-z.

Som, M.-P., Lemée, L. and Amblès, A. (2009) 'Stability and maturity of a green waste and biowaste compost assessed on the basis of a molecular study using spectroscopy, thermal analysis, thermodesorption and thermochemolysis', *Bioresource Technology*, 100(19), pp. 4404–4416. doi: https://doi.org/10.1016/j.biortech.2009.04.019.

Suryawan, I. W. K. *et al*. (2021) 'Potential of Energy Municipal Solid Waste (MSW) to Become Refuse Derived Fuel (RDF) in Bali Province , Indonesia', *Jurnal Bahan Alam Terbarukan*, 10(200).

Wahyono, S. (2016) 'Analisis Efektivitas Konsep Pengelolaan Sampah Organik melalui Teknologi Analisis Efektivitas Konsep Pengelolaan Sampah Organik melalui Teknologi Komposting The Effectiveness Analysis of Organic Waste Management Concept Through Technology Composting', *Jurnal Teknologi Lingkungan*, 17(1), pp. 37–44.

Wahyono, S. *et al*. (2016) 'Metabolisme Pengelolaan Sampah Organik Melalui Teknologi Komposting Di Wilayah Internal Perkotaan', *Jurnal Teknologi Lingkungan*, 13(2), p. 179. doi: 10.29122/jtl.v13i2.1417.

Wahyono, S. (2018) 'Konsep Pengelolaan Sampah Kota dan Kaji Terap Teknologi Pengelolaannya', *Prosiding Seminar Nasional dan Konsultasi Teknologi Lingkungan*, (20 September 2018), pp. 58–64.

Yuan, J. *et al*. (2019) 'Effects of inoculation amount and application method on the biodrying performance of municipal solid waste and the odor emissions produced', *Waste Management*, 93, pp. 91–99. doi: https://doi.org/10.1016/j.wasman.2019.05.029.

Zahrina, I. and Yenie, E. (2021) 'Penerapan Teknologi Windrow Composting Bagi Masyarakat Sekitar Tpa Muara Fajar Pekanbaru', *Dharmakarya*, 10(2), p. 174. doi: 10.24198/dharmakarya.v10i2.33178.