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JENV adalah jurnal yang mengkaji berbagai masalah/persoalan terkini yang bersifat mendasar atau terapan yang berhubungan dengan bidang teknik dan pengelolaan lingkungan serta pengelolaan limbah dengan frekuensi penerbitan dua kali setahun pada April dan Oktober. Kelayakan pemuatan dipertimbangkan oleh penilai dengan *blind review* berdasarkan keaslian dan keabsahan ilmiah.

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Volume 3, No.2, Oktober 2018

EDITORIAL

Pembaca yang terhormat, Jurnal Teknik Lingkungan dan Pengelolaan Limbah (JENV) yang terbit bulan Oktober 2018 ini merupakan jurnal edisi keenam yang diterbitkan oleh Universitas Presiden. Dengan tujuan untuk berkontribusi secara nyata di bidang Teknik Lingkungan berdasarkan ilmu pengetahuan, manajemen dan teknologi yang terkini, kehadiran jurnal ini diharapkan mampu memberikan inspirasi terhadap solusi masalah-masalah lingkungan yang semakin memerlukan perhatian yang memadai.

Pada edisi keenam Jurnal JENV ini terdapat satu naskah mengenai *sustainability*: Pertimbangan Keberlanjutan dalam Perubahan Peruntukan Lahan Pertanian di Kabupaten Bekasi; satu naskah mengenai teknologi pengelolaan sampah: *The Prospect of Using Smart Dustbin for Reducing Garbage Pick Up Time (A Simulation in Padang City)*; satu naskah *review* mengenai dampak lingkugan penggunaan teknologi Li-Fi & Wi-Fi: *Peformance of Environmental Impacts Review of Li-Fi and Wi-Fi Technologies*; satu naskah mengenai *vermicomposting*: Tinjauan Sosioekonomi Pemanfaatan Feses Sapi dengan Teknologi *Vermicomposting* (Studi Kasus di Kampung Papak Mangga Desa Cibodas Kecamatan Pasir Jambu Kabupaten Bandung); serta satu naskah mengenai limbah elektronik: *E-waste: An Underated Hazardous Waste in Indonesia*.

Semua tulisan ilmiah yang dipublikasikan telah melalui proses seleksi dengan metoda *blind review* oleh dewan redaksi dan mitra bestari.

Pada kesempatan ini kami mengucapkan terimakasih kepada dewan pengarah, dewan redaksi, editor pelaksana, tim sekretariat dan para penulis yang telah memberikan peran secara aktif sehingga penerbitan Jurnal JENV ini dapat terlaksana dengan baik. Kami berharap Jurnal JENV volume 3 nomor 2 bulan Oktober 2018 ini dapat bermanfaat bagi perkembangan ilmu dan pendidikan di Indonesia, khususnya di bidang Lingkungan Hidup.

Ketua Dewan Editor

PERTIMBANGAN KEBERLANJUTAN DALAM PERUBAHAN PERUNTUKAN LAHAN PERTANIAN DI KABUPATEN BEKASI

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Abstract: *Changes in land use require consideration of the sustainability of the area. The principle of a triple bottom line in sustainable development must be applied. This research builds a sustainable development model in Bekasi Regency. The secondary data used is from the Central Bureau of Statistics of Bekasi Regency. The variables used are the average of rainfall, the number of population, the number of job seekers, the area of rice field, the area of rice harvest, the production of wetland rice, and the production of field rice as independent variable and GDP as the dependent variable. Consideration of the selection of variables by looking at the economic, social and environmental aspects that are aspects that determine the sustainability of development. Data analysis was done by using multiple linear regression. The results showed that the population, paddy field area, paddy field production have a significant positive effect to PDRB, while the number of job seekers, paddy field area, and paddy field production significantly negatively. The average variable of rainfall has no significant effect to GRDP. Taken together (simultaneously) all the independent variables have a significant effect on GRDP.*

Keywords*: GDP, rice field, rice production*

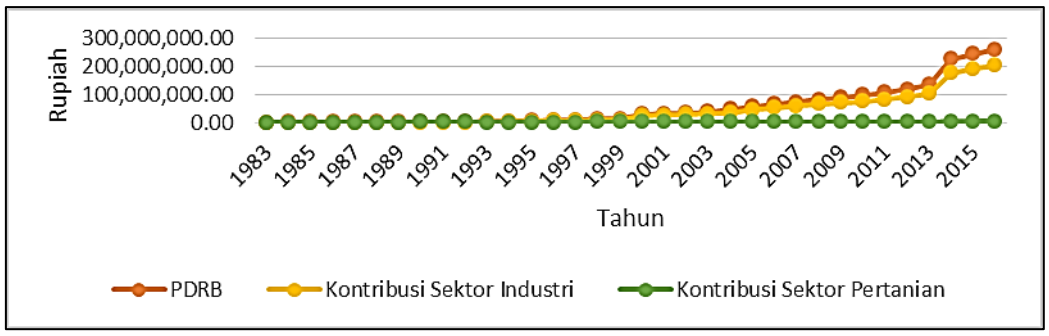
Abstrak: Perubahan peruntukan lahan membutuhkan pertimbangan keberlanjutan wilayah tersebut. Prinsip *triple bottom line* dalam pembangunan berkelanjutan harus tetap diterapkan. Penelitian ini membangun model pembangunan berkelanjutan di Kabupaten Bekasi. Data sekunder yang digunakan berasal dari Badan Pusat Statistik Kabupaten Bekasi. Variabel yang digunakan adalah rata-rata curah hujan, jumlah penduduk, jumlah pencari kerja, luas sawah, luas panen sawah, produksi padi sawah, dan produksi padi ladang sebagai variabel independen dan PDRB sebagai variabel dependen. Pertimbangan pemilihan variabel dengan melihat aspek ekonomi, sosial dan lingkungan yang merupakan aspek yang menentukan keberlanjutan pembangunan. Analisis data dilakukan dengan menggunakan regresi linier berganda. Hasil penelitian menunjukkan bahwa jumlah penduduk, luas sawah, produksi padi sawah berpengaruh positif signifikan terhadap PDRB, sedangkan jumlah pencari kerja, luas panen sawah, dan produksi padi ladang berpengaruh signifikan negatif. Variabel rata-rata curah hujan tidak berpengaruh signifikan terhadap PDRB. Secara bersama-sama (simultan) semua variabel independen berpengaruh signifikan terhadap PDRB.

Kata Kunci: PDRB, *sawah, produksi beras*

PENDAHULUAN

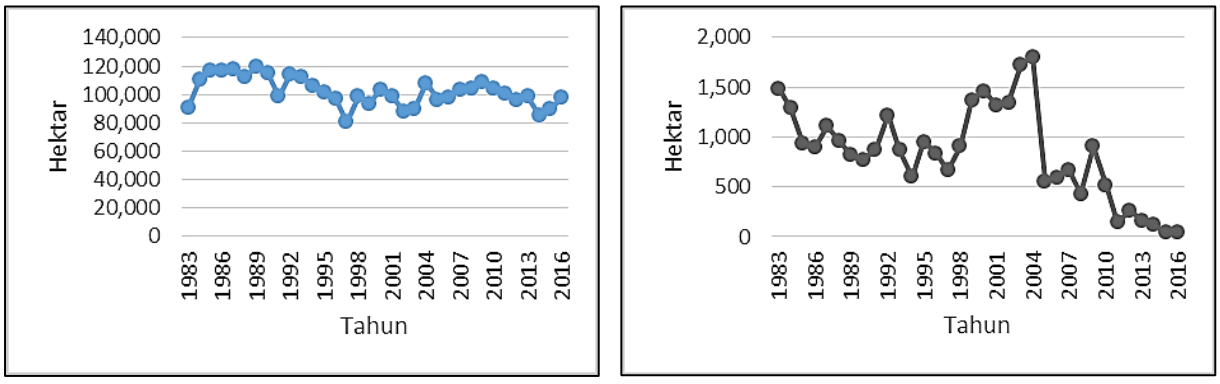
Sejak dulu Bekasi sampai Karawang dikenal sebagai lumbung padi. Wilayah ini merupakan wilayah pertanian padi teknis yang sawahnya diairi oleh irigasi dari Bendungan Jatiluhur. Menurut www.dkpp. jabar.go.id 2015, produksi padi dari Kabupaten Bekasi masih mengalami surplus 200.000 ton, walaupun banyak terjadi perubahan peruntukan lahan dari pertanian keperuntukan yang lain. Perubahan peruntukan lahan pertanian menjadi kawasan industri di Kabupaten Bekasi berlangsung sangat pesat. Pembangunan kawasan industri dimulai oleh PT Jababeka pada tahun 1988 membangun kawasan industri Jababeka dan diikuti oleh pembangunan kawasan industri yang lain. Pada tahun 2018, terdapat 7 kawasan industri di Kabupaten Bekasi, yaitu Jababeka 1, Jababeka 2, Delta Silicon 1, Delta Silicon 2, EJIP, BIIE, dan MM2000. Pada setiap kawasan industri terdapat ratusan perusahaan yang memiliki ribuan karyawan. Ribuan karyawan yang bekerja di kawasan industri membutuhkan pemenuhan kebutuhan hidup, pangan, pakaian dan papan, sebagai kebutuhan primer dan diikuti dengan kebutuhan sekunder dan *tertier*. Oleh karena itu

pembangunan kawasan industri akan diikuti oleh pembangunan kebutuhan hidup yang lain, dan otomatis akan terbangun kota baru yang akan menyediakan semua kebutuhan hidup manusia. Kontribusi sektor pertanian dan sektor industri terhadap PDRB (Pendapatan Daerah Regional Bruto) di Kabupaten Bekasi mengalami perubahan dari tahun ke tahun. Pada periode tahun 1983–2016, kontribusi sektor industri terhadap PDRB makin meningkat, sedangkan kontribusi sektor pertanian relatif tetap (Gambar 1).



Gambar 1. Perkembangan PDRB Berdasarkan Harga Berlaku, Kontribusi Sektor Pertanian dan Kontribusi Sektor Industri di Kabupaten Bekasi, 1983–2016
Sumber: BPS Kabupaten Bekasi 1983–2017

Untuk perkembangan luas panen padi sawah dan padi ladang di Kabupaten Bekasi pada periode 1983–2016 ditampilkan Gambar 2. Dari Gambar 2 terlihat bahwa luas panen padi ladang menurun sampai kurang dari 100 ha pada tahun 2015 dan 2016. Hal ini menggambarkan bahwa telah terjadi perubahan lahan pertanian padi ladang keperuntukan selain pertanian. Perubahan peruntukan lahan pertanian ini memang tidak otomatis menjadi lahan untuk industri, tetapi terjadi perubahan peruntukan lahan pertanian dan peningkatan kontribusi sektor industri terhadap PDRB dapat memberikan sinyal bahwa telah terjadi perubahan peranan sektor pertanian ke sektor industri terhadap perekonomian di Kabupaten Bekasi.



Gambar 2. Perkembangan Luas Panen Padi Sawah (kiri) dan Padi Ladang(kanan) di Kabupaten Bekasi, 1983–2016
Sumber: BPS Kabupaten Bekasi 1983–2016

Tujuan dari paper ini adalah: (1) Untuk menganalisis pengaruh beberapa faktor yang terkategori sebagai faktor ekonomi, sosial dan lingkungan terhadap

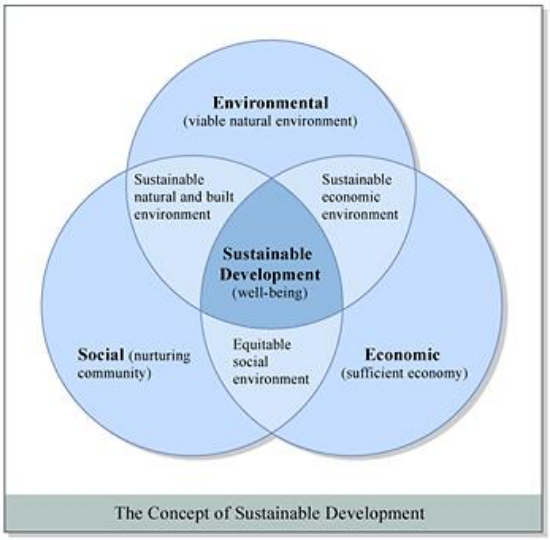
perekonomian Kabupaten Bekasi, yang direpresentatifkan dengan PDRB. (2) Untuk membangun model keberlanjutan dari perekonomian Kabupaten Bekasi dengan adanya perubahan peruntukan lahan. Diharapkan dengan adanya model keberlanjutan perekonomian Kabupaten Bekasi ini perencanaan pembangunan lebih mempertimbangkan aspek ekonomi, sosial dan lingkungan, sehingga pembangunan di Kabupaten Bekasi menjadi berkelanjutan.

KAJIAN PUSTAKA

Pembangunan berkelanjutan diartikan sebagai pembangunan yang tidak henti-henti dengan tingkat hidup generasi yang akan datang tidak boleh lebih buruk atau justru harus lebih baik daripada tingkat hidup generasi saat ini (Suparmoko, 2011). Definisi pembangunan berkelanjutan menurut Munasinge dan Ernst Lutz, 1991 dalam Rogers, 2008 adalah: *Sustainable development is an approach that will permit continuing improvements in the quality of life with a lower intensity of resources use,thereby leaving behind for future generations an undiminished or even enhanced stock of natural resources and other assets.* Pembangunan berkelanjutan adalah pendekatan peningkatan kualitas hidup dengan penggunaan sumberdaya yang lebih rendah, dan tetap mempertahankan kebutuhan generasi yang akan datang. Pembangunan berkelanjutan terus didengungkan lebih keras semenjak pertemuan lingkungan di Rio Jeneiro tahun 1992. Pada pembangunan berkelanjutan dikedepankan keseimbangan tiga pilar pembangunan, yaitu ekonomi, sosial dan lingkungan (*tripple bottom line*).

Tiga dimensi pembangunan berkelanjutan, ekonomi, sosial dan lingkungan diyakini akan menyeimbangkan dampak pembangunan. Setiap dimensi harus diperhatikan agar keberlanjutan dapat diperoleh. Dimensi yang pertama adalah ekonomi, yaitu memaksimumkan penerimaan dari kegiatan ekonomi dengan tetap mempertahankan atau meningkatkan kualitas lingkungan. Dimensi yang kedua adalah dimensi sosial, bahwa pembangunan tersebut akan membawa peningkatan kesejahteraan dan kualitas hidup baik bagi masyarakat dengan tanpa mengorbankan lingkungan alam. Dan dimensi yang ketiga adalah dimensi lingkungan, yaitu menjaga kelestarian lingkungan agar generasi yang akan datang tetap dapat menikmati lingkungan dan sumberdaya alam yang berkualitas baik dan tidak rusak.

Menurut Pearce *et al*., 1988 dalam Rogers, 2008, pembangunan berkelanjutan dilaksanakan untuk: (1) Pemanfaatan sumberdaya alam dengan laju yang lebih rendah daripada laju penyediaan sumberdaya oleh alam, (2) Penggunaan alam yang menyebabkan limbah dengan laju pembentukan limbah lebih rendah dari laju penghancuran limbah tersebut oleh alam. Terlihat bahwa pemanfaatan sumberdaya alam pada kegiatan produksi haruslah memperhatikan limbah yang dikeluarkan. Perpotongan antara ketiga pilar tersebut disajikan dalam Gambar 3.

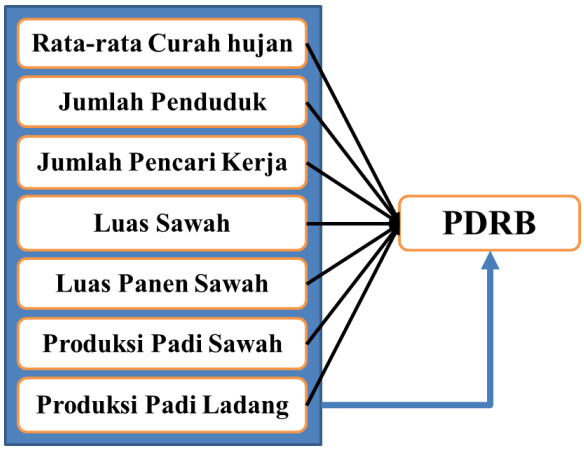


Gambar 3. Tiga Pilar Pembangunan Berkelanjutan (Rogers, 2008)

METODE PENELITIAN

Pembangunan berkelanjutan pada wilayah Kabupaten Bekasi diharapkan diperoleh, walaupun terjadi perubahan peruntukan lahan dari pertanian menjadi peruntukan industri. Penelitian ini dilakukan di Kabupaten Bekasi. Penentuan lokasi

penelitian ini dengan pertimbangan bahwa di kabupaten ini banyak mengalami penambahan jumlah industri yang besar, terutama setelah banyaknya dibangun kawasan industri di kabupaten ini. Pembangunan kawasan industri ini menyebabkan perubahan peruntukan lahan. Perubahan peruntukan lahan dari pertanian menjadi industri mempunyai konsekuensi. Salah satu konsekuensinya adalah terhadap produksi pertanian yang dihasilkan, Menurut Ilham, Yusman dan Supena, 2003, dua faktor yang menentukan produksi padi, yaitu ketersediaan sumberdaya lahan dan teknologi. Perubahan peruntukan lahan ini dilihat dengan kerangka pembangunan berkelanju-tan, yaitu dengan memperha-tikan aspek lingkungan sosial dan ekonomi. Oleh karena itu, dipilih variabel rata-rata curah hujan untuk melihat aspek lingkungan, aspek sosial digunakan variabel jumlah penduduk dan jumlah pencari kerja dan aspek ekonomi digunakan variabel luas sawah, luas panen sawah, produksi padi sawah dan produksi padi ladang. Adapun kerangka teori yang digunakan dalam penelitian ini adalah:



Gambar 4. Kerangka Teori

Metode pengumpulan data yang digunakan adalah metode dokumentasi, dengan menggunakan publikasi Biro Pusat Statistik Kabupaten Bekasi, berupa Bekasi Dalam Angka dari tahun 1985 sampai 2016. Data dalam penelitian ini merupakan data sekunder yang menunjukkan kondisi sosial, ekonomi dan lingkungan dari Kabupaten Bekasi dari tahun 1985 sampai tahun 2016 dengan jumlah data sebanyak 37. Variabel yang digunakan pada penelitian ini adalah PDRB, sebagai variabel dependen dan 7 variabel independen yaitu rata-rata curah hujan (AR) (aspek lingkungan), jumlah penduduk (P), jumlah pencari kerja (UE) (aspek sosial), luas sawah (WF), luas panen sawah (HWF), produksi padi sawah (WRP), dan produksi padi ladang (DRP) (aspek ekonomi). Sebelum dilakukan pengolahan data, terhadap semua data untuk semua variabel dilakukan uji normalitas data dengan menggunakan P-P Plot. Adapun metode analisis data yang digunakan dalam penelitian ini adalah regresi linier berganda karena ingin mengestimasi pengaruh variabel independen terhadap variabel dependen. Analisis regresi berganda dilakukan pada data time series dari tahun 1985–2016.

Model regresi berganda yang digunakan untuk memperlihatkan pengaruh dari masing-masing independen variabel, baik secara sendiri (*partial*) maupun bersama (*simultaneously*), terhadap dependen variabel. Uji asumsi klasik dilakukan untuk menguji apakah model regresi yang diperoleh dapat digunakan untuk mengestimasi pengaruh variabel independen terhadap variabel dependen. Uji asumsi klasik yang dilakukan adalah uji normalitas, uji heteroskedastisitas dan uji multikolinieritas. Untuk uji normalitas, digunakan histogram, jika histogram dari error yang ditimbulkan oleh model mengikuti kurva normal, maka dapat dikatakan bahwa model yang diperoleh akan memberikan simpangan error yang normal sehingga model dapat digunakan untuk melihat pengaruh.

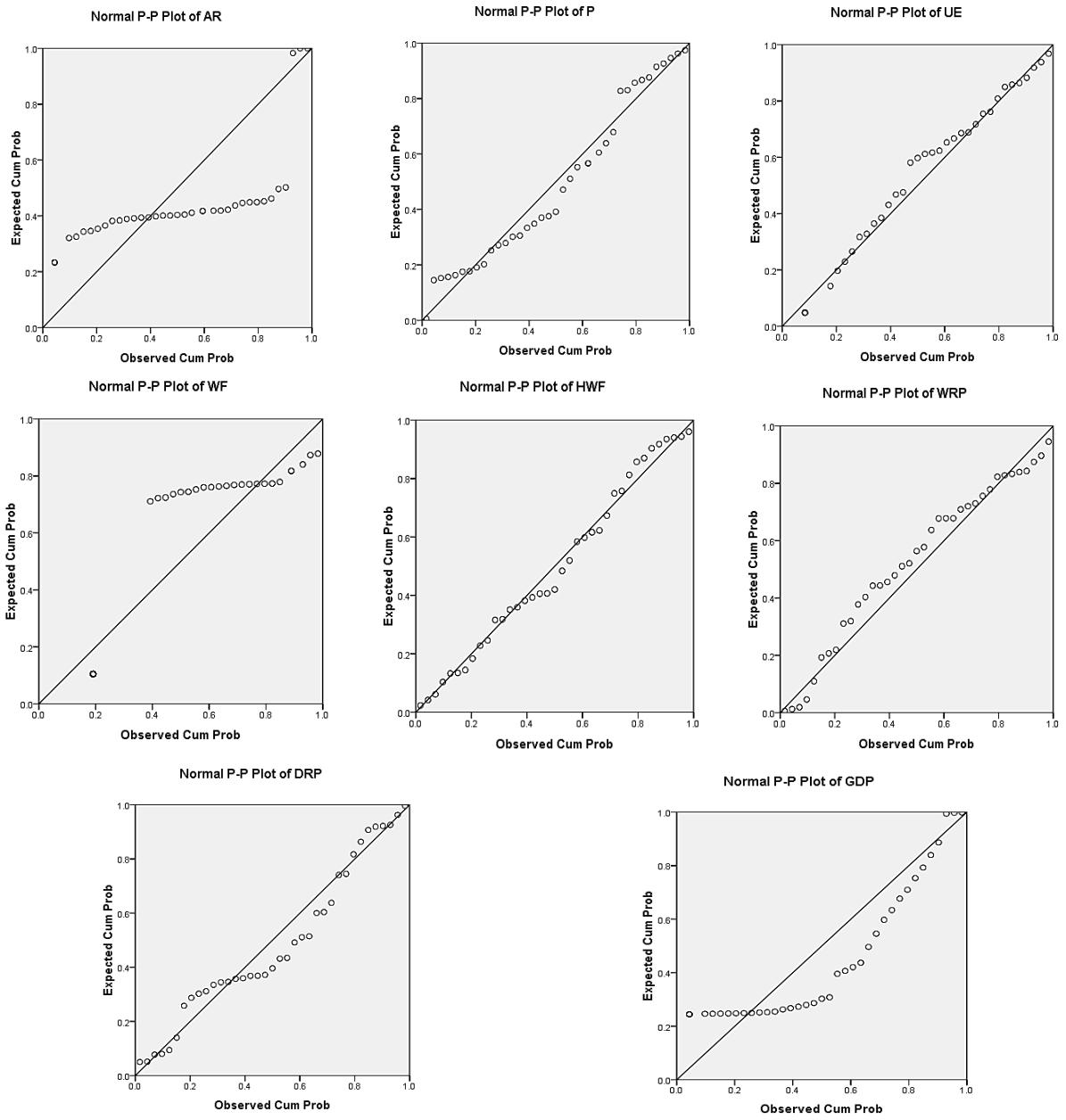
Untuk uji heteroskedastisitas digunakan diagram pencar (*scatter plot*). Jika diagram pencar menunjukkan pola distribusi dari error model menyebar dengan tidak menunjukkan pola tertentu, berarti pada model regresi berganda yang diperoleh tidak menunjukkan homoskedastisitas, tetapi memiliki heteroskedastisitas. Uji

terakhir untuk asumsi klasik ini adalah uji multikolinieritas. Uji ini menggunakan nilai VIF (*Variance Inflantion Factor*), yang jika nilai VIF lebih kecil dari 10, berarti tidak terjadi multikolinieritas, sehingga setiap variabel independen dapat memberikan pengaruh secara sendiri terhadap variabel dependen. Untuk melihat besarnya pengaruh seluruh variabel independen dalam menerangkan perilaku variabel dependen digunakan koefisien determinasi (R^2).

HASIL DAN PEMBAHASAN

Uji Normalitas Data

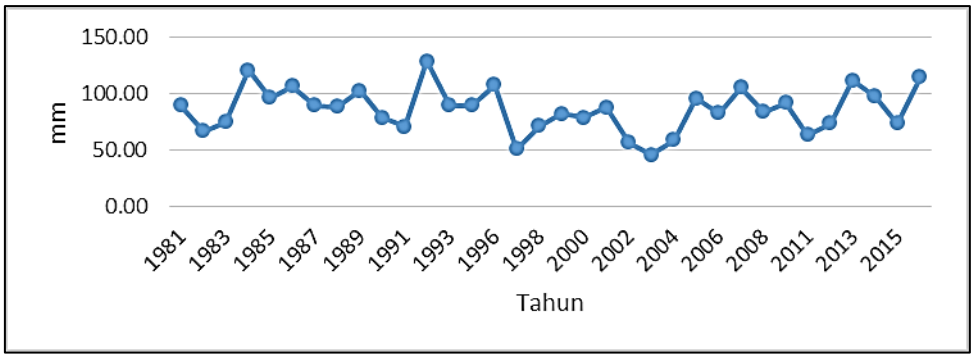
Gambar 5 menampilkan hasil uji normalitas, dan dapat dilihat bahwa semua variabel terdistribusi normal, sehingga dapat diolah dengan statistik parametrik.



Gambar 5. Uji Normalitas dari Semua Variabel dengan P-P Plot

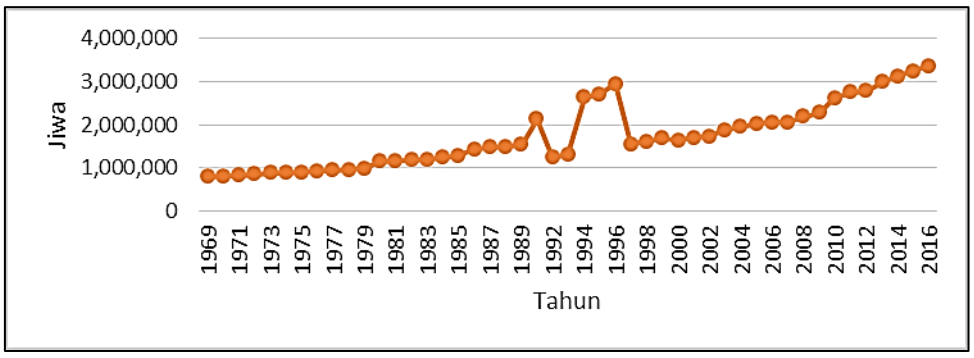
Deskriptif Analisis

Tren nilai variabel pada penelitian ini ditampilkan dalam gambar-gambar berikut. Rata-rata curah hujan di Kabupaten Bekasi dari tahun 1981–2016 ditampilkan Gambar 6. Dari Gambar 6 terlihat bahwa pola curah hujan pada setelah tahun 1995 dan seterusnya mengalami perubahan pola dari yang sebelumnya. Salah satu penyebab perubahan pola curah hujan disebabkan oleh perubahan peruntukan lahan (Pawitan, 2014). Hal ini sesuai dengan temuan dari Pawitan, 2014 yang menyatakan bahwa telah terjadi perubahan pola curah hujan di seluruh wilayah Indonesia, hasil air daerah aliran sungai semakin meningkat sehingga frekuensi kejadian ekstrem, seperti banjir dan kekeringan semakin meningkat.



Gambar 6. Rata-rata Curah Hujan di Kabupaten Bekasi tahun 1981–2016
Sumber: BPS Kabupaten Bekasi 2001–2017

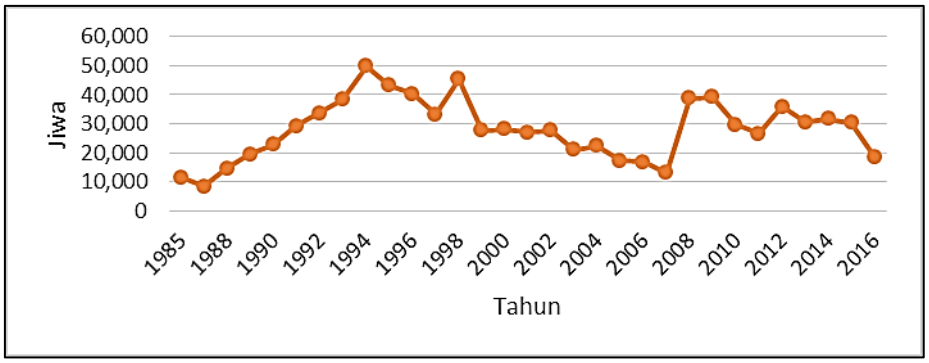
Untuk perkembangan jumlah penduduk pada Gambar 7 terlihat bahwa jumlah penduduk di Kabupaten Bekasi meningkat cukup pesat pada periode tahun 1969–2016. Pertumbuhan jumlah penduduk yang pesat ini banyak ditentukan oleh tingginya migrasi ke wilayah ini. Terjadi lonjakan jumlah penduduk yang cukup tinggi pada awal tahu 1990an, hal ini dikarenakan pada tahun-tahun tersebut perkembangan industri, terutama manufaktur sangat pesat, tetapi kemudian terjadi krisis di tahun 1998 yang menyebabkan banyak perusahaan yang tutup (bangkrut) atau memindahkan perusahaannya keluar negeri. Berhentinya proses produksi dari perusahaan manufaktur tersebut menimbulkan banyak pemutusan hubungan kerja, dan dengan mudah terlihat pada jumlah penduduk yang kebanyakan pendatang tadi.



Gambar 7. Perkembangan Jumlah Penduduk di Kabupaten Bekasi tahun 1969–2016
Sumber: BPS Kabupaten Bekasi 1985–2017

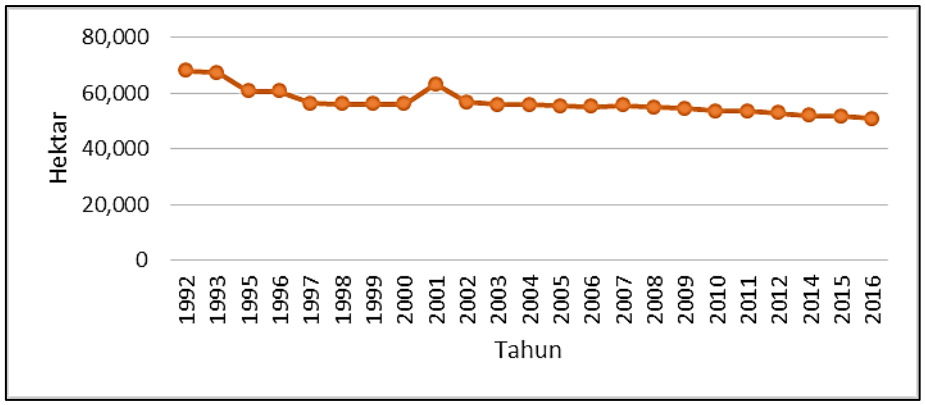
Hal yang menarik diperlihatkan Gambar 8, yang menampilkan tren jumlah pencari kerja di Kabupaten Bekasi. Peningkatan jumlah industri, tidak diikuti oleh

peningkatan pencari kerja, bahkan jumlah pencari kerja cenderung menurun. Hal ini dapat dipahami mengingat, penduduk asli Kabupaten Bekasi masih belum bisa diterima bekerja di sektor industri.



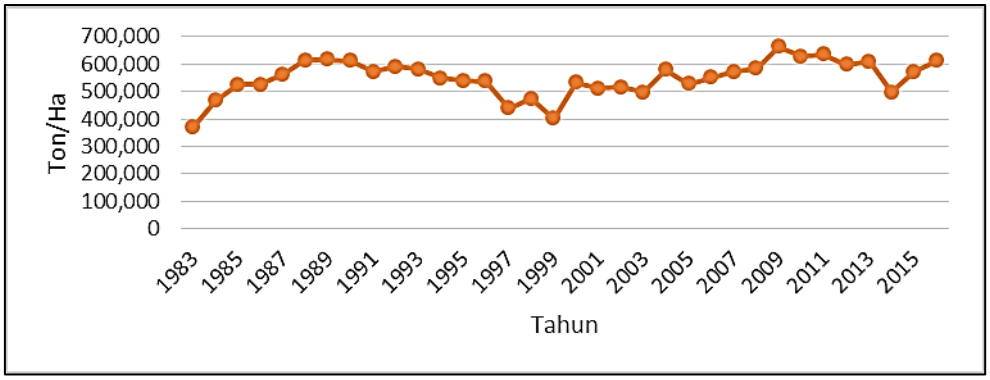
Gambar 8. Perkembangan Jumlah Pencari Kerja di Kabupaten Bekasi tahun 1985–2016
Sumber: BPS Kabupaten Bekasi 1985–2017

Untuk perkembangan luas sawah dan produksi padi sawah dan padi ladang dapat dilihat pada Gambar 9, 10 dan Gambar 11. Luas sawah mengalami penurunan dari tahun ke tahun. Produksi padi sawah masih menunjukkan kecenderungan yang stabil, tapi tidak meningkat, karena sawah yang ada di Kabupaten Bekasi adalah sawah dengan perairan teknis dari irigasi yang disediakan Waduk Jatiluhur. Harga lahan sawah relatif lebih rendah dari harga lahan kering, sehingga lahan sawah akan sangat banyak diminati terutama para developer perumahan.



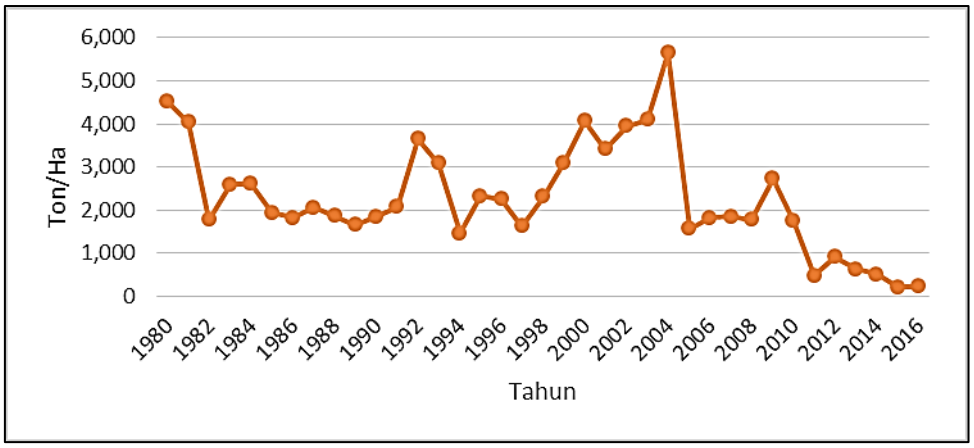
Gambar 9. Perkembangan Luas Sawah di Kabupaten Bekasi tahun 1992-2016
Sumber: BPS Kabupaten Bekasi 1985–2017

Perkembangan jumlah perumahan di Kabupaten Bekasi juga cepat, mengingat di Kabupaten Bekasi banyak perusahaan-perusahaan besar, sehingga permintaan rumah atau tempat tinggal menjadi tinggi. Pada Gambar 2 ditampilkan perkembangan luas panen padi sawah. Luas panen sawah tidak mengalami peningkatan, bahkan relatif mengalami penurunan. Hal ini menunjukkan bahwa teknologi yang digunakan dalam pengusahaan padi sawah tidak mengalami peningkatan dalam kurun 35 tahun terakhir.



Gambar 10. Perkembangan Produksi Padi Sawah di Kabupaten Bekasi tahun 1980–2016
Sumber: BPS Kabupaten Bekasi 1985–2017

Perkembangan produksi padi ladang, merepresentasikan perkembangan luas panen padi ladang ditampilkan Gambar 14. Terlihat bahwa penurunan produksi padi ladang terjadi sangat dratis terutama setelah tahun 2002.



Gambar 11. Perkembangan Produksi Padi Ladang di Kabupaten Bekasi tahun 1980–2016
Sumber: BPS Kabupaten Bekasi 1985–2017

Analisis regresi Linier Berganda

Untuk melihat dampak perubahan peruntukan lahan di Kabupaten Bekasi maka dilakukan analisis statitik dengan menggunakan regresi linier berganda. Variabel dependen yang digunakan adalah PDRB, yang merupakan indikator perkembangan ekonomi suatu daerah. Model regresi berganda (lihat Tabel 1) yang diperoleh adalah:

GDP = 0.029 AR + 0.446 P – 0.381 UE + 0.243 WF – 0.337 HWF+ 0.39 WRP – 0.283 DRP

Dimana:

GDP : Pendapatan Daerah Regional Bruto
AR : Rata-rata curah hujan (mm)
P : Jumlah penduduk (jiwa)
UE : Jumlah pencari kerja (jiwa)
WF : Luas lahan sawah (ha)
HWF : Luas panen padi sawah (ha)
WRP : Produksi padi sawah (ton)
DRP : Produksi padi ladang (ton

Dari model regresi tersebut, terlihat bahwa PDRB mempunyai korelasi positif dengan rata-rata curah hujan (AR), jumlah penduduk (P), luas lahan sawah (WF) dan produksi padi sawah (WRP). Sedangkan dengan jumlah pencari kerja (UE), luas panen padi sawah (HWF) dan produksi padi ladang (DRP) berhubungan negatif.

Uji asumsi klasik untuk model regresi linier berganda ini menunjukkan bahwa, untuk uji normalitas, error model ini telah menyebar secara normal. Hal terlihat dari pengujian normalitas dengan menggunakan histogram (Gambar 12). Uji heterogenitas diantara error yang dihasilkan model dilakukan dengan menggunakan diagram pencar (*scatter plot*) yang ditampilkan Gambar 13. Uji multikolinieritas dilakukan dengan menggunakan nilai VIF (*variance inflation factor)* lebih dari 1 dan kurang dari 10 (Tabel 1).

Uji Pengaruh

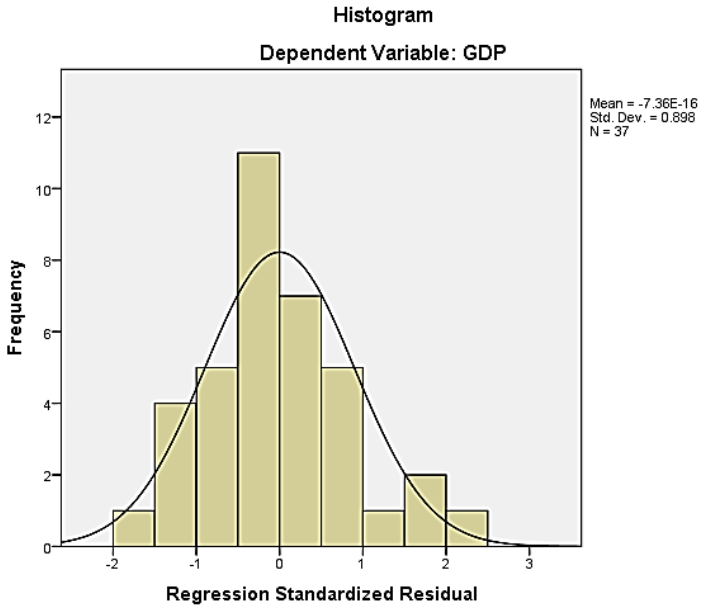
Untuk melihat pengaruh dari independen variabel terhadap dependen variabel dilakukan pengujian dengan menggunakan uji t dan F. Dari Tabel 1, dengan menggunakan tingkat signifikansi 10 % (α = 0.1), terlihat bahwa variabel jumlah penduduk, jumlah pencari kerja, luas sawah, luas panen sawah, produksi padi sawah dan produksi padi ladang memiliki nilai p (p-*value*) kurang dari 0.1, yang artinya variabel-variabel tersebut berpengaruh signifikan terhadap variabel PDRB. Data yang digunakan mendukung dalam penelitian ini mendukung bahwa variabel independen tersebut memiliki pengaruh terhadap besarnya variabel dependen. Variabel rata-rata curah hujan saja yang tidak signifikan berpengaruh terhadap variabel PDRB (p-*value* = 0.782 > 0.1).

Tabel 1. Perhitungan Model Regresi Linier Berganda

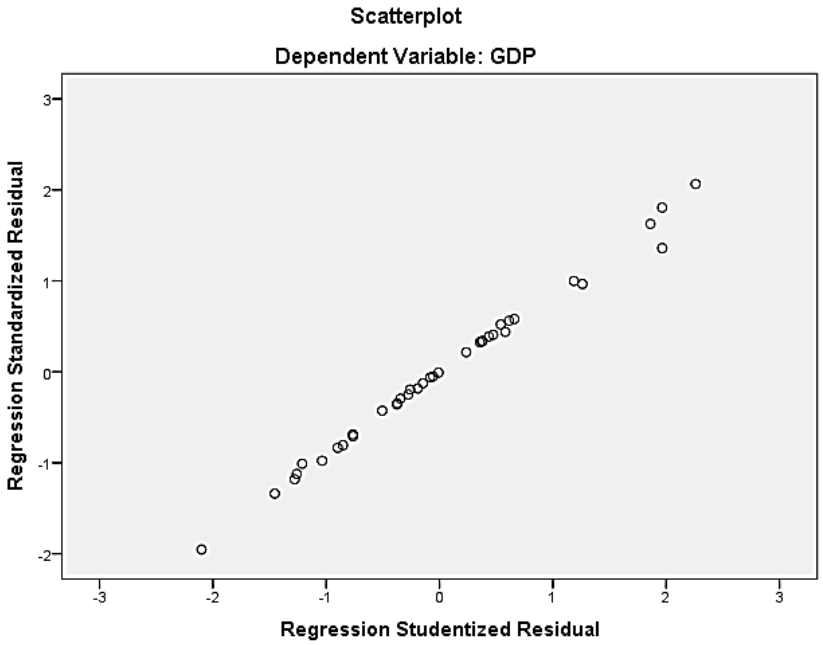
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	69340194.987	87649824.975		.791	.435		
	AR	608.303	2179.799	.029	.279	.782	.843	1.187
	P	42.633	14.789	.446	2.883	.007	.371	2.697
	UE	-1909.430	653.761	-.381	-2.921	.007	.519	1.925
	WF	611.555	349.508	.243	1.750	.091	.461	2.171
	HWF	-2324.305	1147.368	-.337	-2.026	.052	.320	3.129
	WRP	355.727	156.477	.399	2.273	.031	.288	3.478
	DRP	-15861.529	7109.891	-.283	-2.231	.034	.553	1.810

Dependent Variable: GDP
Sumber: Perhitungan dengan SPSS



Gambar 12. Uji Normalitas untuk Error pada Model



Gambar 13. Uji Heteroskedastisitas untuk Model

Uji F digunakan untuk menguji pengaruh semua variabel independen, bersama-sama, terhadap varaibel dependen. Hasil uji F disajikan Tabel 2, dan terlihat bahwa nilai p-*value* adalah 0.000, kurang dari 0.1, berarti semua variabel independen secara bersama-sama berpengaruh signifikan terhadap variabel dependen.

Nilai koefisien determinasi (R^2) adalah 68.1 persen (Tabel 3), yang berarti bahwa variabel independen yang digunakan pada penelitian ini dapat mempengaruhi variabel dependen, yaitu PDRB sebanyak 68.1 persen. Ada 31,9 persen, PDRB dipengaruhi oleh variabel yang lain, yang tidak digunakan dalam penelitian ini.

Tabel 2. Pengujian Pengaruh Simultan Menggunakan Uji F

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	134035622620087456.000	7	191479460885838924.000	11.975	.000[b]
	Residual	463714260201219 28.000	29	159901469034903 2.000		
	Total	180407048640209376.000	36			

a. Dependent Variable: GDP
b. Predictors: (Constant), DRP, HWF, UE, AR, WF, P, WRP

Variabel rata-rata curah hujan tidak berpengaruh signifikan dengan tingkat nyata 10%. Padahal telah terjadi perubahan peruntukan lahan di Indonesia di banyak tempat, terutama di pulau Jawa. Dampak hidrologi dari perubahan peruntukan lahan tersebut, terlihat dari hasil air daerah aliran sungai yang makin besar meningkatkan frekwensi kejadian ekstrim, seperti banjir dan kekeringan (Pawitan, 2014). Perubahan rata-rata curah hujan tidak nyata pada Kabupaten Bekasi, dapat dikarenakan pengukuran rata-rata curah hujan hanya dilakukan di wilayah administrasi bukan pada DAS (daerah aliran sungai).

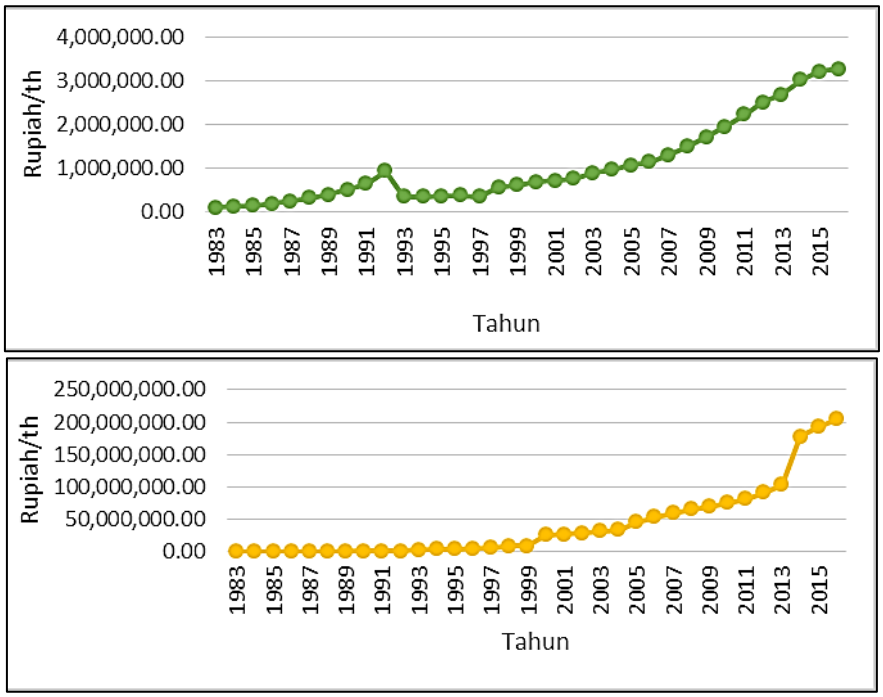
Tabel 3. Nilai Koefisien Determinasi dari Model Regresi Linier Berganda

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.862[a]	.743	.681	39987681.7326165	1.106

a. Predictors: (Constant), DRP, HWF, UE, AR, WF, P, WRP
b. Dependent Variable: GDP

Variabel jumlah penduduk, jumlah pencari kerja, luas sawah, luas panen padi sawah, produksi padi sawah dan produksi padi ladang berpengaruh signifikan terhadap PDRB. Dari koefisien regresi keenam variable ini, variable jumlah penduduk memberikan pengaruh yang paling besar. Penambahan 1 jiwa penduduk akan meningkatkan PDRB sebesar 0.446 rupiah. Hal ini menunjukkan bahwa penambahan jumlah penduduk yang berasal dari penambahan dari migrasi yang masuk ke Kabupaten Bekasi yang disebabkan oleh penambahan industri yang ada di kabupaten ini. Pembangunan kawasan industri yang mendatangkan banyak industri dapat menekan kemiskinan (Winardi *et all*. 2017). Perbedaan kontribusi sektor pertanian dan sektor industri semakin besar. Kontribusi dari sektor pertanian dan sektor industri terhadap PDRB pada periode tahun 1983–2016 ditampilkan pada Gambar 14. Dari ketiga gambar tersebut, terlihat bahwa perkembangan PDRB di Kabupaten Bekasi terlihat peningkatan di tahun 2000an.



Gambar 14. Perkembangan PDRB Berdasarkan Harga Berlaku, Kontribusi Sektor Pertanian (kiri) dan sektor industri (kanan) di Kabupaten Bekasi, 1983–2016
Sumber: BPS Kabupaten Bekasi 1983–2017

KESIMPULAN

Dari analisis dan pembahasan yang sudah dilakukan, maka kesimpulan yang diperoleh adalah:

1. Terjadi perubahan peruntukan lahan di Kabupaten Bekasi, dari peruntukan pertanian menjadi industri terlihat dengan adanya perubahan kontribusi sektor industri dalam PDRB yang terus

meningkat, sedangkan kontribusi sektor pertanian relatif tetap.
2. Rata-rata curah hujan tidak berpengaruh signifikan terhadap PDRB.
3. Variabel independen yang lain (jumlah penduduk, jumlah pencari kerja, luas sawah, luas panen padi sawah, produksi padi sawah dan produksi padi ladang berpengaruh signifikan terhadap PDRB.
4. Secara bersama, semua independen berpengaruh signifikan terhadap PDRB.

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THE PROSPECT OF USING SMART DUSTBIN FOR REDUCING GARBAGE PICK UP TIME (A SIMULATION IN PADANG CITY)

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Abstract: Service on garbage pick-up is an obligatory service which, should be provided by the government. Due to human's active mobility, which doing activities that may result in waste, that may cause bad impact on the environment and also human themselves. However, the service cost for garbage pick up is not that affordable, in which government is required to do efficiency, especially to efficient in terms of time. In this study, the place that was used as sample is Padang City. In Padang City, the time that needed to pick-up the garbage from the time the trucks start the trip from the shelter, up to each pick-up point and drop it to the landfill site takes around 6.97 hours (Komala et al.,2012). This data is a secondary data that obtained by previous researchers. In this study, the time simulation has been elaborated by replacing the conventional garbage bin to smart dustbin. Smart dustbin is equipped with sensor to count how much garbage inside it and other types of sensor are also equipped to accommodate its work. In addition, Smart Dustbin also equipped with GSM module to send information for indicating that the garbage bin was full. A simulation result showed that using smart dustbin can reducing the pick-up time according to the pick-up points that informed by the GSM module.

Keywords: *garbage, simulation, smart dustbin, trash*

Abstrak: *Pelayanan pengangkutan sampah merupakan pelayanan wajib yang disediakan oleh pemerintah. Hal ini dikarenakan manusia merupakan mahluk yang aktif dalam melakukan kegiatan yangmenghasilkan hasil sisa yang disebut sampah yang tentunya dapat menimbulkan dapat buruk bagi lingkungan maupun manusia itu sendiri. Namun, biaya pelayanan pengangkutan sampah tidaklah murah sehingga pemerintah dituntut untuk melakukan efisiensi, khusunya efisiensi waktu. Pada kajian ini daerah sampel yang digunakan adalah Kota Padang. Di Kota Padang, waktu yang dibutuhkan untuk melakukan pengangkutan sampah dari keluarnya truk dari pool, bongkar muat di tiap titik pengangkutan sampah hingga penurunan sampah di TPA ialah 6.97 jam (Komala et al.,2012). Data ini merupakan data sekunder peneliti lain sebelumnya Pada kajian ini dilakukan simulasi efisiensi waktu dalam pengangkutan sampah dengan menggunakan tong sampah pintar atau smart dustbin sebagai ganti dari tong sampah konvensional. Smart dustbin ini memiliki sensor untuk mengetahui jumlah sampah yang mengisi tong sampah dan sensor lainnya. Smart dustbin juga dilengkapi dengan modul GSM untuk mengirim informasi apabila jumlah sampah telah memenuhi tong sampah. Hasil simulasi menunjukkan bahwa penggunaan smart dustbin dapat menurunkan waktu pengambilan sampah karena pengambilan sampah hanya dilakukan pada tong sampah yang telah penuh sesuai dengan informasi GSM modul*

Kata Kunci: *limbah, sampah, simulasi, bak sampah pintar*

INTRODUCTION

Naturally, human is a productive and active being on doing various action for certain purposes (Yaqin, 2015). However, while doing activities, human often left out trash, especially domestic waste that classified as garbage. Garbage is the refuse which comes from the bathroom and kitchen. It is basically organic waste, clothing, food waste, food containers, paper products etc. Trash is the waste which comes from anywhere but the bathroom and kitchen. It could be old furniture, leaves, twigs, grass clippings, junk and other products which might come under the category of hazardous household waste. In addition, domestic waste is the waste that is produced from human daily activities (Damanhuri and Padmi, 2010). For instance, cardboard, plastic bag, and food can are called domestic waste.

Service on domestic waste pick-up is an obligatory service that must be provided by government for every citizen. According to Li et al. (2006) trash pick-up is the most expensive obligatory service

that need to be provided by government. Surprisingly, waste pick-up takes up 85% of the government's total budget on waste management (Apaydin and Gonulu, 2007). By considering that issue, government is forced to have good management system and decent equipment, for the sake of budget effectiveness and efficiency.

According to the Decree of the Ministry of Residential and Regional Infrastructure No.534/KPTS/M/2001, the lowest standard capacity for trash pick-up vehicle is 6 m^3. From the statement above, can be concluded that the majority vehicle that are used in Indonesia is trucks. The usage of trucks is considered to be the suitable solution for garbage pick-up due to its higher volume capacity compare to other types of land vehicles. In terms of application, the usage of truck is efficient, when the distance and time duration taken from the shelter to the landfill site can be minimized.

In Indonesia, the pick-up of garbage is done by the garbage truck once in a day up to once in three day. For instance, the garbage pick-up in Padang City is done every day (Komala et al., 2012). The other example is the picking up garbage time in Jabungan, Semarang is once in two days (Cicilia et al., 2017). The frequency of pick-up is determined by calculation, which is based on total pick-up time, loading and unloading the container time, container landing time, distance from shelter to landfill site, and the velocity of truck when fully-loaded and when its unloaded.

Nonetheless, in reality, amount of domestic waste that are produced daily by every citizen is vary from one another. A research of a case, that is conducted by Corio Waste Management, Australia, found that, trash pick-up scheduling system is ineffective (Gale, P., 2017). This thing is also supported by Ridha et al. (2016), the study showed that one of the biggest problem in picking up a domestic waste is ineffective time. This is caused by the amount of domestic waste / garbage produced by citizen especially during weekends and weekdays is different. Besides that, scheduled garbage pick-up is also risky. While, scheduled pick-up is conducted, the officers did not acknowledge the amount of garbage inside the bin, before reaching pick-up point. When they arrived at the pick-up point, there are two possibility, such as the garbage had been overloaded and scattered or there are only few trashes in it. Both of this possibility, may cause disadvantage for the citizen and the garbage pick-up officers.

According to the problem that stated above, it was intended to seek opportunity for increasing the effectiveness of garbage pick-up. The study was elaborate the opportunity to use *smart dustbin* and comparison between the usage of *smart dustbin* vs the scheduled pick-up. For, regional restriction, the projection on this research is using Padang City as the sample. With the route that will be pass by from shelter -By Pass street – Samarinda street – Belawan I street– Belawan II street– Belawan III street– Banjarmasin street- By Pass street - Lb. Minturun street- Air Dingin landfill site (Komala et al., 2012).

Referring to research that was conducted by Monika et al. (2016), the definition of *smart dustbin* is the garbage bin that equipped with ultrasonic sensor as the detector of the volume of in the bin. Sensor is a device that can be used for sensing surroundings, which also can be used to send and collect information onto other devices under certain conditions (Jazar, 2010). Inside the ultrasonic sensor, piezoelectric component present as component to trigger the sound wave. The common frequency that is emitted from piezoelectric is 40kHz (Satoto et al., 2017). Then, the sound wave is reflected perpendicularly by the soft material in front (Borenstein dan Koren, 2014). Figure 1 is the Picture of Ultrasonic Sensor. In addition, garbage bin need to send the reading through a media. The media can

be SMS or internet connection. Monika et al. (2016) used GSM module to send message whenever the garbage bin is full. Completing the reference GSM module is defined as module that can be integrated with sim card that operates by subscription to the cellular operator (Eseosa & Promise, 2014).

Figure 1. Ultrasonic Sensor
(source : Satoto et al., 2017)

Up to now, GSM module operates on 900MHz frequency (Fauzi et al, 2017). GSM module can operate either as the acceptor (message sender) or the receptor (message recipient) (Gupta, 2015). In this study the GSM module that is installed on the *smart dustbin* will act as the message sender, especially when the garbage bin is full. Figure 2 is the picture of GSM Module.

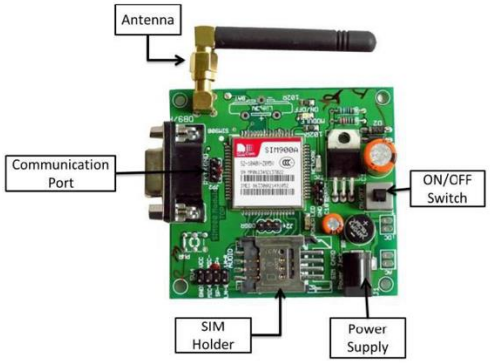

Figure 2.GSM Module
(source : Nagaraju et al., 2017)

In research of Monika et al. (2016), the *smart dustbin* could not be applied on outdoor environment, due to its requirement for power source from serial port of the microcontroller (**Figure 3)**

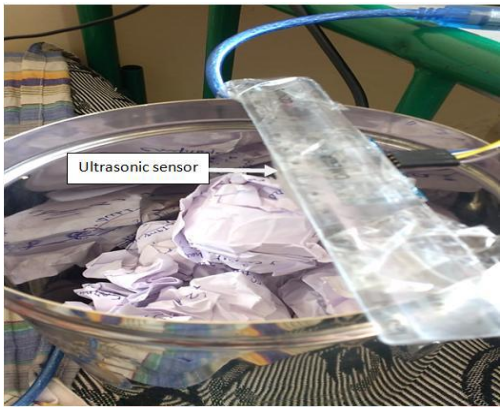

Figure 3. Smart trash bin made by Monika et al.(2016)

Samann (2017) designed and implement *smart dustbin* as the replacement of trash bin that can be used outdoors. *Smart dustbin* that made by Samann has higher specifications and more feature compare to s*mart dustbin* made by Monika et al (2016). Figure 4, showing the physical appearance of *smart dustbin* made by Samann (2017)

Figure 4. Smart dustbin made by Samann (2017).

Samann (2017) has solved the problem on power source by using solar panel and has successfully made smart dustbin that can be used in outdoor environment. PIR (passive infrared sensor) that is used here serves as the trash bin opener which detect the existence of hand gesture waiving

around trash bin. PIR sensor works by detecting the infrared radiation that is emitted by human body (Chodon et al, 2013).The usage of PIR sensor is considered to be appropriate, since it can operates under low power (Yun & Lee, 2014). In addition, PIR sensor can perform up to 180^0 reading (Kumar et al, 2015). Figure 5 is the picture of PIR sensor.

Figure 5. PIR Sensor
(source : Kumar et al., 2015)

In other words, *smart trash bin* that used in this study is garbage bin that equipped with sensor and has the ability to send information to the responsible party to pick-up the garbage. Sensor that is used in the bins are ultrasonic sensor and PIR sensor, in which ultrasonic sensor serve as the load detector of trash bin, and PIR sensor to sense the handwaving gesture around the smart bin, so that the smart bin will automatically open. Having equipped with GSM Module, which has the ability to send information through SMS, *smart dustbin* will directly send the information to the party who is responsible for pick-up the trash, when the trash bin is full and its real-time. Considering all of the justification above, the objective of this study is elaborating the opportunity of using smart bin for increasing time management efficiency in the garbage pick up time.

MATERIAL AND METHODS

The secondary data of scheduled garbage pick-up in Padang City, used in this study is taken from the previous research conducted by Koamal et al. (2012). The used data were : route, distance, and pick-up time in every stop. The component of data for garbage pick-up are elaborated on **Table 1**.

Table 1. Garbage pick-up time component
(Komala et al., 2012)

No	Description	Value (hrs)	Times	Total (hrs)
1	Duration from shelter to landfill site	3.9	1	3.9
2	Loading and unloading time	0.36	8	2.88
3	Time taken for dropping trash from truck to Landfill	0.19	1	0.19
	Total			6.97

Route that used were, Shelter - By Pass street – Samarinda street – Belawan I street – Belawan II street – Belawan III street – Banjarmasin street - By Pass street - Lb. Minturun street -Air Dingin landfill site. The following route were the route pass by the garbage truck to reach Air Dingin landfill site. This route has 8 stop points for garbage pick-up. This 45 km long route is freeway and non-turning one. **Figure 6** shows the route that will be passed by garbage truck.

By referring to the data, the study was made a simulation if the garbage is taken by time scheduled pick-up as existing and compare to when using *smart trash bin.* The simulation is to elaborate the opportunity for reducing pick up time due by using smart bin that can be operated real-time. The device can give the information of number of smart bin that

already have fill up, therefore when the trash bin haven't full yet, the garbage pick-up officer won't have to stop by to do the pick-up process. On the other hand, by having shorter duration or reduced time on pick-up process may result in more efficient fuel consumption of the truck.

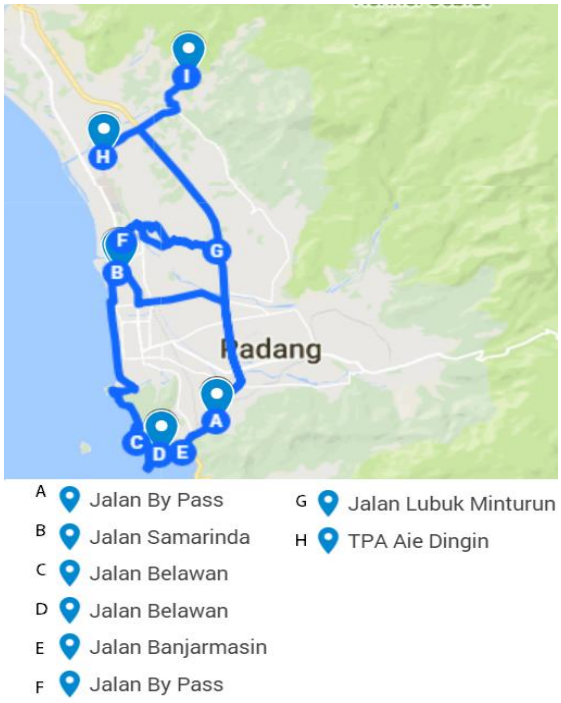

Figure 6. Garbage truck pick-up route

RESULT AND DISCUSSION

Referring to the data on Table 1, the travel duration from the shelter up to landfill site needs 3.9 hours or 3 hours and 54 minutes. Then, the loading and unloading time per pick-up point is 0.36 hours. In which, the time taken for 8 pick-up point is 2.88 hours.On the other hand, the time that required to drop the trash from the truck to landfill site is 0.19 hours. In other words, can be concluded that the time-taken from the shelter to pick-up trash on 8 pick-up point and drop all the trash from the truck to the landfill site is 6.97 hours.

With total time spent 6.97 hours of picking-up and stop at the points where no acknowledgement of whether the trash bin is empty or fully loaded. The other possibility is that, they came late and the trash may have been scattered around that area. By using *smart dustbin*, the garbage pick-up officer does not need to worry about the scattering garbage, with the aid of ultrasonic sensor that will lock the smart bin when it is fully loaded. Besides that, when the smart bin is full it will send message to do the pick-up and whenever they do not get any messages from the smart bin, they don't need to stop for checking the smart bin, when its not fully load yet, which is considered to be ineffective act. In other words, the pick-up time can be shorter, fuel consumption and labour cost can more efficient compare to scheduled pick-up. **Table 2.** Shows the time-taken when using *smart dustbin.*

Tabel 2. Total time-taken for picking-up using smart dustbin
(source : data simulation)

Total pick-up points (times)	Total time-taken (hrs)
1	4.45
2	4.81
3	5.17
4	5.53
5	5.89
6	6.25
7	6.61
8	6.97

Table 2. shows total time-taken for picking-up using *smart dustbin*. As stated in the previous paragraph, that *smart dustbin* will give information real-time, on the volume of trash that filled up the trash bin. On **table 2.**, also shows the total time taken for trash pick-up for one up to eight points that filled up the trash bin. For instance, when there is only four pick-up point to stop by for trash pick-up it only requires 5.53 hours from shelter going to the four stop points and moving the trash from the truck to the landfill site. The calculation for simulation with data from Table 1 is 3.9 + (4 x 0.36)) + 0.19 = 5.53

hours. This pick-up time can not be obtained when *smart dustbin* is not applied, due to the stops made by the truck to check it sequentially. In addition, **Figure 7** shows the graph of total time-taken versus the number of pick-up points.

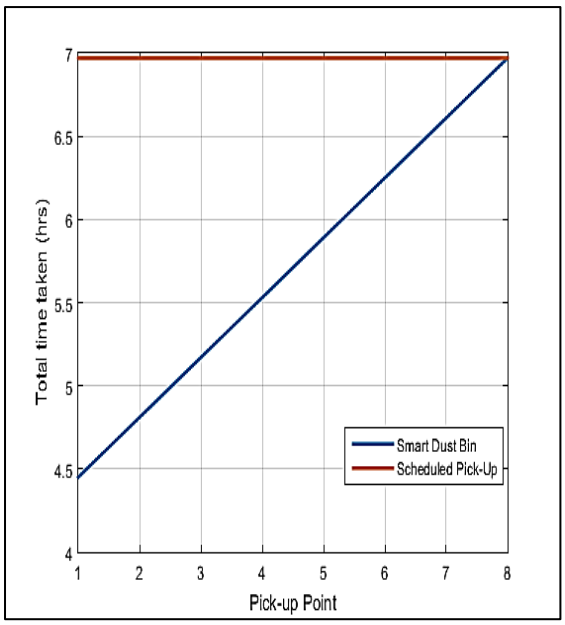

Figure 7. Graph of waktu total time-taken – Pick-up points
(source : data simulation)

Figure 7 shows the comparison between the total time-taken using scheduled pick-up and *smart dustbin* as the pick-up basis. On Scheduled pick-up total time-taken is not determined by the total pick-up points. It is caused by the scheduled pick-up can not determine the number of trash in every pick-up points. Therefore, the trash pick-up truck should stop by and do the checking procedure.

On the other hand, pick-up using the *smart dustbin*, which can send information on the amount of trash that has been accumulated on the trash bin. In which, when the existing trash did not fill up the trash bin yet, the officers did not need to stop and do the checking procedure. By using *smart dustbin*, can save up 0.36 hours per pick-up point.

On the pick-up using *smart dustbin* can be seen that the time-taken is proportional to the number of pick-up point. In other words, the less number of pick-up point then the shorter time it takes and vice versa.

CONCLUSION

The time management in picking up of the City's garbage was studied by implementing smart dustbin. The simulation route and time were using secondary data of Padang City. The smart dustbin that recommended in this study is that equiped by solar panel for energy source, PIR (passive infra red) for open / close the bin, ultrasonic sensor for detecting the load of bin, and also GSM module to send message the officer. By simulation that only for full dustbin the officer will stop by, the picking points will be reduced. Reducing picking up points means reducing serve time, fuel and labour cost and other cost This efficiency opportunity may be followed by the next study that include comparison in the investment, operation and maintenance cost, and may also social aspects

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Performance and Environmental Impacts Review of Li-Fi and Wi-Fi Technologies

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Abstract: Nowadays, internet connectivity is one of the staple things in human lifestyle, especially for those who live in cities. There are a lot of ways to connect to the internet, and one of them is using Wi-Fi (Wireless Fidelity) connection. Wi-Fi connection is seen as the most reliable connection, until Li-Fi (Light Fidelity) technology is coined in 2011. Li-Fi uses visible light as data transfer medium instead of radio frequency (RF) signal used by Wi-Fi. Theoretically, Li-Fi is able to reach hundred times of Wi-Fi connection speed due to their use of light as data transfer medium. Li-Fi is also expected as a solution to environmental problems caused by Wi-Fi. The RF signal used by Wi-Fi can cause some environmental problems such as growth inhibition and diseases to organisms including humans. The visible light used by Li-Fi is expected to cause minimal effects to the environment, as Li-Fi uses common LED light bulbs which are used as home lighting apparatus. In this review, by using descriptive research methodology the performance and environmental impacts of both Wi-Fi and Li-Fi are analysed to determine whether Li-Fi is really capable to be a 'greener' replacement to Wi-Fi technology. As the conclusions, performance wise Li-Fi is expected to be able to provide faster connection than Wi-Fi. In terms of energy consumption, Li-Fi has a lower energy consumption, a wider range of usage, a greater security, and less environmental impact, Li-Fi can be seen as a 'greener' yet more efficient technology compared to Wi-Fi.

Keywords: *Wi-Fi, Li-Fi, Telecommunications, Wireless, Environmental.*

Abstrak: *Dewasa ini, koneksi internet adalah salah satu kebutuhan dan gaya hidup manusia, terutama bagi mereka yang tinggal di wilayah perkotaan. Ada banyak cara untuk terhubung ke internet, salah satunya melalui koneksi Wi-Fi. Koneksi Wi-Fi dianggap sebagai salah satu koneksi yang terpercaya, hingga teknologi Li-Fi akhirnya mulai diperkenalkan pada tahun 2011. Li-Fi menggunakan cahaya tampak sebagai medium dalam perpindahan data, tidak seperti Wi-Fi yang menggunakan sinyal RF (Radio Frequency). Secara teoritis, Li-Fi dapat mencapai ratusan kali kecepatan Wi-Fi karena penggunaan cahaya sebagai medium perpindahan data. Li-Fi juga diperkirakan mampu mengatasi masalah-masalah lingkungan yang disebabkan oleh Wi-Fi. Sinyal RF yang digunakan oleh Wi-Fi dapat menyebabkan berbagai masalah lingkungan seperti hambatan pada pertumbuhan dan penyakit pada makhluk hidup, termasuk manusia. Cahaya tampak yang digunakan oleh Li-Fi diperkirakan akan menyebabkan dampak yang minimal terhadap lingkungan karena Li-Fi menggunakan lampu LED yang biasa digunakan untuk penerangan rumah, sehingga Li-Fi dianggap sebagai teknologi yang lebih ramah lingkungan daripada Wi-Fi. Dalam kajian ini, dengan menggunakan metode penelitian deskriptif performa dan dampak terhadap lingkungan dari Wi-Fi dan Li-Fi akan dianalisa untuk menentukan apakah Li-Fi benar-benar mampu menjadi pengganti teknologi Wi-Fi yang lebih ramah lingkungan. Sebagai kesimpulan, kinerja Li-Fi diharapkan dapat memberikan koneksi yang lebih cepat dibanding Wi-Fi. Dalam hal konsumsi energi, Li-Fi memiliki konsumsi energi yang lebih rendah, penggunaan yang lebih luas, keamanan yang lebih baik, dan dampak lingkungan yang lebih sedikit. Pada akhirnya Li-Fi dapat dilihat sebagai teknologi 'hijau' dan lebih efisien dibandingkan dengan Wi-Fi.*

Kata Kunci: *Wi-Fi, Li-Fi, Telekomunikasi, Nirkabel, Lingkungan.*

INTRODUCTION

Nowadays, human can easily socialize with one another. There are many platforms that provided some sort of application for human to communicate each other. For example, application for video calling and sending short messages. Not only to socialize, but also to do other activities such as shopping and study. All of this can be achieved conveniently by internet. There are many types of internet connectivity, one of them is using wireless network or Wi-Fi (Wireless Fidelity). The term of wireless because Wi-Fi is using Radio Frequency (RF) to transmit data signals (Foster & Moulder, 2013). Wi-Fi technology is able to reach a bandwidth speed of 50-100 Mbps (Cisco, 2018).

However, the average downlink data transfer rate of commercial Wi-Fi is 10.9 Mbps and uplink speed is 2.8 Mbps (Kolhe & Mandavgane, 2017) which is relatively low for this millennial era.

As time comes by, user demand for data continues to grow at an exponential rate and causing the use of devices with internet connectivity is increased Since the radio frequency (RF) resources is limited, the increasing of internet usage made the capacity of WiFi is reduced. Due to the limitations of Wi-Fi, Li-Fi comes into surface. Rather than Wi-Fi that use radio frequency to operate, Li-Fi is using an LED (Light Emitting Diode). As stated by German scientist Hass and Islim (2017), Li-Fi is theoretically able to achieve a bandwidth speed of 5 Gbps using select laboratory equipments.

Currently Wi-Fi technologies are widely used around the world, approximately 61% of American households have Wi-Fi connectivity installed (Thota, 2012). However, exposure of RF may pose some threats to human body. Although the exposures are far from the international limitation (IEEE, 2006), prolonged exposure from multiple sources can be hazardous. Therefore, Li-Fi technology is prospected to replace Wi-Fi, since Li-Fi utilizes visible light which poses minimal harm. The utilization of visible light, which is more environmental-friendly compared to RF also makes Li-Fi technology seen as a 'greener' technology compared to Wi-Fi.

This review is centered towards the comparison of Wi-Fi and Li-Fi technologies in terms of their performance and environmental impacts. The result may determine whether Li-Fi technology is suitable to be an environmental-friendly replacement to current Wi-Fi technology.

METHODOLOGY

As mentioned before that the purpose of this review is to analyze the performance and environmental impacts of both Wi-Fi and Li-Fi and determine whether Li-Fi is really capable to be a 'greener' technology replacing Wi-Fi technology. by using descriptive research methodology the performance and environmental impacts of both Wi-Fi and Li-Fi are analysed to determine whether Li-Fi is really capable to be a 'greener' replacement to Wi-Fi technology, which will describe as follows.

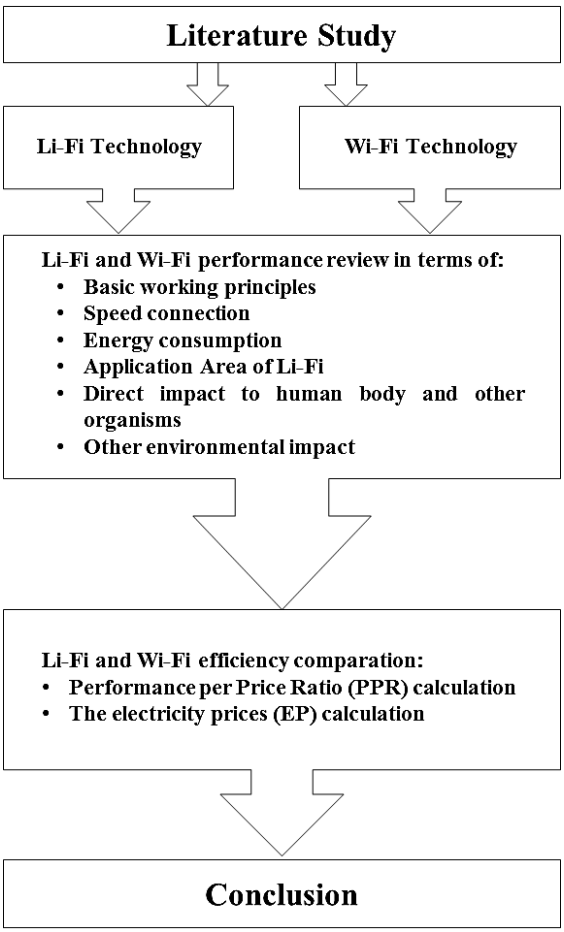

Figure 1. Research Methodology

LITERATURE REVIEW

Definitions and Working Principles

Wireless data transfer can be achieved utilizing any types of electromagnetic wave. Basically, a wave is a disturbance that can travels from one location to another. Because wave can propagate, it can carries information along the way. The great thing about electromagnetic wave is that it does not require a medium to propagate.

Wi-Fi is a commercial name that used for wireless networking technology that certified in accordance with the standards issued by the Institute of Electrical and Electronics Engineers (IEEE) (Foster & Moulder, 2013). These standards are adopted by Wi-Fi Alliance, which is a group of wireless connectivity-related industries with standart defined IEEE 802.11. In addition, the device or router with a "Wi-Fi certified" access point should allow any "Wi-Fi certified" devices to connect to a network and vice versa. Wi-Fi utilizes electromagnetic radiation in the range of Radio Frequency to send the data signal. The illustration of Wi-Fi working principle is shown in Figure 2.

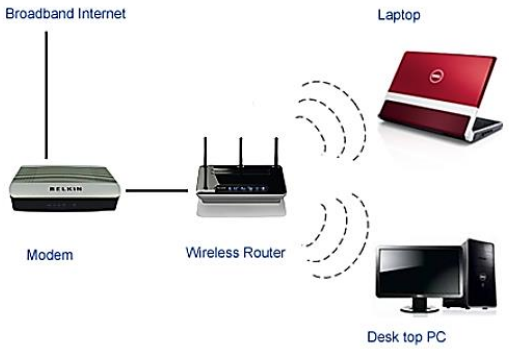

Figure 2. Wi-Fi Working Principle
Sources: (Broadband Analyst UK. 2018)

On the other hand, Li-Fi or called D-LIGHT by its inventor is a communication system that use LED as a things to transmit the signal and it is operate at visible light band (Ekta & Kaur, 2014). Li-Fi (light Fidelity) technology a term defined by IEEE 802.15 standardization comittee, is based on Visible Light Communication (VLC) principles for data transmission, The visible light (VCL) is unregulated and unlicensed THz spectrum, which is sending the data by the light at speeds undetectable to human eyes. VLC is free from any health concerns, and it does not cause any electromagnetic interference harmed to human body, so it claimed as eco-friendly green technology. Both Wi-Fi and Li-Fi has its own frequency to operate. Wi-Fi commonly uses 2.4-5GHz to operate (Shetty, 2016). Furthermore, in Wi-Fi technology it use router to transmit the data in the range of RF. So, the router or called as an access point transmit the signals and device with a wireless card can recognize those signal and translate it into useful information. Li-Fi, in other hand, use visible light band to operate.

Li-Fi technology uses LED light source as both a transmitter and a receiver (sometimes photodiode are also used) in data transmission process. The data signal is represented in binary code which are 1's and 0's, 1's means the LED is on and 0's means the LED is off. VLC uses brisk pulse of light that cannot be followed by human eye to transmit the data (Ekta, 2014). In addition, a photo detector is installed at the device to receives the signal and translate it to original data. Therefore, the brightness LED and the photo detector are the main component of Li-Fi communication system. The illustration of Li-Fi working principle is shown in Figure 3.

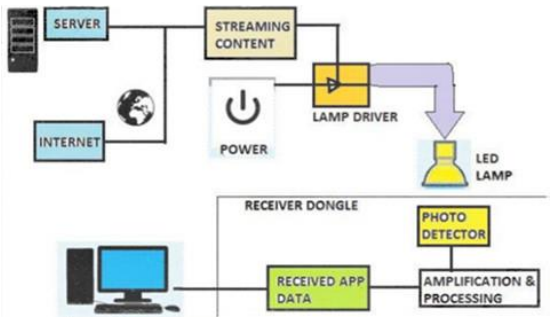

Figure 3. Li-Fi Working Principle
Sources: (Sodhi, A. & Johnson, J, 2015)

Technical Informations

Wi-Fi operates at 2.4-5 GHz RF (Shetty, 2016). Most Wi-Fi connections in Indonesia operate at 2.4 GHz, while recent routers are capable to operate at 5GHz. The bandwidth of Wi-Fi connections are capped around 50-100 Mbps regardless of their operating frequency (Mutthamma, 2013). One of the most used Wi-Fi router in Indonesia is FiberHome AN5506-04 (Figure 4). This particular router is

claimed to have under 15 watt power usage (FiberHome, 2011).

Figure 4. FiberHome AN5506-04 Wi-Fi Router
Sources: (FiberHome International Co., Ltd. 2011)

On the other hand, the maximum recorded bandwidth of Li-Fi connection transmitted by a single colour LED light bulb is at 1.6 Gbps (Sharma et al., 2014). Li-Fi operates in the range of visible light spectrum (390-700nm), which is equal to 430-790 THz (Ghosal & Panda, 2014).

Assuming that most recent Wi-Fi technology operates at 5 GHz, the minimum operating frequency of Li-Fi Li-Fi is 86,000 times of Wi-Fi operating frequency. Furthermore, Li-Fi technology is expected to operate using one or more LED light bulb(s) which intensity differs faster than the capability of human eye, so human will not detect that the LED is actually flickering. This kind of LED light bulb can be used as a normal light source.

For calculations purposes, the LED light bulb with 33 W wattage. The efficiency of each technology is calculated using Performance per Price Ratio (*PPR*). The equation used to calculate *PPR* is expressed in Equation 1 as below (Oklobdzija, 2008).

$$PPR = \frac{P_f}{P_r} \qquad (1)$$

In Equation 1, P_f (Performance) stands for the maximum expected bandwidth speed, while P_r (Price) stands for the combination of hardware and electricity price as shown in Equation 2. The hardware price (H_P) is the average of required hardware prices in thausands Rupiah, which are Wi-Fi router for Wi-Fi technology and LED light bulb with maximum wattage for Li-Fi technology.

The prices are calculated in Rupiah based on newest price update and excluding basic hardware such as cables. The electricity prices (E_P) are calculated using Indonesian base prepaid electricity price per kWh (kilowatt hour) in Rupiah. The power consumption of Wi-Fi router is based on the average of usual router consumption, which is 9 W (Chiaravalloti, et.al, 2011).

$$P_r = (H_P \times 15\%) + (E_P \times 85\%) \qquad (2)$$

Environmental Impacts

As Wi-Fi transmits data using radio waves, the environmental hazards posed by Wi-Fi is similar to those posed by radio waves. Foster and Moulder (2013) stated that prolonged Wi-Fi exposure may affect fertility, pregnancy outcome, brain development, stress level, and immune system. This was based on an experiment where subjects (mice) are exposed to Wi-Fi signal for 1-2 hours a day for 10-50 days. Redmayne and Johansson (2015) claimed that the effects of Wi-Fi (as one of the forms of electromagnetic field) vary by age. Their study showed that young people are more sensitive to electromagnetic field compared to adults, and the use of Wi-Fi in schools are a high level threat to children health. RF-EMF wave also known as the cause of growth inhibition, especially on plants and insects (90%), birds (70%), and other vertebrates (56%) (Cucurachi et al., 2012).

RF signals are also disruptive if used underwater. Kim, et al (2014) stated that RF signals, including Wi-Fi, are a form of acoustic signals which can disrupt underwater ecologies. This disruption may lead to growth inhibition as found on past studies involving plants and animals.

On the other hand, the effects of Li-Fi to environment are similar to the effects of visible light. The most common one is pigmentation, which is caused by UV rays from visible light. The UVA1 ray in the

range of 300-400nm is known as the cause of skin browning and fading after 2 weeks of irradiation (Mahmoud et al., 2010). In the same experiment using Visible Light range (400-700nm), the pigmentation was spontaneous and surrounded by erythema (skin redness) which disappeared in less than 2 hours. The other negative effect of Li-Fi is from the LED light. LED lights tend to produce blue lights, which are the most damaging light to human eyes as shown in Figure 5 (Ticleanu & Littlefair, 2015). Fortunately, blue lights can only reach the retina if the sources (in this case the LED light bulbs) are directly viewed.

Figure 5. Blue Light Penetration to Retina
Sources: (Ticleanu & Littlefair, 2015)

The other possible hazard is if the LED is broken. Broken LED lights may emit arsenic vapour. However, only a small amount of arsenic concentration was found during testing of recently produced LED lights and the vapour itself is non-lethal.

Application Area of Li-Fi

As stated before, Li-Fi technology utilizes visible light instead of RF, which is used in Wi-Fi technology. Due to the absence of RF in Li-Fi technology, it can be applied to Wi-Fi restricted areas, thus expanding its usage area. The most important area which is restricted to Wi-Fi is hospitals, due to the possibility of RF interference in medical apparatus. This interference will not happen if Li-Fi is used, since visible light will not cause such interference (Sodhi & Johnson, 2015).

Since Li-Fi shares the same equipments with home and street lightings, it can greatly support smart home and smart city projects. When used for smart home concept, Li-Fi can easily connects all supported home appliances which get into its line-of-sight. In smart city concept, conventional traffic lights can be augmented with Li-Fi technology to enhance traffic management (Telecommunications Engineering Center; Sodhi & Johnson, 2015), especially for cities struggling with traffic problems.

Moreover, Li-Fi can be used both in flights and underwater. Providing reliable connectivity to these two areas are previously challenging and most of the viable options are extremely expensive (Kim *et al*, 2014). With Li-Fi, people can easily connect to the internet while in flights since it does not interfere with the pilot's radio (Sodhi & Johnson, 2015). And underwater, Li-Fi can penetrate deeper surfaces without disrupting marine ecologies due to the usage of visible light (Kim *et al*, 2014).

Basically, Li-Fi can be used in almost any sectors which Wi-Fi is prohibited, including gas and oil facilities. These flexibilities also contribute to the faster development of Li-Fi technology as the successor of Wi-Fi.

RESULTS AND DISCUSSION

As stated on the literature section, since Li-Fi does not require additional hardware, then the electricity consumption theoretically lower than Wi-Fi. That is why Li-Fi can be assumed as a 'greener' technology compared to Wi-Fi.

Table 1. Wi-Fi and Li-Fi Price Components

Technology	H_P (Thousands IDR)	E_P (IDR)
Wi-Fi	245	21.2715
Li-Fi	97.5*	48.411

*: The H_P of Li-Fi is halved due to the 'shared usage' with home lighting appliances

From the electricity prices (E_P) perspective, it can be seen that Li-Fi has value much lower than Wi-Fi. The

electricity prices (E_P) are using Indonesian base prepaid electricity price per kWh (kilowatt hour) in Rupiah, excluding basic hardware such as cables. Base on the equation (1) and (2), we can calculate the price components for both technologies as listed in Table 1, while the efficiency components are listed in Table 2, and it calculated based on newest price update which currently is Rp 1,467.00

Table 2. Wi-Fi and Li-Fi Efficiency Parameters

Technology	P_F(Mbps)	P_R	PPR
Wi-Fi	100	47.973	2.085
Li-Fi	1600	55.774	28.687

From Table 2, Li-Fi has approximately 24 times of the *PPR* of Wi-Fi. That means Li-Fi is a prospective replacement for Wi-Fi as Li-Fi is expected to be faster (16 times faster than Wi-Fi) and consumes less electricity (due to the 'shared usage' between wireless network transmitter and home lighting). Therefore, Li-Fi usage will contribute in reducing the electricity and generator fuels (e.g. Coal, Oil, and Gas) usage. Furthermore, Li-Fi usage will reduce the pollution caused by electric generators.

Table 3. Wi-Fi and Li-Fi Comparison Table

Parameters	Light Fidelity (Li-Fi)	Wireless Fidelity (Wi-Fi)
Data transfer speed	>1Gbps	50-100 Mbps
Operating frequency	Hundreds of Tera Hz	2.4GHz or 5 GHz
IEEE Standart Comitttee	IEEE 802.15	IEEE 802.11
Medium used for data transfer	Use light as carrier (VLC)	Use Radio spectrum (RF)
Spectrum Range	10,000 times broad in comparison to RF	Less than VLC spectrum
Cost	Cheaper, doesn't need license (free band)	Expensive (due to spectrum charges)
Efficiency	More, LEDs consume less energy and highly efficient	Less, RF consume high amount of energy
Power consumption	Less	More
Environment Impact	Less impact than RF. VLC is free from any health concerns, and it does not cause any electromagnetic interference harmed to human body	Wi-Fi utilizes electromagnetic radiation in the range of Radio Frequency to send the data signal.

Based on the technical comparation, PPR (Performance per Price Ratio), and their effects on environment, Li-Fi technology has its advantage in all discussed aspects against Wi-Fi technology. Li-Fi technology has better speed with lower electricity usage (due to their 'shared usage' with home lighting appliances) and more environtmental-friendly as shown in Table 3.

CONCLUSION

A noticeable hidden cost of Internet connectivity usually goes unstated (if not forgotten), but it relates to the physical environment in which the connection should be housed. The said hidden cost includes, but not limited to health, mental, and environmental cost. These costs are triggered by some factors, including performance, energy consumption, and technology used. Li-Fi, which uses visible light spectrum, are able to achieve this higher speed due to their higher operating frequency and the fact that light travels faster than radio wave. Performance-wise, Li-Fi is expected to be able to provide approximately 16 times faster connection than Wi-Fi. Due to the fact that it uses visible light spectrum instead of RF, Li-Fi has a wider range of usage. Li-Fi has the

potential to provide a reliable internet connectivity in hospitals, power plants, petrochemical plants, airplanes and other Wi-Fi restricted places.

In terms of energy consumption, Li-Fi has a better PPR, which means that Li-Fi can deliver a better connection using the same amount of electricity compared to Wi-Fi. Li-Fi has a lower energy consumption, which later contribute to reduced pollution from electric generators, which mainly use coal, oil, and/or gas. By reducing the electricity demands, the use of coal, oil, and/or gas to generate electricity can be reduced. Li-Fi may affect human skin and vision, but the increased efficiency means less exposure of light is needed to reach the customer level of performance. LED light producers are also keen on perfecting their products to reduce the effects of UV and blue lights emitted from their bulbs, so it is not a major concern.

The use of visible light spectrum also means that Li-Fi has smaller impact to the environment. As known, there was very little impact caused by visible light spectrum to other organisms such as plants, animals, and their ecosystem. So, as LIFI offers greater security, reduced power consumption, and less environmental impact, Li-Fi can be seen as a 'greener' yet more efficient technology compared to Wi-Fi.

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TINJAUAN SOSIOEKONOMI PEMANFAATAN FESES SAPI DENGAN TEKNOLOGI VERMICOMPOSTING

Studi kasus di Kampung Papak Manggu Desa Cibodas Kecamatan Pasir Jambu Kabupaten Bandung

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Abstract: *The Cibodas village is located in Pasir Jambu subdistrict at Bandung Regency, majority community livelihood edged is dairy cattle and agriculture. The problem of waste management in terms of cattle manure that could potentially produce methane (CH4) as one of the greenhouse gases (GRK), and when the cattle manure dumped into the River then it can pollute the rivers directly. The purpose of this study is to see how big the benefits of social and economic aspects of the utilization of cattle manure at the farmer scale. A series of Research include : 1) collect opinions and responses to ranchers, livestock farmers and administrators, by filling the questionnaire against the management of the cattle manure, 2) Observations of operational at the process of vermicomposting in two locations, namely in kampong Papak Manggu and kampong Injeman Cibodas village, during the activities of Demontration plot. The observed data covering 1) production process of vermicomposting (worm production and the weight of the raw materials, daily activities, results of casting, mass balance and quality of organic fertilizer) 2) Required total working hour of process of vermicomposting 3) Space and facilities requirement 4) cost and price analysis. The research show that vermicompost is suitable to be implemented in processing cattle manure, base on the following reason : a) cleaning of the environment b) minimum labor requirement c) providing additional income d) availability of organic fertilizer.*

Keywords: *casting, cattle manure, socioeconomic, environtmental friendly, vermicompost*

Abstrak: Desa Cibodas terletak di kecamatan Pasir Jambu, Kabupaten Bandung, sebagian besar masyarakat bermata pencaharian bertenak sapi perah dan pertanian. Sehingga memiliki masalah dalam hal pengelolaan limbah feses sapi (kohe) yang berpotensi menghasilkan metana (CH4) sebagai salah satu gas rumah kaca (GRK), dan apabila kohe dibuang langsung ke sungai maka dapat mencemari sungai secara langsung. Tujuan penelitian ini adalah melihat seberapa besar benefit dari aspek sosial dan ekonomi dari pemanfaatan kohe sapi perah skala rakyat dengan teknologi *vermicompost*. Rangkaian Penelitian meliputi 1) mengumpulkan pendapat dan tanggapan peternak, pengurus ternak dan petani, melalui pengisian kuesioner terhadap pengelolaan kohe, 2) Pengamatan kegiatanan operasional proses vermicompost di dua lokasi, yaitu di kampong Papak Manggu dan kampung Injeman Desa Cibodas, saat kegiatan Demplot. Data yang diamati meliputi 1) proses produksi vermicompost (berat cacing diawal dan diahir, berat bahan baku, kegiatan harian, hasil kascing, neraca massa dan kualitas casting) 2) Jumlah jam kerja dalam kegiatan prosesing composting, 3) kebutuhan ruang dan peralatan 4) analisa biaya dan harga. Penelitian ini menunjukan bahwa vermicompost sangat cocok diterapkan untuk mengolah kohe sapi, karena disamping menjadikan lingkungan kandang bersih, tenaga kerja yang dibutuhkan sedikit, juga dapat memberikan pengasilan tambahan bagi pengelola nya dengan menjual cacing dan pupuk kascing.

Kata Kunci: *kascing, feses sapi, sosial-ekonomi, ramah lingkungan, vermicompost*

PENDAHULUAN

Desa Cibodas adalah salah satu desa di kecamatan Pasir Jambu, Kabupaten Bandung, terletak pada ketinggian 1000-1200 meter diatas permukaan laut, dengan luas wilayah 1.926,3 Ha mencakup perkampungan, pesawahan, hutan lindung dan hutan produksi. Desa Cibodas merupakan desa penghasil susu sapi di kecamatan Pasirjambu, dengan jumlah peternak 130 orang, populasi ternak sapi perah produktif sekitar 542 ekor. Dampak dari peternakan sapi adalah adanya feses sapi (kohe) yang berpotensi menghasilkan metana (CH4) sebagai salah satu gas rumah kaca (GRK). Selain itu, apabila

dalam penanganannya selama ini kohe dibuang langsung ke sungai maka dapat mencemari sungai secara langsung.

Dalam hal penangan feses sapi, beberapa peternak telah menggunakan teknologi biogas, namun dalam penerapannya belum dapat berjalan secara berkelanjutan. Hal ini dikarenakan peternak menjadikan biogas sebagai pekerjaan sampingan selain beternak. Sehingga, dalam operasionalnya tidak diutamakan dan akhirnya tidak bisa dimanfaatkan secara optimal. Selain itu lumpur effluent dari biogas pun masih belum memenuhi standar untuk dibuang langsung ke perairan. Pengolahan kohe menjadi pupuk meupakan alternatif lain yang lebih berkelanjutan, karena pupuk yang dihasilkan tersebut dapat digunakan sendiri atau dijual ke petani sekitar, karena sebagian penduduk sudah juga bertani. Secara statistik, jumlah penduduk Cibodas yang mempunyai pekerjaan tidak tetap terbilang cukup besar sebanyak 1078 orang.

Vermicomposting, adalah suatu tekonologi pengolahan limbah organik dengan memanfaatkan cacing sebagai decomposer, yang menghasilkan pupuk organik dan masa cacing (Danilo R 2017); Sedangkan menurut Abdullah Hussaini (2013), *Vermicompost* adalah bioteknologi sederhana, yang melibatkan spesies tertentu dari cacing tanah, digunakan untuk memproses dan mengubah limbah dan memproduksi menjadi produk yang lebih baik dan berguna, selanjutnya Abdullah Hussaini (2013) menyampaikan bahwa memproduksi dan memanfaatkan *Vermicompost* merupakan kegiatan ramah lingkungan, melindungi dan memperbaiki kualitias lingkungan.

Kascing merupakan pupuk yang bersumber dari perombakan bahan-bahan organik dengan bantuan cacing (Sri Mursiani 2015), sedangkan berdasarkan hasil penelitian yang dilakukan Dedi (2013) yang disitasi oleh Sri Mursiani (2015) menyatakan, kombinasi pakan 50-65 % bahan hijauan + 30% kotoran ditambah serbuk gergaji 10-15%, dapat meningkatkan selera makan cacing dan menghasilkan kuantitas dan kualitas Kascing yang dihassilkan memiliki kualitas pupuk yang baik. Lebih jauh lagi P.K Sarma at al (2014) menyatakan bahwa kascing merupakan media yang sangat cocok bagi mikroba Azospirillum, Rhizobium dan pelarut *phosphate*, untuk hidup. Sejumlah penelitian telah menunjukkan, cacing tanah mempunyai kemampuan dalam mendekomposisi bermacam-macam limbah organik, seperti feses hewan, lumpur yang berasal dari saluran pembuangan air, sisa hasil panen dan limbah pertanian dan termasuk juga limbah yang berasal dari dapur. Penelitian ini bertujuan untuk melihat seberapa besar benefit dari aspek sosial dan ekonomi dari pemanfaatan kohe sapi perah skala rakyat di Desa Cibodas dengan menggunakan teknologi *Vermicompost*.

METODOLOGI

Tujuan penelitian ini adalah melihat seberapa besar benefit dari aspek sosial dan ekonomi, dalam upaya pemanfaatan feses sapi perah skala rakyat di Desa Cibodas dengan menggunakan teknologi *vermicomposting*. Penelitian berlangsung dari Bulan April 2018 - September 2018, dilakukan pada saat kegiatan Pengabdian Kepada Masyarakat kelompok Pemanfaat feses sapi di Desa Cibodas dan Kelompok Petani Organik di Desa Cisondari Kecamatan Pasir Jambu Kabupaten Bandung Provinsi Jawa Barat, Tahapan Kegiatan Penelitian meliputi: a) Penyebaran kuesioner kepada Peserta sebanyak 25 orang peserta pelatihan pemanfaatan kohe, yang terdiri dari 8 orang peternak, 7 orang calon pemanfaat kohe dan 10 orang petani organik, jajak pendapat melalui kuesioner dilaksanakan setelah selesai presentasi materi pelatihan b) Pengamatan kegiatanan operasional proses *vermicompost* di dua lokasi, yaitu di kampung Papak Manggu dan kampung Injeman Desa Cibodas, saat kegiatan

Demplot. Data yang diamati meliputi : 1) proses produksi *vermicompost* (berat cacing diawal kegiatan dan saat panen, banyaknya feses sapi yang digunakan, kegiatan harian, hasil kascing, neraca massa dan kualitas kascing, 2) Jumlah jam kerja dalam kegiatan proses *vermicompost*, 3) kebutuhan ruang untuk proses dan peralatan 4) Analisis biaya dan pendapatan.

Dillon dan Hardaker (1993) yang disitasi Deepa at al (2014) menyatakan keuntungan kotor adalah perbedaan antara pengembalian kotor dan biaya variable. Keuntungan kotor dihitung dari Pengembalian kotor dikurang Total biaya variable. Waktu titik pulang pokok (*Break even point*) akan ditentukan secara grafik perpotongan kumulatif biaya dengan kumulatif pendapatan, sedang Return on Investment (ROI), bisa juga diartikan sebagai rasio laba bersih terhadap biaya, akan dihitung dengan rumus menghitung ROI adalah sebagai berikut:

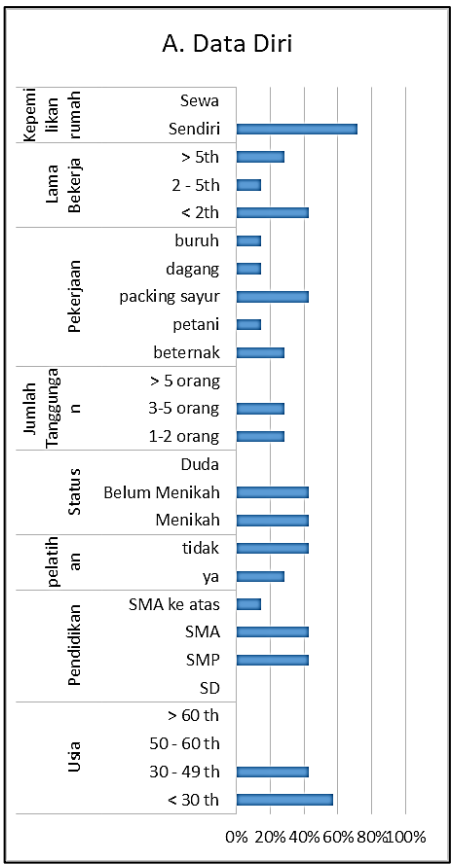
$$ROI = \frac{(Total\ Penjualan - Total\ biaya)}{Total\ biaya}$$

Penelitian kulaitatif dilakukan untuk melihat tanggapan masyarakat terhadap kegiatan pemanfaatan feses sapi dengan teknologi *vermicompost* selama demplot berlangsung (6 bulan) dengan cara observasi partisipatif dan wawancara yang mendalam kepada pengelola kohe, petani dan masyarakat di kampung Papak Manggu. Prof. Dr Sudarwan Danim (2013), menjelaskan bahwa penelitian kualittatif merupakan turunan dari filisofi fenomenologi, dengan prosedur kerja pengumpulan data yang paling umum dipakai adalah observasi partisipasi dan wawancara mendalam.

HASIL DAN PEMBAHASAN

Hasil Jajak pendapat

Untuk mendapatkan informasi seberapa jauh pengetahuan dan keinginan serta tanggapan anggota kelompok dalam hal mengelola feses sapi, telah dilakukan jajak pendapat melalui penyebaran kuesioner kepada tiga kelompok peserta pelatihan, yaitu peserta dari calon pengelola kohe anggota kelompok tani dan anggota peternak (pengisian kuesioner dilakukan setelah kegiatan pelatihan). Khusus dalam pembahasan ini disajikan hasil jajak pendapat dari 2 jenis pekerjaan, yaitu calon pengelola kohe dan peternak.

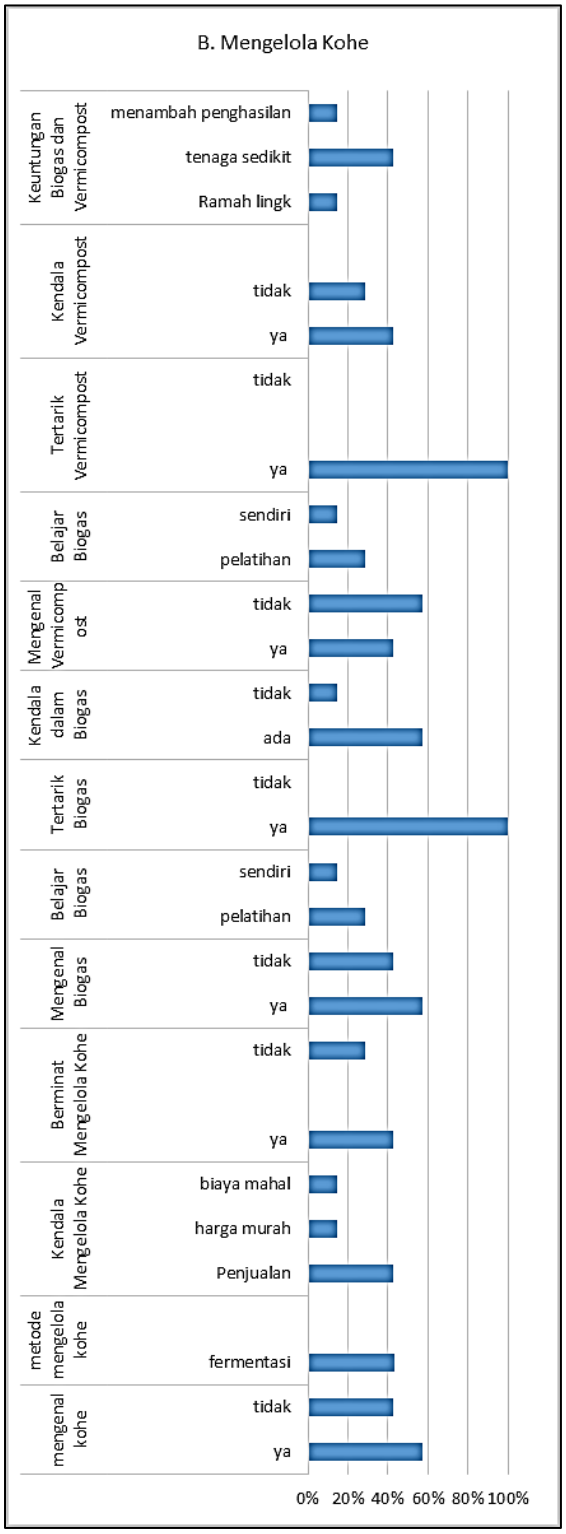


Gambar 1. (A) Grafik hasil Jajak Pendapat kepada Calon Pengelola Kohe

1. Tanggapan Calon Pengelola Kohe

Calon Pengelola kohe adalah anggota kelompok, yang bekerja serabutan, membantu peternak dalam mencari rumput, packing sayuram dan buruh tani, selain itu juga mereka melakukan pengolahan kohe menjadi pupuk organik dengan cara fermentasi, namun produksinya tidak kontinyu, berikut hasil jajak pendapat kepada mereka: Responden yang berminat untuk mengelola kohe mayoritas dalam usia muda dan produktif

(<30th) dengan pendidikan maksimal SMA.



Gambar 1. (B) Grafik hasil Jajak Pendapat kepada Calon Pengelola Kohe

Responden mayoritas sudah berkeluarga dan memiliki tanggungan mulai dari satu hingga lima orang dan tinggal di rumah sendiri. Pekerjaan yang dilakukan selama ini adalah sebagai buruh packing sayur selama kurang dari dua tahun.

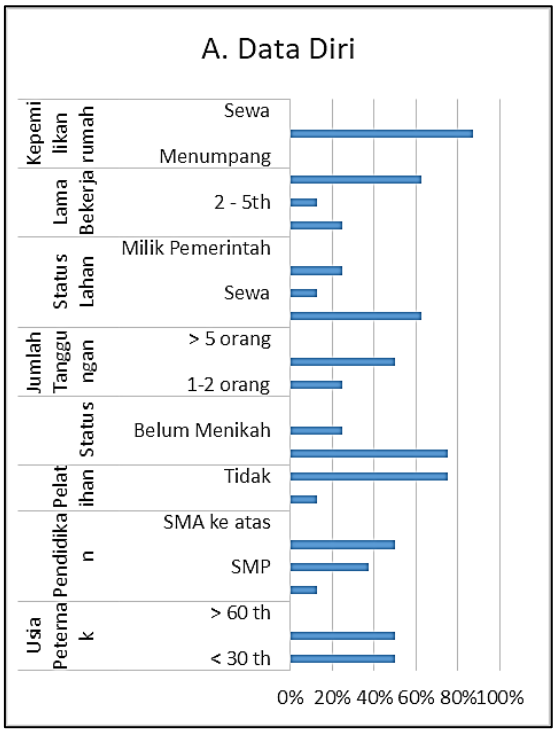
Mayoritas responden sudah mengetahui cara pengelolaan kohe dengan metode fermentasi. Anggapan kendala yang dihadapi adalah sulitnya pemasaran hasil olahan kohe, sedangkan biayanya mahal, tetapi responden masih berminat mengelola kohe, sepanjang ada pasarnya. Mayoritas responden sudah mengenal biogas dari pelatihan dan tertarik untuk menggunakan teknologi biogas. Mayoritas beranggapan ada kendala dalam penerapan biogas. Untuk teknologi *vermicompost* mayoritas responden belum mengenal, sedangkan responden yang sudah mengenal teknologi *vermicompost* dari pelatihan, mereka berpendapat, kendala yang terjadi sedikit dan manfaat yang didapat berupa minimalnya tenaga yang dibutuhkan, lebih ramah lingkungan serta dapat menambah penghasilan.

2. Tanggapan Peternak

Peternak di desa Cibodas mayoritas dalam usia produktif (30-49 th) dengan pendidikan SMA. Peternak mayoritas sudah berkeluarga dan memiliki tanggungan 3-5 orang dan tinggal di rumah sendiri. Lama kerja peternak mayoritas lebih dari 5 tahun. Selain itu, peternak juga memiliki lahan garapan milik sendiri dengan luas bervariasi antara 12 – 300 m2.

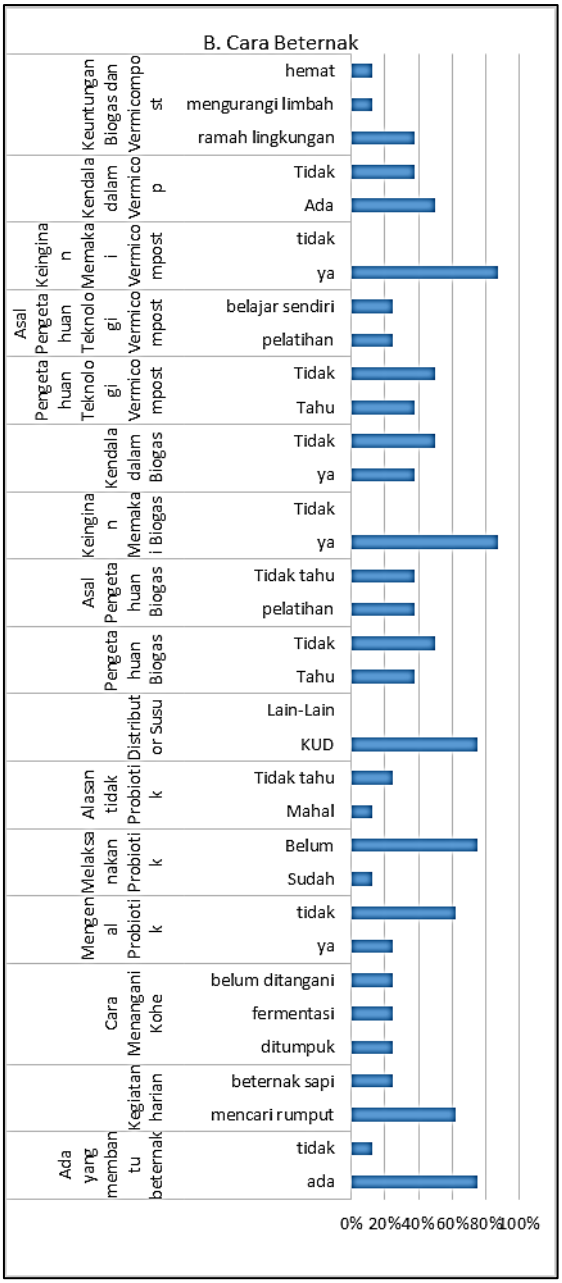
Sumber makanan ternak berasal dari hijauan dan jerami dari kebun, sawah maupun hutan. Jumlah ternak yang dipelihara bervariasi dari 2 hingga 5 ekor sapi ataupun kambing. Biaya pakan yang dikeluarkan perbulan juga bervariasi dari 100 ribu hingga 1,5 juta. Untuk sapi perah, susu yang dihasilkan sekitar 450 – 900 liter per bulan. Sehingga penghasilan yang didapatkan perbulan berkisar 300 ribu hingga 10 juta perbulan. Dalam memelihara ternak, mayoritas ada yang membantu dalam kesehariannya, peternak juga mencari rumput. Selama ini, penanganan feses sapi belum tertangani

dan hanya ditumpuk saja. Peternak mayoritas tidak mengenal dan belum pernah melaksanakan peternakan probiotik. Hal ini dikarenakan ketidaktahuan akan peternakan probiotik dan anggapan bahwa teknologi tersebut mahal. Mayoritas peternak sapi perah menyalurkan hasil susu ke KUD.



Gambar 2. (A) Grafik Hasil Jajak Pendapat Peternak

Peternak mayoritas tidak mengenal teknologi biogas dan berminat menggunakannya, sedangkan peternak yang tahu belajar dari pelatihan. Peternak beranggapan bahwa dalam menerapkan biogas tidak ada kendala. Untuk teknologi *vermicompost* mayoritas peternak juga tidak tahu, sedangkan sisanya belajar dari pelatihan yang pernah diikuti. Peternak beranggapan bahwa terdapat kendala dalam menerapkan *vermicompost* tetapi mengetahui manfaat yang dapat diperoleh darinya berupa ramah lingkungan (mayoritas), mengurangi limbah dan lebih hemat. Gambaran hasil jajak pendapat dari peternak dapat dilihat pada gambar 2 grafik hasil jajak pendapat dari peternak.



Gambar 2. (B) Grafik Hasil Jajak Pendapat Peternak

Proses Vermikompos

Dari pengamatan selama demplot/uji coba penggunaan reaktor biogas dan *vermicompost*, diperoleh data sebagai berikut : feses sapi yang dihasilkan sebanyak 20 kg/ekor/hari, rata2 peternak memelihara 2 -3 ekor sapi, pada kegiatan demplot feses sapi dibersihkan dari lantai dengan disemprot air menggunakan selang, kemudian disapu dan didorong masuk ke reaktor biogas kapasitas 10 m3. Pembersihan kandang dilakukan 2 kali

sehari. Tidak semua kohe sapi masuk ke dalam reaktor, karena kapasitas reaktor yang terbatas. Effluent biogas (lumpur) keluar dan ditampung dalam kolam penampungan.

Kohe sapi yang tidak masuk dalam reaktor biogas, ditumpuk pada kandang kosong ukuran 170 cm x 270 cm dengan tinggi bed 20 cm. Ke dalam tumpukan kohe dimasukan cacing dewasa umur 2.5 bulan sebanyak 25 kg. Pakan cacing diberikan dari lumpur biogas setiap 1 minggu sekali, sebanyak 6 x 10 liter lumpur (1 ember, kapasita 10 liter). Setiap bulan, *vermicompost* di bagi menjadi 3 bedeng dan masing masing bedeng ditambah kohe, untuk mencapai volume bedeng tersedia. Setelah 5 bulan kegiatan demplot, jumlah bedeng mencapai 8 bedeng ukuran 170 cm x 270 cm x 20 cm dan 8 bedeng ukuran 270 cm x 50 cm x 20 cm sehingga diperoleh biomasa sebanyak : kascing 6,666 kg dan 100 kg cacing. Selain itu masih terdapat 6 bed yang berisi telur dan 10 kg cacing, untuk pengembangan berikutnya.

Gambar 3. Proses *Vermicompost* di Kampung Papak Manggu Desa Cibodas

Waktu yang digunakan oleh peternak dalam mengelola kohe untuk biogas dan kascing adalah 1) 60 menit untuk membersihkan kandang, mengisi reaktor biogas setiap harinya dan 2) 120 menit untuk panen cacing dewasa dan kascing termasuk memasukkan kascing ke dalam karung.

Pada Gambar 3. Menunjukan produksi vermicompost berjalan dengan baik dan berkembang, terlihat dari awalnya 2 bed telah berkembang menjadi 16 bed selama 6 bulan, kegiatan ini hanya merupakan kegiatan sambilan yang dikerjakan oleh peternak. Hasil analisis laboratorium terhadap kascing diperoleh dapat dilihat pada Tabel 1.

Tabel 1. Kualitas Pupuk Organik

PARAMETER	Pupuk organik *	Pupuk organik**
pH 1:5 H2O	4-9	6.36
C-Organik (Gravimetri) (%)	Min 15	25.06
Rasio C/N	15-25	16.89
P2O5 + K2O + N (unsur hara)	Min 4	3.19
Kadar Air (%)	15-25	22.9%

**Peraturan Menteri pertanian No 70/Pementan/SR.140/10/2011*
*** Vermicompost dari kohe sapi murni (100%)*

Hasil analisis laboratorium produksi kascing dengan bahan baku kohe murni 100%, menunjukkan hampir semua parameter memenuhi standar kualitas pupuk organik berdasarkan Peraturan Menteri Pertanian no 70 /Permentan/ SR.140/10/2011 (Tabel 1), kecuali unsur hara makro masih dibawah minimal yaitu 3.19 % (seharusnya diatas 4%). Kualitas kascing bisa ditingkatkan dengan penambahan jerami padi misalnya, sebagaimana telah dilakukan oleh Badruzzaman dkk (2016), dalam penelitia-nnya menyimpulkan bahwa Campuran *Feses* Sapi perah dan jerami padi dalam vermicomposting telah meningkatkan unsur hara mlebehi 4 %, (dilihat dari hasil pejumlahan nilai N,P_2O_5 dan K_2O dalam prosentase).

Biaya Investasi *Vermicompost*

Demplot dilakukan di kandang sapi yang tidak digunakan, namun sesungguhnya untuk kegiatan *vermicompost*, tidak perlu bangunan yang mahal, cukup bangunan sederhana, terbuat dari tiang-tiang bambu, dengan atap dan dinding plastik, biaya

penyiapan rumah *vermicompost* dengan tiang bambu, dan tutup/atap dari plastik dan para net adalah Rp 45.000/m2, jadi untuk 6 bed dengan ukuran 170 cm x 270 cm dibutuhkan investasi senilai Rp 1.239.300,- umur bangunan 5 tahun, jadi nilai penyusutan Rp 20.655/bulan.

Pembelian Cacing induk 25 kg x Rp 25.000 = Rp 650.000,- Karena cacing ini terus berkembang biak tidak ada nilai penyusutan.

Biaya Operasional

1. Tenaga kerja yang dibutuhkan 60 menit x 30 hari/bulan + 120 menit x 5 kali/bulan = 2.400 menit/bulan = 40 jam/bulan
2. Biaya tenaga kerja = 40 jam/bulan x Rp 60.000/6jam = Rp 400.000 /bulan. Dikerjakan oleh peternak, merupakan kerja sampingan
3. Biaya Tenaga kerja selama 5 bulan Rp 2.000.000

Pendapatan dari Vermicompost

1. Harga kascing Rp 250/kg dan cacing Rp 10.000/kg ditingkat petani
2. Pendapatan selama 5 bulan adalah sebagai berikut :
   a) dari Kascing setiap bulan = 6.666 kg/bulan x Rp 250/kg = Rp 1.666.500
   b) dari penjualan cacing dewasa = 100 kg/bulan x Rp 10.000 = Rp 1.000.000
   c) Total pendapatan selama 5 bulan = Rp 2.666.500

Analisis Keuangan

Dari hasil pengamatan lapangan pola pertumbuhan cacing sangat pesat, karena setiap cacing dewasa usia 3–12 bulan, bertelur setiap 2 minggu sebanyak 2-3 butir, maka dapat direncanakan panen Kascing dan Cacing selama 1 tahun dapat dilihat pada tabel 2.

Tabel 2. Jumlah Cacing dan kascing yang dipanen setiap bulan selama 1 tahun

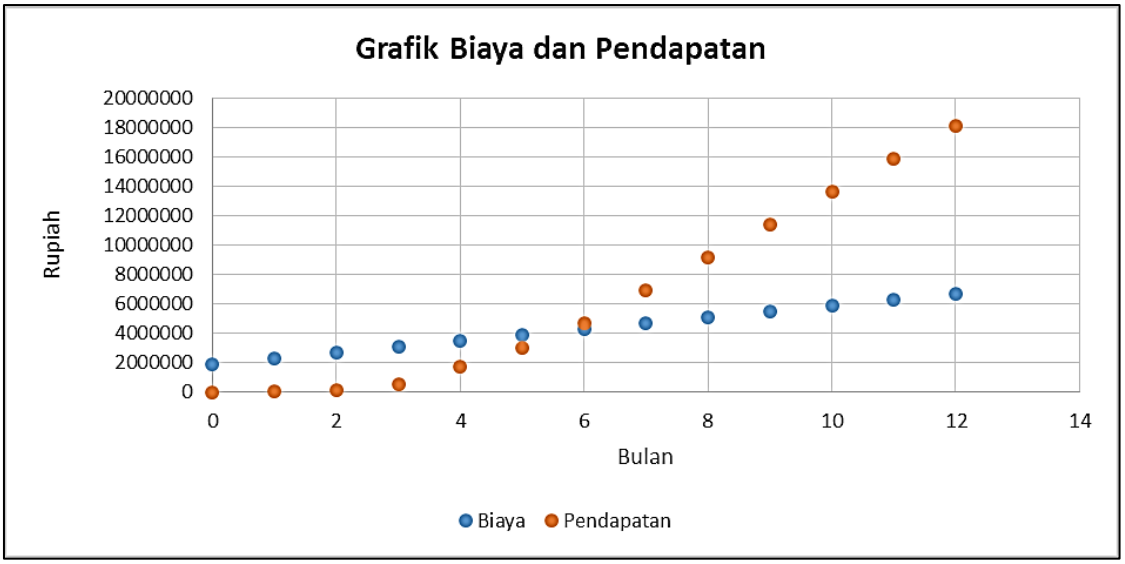
Bulan	SAT	1	2	3	4	5	6	7	8	10	11	12
Panen Cacing	kg			0	25	100	100	150	200	200	200	200
Panen Kascing	kg	300	300	600	900	900	900	900	900	900	900	900

Biaya investasi sebesar Rp 1.889.300 dan biaya tenaga kerja Rp 400.000/bulan, dan dengan harga kascing Rp 250/kg dan Cacing Rp 10.000/kg maka dapat diperoleh gambaran Break Even Point (BEP) pada bulan 6 (gambar 4).

Tabel 3. Tabel Biaya dan Pendapatan Kumuliatif Usaha Vermicompost

BULAN	0	1	3	4	5	6	7	8	9	10	11	12
BIAYA	1,889,300	2,289,300	2,689,300	3,089,300	3,889,300	4,289,300	4,689,300	5,089,300	5,489,300	5,889,300	6,289,300	6,689,300
PENDAPATAN	-	75,000	150,000	1,775,000	3,000,000	4,725,000	6,950,000	9,175,000	11,400,000	13,625,000	15,850,000	18,075,000

Kondisi tersebut telah memperhitungkan penghasilan tambahan bagi pengelola senilai Rp 400.000 setiap bulan dengan waktu kerja yang digunakan 40 jam/bulan. Waktu pengembalian modal, atau Break Even Point (titik impas) usaha vermicompost sangat pendek, karena biaya investasi yang dibutuhkan cukup rendah, dan biaya operasional vermicompost juga rendah, hal ini sesuai dengan hasil penelitian Bajracharya and Lakhe, 2013 yang disitasi oleh Devota at al (2014) menyatakan bahwa waktu tunggu untuk produksi pupuk siap berproduksi yang pendek yaitu 40 – 45 hari, dan modal investasi yang rendah maka waktu titik impas dicapai pada 1,72 tahun.



Gambar 4. Grafik *Break Even Point Vermicompost*

Kegiatan vermicompost dengan menggunakan feses sapi perah dicampur lumpur biogas memberikan nilai ROI dalam tahun pertama adalah = (18.075.000 – 6.689.300)/ 6.689.300 = 1.7

Aspek Sosial

Pada gambar 5 dapat dilihat, ada nya minat masyarakat dalam memanfaatkan kascing, sebagai hasil vermicompost, untuk bercocok tanam di poly bag. Kegiatan ini merupakan inisiatif masyarakat sendiri.

Gambar 5. Pemanfaatan Kascing pada Tanaman di Poly Bag di halaman rumah, Kampung Papak Manggu Desa Cibodas

Dari hasil observasi partisipasi dan wawancara mendalam untuk aspek sosial dapat dilihat bahwa pengelolaan kohe dengan vermicompost, dapat memberikan benefit terhadap:

- Kebersihan kandang, dan keamanan lingkungan dari pencemaran yang disebabkan oleh adanya kohe
- Memberikan penghasilan tambahan bagi petugas/pengurus ternak, atau siapapun yang memanfaatkannya
- Tersedianya pupuk organik (kascing) dengan kualitas yang baik dan harga murah Rp 250/kg, dibandingkan dengan membeli kohe ayam dari Tangerang (kebiasaan petani) dengan harga Rp 20.000/karung (50 kg)
- Tersedianya pupuk organik telah memberikan motivasi bagi ibu rumah tangga memanfaatkan pekarangan, dengan menanam sayuran sebagai dapur hidup
- Perlu dikembangkan pasar cacing kering untuk pakan ternak, hal ini dapat ditangani oleh BumDes
- Dengan ada nya kegiatan pengolahan kohe dengan vermicompost, telah mendorong terciptanya usaha pupuk organik, ternak cacing, pertanian organik dan pakan ternak.

KESIMPULAN

Dari hasil kajian sosioekonomi pemanfaatan feses sapi dengan teknologi *vermicompost* di Desa Cibodas, dapat ditarik kesimpulan sebagai berikut: Peternak sapi perah di desa Cibodas,

mayoritas belum mengelola feses sapi nya secara baik dan benar. Pemanfaatan kohe sapi dengan teknologi *vermicomposting* sangat cocok diterapkan di Desa Cibodas, karena disamping menjadikan lingkungan kandang bersih, tenaga kerja yang dibutuhkan sedikit, juga dapat memberikan pengasilan tambahan bagi pengelola nya dengan menjual cacing dan pupuk kascing, bagi pengelolanya, dilihat dari titik pulang pokok dalam waktu 6 bulan dengan penambahan penghasilan bagi pengelola Rp 400.000 dengan waktu kerja 40 jam/bulan, dengan nilai ROI 170%. Dengan menerapkan *vermicompost* untuk pengolahan feses sapi, maka dapat memberikan keuntungan dari sisi sosial dan ekonomi masyarakat sekitar.

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E-WASTE: AN UNDERRATED HAZARDOUS WASTE IN INDONESIA

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Abstract: The quick advancement of gadgets innovation industry offers an extensive variety of item decisions. This circumstance supported the improvement of electronic industry in Indonesia to be quick. The speeding up development is combined with items that are quickly out of date on the grounds that more current age items have showed up once more. So that, the electronic things which have been unused in the end move toward becoming refuse that is frequently alluded to as Electronic Waste (e-squander) and encountered an exceptionally fast increment. From the aftereffects of research in creating nations including Indonesia, E-Waste isn't found in squander Final Disposal (TPA). This is because of the high number of reusing and reuse (reusing) of utilized electronic products in the casual division. Reusing of the casual division is firmly identified with natural and wellbeing impacts. It isn't understood that numerous segments of electronic products contain hazardous toxic substances (B3). With a specific end goal to handling these issues, creating nations including Indonesia require modern cycle innovation, as well as significant administration measures and the presence of an approach to avert ecological effects. Nevertheless, contrasted and specialized viewpoints, e-squander administration strategy turns out to be more essential and earnest. In this paper, we endeavor to present the conditions and administration approaches that exist in Indonesia today and elective e-waste reusing innovations that identify with e-squander administration arrangements that are coordinated in the formal and casual segments.

Keywords: *e-waste. informal sector, integrated management.*

Abstrak: *Kemajuan cepat industri inovasi gadget menawarkan berbagai macam keputusan barang. Keadaan ini mendukung peningkatan industri elektronik di Indonesia menjadi cepat. Perkembangan yang semakin cepat digabungkan dengan item-item yang cepat ketinggalan zaman dengan alasan bahwa semakin banyak item usia sekarang muncul sekali lagi. Oleh karenanya, barang-barang elektronik yang tidakdigunakan pada akhirnya bergerak menuju menjadi sampah yang sering disinggung sebagai Sampah Elektronik (E-Waste) dan mengalami peningkatan yang sangat cepat. Dari efek samping penelitian dalam menciptakan negara termasuk Indonesia, E- waste tidak ditemukan di Pembuangan Akhir (TPA) penghamburan. Hal ini karena tingginya jumlah untuk menggunaan kembali dan penggunaan kembali (reusing) produk elektronik yang digunakan di divisi kasual. Menggunakan kembali dari divisi kasual secara tegas diidentifikasi dengan dampak alami dan baik. Tidak dipahami bahwa banyak segmen produk elektronik mengandung Bahan Berbahaya dan Beracun (B3). Dengan tujuan akhir yang spesifik untuk menangani masalah ini, menciptakan negara termasuk Indonesia memerlukan inovasi siklus modern, serta langkah-langkah administrasi yang signifikan dan adanya pendekatan untuk mencegah efek ekologi. Meskipun demikian, sudut pandang yang dikontraskan dan khusus, strategi administrasi e-waste ternyata lebih penting dan sungguh-sungguh. Dalam tulisan ini, kami berusaha untuk menyajikan kondisi dan pendekatan administrasi yang ada di Indonesia saat ini dan e-waste menggunakan inovasi yang mengidentifikasi dengan pengaturan administrasi e-penghamburan yang terkoordinasi dalam segmen formal dan kasual.*

Kata Kunci: *E-waste, Sektor Informal, Pengelolaan Terpadu.*

INTRODUCTION

The quick improvement of the electronics technology industry not just offers an extensive variety of item decisions yet in addition value choices. This provides an opportunity for the community to have electronic items in their homes. This circumstance supports the improvement of the electronic business in Indonesia to be quick. The speeding up of development is combine with the items that are rapidly out of date as more up to date age items have returned. According to Osibanjo et al, (2006), in fact, electronic goods are usually not used anymore, even though they can still operate for later replaced with new ones because consumers want new features or old ones inadequate for new services from operators, or just because want to change it. With the goal that these unused electronic things in the end progress toward becoming junk which

is frequently alluded to as Electronic Waste (e-waste) and encountered an extremely quick increment. In (Sutarto E, 2008), e-waste has different characteristics with other wastes. This is because the definition of e-waste is very dependent from the perspective of each person.

In their research Jesica et al (2011), in Indonesia in 2007 produced more than 3 billion units of household electronic equipment and IT equipment. Still in Jesica's research it is stated that Indonesia is one of the biggest consumers of household electronic equipment in Asia. From these data can be imagined in the coming year in Indonesia will experience e-waste boom. While developing countries including in Indonesia there is no agreement on standard or generally accepted definitions. Whereas according to the results of Fishbein (2002); Scharnhorst et al (2005) cited by Jang et al (2010), toxic substances in arson, beryllium, cadmium and tin are found to be very presistent and as substance. bioaccumulation. If during the repairing and recycling process of e-waste is uncontrolled, some of these chemicals can be released into the environment. Because the shape is relatively small so that the impact of disposal is ignored. But with very fast growth, the impact is very significant on health and the environment.

Formally, because e-waste is included hazardous waste, Indonesia has forbidden to importe-waste but in fact can enter illegally (Sukandar, 2011). Meanwhile, according to Triwiswasra (2009) in creating nations including in Indonesia, there are exercises of repair and reuse of utilized electronic products in high amounts. Repair shops can be found in the secondhand sector. The workers at the storelook for broken or unused components and replace them with new locally made components. Components damaged already severe and can not be reused, still have a sale value because it can still be recycled.

According to Widyarsana (2011), e-waste recycling in Indonesia takes place uniquely, where the focus of attention is on the components of Electronic Product is so high that the life time component is getting longer or end-of-life becomes long. Uncontrolled utilization by the informal sector can have health and environmental impacts. In order to address the problem, it currently requires not only sophisticated cycle technology, but also management measures that are relevant to environmental prevention policies. Compared with technical aspects, the e-waste management policy becomes more important and urgent for this specific situation, so it does not just apply the management that has been done in other countries. This paper endeavors to present current e-squander administration arrangements and conditions and additionally elective e-squander reusing innovations identified with coordinated and casual e-squander administration strategies.

E-WASTE CONDITION IN INDONESIA

Although e-waste appears as a global issue, it is not a common term for most people in Indonesia. There is no particular meaning of e-waste in existing controls in Indonesia, although in developed countries (EU Directive), it is clear that e-waste includes hazardous waste regulations. Where in the regulation e-waste can be interpreted as electronic goods and electrical equipment that is not used and or has been unwanted because it has become obsolete items and need to be discarded, either in the form of whole or as part. Compared to other developing countries in Southeast Asia, awareness of e-waste problems in Indonesia is still relatively lagging behind. This is due to the lack of information regarding e-waste to the public and different understanding between institutions regarding waste and procedures management at the government level. In addition, there is no accurate data

for the number of electronic goods in Indonesia and no other technical provisions on the age of reprocessed goods. If e-waste is considered a hazardous waste, it should end up in a landfill as well so it is safe for hazardous waste. Research conducted by Damanhuri and Sukandar (2006), e-waste is not found in Final Disposal (TPA) waste. e-waste sold is usually only part of an electronic component or only one piece or component parts are usually sent to the assembly plant again. This indicates that there is an unofficial system that absorbs most of e-waste in Indonesia, namely the finding of flow of secondhand electronic materials and electronic waste (e-waste).

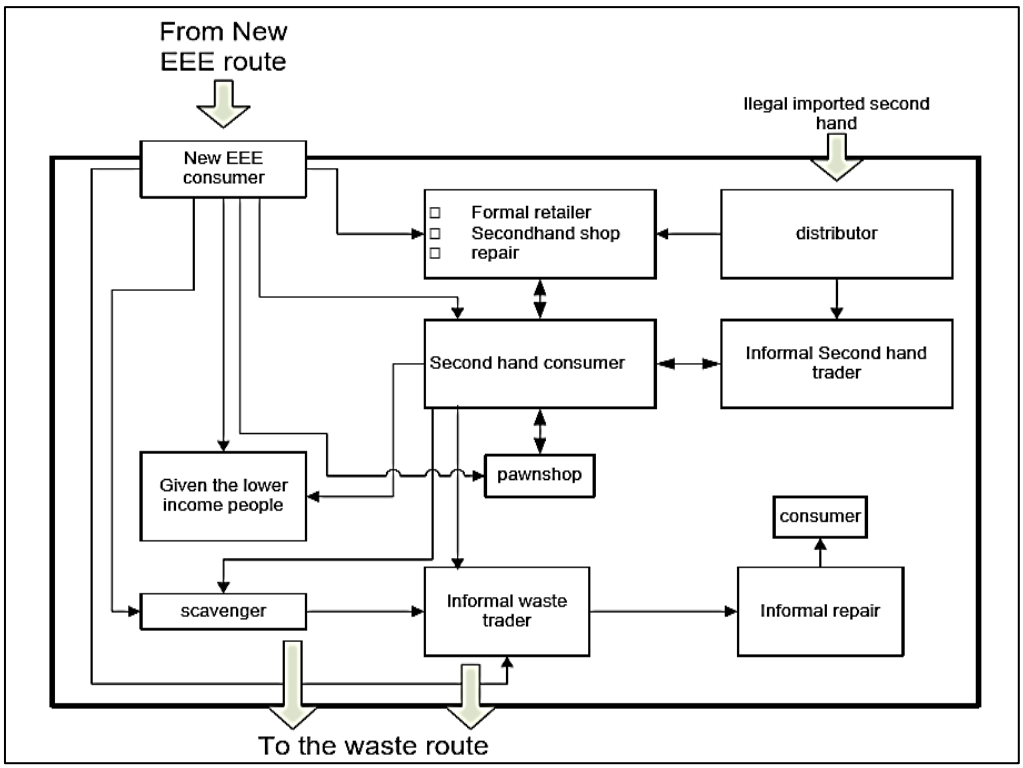

Figure 1. Flow of Electronic Goods and Equipment (EEE) Secondhand
Source: Damanhuri and Sukandar, (2006)

Electronic waste generation forecasts in Indonesia have been issued by the STEP-Initiative organization and show that in 2012, electrical and electronic devices circulating for sale in the Indonesian market amounted to 1.361 kilotonnes or 1.361 million kg. Two years later, electrical and electronic devices are estimated to be still used or circulated in the community, both in the condition still functioning as early as the purchase and have been repaired only amounted to 616 million kg. So that devices which have become electronic waste in 2014 is predicted to amount to 745 metric kilotonnes or about 745 million kg, and Thereis no particular meaning of e-waste in existing controls in Indonesia. To regulate electronic waste, the government has been categorizing electronic waste into hazardous and toxic waste. Therefore, the regulation and management of electronic waste refers to regulations regulating hazardous waste and waste, namely Law no. 32 of 2009 concerning environmental protection and management; Presidental Decree no. 101 of 2014 concerning hazardous waste management; and Law No. 18 of 2008 on waste management. However, all of these regulations only

govern general and do not specify the definition, criteria or flow of electronic waste management.

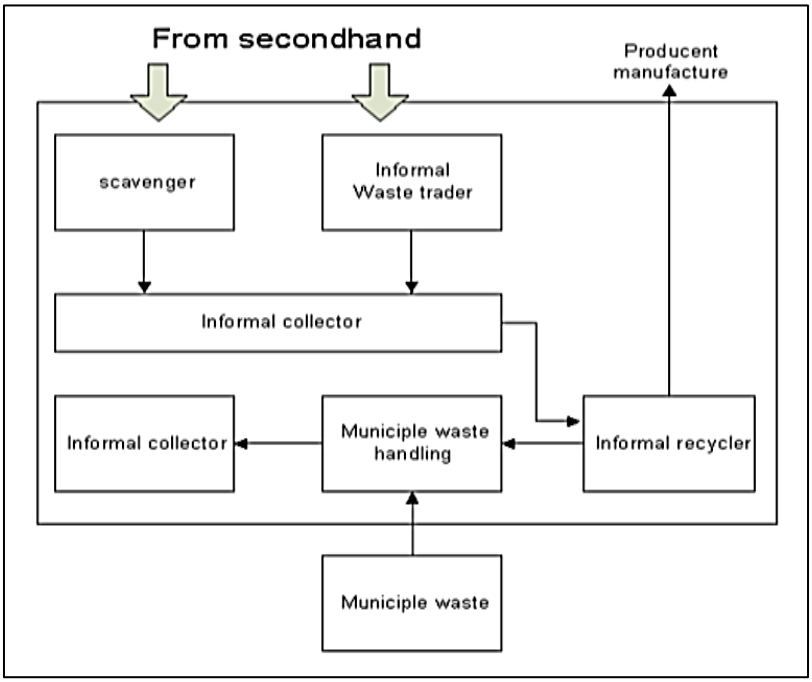

Figure 2. Flow of E-Waste
Source: Damanhuri and Sukandar, (2006)

This weak of legal framework ultimately impacts on the frequent occurrence of violations which in addition to harming the state also pollute the environment and threaten public health, because it is not done through the way environmentally friendly. Such as the sending of electronic waste from abroad into the territory of the Republic of Indonesia which still occurs even though the prohibition of importation of electronic waste has been regulated in Law No.32 of 2009 article 69 paragraph 1 and Law No.18 of 2008 Article 39 paragraph 2. As an archipelago, Indonesia has many ports scattered in the outer islands so that electronic waste or used electronic devices from abroad enter the national market through these ports by utilizing the limitations of officers and standard service facilities of supervision on the importation of goods that are prohibited from entering the country, as well as forgery or the use of inappropriate permissions documents. This then allegedly contributed significantly to the amount of electronic waste in Indonesia, even though the data regarding the illegal import of electronic waste, these cannot be monitored by the government.

While the impact of pollution due to the management of electronic waste that is not environmentally friendly has occurred in several regions in Indonesia. Like the case of environmental pollution that occurred in Pesarean Village, Adiwerna District, Tegal Regency. This village has several metal industries that smelter aluminum, lead, copper, zinc and used batteries. The results of the remaining metal industry activities have caused a pile of metal wastes such as lead ingots produced and become raw materials for industrial batteries, electronics, metal plating, paint, glass and others. In 2011, the results of a regional sample test conducted by the Central Java Provincial Government on 50 villagers provided data that as many as 46 people had been

contaminated with lead and of these, 12 people were in danger because of exposure to a number of harmful substances.

VULNERABLE POPULATIONS

Minimized population bear an unbalanced measure of the negative impacts of despicable e-squander rehearses. Most e-waste recyclers, in either the formal or casual segment, are poor and less instructed than the particular populace normal, Diaz-Barriga (2013). E-waste reusing gives a wellspring of wage to individuals who have couple of other monetary openings. E-waste reusing, particularly in the casual area, is designed for high throughput and yield. Word related security and natural insurance are not organized. Poor kids and ladies, particularly those living in urban territories, speak to an expansive segment of e-waste recyclers, Chi X et al (2011). Because of the holes in information, especially in the casual segment, the aggregate number of kids presented to word related wellbeing and dangers from e-waste is hard to evaluate. Notwithstanding, the International Labor Organization has detailed that e-squander specialists are regularly kids, Lundgren K (2012). Kids are viewed as perfect e-waste laborers since they have little, adroit hands that assistance them effortlessly disassemble disposed of EEE.

The abuse of kids inside the e-waste reusing industry is particularly concerning given the physiological credits that add to a tyke's helplessness. Exposures to unsafe substances, for example, polychlorinated biphenyls and dioxins, at e-squander destinations are higher for kids than for grown-ups. Youngsters are as yet developing so their admission of water, nourishment, and air in extent to their tallness and weight is altogether higher contrasted with the admission of grown-ups (Duffert C). Children likewise have a significantly bigger proportion of surface zone to body weight than grown-ups, bringing about a lifted hazard for dermal retention (Duffert C). Moreover, youngsters have a diminished capacity to detoxify substances. Amid development, a kid's creating frameworks are fundamentally more touchy to harm. Kids regularly invest more energy outside where perilous exposures are inside nearer closeness. From a conduct stance, young children commonly show hand-to-mouth conduct and creep on the ground, which typically prompts the immediate ingestion of possibly unsafe substances. Kids have an immature hazard discernment that can prompt destructive exposures from e-waste, Caravanos J et al (2013). At last, children have a more extended future amid which they would live with the impediment that wounds or introduction to dangerous substances can incite.

EFFECTS OF EXPOSURE

The short-and long term impacts of introduction to risky e-waste substances are not completely seen, be that as it may, there is inquire about on the relationship between e-waste presentation and more elevated amounts of synthetic compounds and metals in human-inferred natural examples, (Duffert C). The lethality of numerous individual substances found in e-squander is all around archived, nonetheless, the harmfulness of the blends of substances prone to be experienced through e-waste reusing is less notable. Overwhelming metals and halogenated mixes seem to impact potential wellbeing dangers, (Duffert C).

The potential antagonistic wellbeing impacts of introduction to ewaste have been explored as of late and may incorporate changes in lung work, thyroid capacity, hormone articulation, birth weight, birth results, youth development rates, psychological wellness, intellectual improvement, cytotoxicity, and genotoxity, (Duffert C). It is likewise conceivable that presentation to dangerous synthetic compounds delivered by e-waste reusing may have cancer-causing impacts and endocrine upsetting properties that

could prompt deep rooted changes because of neuro development inconsistencies, anomalous conceptive advancement, scholarly hindrance, and consideration troubles, (WHO). Raised levels of 8-hydroxydeoxyguanosine, a urinary bio-marker of summed up, cell oxidative pressure, were seen in the post-work-move pee of e-waste laborers. One investigation of Chinese e-waste specialists recorded essentially larger amounts of serum polybrominateddiphenyl ethers (PBDEs) and thyroid-empowering hormone (TSH) than found in the control gathering, Wen S et al (2008).The expanded presentation to PBDEs from ewaste reusing may prompt obstruction with the thyroid hormone framework and other unfavorable wellbeing impacts, Wen S et al (2008). Decreased lung function has been seen in young men matured 8 to 9 years living in an e-squander reusing town however not in young men living in a control town, Grant K et al (2013). Huge negative connections between's constrained essential limit, a measure of lung capacity, and blood chromium fixations have been accounted for. Grant K et al (2013). Lead is additionally a built up neurotoxicant that can prompt scholarly impedance and harm to the anxious, blood, and conceptive frameworks. Research discoveries show there is no limit beneath which lead presentation does not effects lyaffect a creating sensory system,(Duffert C). Brominated fire retardants have a long half-life and supposedly prompt debilitated learning and memory work; changed thyroid, estrogen, and hormone frameworks; social issues; and neurotoxicity. Cadmium tends to bioaccumulate and can be profoundly lethal, particularly to kidneys and bones. Mercury is thought to make harm the mind and focal sensory system, especially amid early advancement. The quantity of unsafe substances that people could be specifically or in a roundabout way presented to by e-squander is huge and hard to measure. The groupings of these materials are variable yet frequently are quite high, particularly inside the genuine e-waste locales. Regardless of whether the centralizations of these substances are low, the synthetic concoctions are frequently still lethal to people and diligent in nature. The heterogeneous idea of risky exposures adds to the challenges encompassing the investigation of the impacts e-squander exposures.

There are extra parts of e-waste presentation that may prompt unfavorable wellbeing results. Regardless of whether every day introduction is low, aggregate presentation is frequently high and to a great degree difficult to gauge, (Duffert C). Notwithstanding, when the impacts of a solitary concoction at specific levels are very much concentrated the impacts of the blends of unsafe e-waste substances are not notable. Inside a blend of synthetic concoctions, a few substances may have synergistic or adjusting impacts that could be to a great degree unsafe, (Duffert C). The reagents utilized as a part of the reusing procedure, such cyanide and other solid draining acids, may add to the dangerous synthetic e-waste blends. Not exclusively do the day by day and total measurements of introduction matter while ascertaining hazard, yet in addition the planning, or "life phase of presentation" is profoundly noteworthy, van den Berg (2013). Unmistakably, destroying e-waste can likewise specifically prompt damage. Certain people, for example, kids, are more helpless given the affectability of their creating frameworks. The planning of presentation likewise may demonstrate the normal span of certain subsequent wellbeing impacts of introduction.

Much research is required on e-squander introduction and potential unfriendly wellbeing impacts. Solid confirmation that connections occupation introduction of perilous e-squander substances to wellbeing impacts is deficient. The potential causal connection amongst presentation and watched negative impacts requires extra, broad

research. Additionally, the blend of e-waste auxiliary synthetic substances and organic specialists is obscure. For instance, the communication amongst lead and mercury with the intestinal sickness parasite requires facilitate examination. On an exceptionally fundamental, human level, innovative work of treatment measures for those presented to perilous e-waste materials is basic. Research on e-waste perils can be restricted by poor access to uncontrolled settings, constrained assets, and political and moral concerns. Observing and reconnaissance, particularly of casual e-waste reusing activities, is meager. In spite of these examination hindrances, additionally considers are indispensable. Not exclusively are hazard appraisals of e-waste presentation basic, yet in addition investigate that will encourage casual neighborhood, provincial, and worldwide e-waste reusing arrangement is required earnestly.

E-WASTE MANAGEMENT POLICY IN INDONESIA

The legal basis for electronic waste management (e-waste) includes:

- Presidential Decree 61/1993 on the Ratification of the Basel Convention.
- Presidential Regulation 47/2005 on Ratification of Ban Amandement
- Law No. 32 of 2009 on Environmental Management
- Presidental Decree No. 18/1999 no Presidental DecreeNumber 85/1999 on B3 Waste Management
- Law No. 18 of 2008 on Waste Management

In Government Regulation No. 18/1999 no Presidental Decree No. 85/1999 on Hazardous Waste Management mentioned in detail as follows:

a) Hazardous waste from a specific source (Annex I, Table 2 "List of B3 Wastes from Specific Source" Waste Code D219: Electronic Components / Electronic Equipment)
b) Source of Pollution: Manufacturing and Assembling; Waste Water Management
c) Origin / Waste Description: sludge remaining process; coated glass (CRT tube); solvent used; painting waste; solder residues and fluxes (PCB, IC, cable); plastic casing
d) Other waste outside the category of B3 waste can be organic or inorganic

Although in recent years, foreign countries, especially the European Union, have issued a series of appeals (such as RoHS, WEEE instructions and others) to promote the eco-design of electrical products and adopt Extended Producer Responsibility (EPR) for the collection and recycling of WEEE, but at the reality is still very difficult to apply directly in developing countries. In Indonesia, the draft Regulation of the Minister of State on Electronic Waste Management will be arranged in terms of definition, scope of electronic waste source, electronic waste type, Extended Producer Responsibility (EPR), electronic waste management through hazardous waste management mechanism, cooperation between producers of electronic goods and hazardous waste managers and their compensation and supervision.

MANAGEMENT OF E-WASTE INTEGRATED FORMAL AND INFORMAL SECTOR IN INDONESIA

The recycling of electronic goods by the informal sector is not new and is the development of recycling practices of low cost e-waste in the management of e-waste this is the case in several developing countries as well as Republic of Indonesia, wherever there's a niche in environmental management, the high demand for secondhand or secondhand electronic equipment and e-waste sales for the collectors encourages strong recycling of the informal sector. The informal sector recycling is not only related to environmental and health impacts, but also

the lack of recycling services in the formal sector. In Xinwen et al, (2010), experience has shown that merely prohibition or competitory with informal sector recyclers and formal recyclers isn't a good answer. The new formal employment system should take under consideration the informal sector, and therefore the policy improve employment, working conditions and the efficiency of the role of the informal sector.

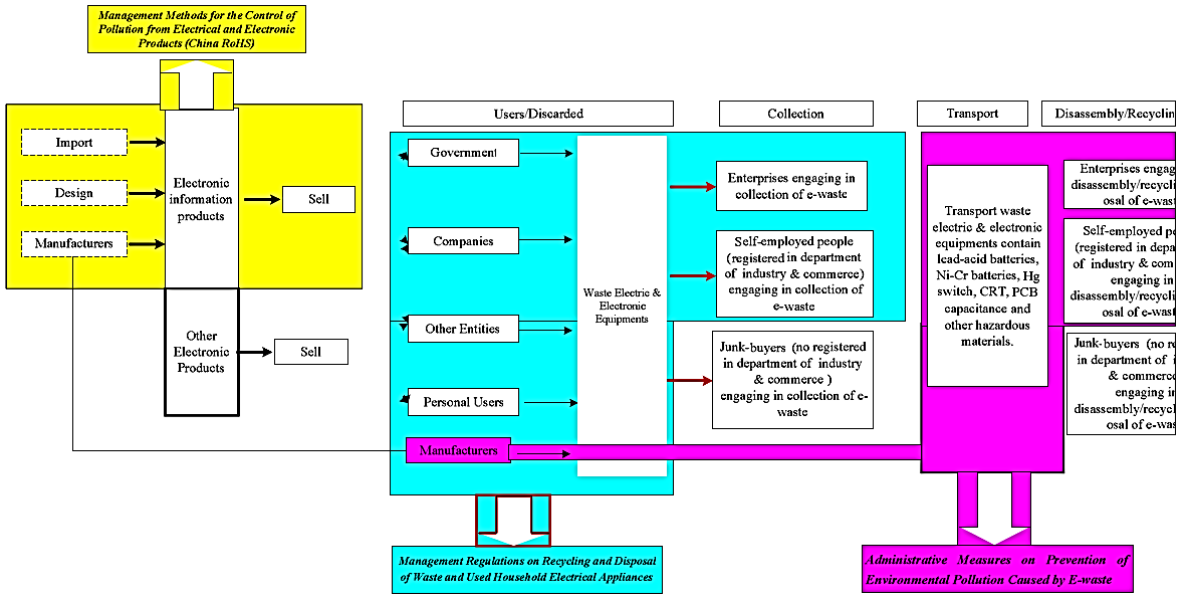

Figure 3. Management of Integrated Waste
Source: Wen Xuefeng et al, (2009)

The main problem in managing e-wastein developing countries is the way to regulate incentives for use the informal sector thus on scale back undesirable cycle activity and to divert additional e-waste to flow into formal sector use. Still in Xinwen et al, (2010), it is reported that the formal and informal sector integrated e-waste management methods introduced in China and developing countries in general have been implemented on March 1, 2007 and their main ideas include:

1) During the design and production process, measurement techniques, such as research changes and design proposals, adjusting technology processes, replacing materials and using innovative methods in the production process, and others.
2) During the process of design, production, import and sale, steps such as identification of the names of toxic substances and hazardous substances and their elements and levels and terms for the environment used by electronic products, and others.
3) During the sales process, there must be strict supervision from the buyer's channel, withholding the sale of electronic goods containing B3, finding industry standards for pollution control by electronic products.
4) Prohibition for the import of electronic goods failing to meet the standards for B3 supervision.

CONCLUSION

Indonesia which is one of the countries in Asia that has sizable amount of electronic home aplliances consumption, and became one amongst the foremost manufacturing e-waste country in Asia. there are several of Indonesian individuals don't seem to be concern to e-waste since most of the

individuals used associate instrumentality equipment for such an extended time even till the equipment visited the second-hand, it is aforesaid that the instrumentality is associate e-waste already. When the e-waste is employed for the while consumption it will caused a long exposure of the venturesome substances from noxious element of e-waste. E-waste utilization is critical however it ought to be conducted in a very safe and standardized manor. Once potential, e-waste ought to be refurbished and reused as an entire product rather than destroyed. Once restoration in unacceptable, e-waste ought to be destroyed by trained, protected, and well-compensated staff in technologically advanced e-waste utilization facilities in each developed and developing countries.

There area unit many basic principles from that all e-waste regulation ought to be supported. First, acceptable risk thresholds for venturesome, secondary e-waste substances shoul not diverge for developing and developed countries. However, the suitable thresholds ought to diverge for kids and adults given the physical variations and pronounced vulnerabilities of youngsters. Utterly eliminating the presence of toxicant elements in EEE, though economical, isn't realistic. though there area unit analysis desires, academic and awareness programs on the potential risks of e-waste use additionally ought to be developed and enforced. These programs area unit of important importance in developing countries.up activity conditions for all e-waste staff and effort for the obliteration of kid labor is non-negotiable. Interventions ought to be specific to the native culture, the earth science, and therefore the limitations of the notably vulnerable communities. Policies that may offer incentives to market safe, regulated, and recompensed use for e-waste ought to be universal.

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8. **Ucapan terima kasih *(Acknowledgment [s])***. Disampaikan kepada yang berhak mendapatkannya, seperti penyandang dana, pihak yang membantu dalam penelitian ataupun penulisan serta narasumber/perorangan yang dipandang layak dihargai (opsional).
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