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Indonesian Cities Green Development Index: A Prototype Measurement

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Abstract

This study attempted to develop a model of performance evaluation instrument of green economic development, which has been run by the cities in Indonesia. This instrument referred to, as the Indonesian Green City Development Index (IGCDI). The purpose of this study was to determine indicators of urban green development, and a prototype for the evaluation of a model of green development indicators cities in Indonesia. The model was applied to several samples tested cities in Indonesia. IGCDI, in the early stages constructed of natural resources and environment, economic and social dimension. The major finding of this study is a drafting of green cities development indicators in Indonesia, along with the evaluation that measured using the index. Of several cities that made this prototype test sample, (9 city of 2 provinces), known cities ranking of green development, with the highest and lowest index, which can be used as an evaluation for the future development of green economy policies on the region.

Keywords: cities; index; Green development; Indicators; Prototype; Green Economy.

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1. Introduction

Sustainable economic development is a necessity in today's era, where people of the world have experienced the impact on development regime which only promotes growth, through the massive extraction of natural resources. In Indonesia, sustainable development's perception is interpreted in various forms of management instruments and environmental protection, which are necessarily legalized in the form of management Act and the Environmental Protection No. 32/2009. The specialty of Law No. 32 of 2009, is the introduction of environmental economic instruments as a complement of other instruments of environmental management and protection, which was already there, and more based on command and control. The economic instrument is a new breakthrough for the environmental problems solution to Indonesia, one of which is characterized by the existence of climate change. This is the context of climate change, which then encourages new thinking in the mainstream economic policy, which was originally based on the brown economy into a green economy. The concept of Green Economy is expected to be a panacea for the problems of the existing environment, by promoting various initiatives, particularly in more controlled and efficient utilization of natural resources and environmental services, through precise calculations based on the scientific that has been developed, namely natural resources and environmental economics.

In the case of the data supply as a basis of the implementation of green economic development, initiatives that have been undertaken by the Ministry of Environment as the frontline in the management and protection of the environment in Indonesia, including the development of Indonesian Environmental Status (SLHI), which contains the basic conditions of the Environment in Indonesia. In addition, as an evaluation that can be used as a basis for environmental development planning, the Ministry of Environment has also developed the Environmental Quality Index (IKL) which shows the performance of the environment (water quality, air and green open space) of a region (province). Although IKL is a very good indicator to see the environmental conditions in the area, however, it is failed to give a more detailed picture of how environmental conditions have been associated with the areas of economic and social development. In addition, the IKL indicators could not give a clearer picture on how the implementation of green economy development in an area, can be evaluated. Because, as well as the Regional Environmental Status (SLHD), the entire data analysis and evaluation are still partial (could not link between the various existing variable, both, biological, physical, social and economic variables). The absence of these indicators led to the dichotomy of the environment and economic development and often put the environment as a limiting factor in economic development.

In order to the development of a green economy feedback can be used as a basis for determining the appropriate policy, it is required evaluation standards that are synergistic and integrated, as the spirit of the green economic policy itself. By funding from the Ministry of Environment, through the minister expert staff of economy and sustainable development, the authors develop a model of performance evaluation instrument of green economic development, which has been implemented by the regions in Indonesia. This instrument will be referred to as the Indonesian Cities Green Economy Index (ICGEI). The model was created as a complement of various evaluation instruments that have already existed, so that the performance that has not been recorded as a whole, can be a more complete, as a feedback for forwarding management planning and environmental protection, within the framework of the green economy.

2. Literature Review

2.1. Green Economic: A Buzzword for Sustainable Development

Theories about the correlation between economic growth and environmental quality the most talked about, is the theory of Kuznets [18]. Kuznets create a curve that shows that a country's economic growth will inevitably be followed by the destruction of natural resources and the environment, up to a certain level of economic growth, which this damage will decrease, along with increased of economic growth. It is based on the belief and empirical, which is traversed by the developed countries, where the condition is shown to occur. However, a variety of rebuttal and debate still continues to this day, because it has not been proved further, how the curve applies to developing countries such as Indonesia.

After Indonesia's independence for more than 50 years, the economic growth conditions, which can be seen from the indicator of Gross Domestic Product (GDP), has not increased significantly. High population growth, along with the increased exploitation of natural resources, increases the level of environmental damage which although not measured in a concrete, proven to have significant negative externalities. The damage basically is not only to the loss of market value of goods and services but also non- market value.

Our failure to capture the market signals that indicate a loss of value of non-market services function of natural resources and the environment (which is often higher than its market value), resulting in us often get caught up in the concept of myopic economic development. This concept, which is justified boosting economic development, by the extraction of natural resources and the environment as much as possible for short-term gain, ignoring the carrying capacity of natural resources and environmental services to be able to support human life any longer. Economic development translates just as simple as the concept of conventional benefit-cost analysis. Where the economic value is not calculated in real value generated from environmental goods and services. Though economic development unrelenting growth, according to Douthwarte [25], it will not only have an impact on the environment but also on the quality of human life. Such conditions would cause us to lose the momentum to generate significant economic growth in the long term.

Beyond the various contradictions and arguments concerning the theory of the Environmental Kuznets Curve [28, 13, 2, 1, 9,14], the high level of natural resources and environmental damage and degradation, as a result of unsustainable development in Indonesia, pushing for the development of alternative policy instruments for environmental protection and management, in addition to command and control instruments that already exist. Through Law No. 32 In 2009, environmental economic instruments introduced. This instrument is considered more appropriate to correct our negligence in responding to the market. Environmental economic instruments are used so that we can accurately assess the environmental goods and services, so that will have an impact on the behaviour patterns of consumption and production more environmentally efficient. This instrument is expected to further encourage behavioural change through market signals, compared with only through direct commands as the command and control policies. In addition, economic instruments which are designed and implemented properly is expected to encourage an incentive to make efficient use of resources, minimizing resource and environmental degradation, pollution and waste, and also promote a more creative approach in order to enhance the synergy between economic growth and environmental protection.

One of the environmental economic instruments policies based recently developed on a global scale as an instrument that is expected to be a solution for the problem of climate change that has occurred is "Green Economy". This concept became very popular because it was declared globally and received a positive response from almost all countries in the world. Green economy is a concept that has recently become the buzzword for all the countries in the world. This concept basically refers to the sustainable development regimes that balance between economic growth and the sustainability of natural resources and the environment. Green economic development, suggests the need for awareness to improve human well-being, which refers to the principles of sustainability. Green development is essentially aimed at encouraging development for the welfare of society, by integrating the precautionary principle, in the face of environmental issues such as climate change. UNEP [30], stated that the green economy will improve well-being and social justice for humanity, and significantly lower the environmental risks and ecological scarcity.

There are various interpretations and definitions concerning the development of a green economy with different names, which rolled out by various institutions concerned with the sustainable development, including the Green Economy Initiative (GEI) of UNEP, Green Industry (GI) of UNIDO, Green Jobs of ILO and UNEP, and Green Growth of UNESCAP. Indonesia itself rather refers to the concept of Green Economy which has their own definition, that is, a model of economic development with the aim to address issues of economic interdependence between humans and natural ecosystems, as well as the adverse impact of human economic activity on climate change and global warming.

UNEP [30] stated that the policy of the green economy can help developing countries like Indonesia for economic and social benefit in several ways, such as pursuing a strategy of clean energy technologies and improving access to energy services; improve resource utilization efficiency through investment in cleaner production approach; improve food security by the use of more sustainable farming methods; and access to new emerging markets for green goods and services. Increased efficiency and diversification of energy can reduce imports, and protect the country from price volatility in the energy market, while lowering the environmental footprint and health costs associated with economic activity. All this needs to be done, by first analysing and evaluating the wealth of natural resources that are owned, in order to more easily determine how best optimization possibilities, for sustainable economic growth.

Various indicators of measurement to describe the performance of the economy and the environment either in the level of global, national and regional, have been developed around the world. These indicators are basically still a partial indicator of economic performance, environmental and social. The following is a description of the various types of indicators for the economy and the environment, which is already widely used globally. Economic indicators that have been used globally, is an indicator of Growth Domestic Product (GDP) or Gross Domestic Product (GDP). Both of these indicators have been using uniformly throughout the country in the world, to describe the level of welfare of a country. GDP has a sense as the overall value of goods and services produced in a region within a specified period (per year). GDP differs from gross national product (GNP), in which only the total production of a region of the country, regardless of whether the production is done by using a factor of production in the country or not, while the GNP, pay attention to the source of production factors. GDP is the sum formula of consumption, investment, expenditures, and export minus import. This indicator is

then referred to as an indicator brown economy or brown GDP. This indicator has a weakness, and could not be considered to reflect the real condition of the welfare society, because it could not reflect the capacity of future consumption, economic sustainability, justice, and degradation of natural resources and the environment.

Other economic indicators that have been developed is the Human Poverty Index, which measures a country's poverty level. This indicator illustrates the standard of living of a country, which was developed by the United Nations. This measurement is almost similar to the Human Development Index (HDI) which was also developed by the United Nations to measure three dimensions of human development concerning the life expectancy, education (literacy rate) and standard of living (GDP per capita). As for the HPI, there are additional variables in terms of access to health institutions, water, and less body weight in children under five.

For the measurement of environmental performance, it has developed several types of measurements such as Ecological footprint that measures how land and water meet the consumption needs of the human population in the production process, and how the absorption of waste through appropriate technology. Other environmental measurements that have been developed is the Environmental Quality Index (EPI) (Emerson and his colleagues 2010) which measures a country's existing condition associated with a variety of resources such as forests, water, pollution, and others.

Integrated economic and environmental measurement were developed after it was realized that existing partial measurement range, apparently not provide an exact picture of the level of human well-being. Among the measurements that have started these integrated, including the Genuine Progress Indicator (GPI), which is a new version of the Sustainability Index of Economic Welfare (ISEW) developed by Herman Daly and John Cobb (1989). GPI develop further indicators of GDP, with an additional adjustment of income distribution, the value of household and volunteer workers, the cost of crime, and pollution. It also has developed the use of Green GDP is also already widely used in various regions in Indonesia. Further development of environmental economic indicators, are the Happy Planet Index (HPI), which has been used to measure the level of prosperity of a country. HPI began popularly used because it gives a different feel in the measurement of the level of well-being through the measurement of a wide range of other indicators which have not been included in the consideration, such as a clean environment and a healthy, ecological footprint, the level of satisfaction in life, and others, as part fulfilment of human life.

2.2. Review on Indonesian Economic and Environmental Status

Indonesia's economic growth in 2017 reached 5.07%, up compared to the year 2016 which reached 5.02%. Indonesian economy in 2016 as measured by gross domestic product (GDP) over the prevailing base price reached USD 932.26 Billion, while GDP per capita reached 3974.1USD. Unfortunately, the performance of this promising economic growth is not accompanied by an increase in the Human Development Index (HDI), which is an indicator that further provides a description of the level of human well-being. HDI is a comparative measure of life expectancy, literacy, education and standard of living. IPM is usually used to classify whether a country is a developed country, developing or underdeveloped countries. IPM also used to see the effects of economic policies on quality of life in Indonesia. Recent data regarding Indonesia's HDI 2016 which was

released in 2017 showed the value of 0.702, an increase of 1.3 point compared to the HDI scores in 2015, amounting to 0.689. Indonesia ranks in 2016 is 113 out of 188 countries. While in ASEAN, Indonesia is on the order of 5 to 11 countries. It shows that the quality of Indonesian human resources in the health sector, education and poverty still low. Lack of human resources is not comparable with the growth of Indonesia's large population and the allocation of the national budget that almost 20% of it for education. Until now, the average education Indonesian society is still about 12.72 years or complete high school. For health, can be seen from the maternal mortality rate in 2015, which is still high at about 126 deaths per 100000 of birth rate. This figure includes the highest in ASEAN countries. For the standard of living, which is seen from poverty, can be seen that, in quantity, the poverty rate in Indonesia is increasing, with a per capita income is also very low. In September 2017, the number of poor people amounted to 27.77 million people [4]. The Central Statistics Agency [4] states that the number of vulnerable poor population in March 2017 reached 17.02% of the total population. Then, there are also almost poor people whose percentage reaches 7.84%. Thus, the total number of people who are slightly above the poverty line reaches 24.86%. Below is a table HDI Indonesia from year to year.

Table 1: Indonesian HDI Figures

Year	HDI
1980	0.522
1985	0.562
1990	0.624
1995	0.658
2000	0.673
2003	0.709
2004	0.714
2005	0.723
2006	0.729
2007	0.734
2008	The new calculation method applies
2009	0.593
2010	0.600
2011	0.624
2012	0.629
2013	0.684
2014	0.686
2015	0.689
2016	0.702

Table 2: Indonesian Economic Development Performance in 2016

Key Statistic	**Value**
Population 2016 (million)	258,7
Population growth rate (%)	1,27
Economic growth in smester 2 2017 (%)	5.19
GDP per capita 2016 (US$)	3974.1
Unemployment August 2017 (%)	7.04
Poverty September 2017 (%)	10.12
Gini Ratio 2017	0,391
HDI 2016 released in 2017	0,702 (ranking 113)

Other economic indicators relating to welfare, is Gini ratio, which describes the level of inequality of incomes. In 2017, Indonesia Gini index, is 0.39. This income inequality index, is decreasing from previous years, along with the increasing growth. But the level of inequality is still high, compared to other countries in Southeast Asia. The following is the data of economic development performance of Indonesia in 2016.

The release of the Environmental Performance Index (EPI) 2018, Indonesia Environmental Performance Index is ranked 133 out of 180 countries in the world, with a value of: 46.92 [11]. Data from EPI shows that Indonesia has a high assessment of the fisheries indicators (ranked 43) and agriculture (ranked 51). However, Indonesia has received low ratings from the forestry sector, due to the performance of the Indonesian forest, considered poor, rank: 135, with a value of 0.01. Poor's assessment of forestry category, due to the coverage of the forest vegetation indicators, considered bad. From the EPI data, basically it can be said that Indonesia's environmental performance still not encouraging. Below, is the EPI data, ranked by categories. As shown in Table 5, the lowest value of Indonesian environmental performance index is from the forestry sector, the provision of safe drinking water, air quality and response to health impact. This condition can be understood, considering the alarming condition of our forests, with the increasing illegal logging and the decline of forest cover in Indonesia.

Table 3: Ranking Indonesian Environment Index (EPI) in 2018 by category

Categories	Score	Rank
Health impact	46.92	135
Air Quality	52.04	147
Water and sanitation	31.41	123
Water resources	13.60	140
Agriculture	37.98	51
Forests	0.01	135
Fisheries	43.00	43
Climate and Energy	53.43	75
Biodiversity and Habitat	70.40	104

Source: EPI, 2018

Performance of Indonesian environmental management, it can be seen from the Indonesian's Environmental Status (SLHI), which is published once a year. The data could be obtained from this SLHI, including media conditions such as: water, air, atmosphere, land and forests, coastal and marine bio-diversity, energy, solid waste, hazardous materials and toxic waste. SLHI can be used as feed back to the planning of future environmental development.

Indonesia's national environmental quality index (IKL) in 2017, was 63.13, down from 65.50 the previous year. These qualities are calculated from river water quality, air and forest cover. The first rank of Indonesian environmental quality index achieved by the Province of West Papua (83.01), followed by Papua, with an index

of 81.35 followed by North Kalimantan with an index of 76.85 [21].

Data from SLHI [6], quoted from Leitman and his colleagues [19], shows that although Indonesia has the capital resources of nearly 25% of the total source of prosperity, unfortunately, these have been much degraded, which allegedly undermine the 5% of Indonesia's GDP. Forests are a resource that is considered the most damage. 1985-1987 data from the World Bank shows that Indonesia has lost around 1.5 million hectares of forest per year, with only about 20 million ha of production forests. This condition is caused by illegal logging due to the high demand from both domestic and abroad, the lack of law enforcement and mental corruption of officials. The Ministry of Forestry noted the destruction of forests in 2009 reached more than 1.08 million hectares per year, less than the previous year by 2 million hectares per year. The rate of forest destruction is also due to the conversion of land into oil palm plantations [29]. This damage condition, causing Indonesia's forests are in critical condition, meaning that the forest could no longer be used as a source of state revenue, and also potentially cause other environmental damage such as reduced groundwater, landslides and flooding. Of the 130 million hectares of forest were there, there were only about 40 million are in the category of forests that have not been exploited. Production forest has also been reduced and only the remaining 48 million hectares. Indonesian's deforestation data, until today still could not be determined accurately, because there is no longer study using satellite imagery.

The quality of water resources in Indonesia, as cited by EPI, and SLHI reported in 2014 [5], had also suffered damage. This damage occurs at some common water sources such as rivers, which has many been contaminated. Most of the rivers in Indonesia, have experienced a decline in water quality, due to various human activities both upstream and downstream. SLHI Data show that in 2007, there were about 13 thousand large and medium industries which have the potential to contaminate surface water and groundwater [7]. However the potential polluter of the river, is the domestic waste. The portion of the waste organic materials can reach 60 percent, while other 30 percent is derived from industries. The rest comes from agriculture and livestock.

Air quality in Indonesia, also includes the still not improved, especially for big cities. Some studies indicate a trend increase in the concentration of NO2 in the capital of the province in Indonesia, especially in big cities in Java, Bali, Lombok and Sumatra, and several cities in Kalimantan [6]. Monitoring 2007-2008 show an increasing trend for parameter CO in the 12 cities monitored. All of this happened, because of the increasing number of vehicles and also the growing traffic congestion in major cities.

In the coastal areas, environmental degradation also occurs. Especially in the case of mangrove forest loss due to conversion of land into aquaculture ponds, as well as other uses. There was also damage to the coral reef resources, sea grass and fish resources. The quality of coastal waters has also been widely declined due to pollution from land base, especially in big cities like Jakarta, Makassar, Bali, and so forth.

The condition of Indonesian biodiversity, are also no less depressing. Several recent cases, such as the slaughter of Orangutans in Borneo, become an indication of the lack of attention from various sectors, concerning the management of biodiversity in Indonesia. Until now, there has been no in-depth study, on the condition of Indonesia's biodiversity trends, but from the observation of several research institutions, shows that the tropical

rain forests, habitat for biodiversity, have been damaged due to illegal logging, forest fires, and others. This indicates a decrease in the number of Indonesian biodiversity, significantly.

Environmental damage in Indonesia, can also be seen from the number of public complaints about environmental damage, which occur from year to year. The Government through the Ministry of Environment opened the Center of Environmental Damage Complaint, through an easier way, both online media, as well as telephone and SMS. The government also opened 46 center of environmental complaints all over Indonesia. The Ministry of Environmental and Forestry alone, receive for the average complaints per year, of less or more 190 cases.

The actual Indonesian environmental conditions, also recorded from institutional building, including the number of actors / environmental management officers who already have an environmental education, the number of institutions related to the environment, and also the number of laws and regulations that have been issued by the government, both central and local, which can be used as a legal basis and law enforcement. The data concerning the number of legal products that have been issued by all local governments in Indonesia, some has been recorded, however, the future of this data is needed to build an index of green development.

The implementation of green development in Indonesia, especially for regional scale (cities and regencies) is basically already underway in several sectors. For example to anticipate the negative impact of climate change, the Government of Indonesia has made various efforts to adapt to climate change, including the formulation of a national policy document to address the impact of climate change, in the form of Indonesia Adaptation Strategy, which should be implemented by all local governments. The strategy is formulated in the National Action Plan on Climate Change Adaptation [3], Indonesia Climate Change sectorial Road Map [3], the National Action Plan for Facing Climate Change [3] and sectorial adaptation plans by the Ministry/Institution. The central government also publish a national action plan adaptation to climate change [3]. The implementation carried out in 15 provinces as a pilot project area.

The implementation of green development is also done by the issuance of a presidential decree 61 of 2011 on a national action plan on reduction of greenhouse gas emissions (RAN-GRK), in response to the government's commitment to the Bali Action Plan at the Conference of Parties (COP) to the 13th United Nation Frameworks Convention on Climate Change (UNFCCC), and the results of COP 15 in Copenhagen and COP 16 in Cancun, as well as the G-20 meeting in Pittsburgh to reduce greenhouse gas emissions by 26% by its own efforts, and reach 41%, if there is international assistance, in 2020, of the conditions in the absence of an action plan (business as usual / BAU). RAN-GRK activity is carried on agriculture, forestry and peat land, energy and transportation, industry, waste management, and other supporting activities. One form of an action plan in the forestry sector is the development of environmental services with a demonstration activity in Reducing Emission from Deforestation and Degradation (REDD) in the conservation area. In public works sector, there is also an implementation of green development through the green infrastructure development program. Government will ive an incentive in the form of tax holiday or 30% tax reduction on the machine and material. All of the instruments, which is in the green development format actually should be translated to the local scale of regional and cities/regencies. The evaluation models of this implemented instrument should be created, using

some indicators agreed. The development of Green development index in the level of cities, then become a necessity.

3. Materials and methods

3.1. Framework for Development of Green Cities Development Index in Indonesia

Some models concerning the green urban development index have been developed such as from [26, 16, 10, 22, 20, 8, 23, 27]. The basic framework of thought, and the development of preliminary cities green economy development index in Indonesia referred to some former model, but adjusted simply as can be seen in Figure below. As shown in the figure below, the contribution of the goods and services sector is an indicator for the performance of economic development, will directly provide externalities in the form of degradation or appreciation for the environment. Degradation/ appreciation also directly affects the performance of economic development, or indirectly through environmental policies, as well the contribution of social capital and human resources, which used to be measured in the human development index, as supporting indicators of sustainability. Various conditions of degradation/appreciation of the environment has been evaluating by various measurements, such as the Environmental Quality Index (IKL / EPI), also in the form of Regional Environmental Status (SLHD), Program Performance Rating in Environmental Management (PROPER), and so forth. The indicators basically more talking about the situation of the environment, while the Green Cities Development Index (IGCDI), summarizes other indicators, both from the environmental dimension, economic and social.

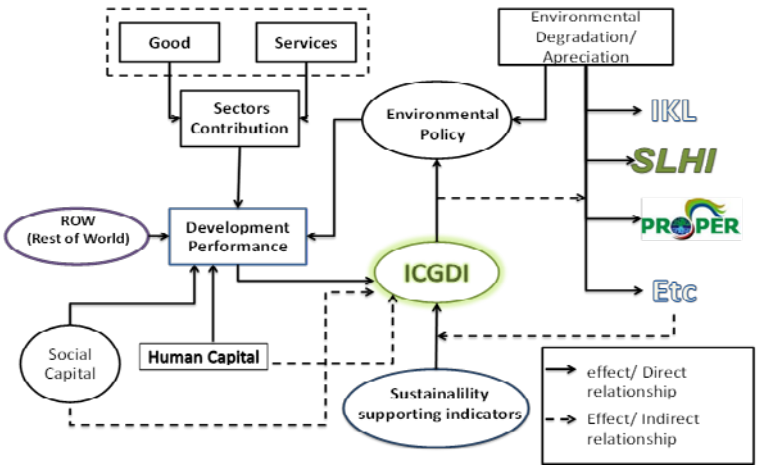

Figure 1: Framework of ICGDI

ICGDI, as described previously, is a development of various indices of measurement associated with economic, environmental, and social, which is already there. In this index, a variety of economic and environmental performance measurement, which are already there, used as a basis for measuring the Indonesian Cities Green (Development Index ICGDI).

As shown in the figure below, ICGDI at an early stage, constructed from the dimensions of natural resources and Environmental, Economic and Social. Of the three dimensions, there are several categories of policies

which will become the region's track record for future improvements, in terms of the value of existing indicators next to policy category giving the lower final result for example. Forestry policy category, for example, can be seen from the indicators% of protected areas to the area, % reforestation and %, the area of degraded land to the area. For the category of policies concerning other natural resources such as fisheries, agriculture and mining, can be seen from the indicators GDP share of Natural Resources. While for other policy categories such as climate change, water pollution, biodiversity, habitat, and environmental management as a whole, derived from several indicators such as the Environmental Quality Index, and the number of cases of environmental damage. For the economic dimension, there are several categories of policies concerning export-import, as well as the income and standard of living, which translate data from several existing indicators such as growth, GDP per capita, and the Gini Ratio. For the social dimension, policy categories covering life expectancy, literacy rates, education, law enforcement and health. While the indicators used are poverty, IPM, access to sanitation and access to clean water. Prototype with this indicator can be dynamic and flexible, it is can just forward be developed, into a more complete and to be more integrated.an incentive in the form of tax holiday or 30% tax reduction on the machine and material.

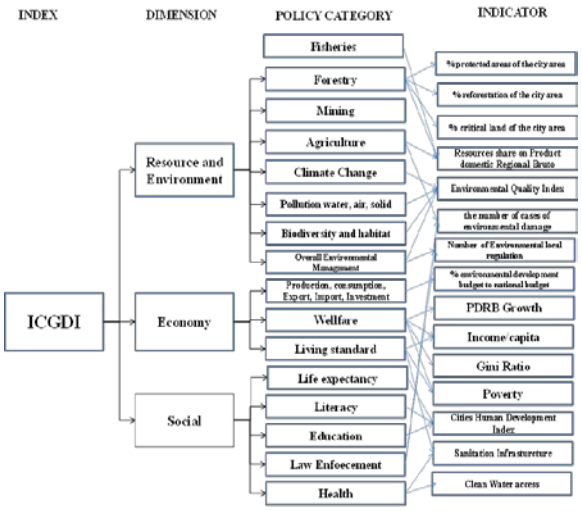

Figure 2: ICGDI Dimension and Variable

3.2. Method for Development of Green Cities Development Index in Indonesia

ICGDI constructed by collecting and setting data in the form of a matrix. In Building ICGDI, the first step is to determine the indicators of green economy, after that carried out the selection of cities and regencies, to be tested for a prototype model of ICGDI. Next step is collecting data set compiled in the matrix form, as can be seen in Table 1. If i supposed to be a number of areas investigated, with a number of indicators j, then the data will then shaped as below.

Once the data are arranged in a matrix form as in Table, the next step is to normalize the data. This is done because the data from these indicators and the unit have a different scale. Therefore, data normalization is done, so that the data obtained become unit less, and also standardized its value, so it will range between 0 and 1. UNDP's method for Human Development Index (HDI) is hired to do the normalization (UNDP, 2006). Before

normalization is done, the important thing to note is the relationship between the indicator and the function of green construction, whether proportional or inverted. For example, the higher the value of the indicator green development will be high as well, or vice versa if the lower value of the indicator, the development will be even less green. Below is a table of functional relationships, of the existing indicators.

Table 4: Matrix Index of ICGDI

City	Dimension Resource and Environment		Economy		Social	
	Indicator1	Indicator 2..j	Indicator1	Indicator 2..j	Indicator1	Indicator 2..j
1	X_{111}	$X_{112...}$ X_{11j}	X_{121}	$X_{122..}X_{12j}$	X_{131}	$X_{132..}$ X_{13j}
2	X_{211}	$X_{212...}$ X_{21j}	X_{221}	$X_{222..}X_{22j}$	X_{231}	$X_{232..}$ X_{23j}
.	.	.	.	.	.	.
I	X_{i11}	$X_{i12...}$ X_{i1j}	X_{i21}	$X_{i22..}X_{i2j}$	X_{i31}	$X_{i32..}$ X_{i3j}

Table 5: Functional Indicator Relationship

Dimension	Code	Indicator	Fungsional
Resource and Enviromental	R1	%Protected areas of the city area	↑
	R2	% Reforestation	↑
	R3	% Critical land of the city area	↓
	R4	Resources share on PDRB	↑
	R5	Environmental Quality Index	↑
	R6	Number of cases of environmental	↓
	R7	Number or environmental local regulation	↑
	R8	% environmental development budget to city's development budget	↑
Economy	E1	PDRB Growth	↑
	E2	Income/Capita	↑
	E3	Gini Ratio	↓
	E4	Poverty	↓
Social	S1	City's Human Development Index	↑
	S2	Sanitation infrastructure	↑
	S3	Clean water	↑

Variables with an indicator which is directly proportional to the development of green normalized using the formula:

$$x_{ij} = \frac{X_{ij} - \underset{i}{Min}\left\{X_{ij}\right\}}{\underset{i}{Max}\left\{X_{ij}\right\} - \underset{i}{Min}\left\{X_{ij}\right\}} \qquad (1)$$

As for the indicator that is inversely proportional to the development of green, normalized by using the formula:

$$y_{ij} = \frac{\underset{i}{Max}\left\{X_{ij}\right\} - X_{ij}}{\underset{i}{Max}\left\{X_{ij}\right\} - \underset{i}{Min}\left\{X_{ij}\right\}} \qquad (2)$$

Once the data is normalized, the next step is to conduct weighting for green development indicators. It can be given equal weighting, or vary between indicators. In doing equal weighting, is done by averaging the scores by simple methods Patnaik and Narain [24]. For the first method, when all the data has been normalized, indicator is given equal weight, then averaged by using the formula:

$$VI = \frac{\sum_{j} x_{ij} + \sum_{j} y_{ij}}{K} \qquad (3)$$

In this method, the first thing to do is to identify the category of policy and of each of these categories, identified indicators. The first thing to do is to normalize the data then averaged by the source. After an average of each source is obtained, then the city green development index as a whole is calculated using the following formula:

$$VI = \frac{\left[\sum_{i=1}^{n}\left(AI_i\right)^{\alpha}\right]^{1/\alpha}}{n} \qquad (4)$$

Where n is the number of green development indicators, and α=n

Further weighting method developed by lyengar and Sudarshan [17], was made in order to do a composite index of multivariate data, which is used to rank the cities, in terms of green development performance. By using this method it is assumed there are a number of cities M with green development indicators K and 〖 x〗_ij,i=1,2..M;j=1,2..K is already normalized score. The level of development of the region to ith, and assumed linear y_iwith〖 x〗_ij namely :

$$\overline{y_i} = \sum_{j=1}^{K} w_j x_{ij} \qquad (5)$$

Where c is a normalized constant as follows:

$$c = \left[\sum_{j=1}^{j=K} 1/\sqrt{\underset{i}{\mathrm{var}}\left(x_{ij}\right)}\right] \qquad (6)$$

Determination of weighting by using this method will ensure that the variation in one of the indicators, will not be too dominating contribution of the rest indicators, and changing the comparison between cities. So that green development index value will be between 0 and 1. Value of 1 indicates a perfect implementation of green development and the value of 0 indicates no implementation of green development at all..For classification

purposes, a simple grading for cities by index will suffice. However, for the characteristics of the several levels of green development, suitable for classification of fractile, require the assumption of the probability distribution. Assuming a suitable probability distribution is the distribution of beta, which in general is skewed and has a value in the interval (0,1), as has been done by lyengar and sudarshan [17]. This distribution has the probability density levels:

$$f\left(z\right)=\frac{z^{a-1}\left(1-z\right)^{b-1}}{\beta\left(a,b\right)},0<z<1 \text{ dan } a,b>0 \qquad (7)$$

Where is a beta function, that defined as follows:

$$\beta\left(a,b\right)=\int_{0}^{1}x^{a-1}\left(1-x\right)^{b-1}dx \qquad (8)$$

Two parameters of the distribution, namely a and b can be estimated by the method described in lyengar and Sudarshan [17], or by using the software. Beta distribution is skewed, if (0,z_1),(z_1,z_2),(z_2,z_2),(z_3,z_4)and(z_4,1)is a linear intervals where each interval has a probability weighting of 20%. Fractile interval can be used to categorize several levels in green development as follows:

1. Not good, if $0<\bar{y}_i<z_1$
2. Good enough, if $z_1<\bar{y}_i<z_2$
3. Good, if $z_2<\bar{y}_i<z_3$
4. Very good, if $z_3<\bar{y}_i<z_4$
5. Perfect, if $z_4<\bar{y}_i<1$

ICGDI models are then tested on data obtained from sample cities in two provinces, namely West Java and Bali Province. Data were taken from the 9 cities and regencies, as can be seen in the following table. The index calculation is conducted for 3 years of observation, from 2014 to 2016, because the data for 2017 is not yet complete entirely.

Table 6: Cities and Regencies for ICGDI Model Tested

West Java Province	Bali Province
• Bandung City	• Denpasar City
• Bandung Regency	• Badung Regency
• Bogor City	• Gianyar Regency
• Bogor Regency	• Klungkung Regency
	• Buleleng Regency

4. Result and Discussion

Tables and figures below are the results of the calculation of the index for 2016. As shown in the figure, the highest index of green development, achieved by Denpasar, followed by Bandung regency, and Badung regency. The Index values between the cities in the two provinces are indeed varied, and could not describe, which province that the towns have the best index. Each province has towns with a good index and good enough. However, it can be said that an index above 50%, only achieved by the city of Denpasar, which illustrates good index. Other cities, has a value in the range of 40%, which means having a good index as well, while the city of Bandung with the index 30%, can be said to be quite good. Denpasar has good scores for the dimensions of natural resources and the environment. Of the conditions in the field, shows the government of Denpasar consistent in improving the quality of their living environment, by continuing to manage well the protective region, as well as by managing both institutional, through the application of environmental regulations is quite massive (15 rules). In addition, the city of Denpasar has a high economic dimension, of the highest GDP growth, and the lowest Gini ratio. Bandung is the region with the lowest ranking among the nine cities analysed. This is because the city of Bandung possess the lowest value in terms of natural resource contribution to the GDP, in addition to the lowest value for the Environmental quality index, but the highest value for the case of damage to the environment, and poverty and the Gini ratio is the highest compared to other sample cities.

Table 7: Cities Green development index score (2013)

Area	Resource and Enviromental	Economy	Social	GREEN INDEX	Rank
Bandung City	0,12	0,05	0,12	0,29	9
Bandung Regency	0,21	0,13	0,14	0,48	3
Bogor City	0,20	0,09	0,13	0,43	6
Bogor Regency	0,19	0,15	0,10	0,44	5
Gianjar	0,20	0,17	0,09	0,46	4
Klungkung	0,22	0,09	0,07	0,38	8
Denpasar	0,24	0,14	0,15	0,53	1
Buleleng	0,25	0,11	0,07	0,42	7
Badung	0,19	0,17	0,13	0,49	2

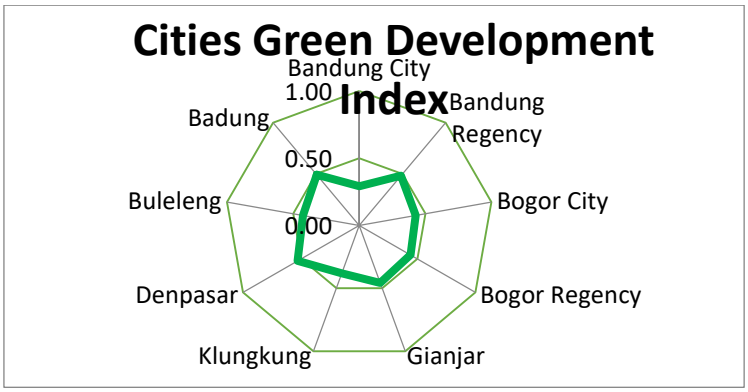

Figure 3: Kite diagram of ICGDI

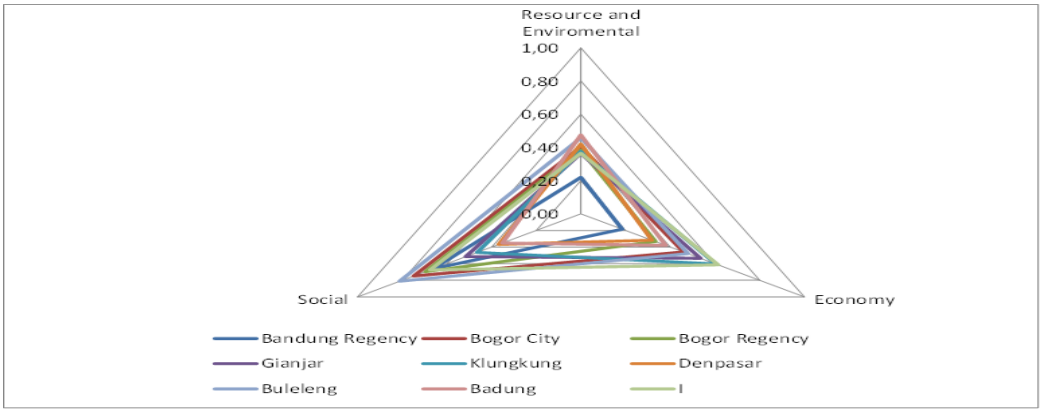

Figure 4: Kite diagram of ICGDI

The table below shows the change in the value of urban green development index From the Year 2014 to 2016. From the table appears that the index value of every city, change every year depending on government efforts to encourage the development of various dimensions. Bandung city, for example, experienced a decline in the index from year to year, but Bandung Regency index value has increased from year to year. Denpasar city has a consistent green development index value, always in the first rank of nine city/regency analyzed.

Table 8: Cities Green Development Index 2014-2016

Area	Green Development Index/Rank		
	2014	2015	2016
Bandung City	0.45/3	0.38/7	0.29/9
Bandung Regency	0.41/5	0.39/5	0.48/3
Bogor City	0.39/7	0.39/4	0.43/6
Bogor Regency	0.35/8	0.27/9	0.44/5
Gianjar Regency	0.40/6	0.43/3	0.46/4
Klungkung Regency	0.33/9	0.33/8	0.38/8
Denpasar City	0.53/1	0.69/1	0.53/1
Buleleng Regency	0.47/2	0.38/6	0.42/7
Badung Regency	0.43/4	0.44/2	0.49/2

In the prototype development process of green development index, conducted the workshop which was attended by various groups of academics, practitioners from the Ministry of Environment, Ministry of Interior, Ministry of Marine and Fisheries, Ministry of Forestry, Ministry of, Ministry of national planning (BAPENAS), NGO's. Almost all workshop participants welcomed the preparation of ICGDI, because they believe this index can be used as complementary indicators, which has the feel of a more holistic compared to other indicators that exist today. This indicator is also considered to possess the advantages, in terms of providing input to policymakers, for the improvement of future policy, with a holistic dimension. This indicator also is considered to provide an

overview of green building, which is now becoming quite an interesting issue for the campaign in the management and protection of the environment as a whole. However, in its development, prototype concept for green development index basically is still incomplete and requires further elaboration. Some of the input and ideas that emerged during the preparation of the index are as follows. In determining the indicators that will be used as input in the calculation ICGDI, considered the availability of the data required in the city. Data in each area, especially the city/regency, generally the availability are very varied. Indicators developed need to be expanded, with indicators that reflect changes in people's behaviour, and or local governments in addressing climate change. It can be developed from a variety of activities or program initiatives and instruments that are creative in dealing with and mitigating climate change. The use of indicators of green open space, or space urban forest and others, need to accommodate the spatial suitability for consideration. The use of an indicator of local government Regulation, it is necessary to consider the effectiveness of the regulation, regarding the management and protection of the environment. Whether the local government regulation has an impact on the improvement of environmental quality in the area. Then should be limited to what is meant by this local government regulation whether concerns also Local Government Regulation (PERDA) issued by all sectors or just for the Environmental sector alone. In the case of environmental damage, should be detailed restrictions cases whether such pollution standards, or also about the wider environmental damage, natural and non- natural. There was also a suggestion to add indicators of land conversion from agricultural to non-agricultural, of green land into cultivation or other. It is also reveal that there is a need to be elaborated whether Gini index has anything to do with the development of green. It should be a lot of rethinking whether the industry including input material for IPHD calculation. There should be a clear relationship between some of the indicators that have been developed previously with green development indicators, including Index of Environmental quality, Human Development Index, Genuine saving, and so forth, so obviously the track of sustainable development into the direction of our development. For Environmental Quality Indicator can be broken down into several dimensions, air, water and soil, and the weighting to indicate which of the three that have contributed to the increase and decrease in the index. It should also incorporate community input behaviour such as cooperation and also an indication of the conflict area, and so forth. Last but not least, to prevent the same calculations on two regions with very different characteristics, weighting is necessary.

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