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by Hasddin Hasddin

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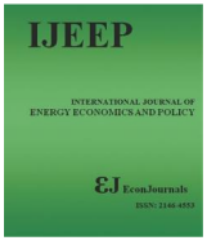

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Study of Environmental Economic Performance According to Energy Use and CO_2 Emissions, Air Quality, and Government Policies to Achieve SDGs in Baubau City

Yohanes Boni[1*], Wa Ode Rachmasari Ariani[2], Hasddin, Hasddin[3]

[1,2] Faculty of Economics and Business Halu Oleo University, Kendari 93232, Indonesia.
[3]Department of Urban and Regional Planning, Faculty of Engineering, Lakidende University. Unaaha 93461, Indonesia.
*Email: yohanesboni23@gmail.com

ABSTRACT

Economic development is required to prioritize aspects of sustainability, namely by not ignoring environmental elements to ensure the benefits of future generations. This study focuses more on presenting development achievement information (in GDP) on ecological performance through energy use, CO_2 emissions, air quality, and environmental management by taking the case of medium-scale cities as a differentiator from previous studies. Ecological performance using the standard issued by AGCI. It was found that economic performance was under pressure as indicated by slowing economic growth. Seven sectors make up the GDP structure which is in the process of using energy and producing CO_2 emissions. Environmental quality is maintained, and the government's seriousness in creating environmentally sound economic development is demonstrated by the regulations that govern this matter.

Keywords: Regional Economy, Energy, Air Quality, Environmental Economics
JEL Classifications : O4, Q4, Q5, R1

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I. INTRODUCTION

The economic development of a region and a country is a demand to meet human needs in various scenarios. The scenario arises because there are several variables that are difficult to control, such as population growth specifically in urban areas (urbanization), global economic turmoil which has multiple effects, to issues regarding the availability and distribution of resources. However, the most fundamental focus that is no less important at this time is regarding limited and renewable special natural resources as the main basis of economic development activities.

Developing countries generally have sufficient availability of natural resources, even though some countries are said to be abundant, including Indonesia. The challenge is that there are still practices of using natural resources to achieve excessive economic growth without considering sustainability aspects. This dichotomy by some experts offers the concept of sustainable development which is then emphasized by the United Nations by setting a sustainable development agenda/goal (Petrenko, 2021). There are 17 agendas in the SDGs that integrate development activities as a main pillar of sustainability (Rostin et al., 2023), namely economic, environmental/ecological, and social (Hasddin, 2022a; Ferreira et al., 2022; Kharas & Dooley, 2022; Anderson et al., 2017; Petrenko, 2021; Du et al., 2020; and Ivanitsky and Petrenko, 2020).

As a consequence of achieving the SDGs agenda, several development concepts and theories were born that emphasized environmentally sound economic growth such as green economic growth, green GRDP, to the blue economy in maritime countries. These concepts were born as an effort to respond to global phenomena due to development activities that have negative consequences for global climate change, the impacts of which are widely felt are the decline in air quality, to the energy crisis. Energy then becomes crucial, because some economic activities use energy and at the same time produce emissions such as CO_2 (Hasddin et al., 2022b) supported by other studies (Jaya and Hasddin, 2019; Yu et al., 2022; Ling et al., 2022; Hussain et al., 2022; Huang et al., 2021; Mehmood, 2021), and greenhouse gas effects (Hasddin et al., 2022b; and Jaya and Hasddin, 2019).

Economic development and urban problems from environmental aspects (energy, CO_2, and declining air quality) are experienced by all cities in the world. Brilhante and Klaas (2018) state that the integration of environmental aspects in economic and social development is not entirely good. Brilhante and Klaas conducted a study in 50 cities in 29 countries of the world there were 16 cities (32%) with low performance, 17 cities (34%) with medium or moderate performance, and 17 cities with good performance (34%). Low-performing cities in general in countries such as Latin America, the Middle East, Africa, and Asia including Indonesia. Mid-performing cities are spread across the states of Europe, Latin America, and Asia including the Middle East, and Africa; as well as high-performing cities in European countries, the Americas-Latin America continents, and Australia.

The same thing was reported by Permana and Harsanto (2020); Dennis et al., (2019); El-Kholei et al., (2019); Rojas et al., (2019), the results of the study found that some cities were able to implement economic and social development policies that were based on environmental quality standards (energy and CO2), but a concern is that some cities still have difficulty achieving this. Continue Permana and Harsanto (2020); Dennis et al., (2019); El-Kholei et al., (2019); Rojas et al., (2019), that cities in Asia and Africa have difficulty integrating economic, social, and environmental development coming from city government commitment and public participation. Observing this phenomenon and the target of achieving development in 2030, by Arena et al., (2022); and Mbanda and Fourie (2020) seemed to force the government to try the rest of the time.

Borck and Pflüger (2019) found that there is a dichotomy (big difference) between economic and social development achievements and the environment between big cities and medium/small cities, even though they are in the same region with the same socio-cultural characteristics. This is consistent with the results reported by Permana and Harsanto (2020); Dennis et al., (2019); El-Kholei et al., (2019); Rojas et al., (2019), that aspects of government (governance) policies are still a challenge for achieving sustainable urban economic development.

The opinion of Borck and Pflüger (2019) has previously been expressed by Pace et al., (2016) in their study and the latest was conveyed by Hasddin et al., (2022a and 2022b) that the interesting discourse being discussed at this time is the achievement of sustainable development goals in cities. not only focus on big cities and metropolitan cities but must shift to developing cities, in this case, medium-scale cities and/or small cities. This is because people's current behavior prefers cities as a destination for living with a composition of 50-60% of the total world population (Hala and Saun, 2022), so developing cities will later become migration destinations. Therefore, earlier strategic efforts need to be made to design future cities that are more livable.

Indonesia's position is very likely to become a reference model for implementing a sustainable and livable (economic, social, and environmental) urban design agenda specifically in tropical and coastal cities. The perspective of cities in Indonesia when classifying cities according to typology and population, namely metropolitan cities, big cities, medium cities, and small cities as stated in Law (UU) Number 26 of 2007 concerning Spatial Planning (Andriono et al., 2013). Currently, Indonesia has 95 cities with details of 13 metropolitan cities, 14 big cities, 59 medium cities, and 9 small cities. Medium-scale cities are more dominant, up to 62% of the total cities. This fact is consistent with the results of Pace et al., (2016); and Borck and Pflüger (2019) that the agenda for sustainable economic development in the future is to prepare early for a roll model starting from medium and small-scale cities.

In the end, the points that became the main theme of this research were obtained, namely sustainable economic development that is integrated with the environment as a pillar of sustainable development. The environmental aspects are concerned with energy and CO_2, and air quality, while the social aspects are based on government policies that are environmentally sound. The emphasis suggested by previous researchers is to take cases other than big cities and metropolitan cities.

Based on these considerations, this study takes the case of a medium-scale city in Baubau City, Southeast Sulawesi Province, Indonesia. There are several logical reasons for taking the case of Baubau City. The first is that Baubau City is projected to become the government center (capital) for the plan to form the Buton Islands Province (or another name). The two cities of Baubau experience population growth every year as a result of urbanization and trade purposes in the surrounding buffer zones such as Buton Regency, Central Buton Regency, South Buton Regency, Wakatobi Regency, North Buton Regency, including Muna Regency and Bombana Regency. The population of Baubau City in 2015

was 154,877 people, in 2018 there were 167,519 people and in 2020 there were 176,312 people.

The third consideration is that the City of Baubau is projected to experience rapid economic growth because of its strategic location in the maritime trade route, namely the transportation of the eastern and western regions of Indonesia. This figure is proven by economic developments that continue to grow where in 2013 it grew by around 7.9%, in 2015 it was 8.97% and in 2018/2019 it was 9% (2020 to 2022 decreased due to global economic turmoil and the Covid-19 pandemic).
The novelty of the research is to present environmentally sound economic growth according to energy use and CO_2 emissions, air quality, and environmentally sound government policies in medium-scale cities with special characteristics of coastal cities or suburban cities.

2. LITERATURE REVIEW

2.1. Economic Development and Growth

The description of the theory of economic development in this study refers to the views of Arthus Lews and Rostow. Quoted from Lestari et al., (2021) explains Arthus Lews' view that economic development basically discusses the processes that occur in rural areas and urban areas (urban). Then Rostow saw economic development as a process of transforming a traditional society into a modern, multidimensional society. The similarity between the two lies in the indicator of the successful implementation of development which is at the macro level through economic growth.

Furthermore, a review of the theories and concepts of economic growth in research uses Keynes's opinion. According to Keynes (Yu et al., 2019), consumption by one person in the economy will become income for other people in the same economy. when someone spends his money, he helps increase other people's income (Restiasanti & Yuliana, 2023; and Yu et al., 2019). Related to that, the presentation of the development of a city in this study presents the development of economic growth in the City of Baubau. Economic growth is presented according to the aggregate results of economic performance in gross regional domestic product (GDP).

2.2. Sustainable Development

Sustainable (economic) development is motivated by global climate change. Starting from the World Climate Conference by the United Nations in Stockholm on June 5, 1972. The issue in the spotlight is global climate change so every country is obliged to reduce emissions from its industrial activities. Reinforcing the results of the Stockholm conference, then followed by a special session by the world's environmental organizations under the United Nations through the United Nations Environment Program (UNEP) in Nairobi, Kenya in 1982. The main points discussed were still related to global climate change. In 1987 the world commission on Environment and Development initiated by the United Nations through the World Commission on Environment & Development (WCED) held a meeting with the agenda for discussion on economic development in relation to the environment for sustainable development (Fauzi and Oxtavianus, 2014).

Five years later, in 1992 to be precise, the UN held a Summit (Summit) known as the Earth Summit with the theme of sustainable development (Wheeler, 2013). The Summit was organized by the United Nations through the United Nations Conference on Environment & Development (UNCED) in the city of Rio de Janeiro, Brazil around June 1992. In 2000, the issues fought for by countries gathered in the Level Conference (Summit) Bumi then developed on the issues of poverty, health, and gender equality. This issue was then emphasized in a follow-up session at the Summit held by the United Nations (UN) in 2012 with three main issues namely environment, society, and economy as principles that must be integrated in development, especially in urban areas. This goal is packaged in the concept of the Millennium Development Goals (MDGs) by setting twenty priority programs (goals) for sustainable development.

Since 2015, the MDGs have been revised and refined through the concept of Sustainable Development Goals (SDG) by establishing seventeen (17) sustainable development goals. The seventeen goals relate to the issue of poverty; starvation; healthy and prosperous life; quality education; gender equality; clean water and proper sanitation; clean and affordable energy; economic growth and decent work; Industry, Innovation, and Infrastructure; reducing gaps; sustainable cities and settlements; responsible consumption and production; handling climate change; marine ecosystem; terrestrial ecosystems; peace, justice, and strong institutions; and partnerships to achieve goals (Regulation of the President of the Republic of Indonesia Number 111 of 2022).

2.3. City Classification

Greek planologist Konstantinos Apostolos Doxiadis classifies cities according to population. By Ekistics (1968) in Surtiani (2006) that: a) Small Town is a city with a population of between 20,000 - 100,000 inhabitants; b) Big City is a city with a population of between 100,000 - 1,000,000 people; c) Metropolitan Municipality is a city with a population of more than 1,000,000 people; d) Megalopolis is a city with a population of more than 10,000,000 people; and e) The City of Ekumenopolis has a population of more than 1,000,000,000 inhabitants. The World Bank makes standard population numbers for a city, namely; a) Areas with a population of more than 20,000 people are called urban (urban or small towns); b) Areas with a population of more than 100,000 people are called cities (medium cities); and c) Regions with a population of more than 5 million are called big cities (Zoer'aini, 2004).

In Indonesia itself, the classification of cities according to population has been regulated in Law (UU) Number 26 of 2007 concerning Spatial Planning, that urban areas with a population of between 50,000-100,000 people are categorized as "small towns", urban areas with a population > 100,000 -500,000 people are categorized as "medium cities", cities with a population of at least 500,000 people are categorized as "big cities", and cities with a population of at least 1,000,000 people are categorized as "metropolitan cities" (UU No. 26 of 2007).

3. DATA AND ANALYSIS

The research uses a descriptive quantitative approach to present data and process analysis with statistical processes to then carry out descriptions according to facts and real phenomena in the field. Data are generally sourced from secondary and primary compilations from the Baubau City Government as cross-sectional primary data covering agencies that organize the fields of Public Works, Spatial Planning, Regional Development Planning, and the Environment.

These data were obtained through document searches that presented data according to the variable or focus of analysis, then cross-examination (semi-interviews) was carried out with the relevant agencies to confirm the correctness of the secondary data. The second data collection technique is through distributing questionnaires to government stakeholders in Baubau City with a target (key informant) of 4 people.

Data on regional economic performance uses economic growth achievements between 2015-2019 (data for 2020-2022 was not taken due to the Covid-19 pandemic). Calculation of economic growth using the equation:

$$R = (PDBrt - PDBt_1)/PDBt\_1 \times 100\% \quad (1)$$

R = economic growth rate in percent (%)
PDBrt = Gross Domestic Product (real national income) in a given year
PDBt-1 = Gross Domestic Product (real national income) in the previous year.

The calculation of environmental performance for energy and CO_2 is based on 9 indicators as presented in Table 1. Data needed for air quality measurement is based on four analysis indicators, and environmental governance data includes 3 indicators (Table 1).

Table 1: Green City Environmental Performance Assessment According to AGCI and P2KH Standards

No.	Category	Indicator	Data Type	Weight	Analysis
1.	*Energy & CO_2*	a. CO_2 emission	Quantitative	25%	Equation (2)
		b. Energy consumption	Quantitative	25%	Equation (2)
		c. Clean energy policy (regulation)	Qualitative	25%	Scoring
		d. Policies related to (mitigation) of climate change	Qualitative	25%	Scoring
		e. Solar energy application plan	Qualitative	25%	Scoring
		f. Wind energy application plan	Qualitative	25%	Scoring
		g. Water energy application plan	Qualitative	25%	Scoring
		h. Plans for implementing energy from waste	Qualitative	25%	Scoring
		i. Plant energy application plan	Qualitative	25%	Scoring
2.	*Air Quality*	a. Daily nitrogen dioxide (NO_2) level (ug/m^3)	Quantitative	25%	Equation (2)
		b. Daily sulfur dioxide level (SO_2) (ug/m^3)	Quantitative	25%	Equation (2)
		c. Daily suspended particulate level (daily PM_{10}) (ug/m^3)	Quantitative	25%	Equation (2)
		d. Clean air policy and planning	Qualitative	25%	Scoring
3.	*Environmental Governance*	a. Environmental protection/management	Qualitative	33%	Scoring
		b. Environmental monitoring/control	Qualitative	33%	Scoring
		c. Public/community participation	Qualitative	33%	Scoring

Sumber: AGCI, (2011)

These data were analyzed by presenting quantitative and qualitative data/types of data. Analysis with quantitative data types of performance results uses a weighting/scoring system with reference to the Asian Green City Index (AGCI) and the Green City Development Program (P2KH) by the Ministry of Public Works and Public Housing, Republic of Indonesia as presented in Table 1 and Table 2. The quantitative data type analysis equation for energy and CO_2, and air quality is:

$$\text{Weight (\%)} = \left(1 - \frac{\text{Obtained value}}{\text{Environmental quality standard values}}\right) \times \text{Weight (\%)} \quad (2)$$

Thresholds or environmental quality standards in the AGCI quantitative type assessment are presented in Table 2 below,

Table 2: Quantitative Data Type of Green City Attribute Environmental Quality Standards

No.	Analysis Object	Indicator	Quality standards
1	*Energy & CO_2*	CO_2 emission	≤245.410.270 Ton CO_2
		Energy consumption	≤900 kwh/person
2	*Air Quality*	NO_2 level/day	≤150 µg/ Nm^3/day
		SO_2 level/day	≤365 µg/ Nm^3/day
		PM_{10} level/day	≤150 µg/ Nm^3/day

Sumber: AGCI (2011)

Aspects of types of qualitative data were analyzed descriptively with a scoring system to determine the extent or level of performance in implementing green city attributes and indicators, as presented in Table 3. The scoring results will then be calculated to get the weight of each indicator according to the attributes of a green city with the following equation:

$$\text{Value Weight}\,(\%) = \left(\frac{\text{Total score}}{\text{Highest Score}}\right) xWeight(\%) \quad (3)$$

Table 3: Qualitative Data Types of Green City Attribute Assessment Scores

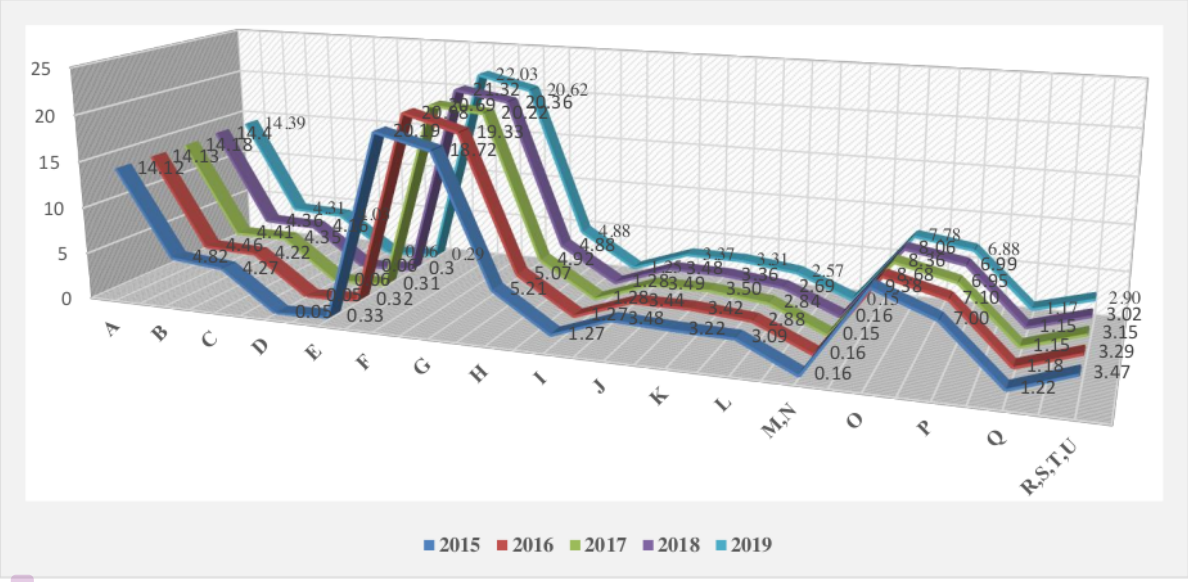
No.	Statement	Score
1	There are no rules and/or plans (in regional regulations and similar as the implementation of the regulations above), and there is no implementation of them	0
2	There are already regulations and/or planning (in regional regulations and the like as the implementation of the regulations above) but not yet planned/implemented/implemented	1
3	There are no rules and/or planning (in regional regulations and the like as the implementation of the regulations above), but some/all of them have been implemented	2
4	Rules and/or plans already exist (in local regulations and the like as the implementation of the regulations above) and are implemented (achievements ≤ 50%)	3
5	There are already rules and/or planning (in regional regulations and the like as the implementation of the regulations above) and are implemented properly and/or achievement is >50%	4

It will then be tabulated to obtain the achievement categories of green cities according to AGCI standards categorized in five (5), namely: a) Achievements between 81-100% are categorized as "very above average" or "very good"; b) 61-80% are categorized as "above average" or "very good"; c) 41-60% are categorized as "meet average" or "good"; d) 21-40% are categorized as "below average" or "not good/bad"; and e) 0-20% are categorized as "very below average" or "very bad".

4. RESULTS AND DISCUSSION

4.1. The Economy (Growth) of Baubau City

Baubau City's economy is distributed in 17 sectors, with the percentage of performance presented in Figure 1. From 2015 to 2019, the sector that consistently contributed high was Construction (≥20%). The wholesale and retail trade, car, and motorcycle repair sector is ranked second and is performing well because it shows an increased rate (18.72% up to 20.62%). Ranked third by the Agriculture, forestry, and fisheries sector (≥24%).



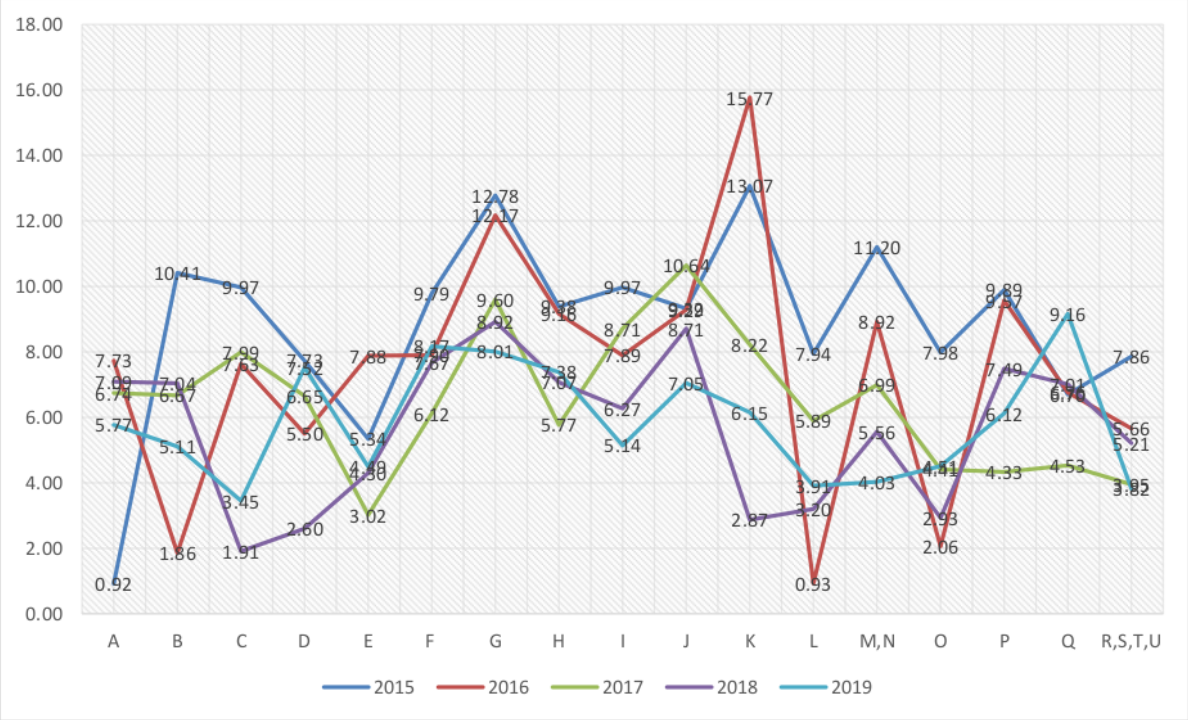
Noted:

A	Agriculture, forestry and fisheries	J	Information and Communication
B	Mining and excavation	K	Financial Services and Insurance
C	Processing industry	L	Real estate
D	Procurement of electricity and gas	M,N	Company Services
E	Water procurement, waste management, waste and recycling	O	Government Administration, Defense and Compulsory Social Security
F	Konstruction	P	Education Services
G	Wholesale and retail trade; car and motorcycle repair	Q	Health Services and Social Activities
H	Transportation and warehousing	R,S,T,U	other services
I	Provision of accommodation and food and drink		

Figure 1: Percentage (%) of Sector Contribution to the GDP of Baubau City 2015-2019 (Source: Central Bureau of Statistics, Baubau City, 2020)

The sector with the lowest contribution to the economic structure (GDP) is the electricity and gas supply sector (0.5% to 0.6%) and the water supply, waste management, waste, and recycling sector (≥0.29%). The sectors experiencing a trend of increasing the value of their contribution are three sectors, namely agriculture, forestry, and fisheries; construction; and the wholesale and retail trade sectors. It can be said that this sector plays an important role in describing the economy of Baubau City. Finally, there are sectors that experience fluctuations and tend to decline. Occurs in three sectors namely information and communication; Financial and insurance services; as well as the corporate services sector.

This dynamic then has consequences for the achievement of economic growth. During 2015-2019 the economic growth of Baubau City in terms of real GDP tends to be stagnant and shows a downward trend. Economic growth in 2015 was 8.84% while in 2019 it fell to 6.59%. The complete economic growth of Baubau City by the business sector in 2015-2019 is presented in Figure 2.



Noted: Symbol Description A – R,S,T,U is the same as Figure 1.

Figure 2: Economic Growth (%) Real GRDP of Baubau City 2015-2019 (Source: Central Statistics Agency of Baubau City, 2020)

Judging from the performance of the sector or business field, the sixteen business sectors experienced a decline in growth performance, only one sector, namely health services and social activities, experienced an increase, where in 2016 it grew around 6.70% then in 2018 it grew to 7.01% and in 2019 to 9.16%. It's just that the health services sector and social activities contribute to the economic structure (GDP) relatively low at ≥1.15%.

The highest economic growth rate during the 2015-2016 period was occupied by the financial services and insurance sectors (13.07% and 15.77% respectively). Entering 2017-2019, it shifted to second place, where the sector with the highest economic growth was wholesale and retail trade, respectively 9.60%, 8.92 and 8.01%. Despite this, the results show a decline and this occurs in almost all sectors except health services and social activities.

The next fact is that the manufacturing industry sector has experienced a significant decline in growth, in 2015 it was around 9.97%, down to 3.45%. The same thing happened to the mining and quarrying sector from 10.41% to 5.11%. Including other services from 7.86% to 3.82%. Ironically, the financial and insurance services sector initially occupied the top position, actually showing a significant decline from 13.07% to 6.15%.

Based on these facts it can be said that in the 2015-2019 period, the economy of Baubau City can be said to be not good. This research has not been able to reveal further to

explain this phenomenon. This research focuses on economic performance in terms of GDP to be associated with environmental performance as a basis for future planning toward a sustainable city.

It is important that future research needs to further explore the economic phenomena of the City of Baubau to obtain the factors that influence and cause the decline in the economic performance of the City of Baubau.

4.2. Energy and CO_2 Baubau City

4.2.1. Quantitative Aspect Analysis

Data from the State Electricity Company (PLN) Branch of the Southeast Sulawesi Branch in Kendari and the Baubau City BPS (2021) obtained the total use/consumption of electricity in Baubau City as much as 116,182,141 KWh. This amount serves the electricity needs of the Baubau population of around 176,312 people. Based on this amount of data, the average energy use in Baubau City is 659 KWh/person. The amount of electrical energy consumption by the residents of Baubau City is below the tolerable amount because it is still below the quality standard of the AGCI green city standard, namely ≤900 Kwh/person (Table 2).

Departing from the data on the use/consumption of electrical energy, the energy consumption indicator performance weight of 6.75% is obtained from the following calculation (equation 2),

$$\left(1-\frac{659}{900}\right)x\ 25\% = (1-0{,}73)x\ 25\%$$
$$= 0{,}27x\ 25\% = 6{,}75\%$$

The results of the analysis (equation 2) show that the amount of CO_2 emissions from electricity use in Baubau City is 83,534.96 tons/year. This amount is still below the permissible quality standard value in accordance with the Asian Green City Index (AGCI) environmental quality standard, namely 245,410.27 tonnes of CO_2 (Table 2). Obtaining the weight value of CO_2 emissions in Baubau City according to the Asian Green City Index (AGCI) standard calculated through equation 2, the result is 16.49%.

$$\left(1-\frac{83.534{,}96}{245.410{,}27}\right)x\ 25\% = (1-0{,}34)x\ 25\%$$
$$= 0{,}66\ x\ 25\% = 16{,}50\%$$

The total value of the performance-weighted quantitative aspect of the energy and CO_2 attribute in Baubau City is 23.25% in the range of 21-40% which is categorized as "below average" by the AGCI standard. This happens because the average energy consumption of Baubau City residents is relatively large, almost close to the quality standard, so the performance weight value is low. The closer to the quality standard value, the lower the value (weight) of performance. If the weight value is far or further away from the quality standard, the higher the value weight produced, this is what happens to the CO_2 emission indicator so that the weight value is higher than the average energy consumption.

4.2.2. Qualitative Aspect Analysis

The results of the analysis as presented in Table 4 show that the weight of the performance value of the clean energy policy is 6.25%; policies and implementation related to climate change mitigation of 12.50%; and policies and plans for implementing renewable energy is 5.21%.

Table 4: Analysis of Qualitative Aspects of Environmental Performance Based on Energy and *CO_2* Attributes in Baubau City

Indicator	Implementation	Scoring				
		0	1	2	3	4
Clean energy policy	a. Appeal/socialization of smart electricity usage			√		
	b. Smart electricity use (prepaid/token)			√		
	c. Policy on the use of Solar Cell public street lighting.			√		
	d. Developing a grid energy system (distribution substation)	√				
	e. Construction of bicycle paths (Regional Regulation of Baubau City No.4 of 2014)	√				
	f. Construction of pedestrian paths (Regional Regulation of Baubau City No.4 of 2014)				√	
	Total score	9				
	Value weight = $\left(\frac{9}{24}\right)x\ 25\% = 0{,}42\ x\ 25\%$	9,38%				
Policies and implementation related to climate change mitigation	a. Planting trees and specific instructions for planting trees at points/areas of emission sources (industrial areas and dense vehicles)			√		
	b. Allocation of green open space and parks in energy resource areas (Regional Regulation of Baubau City No.4 of 2014)			√		
	Total score	4				
	Value weight = $\left(\frac{4}{8}\right)x\ 25\% = 0{,}50\ x\ 25\%$	12,50%				
Renewable energy policies and plans	a. Solar energy electricity (solar cells), through Regional Regulation No. 4 of 2014		√			
	b. Steam energy electricity (PLTU), through		√			

	Regional Regulation No. 4 of 2014					
	c. Wind energy electricity	√				
	d. Water energy electricity (micro hydro), through Regional Regulation No. 4 of 2014		√			
	e. Listrik dari limbah gas metana			√		
	f. Power generation from plant energy	√				
	Total score	5				
	Value weight = $\left(\frac{5}{24}\right) x\ 25\% = 0{,}21\ x\ 25\%$	5,21%				

Thus, the total value of the performance-weighted qualitative aspect of the energy and CO_2 attributes as an effort in developing a green city in Baubau City is 27.09% in the range of 21-40% which is categorized as "below average" by the AGCI standard.

Finally, the total average environmental performance in the development of Baubau City according to the aspects of energy and CO_2 is 25.17% (the average of 23.25% and 27.09%). According to the classification of environmental performance by AGCI, a value of 25.17% is categorized as not meeting environmental performance criteria because it is in the range of 21-40%.

4.3. Baubau City Air Quality

4.3.1. Quantitative Aspect Analysis

Air quality measurement in Baubau City is currently still using the passive sampler method, which is a method that uses a gas absorption system by diffusion through the media exposed for a certain time without using a suction pump by utilizing the physical properties of gases that diffuse from high concentrations to low concentrations. The use of the passive sampler method in Baubau City can only reach the air quality (air quality) of daily NO_2 and SO_2 levels.

The results of the last measurement carried out by the Baubau City Environmental Service (DLH) are from 2020, so the air quality measurements in this study refer to this data. Air quality measurement samples (daily NO_2 and daily SO_2) at four points as a representation of the characteristics of the urban environment, namely; 1) a dense point of vehicles on Jl. Raya Betoambari, 2) industrial activities at PLTD Kaobula Jl. Hayam Wuruk, 3) settlements in Nataraguru Village, and 4) office points.

The results of daily NO_2 measurements by DLH Baubau City were 6 µg/Nm3/day, still below the environmental quality standard (≤150 µg/Nm3/day). From this value, the air quality performance weight for the daily nitrogen dioxide (NO2) gas content indicator based on the quality standard in Baubau City is 24%. This value is obtained from the calculation (equation 2) below,

$$\left(1-\frac{6}{150}\right) x\ 25(\%) = (1-0{,}04) x\ 25\% = 0{,}96\ x\ 25\% = 24\%$$

The performance weight of the air quality indicator for daily sulfur dioxide (SO_2) content from DLH data for Baubau City is 11 µg/Nm3/day, still below the quality standard (≤365 µg/Nm3/day). This value is then calculated (with equation 2) to produce a weight of 24.25%, obtained through the calculation (equation 2) below,

$$\left(1-\frac{11}{365}\right) x\ 25(\%) = (1-0{,}03) x\ 25\% = 0{,}97\ x\ 25\% = 24{,}25\%$$

The results of these calculations obtained the total value of the weighted performance of green city development from the quantitative aspect of air quality, namely NO_2 and daily SO_2, which is 48.25%. This value meets the "average value" required by the Asian Green City Index (AGCI). Thus, the performance of green city development from a quantitative aspect (daily NO_2 and SO_2) in Baubau City can be said to be "good".

NO_2 is an exhaust gas in the form of smoke (which can be toxic) from combustion products such as burning garbage, motor vehicle fumes, and fumes/vapor from other activities. NO_2 itself is a gas (compound) with a characteristic pungent odor and is non-flammable (absorbed) in the air originating from combustion products (smoke) or the results of processing industrial activities. In accordance with the performance values and weights above, it can be said that the daily NO_2 and SO_2 content in the air of Baubau City is in the healthy category. In another sense, the activities of the residents of Baubau City which produce NO_2 and SO_2 cannot yet be dangerous.

This fact is also supported by the Air Pollution Standard Index (ISPU) issued by the Indonesian Ministry of Environment and Forestry through the Regulation of the Director General of Climate Change Control No. P5/PPI/SET/KUM I/12/the year 2017, that a value of 0-50 µg/Nm^3/day is categorized as good, a value of 51-100 µg/Nm^3/day is categorized as moderate, above 100 µg/Nm^3/day is unhealthy, and/or above 300 μg/Nm^3/day is dangerous. Likewise, the quality standards required by the Asian Green City Index (AGCI) that daily NO_2 values ≤150 µg/Nm^3/day, and SO_2 ≤365 µg/Nm3/day are still tolerated, even the lower the quality standards, the healthier the air. (quality).

4.3.2. Qualitative Aspect Analysis

The results of the analysis of the qualitative aspects of the air quality aspect in Baubau City are presented in Table 5. The results of the analysis obtained a performance weight of 12.50%. This value is relatively low from the total ideal weight so it cannot meet the minimum environmental performance value by AGCI.

Table 5: Analysis of Qualitative Aspects of Environmental Performance Based on Air Quality Attributes in Baubau City

Indicator	Implementation	Scoring				
		0	1	2	3	4
Policies for maintaining clean air quality	a. Tree planting					√
	b. *Car-free day*	√				
	c. Air quality monitoring, through Baubau City Regional Regulation No. 6 of 2005				√	
	d. Motor vehicle emission test, through Baubau City Regional Regulation No. 6 of 2005		√			
	Total score	11				
	Value weight = $\left(\frac{11}{16}\right) x\ 25\% = 0{,}50\ x\ 25\%$	12,50%				

Trees in urban areas (Baubau City) have many benefits, one of which is maintaining the climate and controlling emissions and other toxic gases. Tree planting is also part of the implementation of the provision of green open space in urban areas, especially artificial green open spaces. The 2014-2034 Baubau City Spatial Planning document, Article 40 regulates green open space, it's just that the obligation to plant trees has not been explicitly regulated. Other regulations regarding tree planting have also not been promulgated (in regional regulations). Nonetheless, tree planting activities in Baubau City are routinely carried out, both at the initiative of the Baubau City government and other organizations (including the general public).

The biggest contribution to carbon and greenhouse gas effects in urban areas, including developing countries, is from motorized vehicles which produce hazardous substances such as NO_2, SO_2, NOx, SO, CO_2, VHC, and other particulates (Ikhlas et al., 2017; and Andriono et al., 2013). One of the efforts to reduce this effect is to reduce the use of vehicles on certain days which are more commonly known as car-free days or motorized vehicle-free days. Policies related to the implementation of car-free days in Baubau City have not been implemented. Based on data on the performance weight of public transportation and air quality data, it seems that this is not that urgent. The average number of vehicles and air quality are still in the healthy category. Even so, in the future car-free days can be carried out by the Baubau City Government as an effort to maintain air quality and to achieve a sustainable city.

Air quality measurement activities by DLH Baubau City are not optimal, because the method used is still using the passive sampler method, what is recommended is the use of the AQMS method or Air Quality Monitoring System (as done by Kendari City). Another reason is that the observation sample is relatively limited, so it cannot cover the entire area of Baubau City.

Motor vehicle emission test activities in Baubau City are also mandated in Baubau City Regional Regulation No. 6 of 2005 to be precise in Article 29 Paragraph 2. The regional regulation states that vehicle emission tests (moving sources) begin with setting thresholds, vehicle exhaust emission limits, and exhaust emission inspection. Even though it has been set up, the implementation is not running yet. This was also acknowledged by DLH Baubau City that this had not been done in Baubau City. The results of field monitoring (observation) are in line with this because no vehicle was found that had an information sign (sticker) that passed the emission test.

4.4. Environmental Governance

The results of the green city performance analysis for environmental governance attributes in Baubau City are presented in full in Table 6.

Table 6: Analysis of Qualitative Aspects of Environmental Performance Based on Environmental Governance Attributes in Baubau City

Indicator	Implementation	Scoring				
		0	1	2	3	4
Environmental Protection and Management	Protection and management of the environment, through the Regional Regulation of the City of Baubau No.6 of 2005					√
	Standard operational procedures for assessing environmental management at the city level, through Baubau City Regional Regulation No. 6 of 2005, and Baubau Mayor Regulation No. 103 of 2014					√
	Implementation and retribution for building permits or buildings, through Baubau City Regional Regulation No.6 of 2005, Baubau City Regional Regulation No.1 of 2009, Baubau City Regional Regulation No.12 of 2009, Regional Regulation No.2 of 2009, Regional Regulation Baubau City No.4 of 2014, Baubau City Regional Regulation No.4 of 2015, Baubau City Regional Regulation No.7 of 2018, Baubau Mayor Regulation No.53 of 2020.				√	

Indicator	Implementation	Scoring				
		0	1	2	3	4
	Garbage and sewage treatment, through the Regional Regulation of Baubau City No.6 of 2005, Regional Regulation No.17 of 2012, Regional Regulation of Baubau City No.27 of 2017, Regulation of the Mayor of Baubau No.33 of 2018, Regulation of the Mayor of Baubau Baubau No.177 of 2013, and Instructions Mayor of Baubau City No.37 of 2018.					√
	Administration of residential areas, through the Regional Regulation of Baubau City No.6 of 2005, Regional Regulation No.1 of 2009, and Regional Regulation No.4 of 2015				√	
	Preparation of a Detailed Spatial Plan (RDTR) for three (3) RDTRs, through the Regional Regulation of the City of Baubau No.4 of 2014 concerning Regional Spatial Planning		√			
	Dissemination of environmental management in various media				√	
	Total score	22				
	Value wiight = $\left(\frac{21}{28}\right) x\ 33\% = 0{,}79\ x\ 33\%$	25,93%				
Supervision/ Monitoring, and environmental control	Preparation of environmental documents/reports and reports on Regional Environmental Status, through the Regional Regulation of the City of Baubau No.6 of 2005				√	
	Garbage bank assistance, through Baubau City Regional Regulation No.6 of 2009, and Baubau Mayor Regulation No.43 of 2019				√	
	Assistance for integrated waste processing sites (TPST) 3/4-R, through Baubau City Regional Regulation No. 6 of 2009, and Baubau Mayor Regulation No. 43 of 2019.				√	
	Environmental management, monitoring and control planning (master plan).		√			
	Evaluation and enforcement of spatial use (RTRW/RDTR), through the 2011-2030 RTRW to become the 2014-2034 RTRW.				√	
	Total score	13				
	Value weight = $\left(\frac{13}{20}\right) x\ 33\% = 0{,}65\ x\ 33\%$	21,45%				
Public participation	a. Community organizations that care about the environment (protection)		√			
	b. Formation of a green community		√			
	c. Contributions from the community for environmental maintenance	√				
	d. Adipura Award					√
	e. Adiwiyata award		√			
	f. Langit biru award		√			
	g. Giving awards to individuals/groups/organizations who excel in environmental management			√		
	Total score	13				
	Value weight = $\left(\frac{13}{28}\right) x\ 33\% = 0{,}36\ x\ 33\%$	11,79%				
Total		59,17%				

The results of scoring the performance assessment of the environmental governance in Baubau City obtained a total weight value of 59.17%. The performance value is in the range of 41-60% in the category of meeting the "average value" of the green city performance classification by the Asian Green City Index (AGCI). This means that the green city performance from environmental governance attributes in Baubau City has met the required average value (standard) of performance by AGCI. Thus it can be said that the Baubau City government in terms of environmental protection and management; supervision/monitoring, and environmental control; and public participation has led to green governance (environmental governance).

5. CONCLUSION

Judging from the progress of the development achievements in the economy (GDP) of Baubau City it is not good enough because economic growth shows a downward trend. In fact, from each sector, there is a shift in the ranking of performance which contributes highly. Development performance that leads to the creation and control of environmental quality according to energy use and CO_2 emissions is not good because it is below the standard set by AGCI. A good environment in Baubau City from the aspect of air quality and environmental governance with each performance weight meets the AGCI standard.

When it comes to data on energy consumption and CO_2 emissions, not meeting environmental performance standards (by AGCI) creates gaps. The gap in question is that economic performance by extracting natural resources does not show improvement, at the same time there is energy use and produces CO_2 emissions that are high enough to approach the quality standard. The idea is that if the use of natural resources with immediate inputs is not very significant for

development, then the resulting energy and CO_2 emissions can be reduced. Economic development activities with all inputs in Baubau City have not had a bad consequence on environmental quality which is produced in daily NO_2 and SO_2. The daily air quality values for these two compounds are still good, far from the quality standard threshold values. It can be said that the two air quality compounds produced from economic activities in Bubau City are not yet dangerous and healthy for humans and other living things. From the aspect of environmental governance, the City of Baubau is good and meets the standards set by the AGCI. This means that the Baubau City government's policy has led to efforts to create and control the environment which is supported by several regional regulations issued.

The urgent agenda for the government of Baubau City and other relevant cities (medium-scale cities) is to address the gap between economic activities by reducing the use of energy and CO_2 in inputs and other activities that contribute to the economy (GDP). The government certainly has limitations in determining strategic and measurable efforts, so further studies are needed to reveal what is meant. The urgent step by Baubau City and other cities in the world is to reduce energy use and CO_2 emissions, starting with the identification of economic sectors that use energy and produce excess CO_2 emissions.

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