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# ESTIMATION OF EMISSION TAX VALUE OF HOSPITALITY AND RESTAURANT INDUSTRY IN BOGOR CITY, WEST JAVA, INDONESIA

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## ABSTRAK

*Jumlah hotel dan restoran di Kota Bogor meningkat setiap tahun. Menurut Dinas Pariwisata dan Kebudayaan Kota Bogor (2018), jumlah hotel meningkat dari 53 unit pada tahun 2016 menjadi 87 unit, sementara restoran meningkat dari 162 unit menjadi 680 unit. Pertumbuhan ini menyebabkan emisi $CO_2$ meningkat, sementara ruang terbuka hijau tetap. Studi ini bertujuan untuk memperkirakan emisi $CO_2$ dari industri hotel dan restoran menggunakan metode TIER-1, menentukan lahan taman kota yang dibutuhkan untuk menyerap emisi tersebut menggunakan pendekatan deskriptif kuantitatif, memperkirakan nilai pajak emisi $CO_2$ berdasarkan biaya pembuatan taman kota, dan mengusulkan implikasi kebijakan alternatif untuk penerapan pajak emisi menggunakan pendekatan deskriptif kualitatif. Hasil penelitian menunjukkan bahwa hotel di Kota Bogor menghasilkan 3.221 ton $CO_2$ per tahun, dan restoran menghasilkan 9583 ton per tahun. Ruang terbuka hijau yang ada saat ini tidak cukup untuk menyerap emisi tersebut, sehingga diperlukan tambahan lahan taman kota. Secara spesifik, industri hotel membutuhkan 57 hektar taman kota, dan industri restoran membutuhkan 167 hektar. Pendanaan untuk pengembangan taman-taman ini akan diperoleh dari pajak emisi yang dikenakan pada hotel dan restoran. Pajak emisi yang diusulkan adalah Rp 3.415 per kamar per malam untuk hotel dan Rp 239 per transaksi untuk restoran.*

***Kata kunci**: biaya pajak emisi, emisi hotel dan restoran, luasan taman kota, peningkatan jumlah hotel dan restoran.*

## ABSTRACT

*The number of hotels and restaurants in Bogor City has increased annually. According to the Bogor City Tourism and Culture Office (2018), the number of hotels rose from 53 units in 2016 to 87 units, while restaurants increased from 162 units to 680 units. This growth leads to higher $CO_2$ emissions, while green open spaces remain static. This study aims to estimate $CO_2$ emissions from the hotel and restaurant industry using the TIER-1 method, determine the urban park land needed to absorb these emissions using a quantitative descriptive approach, estimate the $CO_2$ emission tax value based on the cost of creating urban parks, and propose alternative policy implications for emission tax implementation using a qualitative descriptive approach. The results indicate that hotels in Bogor City produce 3.221 tons of $CO_2$ per year, and restaurants produce 9.583 tons per year. The current green open spaces are insufficient to absorb these emissions, necessitating additional urban park land. Specifically, the hotel industry requires 57 hectares of city park, and the restaurant industry requires 167 hectares. Funding for the development of these parks is to be sourced from emission taxes levied on hotels and restaurants. The proposed emission tax is Rp 3.415 per room per night for hotels and Rp 239 per transaction for restaurants.*

***Keywords**: emission tax fees, hotel and restaurant emissions, green open space area, increase in the number of hotels and restaurants.*

# 1. INTRODUCTION

Cities are characterized by their high population density compared to rural areas. In 2015, 54% of Indonesia's population lived in urban areas (Indonesia Investments, 2017). This urbanization brings challenges for sustainable development, which, according to UN-Habitat (2018), includes generating better income and employment opportunities, developing infrastructure for water, sanitation, energy, transportation, and communication, ensuring equal access to services, reducing slums, and protecting natural resources.

Urban areas, such as Bogor City, are hubs of non-agricultural activities and settlements. Bogor City spans 11,850 hectares and has a population of 1,064,687 (Bogor City Regional Development Planning Agency, 2015). Urban areas typically have higher population density and greater air pollution than rural areas. Most air pollution in cities comes from carbon dioxide (CO2) emissions due to human activities. Research by Friedlingstein et al. (2010) and Houghton et al. (2012) shows that emissions from land use changes accounted for 12.5% of total emissions from 2000-2009, with the commercial sector being a major contributor (Pratiwi dan Hermana, 2013). In Bogor City, hotels and restaurants are significant energy consumers, using electricity, gas, and diesel. In 2016, the electricity and gas sector contributed 5.57% to Bogor City's economic growth, while the food and beverage sector contributed 4.48% (Bogor City Statistics Center Agency, 2018b).

Hotels and restaurants are crucial to the tourism sector, providing accommodation and dining options for visitors. With ongoing development in Bogor's tourist attractions, the city is increasingly becoming a hub for tourism. This growth boosts the local economy. In 2016, Bogor City attracted 5,262,224 tourists, which increased to 5,740,609 in 2017 (Bogor City Statistics Center Agency, n.d.).

The rise in tourism has led to more hotels and restaurants. In 2016, Bogor City had 53 hotels and 162 restaurants. By 2017, these numbers grew to 87 hotels and 680 restaurants (Bogor City Statistics Center Agency, 2023; 2018a). This expansion leads to higher energy consumption, as hotels and restaurants use electricity, LPG, natural gas, and diesel. According to the IPCC (2006) cited by the Ministry of Environment of the Republic of Indonesia (2012), fuel use is categorized into mobile sources (transportation) and immobile sources (buildings like hotels and restaurants). Emissions from stationary sources include CO2, CH4, and N2O, but this study focuses on CO2 emissions. Greater energy use results in higher emissions.

In 2016, Bogor City emitted 1,583,031.78 tons of $CO_2$ (Bogor City Environment and Forestry Agency, 2016). Without intervention, emissions will likely rise, especially if green open spaces decrease. Bogor City currently has only 2.7% green open space, far below the 30% mandated by Law No. 26 of 2007 on Spatial Planning, which includes 20% public and 10% private green spaces. The existing green spaces cannot fully absorb $CO_2$ emissions from the hotel and restaurant sector. To address this, it is crucial to implement measures to control and absorb $CO_2$ emissions by increasing green open spaces in Bogor City.

# 2. METHODS

## 2.1 Type and Source

The types of data used are primary data and secondary data, both qualitative and quantitative. Primary data is obtained through interviews with respondents using a questionnaire as a guide to the questions to be asked. Respondents in this study were divided into two respondents, namely hotel and restaurant managers , as well as hotel and restaurant visitors, both domiciled and non-domiciled visitors to Bogor City. Secondary data

was obtained through data collection from various agencies including the Bogor City Tourism and Culture Office, Bogor City Sanitary and Parks Office, Bogor City BPS, Bogor City Bapedda as well as various literature and previous studies that support research data.

### 2.2 Data Analysis Method

The data obtained in this study were analyzed qualitatively and quantitatively. Data processing was carried out using Microsoft Excel 2010 software.


**Figure 1. Infographic Related to The Stages of Calculating Emissions Tax for The Hotel and Restaurant Industry (Source: Primary Data)**

### Estimation of Total $CO_2$ Emissions Produced by the Hotel and Restaurant Industry in Bogor City

Estimation of the amount of $CO_2$ emissions was carried out by going directly to the field by conducting interviews using questionnaires to hotel and restaurant managers in Bogor City. The amount of emissions is obtained from the energy consumption of each fuel multiplied by the calorific value and emission factor per each fuel. The calorific value and emission factor used are sourced from (IPCC, 2006). The formula used in estimating emissions is as follows:

$$CO_2 \text{ Emissions (Kg/yr)} = \text{Total Energy Consumption (TJ yr)} \times \text{Emission Factor (Kg/TJ)} \quad (1)$$

Note: after the result is obtained, the unit is converted to Ton/year The emission factor according to the IPCC default is expressed in units of emissions per unit of energy consumed (kg $CO_2$/TJ). On the other hand, available energy consumption data are generally in physical units (tons o-coal, kilos of diesel oil etc.). Therefore, before being used in Equation 1, energy consumption data must first be converted into TJ (Terra Joule) energy units with Equation 2.

Conversion of energy consumption units (TJ) = Energy Consumption (physical units) x Calorific value (TJ physical units) (2)

In this study, four types of fuels were calculated: electricity, LPG, natural gas and diesel. The emission factors and heating values of each fuel for stationary sources refer to GHG Inventory Handbook National from (Ministry of Environment of the Republic of Indonesia, 2012).

**Estimation of Urban Park Land Area Needed to Absorb Excess $CO_2$ Emissions in the Hospitality and Restaurant Industry in Bogor City**

Estimating the land area of city parks uses several data equations. Data that must be known include the absorption capacity of GOS (Green Open Space) and the remaining $CO_2$ emissions that are not absorbed, here are some equations to find the need for urban park land area.

1. Calculating the total absorption capacity of green space (city park)

$$TAC = AC \times GOS \quad (3)$$

Description:
TAC = Total absorption capacity of green spaces (Ton/year)
AC = $CO_2$ absorption capacity (Ton/ha/year)
GOS = Green Open Space area (ha)

Where $CO_2$ absorption capacity and green space area using each type of land cover. Various types of land cover have different abilities or absorption of carbon dioxide. These land cover types include trees, shrubs, grass, and rice fields. $CO_2$ gas absorption capacity and green space area based on land cover refers to (Prasetyo, 2002).

2. Calculating the remaining unabsorbed $CO_2$ emissions per sector

$$TUC = TCEb \times TCEa \quad (4)$$

Description:
TUC = Total unabsorbed $CO_2$ emissions across all sectors (Ton/year)
TCEb = Total $CO_2$ emissions of Bogor City (tons/year)
TCEa = Total $CO_2$ emissions absorbed = Total absorption capacity of green spaces

$$UCE = \frac{PE}{100} X\ TUC \quad (5)$$

Description:
UCE = Unabsorbed $CO_2$ emissions per sector (Ton/year)
PE = Proportion of emissions per sector (%)
TUC = Total unabsorbed $CO_2$ emissions across all sectors (Ton/year)

3. Calculating urban park land area requirements per sector

$$UPAR = \frac{UCE}{ACU} \quad (6)$$

Description:
UPAR = Urban park area requirement per sector (ha)
UCE = Unabsorbed $CO_2$ emissions per sector (Ton/year)
ACU = Absorption capacity of urban park per land cover (Ton/ha/year)

The absorption capacity of urban parks used is the absorption capacity of trees and the absorption capacity of grass.

**Estimation of $CO_2$ Emission Tax Value of Hospitality and Restaurant Industry in Bogor City**

To estimate the value of $CO_2$ gas emission tax on hotels and restaurants in Bogor City, the cost of handling emissions in the form of making city parks is used. The steps to find the value of $CO_2$ emission tax for hotels and restaurants:

1. Knowing the need for urban park land area per sector. The calculation formula can be seen in point 2.2
2. Knowing the cost of making green spaces (Rp/ha). The cost of making RTH was obtained from (Bogor City Regional Development Planning Agency, 2015) in the amount of Rp 80,693,273/ha, this cost includes the cost of making, maintaining and wage costs for workers.
3. Calculate sector-wide emissions tax costs.

$$VSET = UPAR \times CMG \quad (7)$$

Description:
VSET = Value of sector-wide emission tax (IDR)
UPAR = Urban park area requirement (ha)
CMG = Cost of making green open space (Rp/ha)

4. Calculating the value of hospitality emission tax.

$$HETV = \frac{VSET}{AHO \times RP \times ND} \quad (8)$$

Description:
HETV = Hospitality emission tax value (IDR/night/room)
VSET = Value of sector-wide emission tax (IDR)
AHO = Average hotel occupancy (%)
RP = Room population (unit)
ND = Number of days in one year (days)

The average hotel occupancy of 80% and room population of 4612 units were obtained from (Bogor City Statistics Center Agency, 2023).

5. Calculating the value of restaurant emission tax.

$$RETV = \frac{VSET}{AV \times RP} \quad (9)$$

Description:
RETV = Restaurant emission tax value (IDR/transaction)
VSET = Value of sector-wide emission tax (IDR)
AV = Average visitors per restaurant (people)
RP = Restaurant population (unit)

The average number of visitors per restaurant in one year is 82,855 people obtained from (Bogor City Statistics Center Agency, 2018). Restaurant population of 680 units obtained from (Bogor City Statistics Center Agency, 2018a).

**City Park Fee, Hotel Emission Tax Value per Room per Night and Percentage by Star Level**

To find out the percentage of emission tax fees paid by hotel visitors per room per night

based on hotel level or star level, the calculation steps are as follows.

1. Calculate the cost of city parks per star level.

$$TMC = \frac{TESL}{ACSU} \; X \; CMG \qquad (10)$$

Description:
TMC = Tree-specific manufacturing cost (Rp)
TESL = Total emission per star level (Ton/year)
ACSU= Absorption capacity of special urban parks for trees (Ton/ha/year)
CMG = Cost of making green space (Rp/ha)

$$TCPC = TMC + CMSG \qquad (11)$$

Description:
TCPC = Total city park creation (Rp)
TMC = Tree-specific manufacturing cost (Rp)
CMSG = Cost of making special grass (Rp)

2. Calculate the emission tax value per star level.

$$ETSL = \frac{TCMP}{AHO \; x \; RPSL \; X \; ND} \qquad (12)$$

Description:
ETSL = Emission tax value per star level (IDR/room/night)
TCMP = Total cost of making city parks (Rp)
AHO = Average hotel occupancy (%)
RPSL = Room population per star level (units)
ND = Number of days in one year (days)

3. Calculate the percentage of emission tax value.

$$PHET = \frac{ETSL}{AMRP} \; X \; 100\% \qquad (13)$$

Description:
PHET = Percentage of hotel emission tax value (%)
ETSL = Emission tax value per star level (IDR/room/night)
AMRP = Average minimum room price (Rp)

The average minimum room rate per night by star level refers to (Bogor City Tourism and Culture Office, 2018).

**City Park Fee and Percentage of Restaurant Emission Tax Value per Single Transaction**

To find out the percentage of emission tax fees paid by restaurant visitors per transaction, the calculation formula is as follows.

$$PRET = \frac{RETV}{AMC} \; X \; 100\% \qquad (14)$$

Description:
PRET = Percentage of restaurant emission tax value (%)
RETV = Restaurant emission tax value (IDR/transaction)
AMC = Average meal cost (IDR/transaction)

The average cost of a meal per person per transaction refers to primary data.

**Formulation of Alternative Policy Implication for the Implementation of Hospitality and Restaurant Emission Taxes in Bogor City**

Policy implications play a crucial role in determining the success of a policy. The qualitative descriptive method can assess the impact of a hotel and restaurant emission tax. This tax will likely raise hotel rates and menu prices, but aims to reduce global emissions and mitigate climate change. The goal is for hotels and restaurants to upgrade facilities, enhance consumer comfort, and transition to greener practices, ultimately leading to cleaner air and lower CO2 emissions in Bogor City.

## 3. RESULTS AND DISCUSSIONS

**Estimated Total CO2 Emissions of the Hospitality Industry**

With the rise in hotels in Bogor City, CO2 emissions from their energy use have also increased. Hotels utilize various fuels like electricity, LPG, natural gas, and diesel. This study employed the TIER-1 method to estimate emissions by calculating the total energy consumption multiplied by each fuel's heating value and emission factor. Results show the total $CO_2$ emissions from hotels in Bogor, categorized by star ratings and non-starred hotels.

**Table 1. Total $CO_2$ Emissions of Hotels in Bogor City Based on Star and Non-Star Classification**

| Level Star | Total Sample Hotel (unit) a | Total Emissions $CO_2$ (Kg/day) b | Total $CO_2$ Emissions (Ton/year) | Average Emissions $CO_2$ (Kg/day) c = b/a | Total Population Hotel (unit) d | Total Emissions $CO_2$ (Kg/day) e = c x d | Total Emissions $CO_2$ (Ton/year) |
|---|---|---|---|---|---|---|---|
| 4 | 10 | 2043 | 746 | 204 | 17 | 3474 | 1268 |
| 3 | 21 | 2037 | 744 | 97 | 30 | 2911 | 1062 |
| 2 | 7 | 596 | 217 | 85 | 13 | 1106 | 404 |
| 1 | 2 | 159 | 58 | 79 | 12 | 953 | 348 |
| Non-Star | 4 | 101 | 37 | 25 | 15 | 380 | 139 |
| **Total** | **44** | | | | **87** | | **3221** |

Based on Table 1, total $CO_2$ emissions from Bogor City's hotels are 8,824 kg/day, calculated by summing emissions from all star levels. This converts to 3.221 tons/year. Four-star hotels emit the most, at 3.474 kg/day, due to their larger number of rooms and facilities. Non-star hotels emit the least, at 380 kg/day, because they have fewer rooms and services, resulting in lower energy use.

**Estimated Total $CO_2$ Emissions of Restaurant Industry**

As the number of restaurants in Bogor City increases, the amount of $CO_2$ emissions generated from energy use in these buildings is also increasing. Restaurant energy use is the same as in hotel buildings such as electricity, LPG, natural gas and diesel. The calculation of total restaurant emissions also uses the TIER -1 method. The calculation of total emissions is obtained from the total energy consumption of each fuel multiplied by the calorific value and emission factor of each fuel (Moreno-Gutiérrez et al., 2015). The following are the results of the total $CO_2$ emissions of restaurants on five roads in Bogor City.

**Table 2. Total $CO_2$ Emissions of Restaurants on Five Roads in Bogor City**

| Location | Total Sample Restaurant (unit) a | Total Emissions $CO_2$ (Kg/day) b | Total Emissions $CO_2$ (Ton/year) | Average $CO_2$ emissions (Kg/day) c = b/a | Total Population Restaurant (unit)[2] d | Total Emissions $CO_2$ (Kg/day) e = c x d | Total $CO_2$ Emissions (Ton/yr) |
|---|---|---|---|---|---|---|---|
| New Street | 22 | 801 | 292 | 36 | 150 | 5.400 | 1971 |
| Taken-Fountain | 15 | 758 | 277 | 51 | 129 | 6.579 | 2401 |
| Jl.Pajajaran | 14 | 861 | 314 | 61 | 128 | 7.808 | 2850 |
| Semeru-Cilendek | 15 | 293 | 107 | 20 | 129 | 2580 | 942 |
| Jl. Bangbarung | 21 | 570 | 208 | 27 | 144 | 3888 | 1419 |
| **Total** | **87** | | | | **680** | | **9583** |

Based on Table 14, total $CO_2$ emissions from Bogor City's restaurants are 26,255 kg/day, totaling 9,583 tons/year. This figure combines emissions from all road sections, calculated using the population and average $CO_2$ emissions per section (Houghton et al., 2012). Pajajaran Street has the highest emissions at 7,808 kg/day due to its proximity to the Bogor toll road, attracting many visitors.

## Estimation of Total $CO_2$ Emissions in Bogor City

The amount of $CO_2$ emissions from all sectors in Bogor City is obtained, namely the transportation sector (cars, motorbikes, and angkot), industry (hotels and restaurants) and other sectors (Bogor City Statistics Center Agency, 2018b). In this case, researchers only calculated $CO_2$ emissions from the hotel and restaurant industry sector. The following table shows the amount of emissions generated in each sector mentioned above.

**Table 3. Total $CO_2$ Emissions All Contributing Sectors**

| No. | $CO_2$ Emissions Sectors | Total $CO_2$ Emissions City Bogor (tons/year) | Emission Proportion |
|---|---|---|---|
| 1 | Car | 449,749 | 22.15 |
| 2 | Motorcycle | 52,161 | 2.57 |
| 3 | Angkot | 231,845 | 11.42 |
| 4 | Hotel | 3,221 | 0.16 |
| 5 | Restaurant | 9,583 | 0.47 |
| | Other* | 1,283,752 | 63.23 |
| | **Total** | **2,030,311** | 100.00 |

$CO_2$ emissions generated from the hotel and restaurant sectors in Bogor City are not as large as emissions generated from the transportation sector. It can be seen that the proportion of emission contributor s from hotels is 0.16% and restaurants is 0.47%. This is because the fuel installations used in hotel and restaurant buildings are relatively better maintained than the transportation industry, which is *mobile*, so the amount of emissions produced by hotels and restaurants is less.

## $CO_2$ Absorption Capability

Green Open Space is crucial for a city's ecological balance, serving as an oxygen producer, CO2 absorber, and water catchment. The optimal green space area is determined by its CO2 absorption capacity, which depends on the land cover and vegetation type. To determine this, we predict green space needs based on CO2 absorption potential and compare it with current conditions (Dewiyanti, 2011; Miharja et al., 2018).

**Table 4. $CO_2$ Absorption Capacity Based on Land Cover**

| Land Cover | Area* (Ha) a | Power Absorption (Ton/ha/year) b | Proportion (%) | $CO_2$ Absorption Capability (Ton/year) c = a x b |
|---|---|---|---|---|
| Trees | 2,715. 85 | 569.07 | | 1,545,506 |
| Bushes | 1,112.13 | 55 | | 61,167.,13 |
| Grass | 34.12 | 12 | | 409.43 |
| Sawah | 396.31 | 12 | | 4,755.72 |
| Total | **4,258.4** | | **35.94** | **1,611,838** |
| Size of Bogor City | 11,850 | | 100 | |

Table 4 shows the $CO_2$ absorption capability of based on land cover. Land cover is classified based on trees, shrubs, grass and rice fields. It is known that the area of green space based on land cover is 4.258.4 Ha or 35,94 percent of the total area of Bogor City (Bogor City Regional Development Planning Agency, 2015). The calculation of absorption capacity is obtained from the land area multiplied by the absorption capacity of each land cover. It is obtained that the absorption capacity of $CO_2$ is 1.611.838 tons/year.

**Estimation of Land Area of City Park for Hospitality and Restaurant Industry in Bogor City**

To determine the required urban park area, divide unabsorbed $CO_2$ emissions by the absorption capacity of trees, which is 569.07 tons/ha/year. Trees are used due to their higher $CO_2$ absorption compared to other vegetation. Unabsorbed $CO_2$ is calculated by subtracting the absorbed emissions by existing green spaces from the total $CO_2$ emissions. The resulting area needed will absorb the remaining $CO_2$ in Bogor City.

**Table 5. Urban Park Area Required by Bogor City Hospitality and Restaurant Industry**

| Total $CO_2$ emissions of Bogor City (tons/year) | Absorption capacity of Bogor City green spaces (tons/year) | Total $CO_2$ emissions absorbed (tons/year) | Proportion of emissions per sector (%) | Total unabsorbed $CO_2$ emissions (tons/year) | Total city park area required (ha) |
|---|---|---|---|---|---|
| **2,030,311 (a)** | **1,611,838** | **1,611,838 (b)** | **100** | **418,473 (c = a-b)** | Urban park absorption capacity (tons/ha/yr) Trees = 569.07 Grass = 12 |
| Hotel Industry | | | 0.16 | 670* | 57** |
| Restaurant Industry | | | 0.47 | 1967* | 167** |

Description:

* Unabsorbed $CO_2$ emissions per sector = $\frac{proportion\ of\ emissions\ per\ sector}{100}$ x *Total unabsorbed* $CO_2$ *emissions*

Urban park area per tree-specific sector (ha) = $\frac{Unabsorbed\ CO2\ emissions\ per\ sector\ (ton/year)}{Absorption\ capacity\ of\ urban\ park\ tree\ type\ (ton/ha/year)}$

Urban park area per grass-specific sector (ha) = $\frac{Unabsorbed\ CO2\ emissions\ per\ sector\ (ton/year)}{absorption\ capacity\ of\ grass\ type\ city\ park\ (ton/ha/year)}$

** Total urban park area required (ha) = Urban park area dedicated to trees (ha) + Urban park area dedicated to grass (ha).

Table 5 shows the area of urban parks needed to absorb the remaining $CO_2$ emissions that are not absorbed by existing green spaces in Bogor City. The urban park area needed to absorb the remaining $CO_2$ emissions of hotels is 57 Ha, where the remaining emissions generated are 670 tons/year. While the urban park area needed to absorb the remaining $CO_2$ emissions of restaurants is 167 Ha, where the remaining emissions produced are 1.967 tons / year.

## Estimated Value of $CO_2$ Emission Tax Hospitality and Restaurant Industry in Bogor City

This study calculates the emission tax for the hotel and restaurant industry by multiplying the required urban park area for each unit by the cost of creating green spaces. The tax per unit is divided by the total population: hotel population is based on 4.612 rooms (2017 data), and restaurant population on 56.341.400 annual visitors. The following presents Bogor City's hotel and restaurant emission tax costs.

**Table 6. Emission Tax Value of Hotel Industry in Bogor City**

| Sector | Area City Park Required (Ha) a | Cost Creation RTH (Rp/Ha)* b | Tax Value Whole Emissions Hotel (Rp) c = a x b | Average Occupancy City Hotels Bogor** | Population Room ** d | 1 year = 365 day | Emission Tax Value (Rp/room /night) |
|---|---|---|---|---|---|---|---|
| Hotel | 57 | 80,693,273 | **4,599,516,561** | 80% | 4,612 | | **3,415** |

It is obtained that the value of hotel emission tax in Bogor City is Rp 3,415 per room per night. This tax valu e is the same for all hotels in Bogor City, not yet classified by star hotels and non-star hotels. The value of hotel emission tax based on star level can be seen in Table 8.

**Table 7. Emission Tax Value of Restaurant Industry in Bogor City**

| Sector | Required City Park Area (Ha) **a** | Cost Creation Special green space for trees (Rp/Ha)* **b** | Emission Tax Value of All Restaurant (IDR) **c = a x b** | Average visitors per restaurant in Bogor City in a year (people)** | Population restaurant (unit)** | 1 year = 365 day | Tax Value Emission (IDR/trans action) |
|---|---|---|---|---|---|---|---|
| Restaurant | 167 | 80,693,273 | **13,475,776,591** | 82,855 | 680 | | **239** |

The restaurant emission tax is calculated by multiplying the urban park area needed to absorb excess emissions by the cost of creating green spaces. This total tax is then divided by the average yearly visitors and restaurant population in Bogor City, resulting in Rp 239 per transaction, which can be added to the food cost on receipts.

## City Park Cost, Emission Tax Value, and Percentage of Hotel Emission Tax Value by Star Level

The cost of creating a city park is linked to emissions, with higher star levels producing more emissions and thus higher costs (Seutche et al., 2021). Emission tax varies based on hotel room count and average room price, with different values per star level (Tsai et al., 2014). Below are the costs, emission taxes, and percentage of hotel emission tax by star level.

This study classifies urban park construction costs into two types of land cover: trees and

grass. The cost is calculated from total restaurant emissions divided by the absorption capacity of each land cover, then multiplied by the cost of green space creation, which is IDR 80,693,273/Ha. The restaurant emission tax percentage is derived from the emission tax value divided by the average meal cost, based on interviews with 90 respondents in Bogor City, averaging IDR 73,306 per person per transaction.

**Table 8. Cost of urban gardening, emission tax value and percentage of hotel emission tax value by star level**

| Star level | Cost of creating a city park (IDR/ha) | Emission tax value (IDR/room/night) | Emission tax value percentage (%) |
|---|---|---|---|
| 4 | 8,706,389,679 | 11,552 | 0.01 |
| 3 | 7,291,944,668 | 33,032 | 5.5 |
| 2 | 2,773,960,118 | 14,913 | 0.05 |
| 1 | 2,389,450,795 | 23,927 | 12.2 |
| Non-star | 954,407,071 | 11,042 | 12.8 |

**Table 9. City Park Cost and Percentage of Restaurant Emission Tax Value per Transaction**

| Al Restaurants in Bogor City | Cost of creating a city park (Rp/Ha) | Percentage of single-transaction emission tax value (%) |
|---|---|---|
| | 1,365,299,065,981 | 0.3 |

**Formulation of Alternative Policy Implications of $CO_2$ Emission Tax Implementation Hospitality and Restaurant Industry in Bogor City**

This emission tax will raise prices in hotels and restaurants, impacting demand. According to Extended Producer Responsibility (EPR), producers are responsible for their environmental impact. Initially, the local economy will be affected, but it will eventually reach equilibrium. Pollution control uses two instruments: market-based and command-control. Market-based instruments aim to shift producer behavior toward environmentally friendly practices, with two main implications for pollution control. Further research is needed to determine the transition period.

1. Internalization of external costs

According to Law Number 32 of 2009, what is meant by internalization of environmental (external) costs is to include the cost of pollution or environmental damage in the calculation of production costs or the cost of a business activity. In this study, the business in question is the hotel and restaurant business, hotel and restaurant managers can internalize external costs in two ways:

   a. Emission limitation policies can reduce environmental damage through clean technology, such as low-emission power generation. LED lighting is an eco-friendly product with a lifespan of over 30,000 hours, using renewable solar energy, which lowers emissions (Suhardi, 2014).
   b. Hotels and restaurants must allocate at least 10% of their area for green space, ideally with trees for maximum $CO_2$ absorption. Limited space can be addressed using vertical gardens, which significantly expand planting capacity. This method improves energy efficiency and reduces cooling costs by up to 23% (Wicaksono KD, 2016).
   c. Campaigns encouraging hotel guests to save water and electricity are crucial. Guests are reminded to turn off lights when leaving rooms, especially in hotels without automatic lighting systems, to reduce energy consumption.

2. External cost
   a. Emission tax withdrawal for creating city parks in Bogor aims to reduce emissions and

improve air quality. Managed by the Bogor City Revenue Agency, this tax can be earmarked for specific uses, including park creation. According to Bela (2010), earmarking tax involves allocating revenue from one or more sources for specific purposes. In this case, funds from the emission tax, paid by hotel and restaurant visitors, will be used to create parks in high-emission areas like Jalan Pajajaran. Visitors indirectly contribute to emissions through energy consumption at these venues.

b. Bogor City has limited green space to absorb emissions (Nurisjah, 2005), so emissions may be absorbed by the greener Bogor Regency. Bogor City must compensate Bogor Regency for preserving its green spaces, a joint effort to reduce global warming, particularly $CO_2$ emissions (Friedlingstein et al., 2010).

Command-and-control instruments regulate pollution by setting limits on allowable emissions and technology use (Fauzi, 2006). Haryanto et al. (2017) discuss France's policy to reduce $CO_2$ emissions through incentives and disincentives. Hotels and restaurants below the emission standard are exempt from taxes, while those exceeding it must pay. This emission standard determines whether a company pays taxes based on its pollutant output. If emissions exceed the limit, taxes apply; otherwise, no tax is imposed. The policy serves as an example for emission standards in Bogor City.

**Table 10. Emission Standards for the Hospitality Industry in Bogor City**

| Absorption capacity of urban green spaces Bogor (Ton/year) a | Emission Proportion Hospitality Industry (%) b | Total Population Hotel (unit)[2] | Emission Standard (Ton/year/unit) d = axb/100 c |
|---|---|---|---|
| 1,611,838 | 0.16 | 87 | 29.6 |

Table 10 shows the hotel emission standards that are allowed to be discharged into the environment according to the absorption capacity of existing green spaces in Bogor City. Setting emission standards can be done based on the amount of emissions produced by each hotel. This standard setting is not based on the star level because the amount of emissions for each hotel is different.

**Table 11. Emission Standard for Restaurant Industry in Bogor City**

| Absorption capacity of urban green spaces Bogor (Ton/year) a | Emission Proportion Restaurant Industry (%) b | Total Population Restaurant (unit) | Emission Standard (Ton/year/unit) d = axb/100 c |
|---|---|---|---|
| 1,611,838 | 0.47 | 680 | 11.14 |

Table 11 shows the restaurant emission standards that are allowed to be discharged into the environment according to the absorption capacity of existing green spaces in Bogor City. Setting emission standards can be done based on the amount of emissions produced by each restaurant. This standard is not based on location or business scale because the amount of emissions from each restaurant is different.

The next *command and control* instrument that can be carried out is the making of a Regional Regulation regarding the regional action plan for reducing greenhouse gas emissions. According to data from the Environment Agency in the 2017 GHG results report, until 2017 the Bogor City government had not yet established a regional action plan for

reducing greenhouse gas emissions in the form of a legal umbrella, namely the Bogor City Regional Regulation or Bogor Mayor Regulation. Ideally, this regulation should be made immediately so that it becomes a reference for the community and also related agencies in reducing greenhouse gas emissions in Bogor City, especially $CO_2$ gas emissions.

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## CONCLUSION

The conclusions of this research are as follows:

1. Hotels are classified based on star and non-star hotels, resulting in four-star hotel emissions of 1,268 tons/year, three-star hotels of 1,062 tons/year, two-star hotels of 404 tons/year, one-star hotels of 348 tons/year, and non-star hotels of 139 tons/year. Four-star hotels produce the most emissions because four -star hotels have more complete facilities and have more rooms than the lower star hotels so that the energy consumed is greater and produces more emissions.
2. The amount of restaurant $CO_2$ emissions by road section varies. Jalan Baru produces emissions of 1,971 tons/year. Jalan Taken-Fountain produces emissions of 2,401 tons/year. Jalan Pajajaran produces emissions of 2,850 tons/year. Jalan Semeru-Cilendek produces emissions of 942 tons/year and Jalan Bangbarung produces emissions of 1,419 tons/year. Jalan Pajajaran produces the most emissions because Jalan Pajajaran is located in the city center which is crowded with culinary centers and is near the entrance to Bogor City.
3. The amount of restaurant $CO_2$ emissions by road section varies. Jalan Baru produces emissions of 1,971 tons/year. Jalan Taken-Fountain produces emissions of 2,401 tons/year. Jalan Pajajaran produces emissions of 2,850 tons/year. Jalan Semeru-Cilendek produces emissions of 942 tons/year and Jalan Bangbarung produces emissions of 1,419 tons/year. Jalan Pajajaran produces the most emissions because Jalan Pajajaran is located in the city center which is crowded with culinary centers and is near the entrance to Bogor City.
4. The estimated emission tax value obtained for the hotel sector in Bogor City is IDR 3,415 per night per room and the Bogor City restaurant emission tax value is IDR 239 per transaction.
5. Controlling $CO_2$ emissions in Bogor City uses market-based and command-control approaches. Market-based methods include internalizing external costs by limiting emissions with clean technology, requiring 10% green space in hotels/restaurants, and promoting resource-saving. External cost applications include emission taxes for urban parks and compensation to Bogor Regency. Command-control measures involve setting emission standards with incentives/disincentives and creating regional regulations to reduce greenhouse gas emissions.

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