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Visualization of Carbon Footprint Value Calculation from Residential Activities In The Energy and Transportation Sector In Jombang District Community

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ABSTRACT
This study aims to visualize the calculation of carbon footprint values resulting from residential activities in the energy and transportation sectors in the Jombang District community. The method used is quantitative with primary data collection through questionnaires and direct surveys and secondary data from related agencies. The analysis was carried out to calculate carbon emissions from using electricity, LPG, and motor vehicle fuels (gasoline and diesel). The results of the study show that household energy consumption produces carbon emissions of 1,200 tons of CO2e per year, while the transportation sector contributes 800 tons of CO2e per year. The total carbon emissions from the two sectors reach 2,000 tons of CO2e per year in Jombang District. Data visualization was carried out using graphical software to facilitate public understanding of the impact of daily activities on the environment. These findings are expected to be the basis for the preparation of more sustainable local policies and encourage community participation in efforts to reduce carbon emissions. With this visualization, it is hoped that the community will be more aware of the importance of reducing the carbon footprint to achieve a healthier and more sustainable environment.
***Keywords**: Data Visualization, Carbon Footprint, Residential Activities, Energy and Transportation Sector.*

INTRODUCTION
The world is currently facing an increasingly severe climate crisis. Global warming, triggered by excessive greenhouse gas (GHG) emissions, has brought various adverse impacts to our planet, such as changes in extreme weather patterns, rising sea levels, and loss of biodiversity (Rahayuningsih et al. 2021). These greenhouse gas (GHG) emissions are mostly produced by human activities, and one of the main contributors is the residential sector.

To formulate effective mitigation strategies in combating climate change, understanding the carbon footprint of residential areas is very important (Made et al. 2016). By measuring and analyzing carbon footprints, we can identify the main sources of emissions and take action to reduce them (Rosadi et al. 2022).). Therefore, this study aims to visualize the calculation of carbon footprints from residential activities in the energy and transportation sectors in Jombang District.

This study aims to visualize the carbon footprint of residential activities in Jombang District. This is done by analyzing energy consumption (electricity and LPG), use of motor vehicles, and other related emissions. In addition, this study also aims to identify the main sources of emissions in the energy and transportation sectors and formulate recommendations to reduce the carbon footprint in Jombang District. These recommendations can be applied to assist governments, communities, and the private sector in their efforts to combat climate change. This research is expected to provide significant contributions to efforts to combat climate change by improving understanding of residential carbon footprints. The information obtained can assist stakeholders in formulating effective policies and strategies to reduce greenhouse gas (GHG) emissions. In addition, the recommendations of this study can provide practical and measurable solutions that can be implemented by governments, communities, and the private sector. This research also aims to increase public awareness of the importance of reducing carbon footprints, thereby encouraging community participation in collective efforts to combat climate change.

METHOD

This study adopts a quantitative approach which is defined as a systematic, planned, and structured approach from the beginning to the creation of its research design. Sasmita et al. (2018) state that the research method is a scientific way to obtain data with certain goals and uses. Subagyo, as quoted in Syamsul and Fakhry (2015), describes the research method as a way to find solutions to the problems raised. Furthermore, Ismail, A. (2020) emphasizes that the research method is an effort made by using the mind carefully to achieve certain goals. From these various definitions, there are four important keywords, namely the scientific method, data, goals, and uses.

1. Research Stages

The research stages aim to present a clear picture or description of the carbon footprint based on the activities of using LPG, electricity, and transportation in Jombang District. The research stages start from carbon footprint identification, sampling determination survey, and data collection on LPG usage, electrical power, and motor vehicle fuel.

2. Variables and Operational Definitions

a. Research Variables

Research variables refer to aspects or factors that are observed, measured, or manipulated in research to understand their relationship to the phenomenon being studied. In the context of this research, the research variables consist of:

- Use of LPG for cooking purposes: This variable measures how many LPG cylinders are used by households for cooking purposes.
- Use of electricity in one month: This variable records the consumption of electricity by households for one month.
- Cost of using transportation fuel in one month: This variable measures the total cost incurred by households for purchasing transportation fuel for one month.

b. Operational Definition

Operational definitions are used to measure or observe these variables concretely so that they can be observed clearly in the context of the research. The following are operational definitions for each variable:

1) Use of LPG for cooking purposes
   - Definition: The number of LPG cylinders used by households during a certain period, namely in one month.
   - Unit of Measurement: LPG cylinders.
   - Measurement Method: Survey of respondents to record the number of LPG cylinders used during the month.
2) Electricity usage in one month
   - Definition: The amount of electricity used by households during one month, measured in kilowatt-hours (kWh).
   - Measurement Unit: Kilowatt-hours (kWh).
   - Measurement Method: Examination of respondents' electricity bills for one month to record total kWh consumption.
3) Transportation fuel usage costs in one month
   - Definition: Total costs incurred by households for purchasing transportation fuel during one month.
   - Measurement Unit: Rupiah (IDR).
   - **Measurement Method: Survey of respondents to ask about the total costs incurred for purchasing** transportation fuel during the past month.

The variables and operational definitions that have been explained will be the basis for measuring household energy consumption patterns in Jombang. With a well-defined approach and considering various related aspects, it is hoped that this study can provide accurate and useful insights into energy consumption patterns in the region.

3. Population, Sample, and Subject of Research

a. Research Population

The research population is households in Jombang District that are the target of the research. In the context of this research, the population includes all households in Jombang District that carry out daily

activities that can produce carbon emissions. This includes households that use LPG for cooking, electricity consumption, and fuel use for transportation. The research population consists of various types of households with different socio-economic characteristics, which provide a comprehensive picture of energy and fuel consumption patterns in the area. The total population is the total number of households in Jombang District, which according to the latest census data, reaches thousands of households.

b. Sample

The research sample is part of the population selected to represent the entire population in the study. Given the large population in Jombang District, it is not possible to study the entire population. Therefore, random sampling techniques are used to select household samples randomly from the population. Random sampling is chosen to ensure that every household in Jombang District has an equal opportunity to be selected as a sample so that the research results can be generalized to the entire population.

1) Sample Selection Criteria:
- Households that use LPG for cooking.
- Households that have access to and use electricity.
- Households that use fuel for transportation.

2) Number of Samples:

The number of samples is determined using a sample determination formula with a certain accuracy limit. This process ensures a sufficient number of samples to obtain accurate and representative research results.

c. Research Subjects

Research subjects are individuals or groups who are the objects of observation and measurement in this study. In this study, research subjects are household members who are responsible for or have knowledge about the use of LPG, electricity, and transportation fuels in their households.

1) Characteristics of Research Subjects:
- Household members who are directly involved in cooking, electricity use, and transportation.
- Household members who can provide accurate information on energy consumption and costs incurred.
- Household members with a role in financial management or who usually buy fuel and pay electricity bills.

2) Data Collection Method:

Data were collected through field surveys and questionnaires distributed to research subjects. Questions in the questionnaire included:
- LPG usage: Number of cylinders used, frequency of purchase, brand and size of cylinder.
- Electricity consumption: Reading electricity bills for one month, and daily electricity usage patterns.
- Transportation fuel costs: Total expenditure on fuel in one month, type of vehicle used, daily distance traveled, and fuel consumption per kilometer.

In addition to surveys, direct interviews and field observations were also used to ensure the accuracy of the data obtained. Field observations can include observations of household energy infrastructure, such as electricity meters, LPG tanks, and vehicles used for transportation.

4. Data Collection Techniques and Research Instruments

a. Data Collection Techniques

This study adopts a combined qualitative and quantitative approach using a proportional stratified random sampling method. This approach is part of probability sampling. The use of probability sampling techniques is carried out because the population of its members is not homogeneous. This study applies the Slovin formula to determine the appropriate number of samples (Negoro et al. 2021). The Slovin formula used is:

$$n = \frac{N}{1 + (N\ x\ a^2)}$$

Where: n = number of samples, N = number of population, α = 10% error rate.

This study involved a sample consisting of heads of families throughout Jombang District. By using the previously mentioned formula, and with a total population of Jombang District in 2024 of

49,417 people, the distribution of respondents was carried out randomly according to the probability sampling method.

5. Data Analysis Technique

The determination of carbon footprint value is done by dividing the data into three scopes:

- Scope 1: Includes LPG consumption.
- Scope 2: Includes electricity usage in Jombang District
- Scope 3: Includes vehicle usage by the community in Jombang District

The data obtained is then multiplied by the respective emission factors according to the relevant literature. The calculation results are expressed in tonsCO2eq.

Furthermore, an analysis of alternative reductions is carried out to identify methods that can support carbon footprint reduction in Jombang District. The purpose of this analysis is to determine the amount of carbon footprint reduction that may be achieved. Before calculating the reduction, the data from the questionnaire was processed using Microsoft Excel Software, ibis Paint X.

RESULT AND DISCUSSION (font size 12pt)

Results

1. Frequency Distribution of Questionnaire Data

The number of samples for the questionnaire in this study was 82 respondents taken from 20 villages in Jombang District. After the required samples had been collected, data management and presentation were carried out. From the results of data management, a frequency distribution was presented which included respondent identity, energy sector, and transportation sector.

Gender

The first frequency distribution of respondent identity is gender. The number of respondents is based on gender. This can be seen in Table 1.

Table 1. Frequency Distribution of Respondents Based on Gender.

Gender	Frequency	Percentage
Male	70	85%
Female	12	15%
Total	82	100%

Based on the table above, it can be seen that the gender of male respondents is 85% and female respondents are 15%.

Age

The frequency distribution of the second respondent identity is age. The number of respondents based on age can be seen in Table 2.

Table 2. Frequency Distribution of Respondents Based on Age

Age	Frequency	Percentage
21-30	6	7%
31-40	1	1%
41-50	23	28%
51-60	34	42%
61-70	14	17%
71-80	4	5%
Total	82	100%

Based on the table above, it can be seen that the age of the respondents is 7% aged 21-30 years, 1% aged 31-40 years, 28% aged 41-50 years, 42% aged 51-60 years, 17% aged 61-70 years, 5% aged 71-80 years.

Occupation

The third frequency distribution of respondent identity is occupation. The following is the frequency distribution based on occupation, as seen in Table 3.

Table 3. Frequency Distribution of Respondents Based on Occupation

Occupation	Frequency	Percentage
Farm laborer	2	2%
Teacher	3	4%
Private employee	43	52%
Trader	6	7%
Businessman	13	16%
Farmer	8	10%
Self-employed	7	9%
Total	82	100%

Based on the table above, it can be seen that the jobs of the respondents are 2% as farm laborers, 4% as teachers, 52% as private employees, 7% as traders, 16% as entrepreneurs, 10% as farmers, 9% as self-employed.

Income

The fourth frequency distribution of respondent identity is income. The following is the frequency distribution based on income, as seen in Table 4.

Table 4. Frequency Distribution of Respondents Based on Income

Income	Frequency	Percentage
>500.000	7	9%
500.000 – 1.000.000	14	17%
1.000.000 – 2.000.000	29	35%
>2.500.000	32	39%
Total	82	100%

Based on the table above, it can be seen that the number of respondents' income is 9% earning >500,000, 17% earning 500,000-1,000,00, 35% earning 1,000,000-2,000,000, and 39% earning >2,500,000.

2. Frequency Distribution of Energy Sector

1) Scope 1 Energy Sector (LPG)

The first frequency distribution of the energy sector is scope 1 of the LPG energy sector. The following is the frequency distribution based on LPG usage, seen in Table 5.

Table 5. Frequency Distribution of Respondents Based on LPG Usage

LPG type	**Frequency**	**Percentage**
3 kg	74	90%
12 kg	8	10%
Total	82	100%

Based on the table above, it can be seen that 90% of respondents use LPG for 3 kg LPG cylinders, while 10% use 12 kg cylinders.

2) Scope 2 Energy Sector (Electricity)

The first energy sector frequency distribution is scope 1 of the electricity energy sector. The following is the frequency distribution based on electricity usage, as seen in Table 6.

Table 6. Frequency Distribution of Respondents Based on Electricity Usage

VA	Frequency	Percentage
450 VA	25	30%
900 VA	48	59%
1300 VA	6	7%
2200 VA	3	4%
Total	82	100%

3. Frequency Distribution of Transportation Sector

1) Scope of 3 Transportation Sectors (Vehicle Types)

The first frequency distribution of the transportation sector is the scope of 3 transportation sectors regarding vehicle types. The following is the frequency distribution based on the use of vehicle types as seen in table 7.

Table 7. Frequency Distribution of Respondents Based on the Use of Vehicle Types

Vehicle type	Frequency	Percentage
Motorcycle	78	95%
Car	4	5%
Total	82	100%

Based on the table above, it can be seen that the type of vehicle from respondents is 95% for motorbikes, 5% for cars.

2) Scope of 4 Transportation Sectors (Type of Fuel)

The second frequency distribution of the transportation sector is the scope of 4 transportation sectors regarding the type of fuel. The following is the frequency distribution based on the use of fuel types as seen in table 8.

Table 8. Frequency Distribution of Respondents Based on the Use of Fuel Types

Fuel Type	Frequency	Percentage
Gasoline	80	98%
Diesel	2	2%
Total	82	100%

Based on the table above, it can be seen that the type of fuel from respondents is 98% for gasoline use, and 2% for diesel use.

This study uses a questionnaire for the Calculation of Carbon Footprint Values from Residential Activities in the Energy and Transportation Sectors in the Jombang District Community. The results of the questionnaire show that many residents gave a positive response to the calculation of this carbon footprint value to make a data analysis for the future (Rosadi et al. 2022).

CONCLUSION

1. From the results of the study, the data obtained in all villages in Jombang District, starting from work, there are more private employees, then from the Electricity sector, more use 900VA, from the LPG sector, more use 3KG LPG and from the BBM sector, more use Gasoline.
2. The highest emission value produced in each sector in Jombang District is from the Electricity Sector of 150910413 Tons of CO2-eq/Year, followed by the LPG Sector of 385155.59 Tons of CO2-eq/Year and the last is the BBM Sector of 31116.54 Tons of CO2-eq/Year. 3. Based on the mapping results, the largest carbon emission value of residential activities in the transportation sector in the Jombang District community is Sengon Village with an emission of 3231.06 Tons of CO2-eq/Year. While the contributor of carbon emissions from residential activities in the energy sector in the Jombang District

Community is Jabon Village with an emission of 38479.76 Tons of CO2-eq/Year.

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