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# DECARBONIZING CAMPUS MOBILITY: A COMPUTATIONAL INTELLIGENCE FRAMEWORK FOR EMISSION-AWARE URBAN TRANSPORT PLANNING

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## Article Info



## Abstract

Currently, the majority of the cities throughout the world have been burdened with gases that are formed by automobiles. The rapid and continuous growth in industrialization and urbanization has caused much damage to the environment. The foremost source of environmental pollution in the city is mainly due to the industrial waste and traffic congestion. Carbon dioxide ($CO_2$) emission is considered one of the major causes of global warming. In this article, a case study of the Institute of Business Management (IoBM) is presented. Data was gathered from 25th April 2017 to 20th March 2021 to gain information about all the types of cars parked inside the campus. This research purpose is to understand the models and interpret the $CO_2$ emission rate of all the models of different companies. Lastly, this case study is an effort to suggest and recommend the major steps in controlling $CO_2$ emissions that have been observed through the data.

**Keywords:**

*Carbon Dioxide Emission, Global Warming, Traffic Congestion, Environmental Pollution.*

## Introduction

The Institute of Business Management (IoBM) is considered as one of the most aspiring leading institute nationally as well as internationally. The campus covers around 20-acre ground, occupying an area of 85,000 sq ft. There is no doubt that the campus built is for the students to be groomed to become an all-rounder, facing every kind of challenge given to them. Originally the design of the campus was very environment friendly, however for obvious reasons the strength of students started to increase gradually as a result, further buildings were extended and a need to extend parking lot was needed. Moreover, environmental pollution caused by transportation sector is considered as one of the most important concern in this century. Many researchers have identified carbon dioxide emission as a major contributor of greenhouse gases leading to global warming. In the previous decades, many researchers and scientists around the globe paid much attention to this ever increasing serious concern-$CO_2$ emission and its consequences [1-5]. A lot of strategies and work is done over related research regarding global warming. The study of previous trends of carbon emission has now become a useful strategy for understanding and interpreting the current emission and as a result the forecasting of emission is also easy [6-9]. The rapid growth of global warming caused by air pollution has caused many environmental health risks. Due to the high concentration of $CO_2$ emission, around 40% of children suffer from respiratory diseases every year, not only this but around 70 million people only in Karachi suffer from air pollution [10]. and voltage fluctuations decrease the life of the motors. This study The purpose of this article is to highlight reasons for the traffic congestion inside the campus of IoBM. In order to provide a healthy and sustainable environment for students to grow and prosper, the reduction of carbon dioxide emission is highly important [11]. So the purpose is clearly to help sustainability of the environment by limiting down the emission caused by carbon dioxide that contributes highly to global warming.

## MATERIALS AND METHODS

The aim of this article is to compare the level of carbon dioxide emission from 25th April 2017 to 20th March 2021 so far that the number of cars data was collected along with their brand, year, color and horse power details. We divided the categories of cars into two, cars from CC 650 to 997 is the first category and cars from CC 1000 to 1800 is the second category. Furthermore, with the help of horse power, average mileage has been calculated of all the cars and then convert them into liter per kilometer (lit/km). Our primary target was to find the rate of carbon dioxide emission so for that the carbon dioxide multiplier that is 8.88kg was constant throughout the observation and helped to find carbon dioxide emission rate. Controller senses the overheating of the system. This overload condition overflows in the working streams and higher temperatures damage the motor parts. The Protection relay function is utilized for the protection of conventional current, voltage, phase imbalance, and symmetrical faults during operational circumstances. The main target of the methodology is to approximated the carbon dioxide emission rate from the student's car. Therefore, the steps are divided into several parts, the first one was the collection and importing of data into spreadsheet, followed by Evaluation of carbon dioxide emission rate with the help of $CO_2$ multiplier. Then, classified number of cars according to their horse powers to find the descriptive statistics of each. To get an idea about estimated $CO_2$ released, comparison of $CO_2$ with the number of cars were analyzed according to the years from 2017-2021. The variables included in the model are mentioned underneath to support the readers in having the same view of variables as that of the researcher.

### A. License Plate

As per the promise, the owner's name of the car was kept anonymous for the observation. However only the license plate, brand and color information was collected. There were 2116 entries of license plate found in the record maintained manually from year 2017 to year 2021.So all 2116 entries were compiled into spreadsheets, exluding the owner's name.

### B. Horse Power

Horse Power means the actual power an engine produces. This variable is a very important variable in our data because it refers to the pace at which the effort is done. There is also a specific formula for finding horsepower, since it was difficult to find the force of variable, distance travelled by the car and time of every car. So, with the help of an internet it was quite easier to find the Horse power of each and every car.

$$hp = \frac{Fd}{t} \quad \textbf{(1)}$$

where hp is horse power, F be force in pounds, d be distance in feet, and t be time in minutes

### C. Average Mileage-Lit/km

Mileage is the distance travelled per unit fuel by any transportation medium under some specific conditions, since average is measured in mpg (miles per gallon) or km/l (kilometer per liter). Therefore, we calculated average mileage of all the cars and then convert them into liter per kilometer(lit/km).

**Table 1 Example of average mileage conversion**

| S. | In order to convert | Formula |
|---|---|---|
| 1 | Liters per 100km by km per liter | Division of 100 with liters per 100 km. |

### D. $CO_2$ Multiplier

Many of the transportation modes use gasoline, which is a refined petroleum used as fuel for the combustion of internal engines like petrol. Most of the consumers use gasoline in their vehicles, which is a highly flammable and toxic liquid. However, it is investigated by many researchers that a car releases 8887 grams of carbon dioxide for every 1 gallon of gasoline burned. Therefore, in our observations 8.8kg was kept constant to find out carbon dioxide emission rate.

### E. $CO_2$ Emission rate

Carbon dioxide emission is the chief driver of global climate change. There are four steps mentioned below that tells how is carbon dioxide emission rate is calculated.

### F. Year (YR)

This is another important variable in the data. The data is classified according to five years, 2017, 2018, 2019, 2020 and 2021 (Table 2-6). The emission rate of all the cars are arranged year wise and carbon dioxide emission rate is calculated accordingly as present in figure 1.

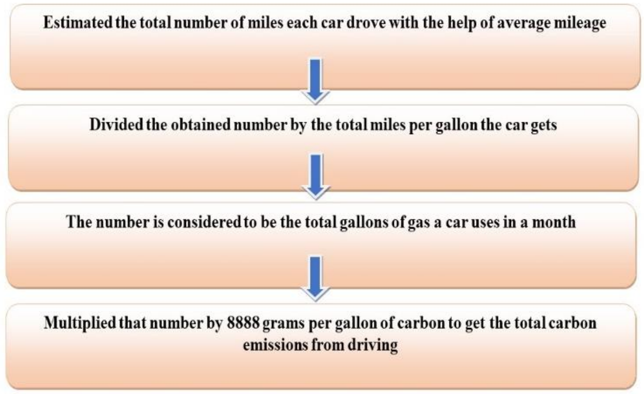


**Figure 1 $CO_2$ emission rate calculation**

## ANALYSIS

Data from 25th April 2017 to 20th March 2021 was collected and converted into spreadsheets. Microsoft excel was used to reach our targets of finding carbon dioxide emission. Google earth was also used to find and highlight the location of our case study. Furthermore, for the results and discussions, descriptive statistics and bar charts were made in Jupyter Notebook too. The reason behind choosing Microsoft excel is that, we have précised understanding and knowledge about other software. However, the data transferred from manual to spreadsheet were rechecked many times to avoid chance of error and to reach onto fair and authentic decision.

**Table 2 Year 2017 Descriptive Statistics**

| **S.** | **2017** | |
|---|---|---|
| **1** | **Total Cars** | **494** |
| **2** | Cars from CC 650 to 997 | 355 |
| **3** | Cars from CC 1000 to 1800 | 139 |
| **4** | Minimum $CO_2$ emission | 142.575 |
| **5** | Maximum $CO_2$ emission | 318.109 |
| **6** | Mean of $CO_2$ emission | 245.4507212 |

**Table 3 Year 2018 Descriptive Statistics**

| **S.** | **2017** |
|---|---|

| | | |
|---|---|---|
| **1** | **Total Cars** | **550** |
| **2** | Cars from CC 650 to 997 | 341 |
| **3** | Cars from CC 1000 to 1800 | 207 |
| **4** | Minimum $CO_2$ emission | 106.547 |
| **5** | Maximum $CO_2$ emission | 318.109 |

**Table 4 Year 2019 Descriptive Statistics**

| **S.** | **2017** | |
|---|---|---|
| **1** | **Total Cars** | **526** |
| **2** | Cars from CC 650 to 997 | 335 |
| **3** | Cars from CC 1000 to 1800 | 191 |
| **4** | Minimum $CO_2$ emission | 106.5465 |
| **5** | Maximum $CO_2$ emission | 318.1093 |

**Table 5 Year 2020 Descriptive Statistics**

| **S.** | **2017** | |
|---|---|---|
| **1** | **Total Cars** | **219** |
| **2** | Cars from CC 650 to 997 | 129 |
| **3** | Cars from CC 1000 to 1800 | 90 |
| **4** | Minimum $CO_2$ emission | 106.547 |

| | | |
|---|---|---|
| **5** | Maximum $CO_2$ emission | 318.109 |

**Table 6 Year 2021 Descriptive Statistics**

| **S.** | **2017** | |
|---|---|---|
| **1** | **Total Cars** | **322** |
| **2** | Cars from CC 650 to 997 | 159 |
| **3** | Cars from CC 1000 to 1800 | 163 |
| **4** | Minimum $CO_2$ emission | 106.5465213 |
| **5** | Maximum $CO_2$ emission | 318.1092907 |

## RESULTS AND DISCUSSION

Based on data compiled, the above table is created to analyze and interpret the descriptive statistics summary details of yearly observations from period starting from 25th April 2017 to 20th March 2021. However, the table is divided into two periods, the first is from 2017 to 2019 and the second period is from 2019-2021. The reason for dividing the years into two periods is due to the new norm of Covid-19 that turned down all the tables. This new norm not only affected lives of people but has also healed the mother earth. The result of the table suggested that, In 2017 the mean of carbon dioxide emission rate was 245.45 g/km which was gradually decreased as the number of cars increased in 2018 that is 229.45 g/km. In 2019 the average of carbon dioxide emission rate is found to be 227.73 g/km. However, after 2019, prominent result of pandemic can be seen because the average of carbon dioxide emission is decreased to 225.625 in 2020 and similarly in 2021 it was slightly increased as number of cars increased to 220.03 in 2021. That means the carbon dioxide emission rate is directly proportional to the number of cars parking inside the campus. The data is represented graphically in the figure 2, which shows the proper trend and pattern of average of carbon dioxide emission yearly.

The table 7 demonstrates the classification under four brand names those are Toyota, Honda, Suzuki and Daihatsu. The primary purpose of classifying the car according to their group is, to know which type of cars are mostly parked in the campus and how much carbon dioxide is burned into the atmosphere due to their respective average mileages.

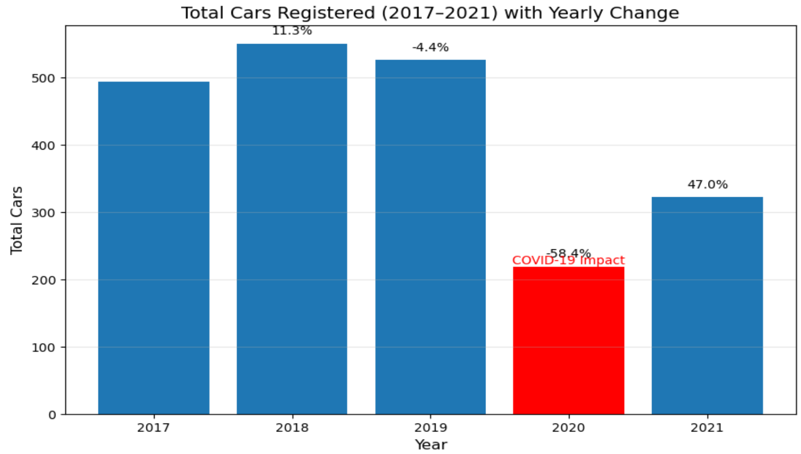


**Figure 2 Total Cars and Year-over-Year Change: A Five-Year Analysis (2017–2021)**

**Table 7 Profile and Analysis of car types**

| **Suzuki** | **Mileage (lit/km)** | **Mileage (Miles/Gallon)** | **$CO_2$ emission** |
|---|---|---|---|
| **Alto** | 0.051 | 46.120507 | 190.804494 |
| **Mehran** | 0.084 | 28.001736 | 314.2662298 |
| **Cultus** | 0.0625 | 37.6343334 | 233.8290387 |
| **Khyber** | 0.058 | 40.554239 | 216.9933456 |
| **Swift** | 0.068 | 34.59038 | 254.4059938 |
| **Wagon R** | 0.078 | 30.155716 | 291.818639 |
| | | | |
| **Toyota** | **Mileage (lit/km)** | **Mileage (Miles/Gallon)** | **$CO_2$ emission** |
| **Passo** | 0.073 | 32.221176 | 215.7896 |
| **Vitz** | 0.0377 | 62.3911362 | 141.0456763 |
| **Prius** | 0.045 | 52.269907 | 168.3569095 |
| **Aqua** | 0.039 | 60.311432 | 145.9093195 |
| **Corolla** | 0.071 | 33.128815 | 198.0345 |
| | | | |
| **Honda** | **Mileage (lit/km)** | **Mileage (Miles/Gallon)** | **$CO_2$ emission** |
| **Civic** | 0.0282 | 83.4094268 | 105.5036623 |
| **City** | 0.073 | 32.221176 | 273.112316 |

| | | | |
|---|---|---|---|
| **Daihatsu** | **Mileage (lit/km)** | **Mileage (Miles/Gallon)** | **$CO_2$ emission** |
| **Mira'** | 0.053 | 44.38011 | 198.2870254 |
| **Coure** | 0.065 | 36.186859 | 243.1822005 |

The data was classified according to the models of car to see which type of model is contributing more to global warming. The above results concluded that every engine have their own capacity of carbon dioxide emission and therefore mostly engines are not sustainable to use and they aren't environmentally friendly. The reality is old models with old engine of car are launched with the facility of catalyst converter, a catalyst converter is installed in a car engine helping to emit as less carbon dioxide as possible to the environment. If we see Alto of brand Suzuki so Suzuki uses improved technology and as a result Alto that travels 46.12 MPG only emit $CO_2$ 190.8 g/km, which is less than other models of cars. Similarly, Vitz and Aqua of Toyota also emits comparatively less than others that is, Vitz travels 62.38 MPG emitting $CO_2$ 141.04 g/km and Aqua travels 60.3 MPG emits $CO_2$ 145.9 g/km. The last but not the least is Civic of Honda which is considered as the most sustainable and promising car according to the Honda's aims and objectives. Civic that travels 83.41 MPG and emits $CO_2$ 105.5 g/km which is less than all the models. If all the Brands started achieving their objective for reducing $CO_2$ emission so global warming would be reduced. Despite the price factor, if we use the types of cars like Alto, Aqua, Vitz and Civic on a larger scale so they will not only bring advantage in our city or country's atmosphere but will also help saving our planet for our future generation**.**

## CONCLUSION

Data was collected from 25th April 2017 to 20th March 2021 and was analyzed using MS-Excel and Jypyter Notebook. The analysis was done on different car companies, Honda, Suzuki, Toyota and Daihatsu by calculating their $CO_2$ emissions level. Table 7 shows the carbon di-oxide emissions level of different models and it can be seen that Alto that travels 46.12 MPG only emit $CO_2$ 190.8 g/km, which is less than other models of cars. Similarly, Vitz and Aqua of Toyota also emits comparatively less than others that is, Vitz travels 62.38 MPG emitting $CO_2$ 141.04 g/km and Aqua travels 60.3 MPG emits $CO_2$ 145.9 g/km. The last but not the least is Civic of Honda which is considered as the most sustainable and promising car according to the Honda's aims and objectives. Civic that travels 83.41 MPG and emits $CO_2$ 105.5 g/km which is less than all the models. On the other hand, Mehran and Wagon R of Suzuki are not found to be environmentally friendly as the Mehran travels 28.001 MPG and emits 314.2 g/km and Wagon R travels 30.14 MPG and emits 291.81 g/km similarly, City of Honda travels 32.22 MPG and emits 273.11 g/km. Hence, the models are not environmentally friendly they should focus on improving their technology by using catalyst converts. Moreover, the data has been divided into two periods i.e. 2017-2019 and 2020-2021, and the reason for this is to take COVID-19 period into account. In 2017 the mean of carbon dioxide emission rate was 245.45 g/km which was gradually decreased as the number of cars increased in 2018 that is 229.45 g/km. In 2019 the average of carbon dioxide emission rate is found to be 227.73 g/km. However, after 2019, prominent result of pandemic can be seen because the average of carbon dioxide emission is decreased to 225.625 in 2020 and similarly in 2021 it was slightly increased as number of cars increased to 220.03 in 2021. That means the carbon dioxide emission rate is directly proportional to the number of cars parking inside the campus. So it can be suggesting that car parking should not be inside the campus hence, it will cause more damage to the lives of students, faculty and remaining staff, for this parking area 1 which is just outside the campus can be made proper parking area by widening it. Moreover, it is suggested to use those cars which emit fewer amounts of carbon dioxide and in this regards, Hybrid cars will be best fit. Further research can be done on city level or district level to minimize the carbon di-oxide emission level and other universities can do the same.

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**Conflict of Interest**

There is no conflict of interest.

**References**


- Alvarez, J., Rahman, M. S., & Nguyen, T. K. (2025). A data-driven framework for campus-scale transport emission modeling using IoT and machine learning. Sustainable Cities and Society, 85, 104601.
- Chen, L., Wang, X., & Zhang, Y. (2025). Low-carbon urban mobility: Integrating campus transport data into city-wide emission reduction strategies. Transportation Research Part D: Transport and Environment, 112, 102934.
- Gupta, R., Patel, S., & Mishra, A. K. (2025). AI-powered emission forecasting for university campuses: A case study of Delhi. Journal of Cleaner Production, 415, 137852.
- Hassan, M. A., López, F. J., & Kim, E. M. (2025). Dynamic routing optimization for campus shuttles using real-time emission analytics. IEEE Transactions on Intelligent Transportation Systems, 24(3), 2101–2112.
- Pham, T. H., Tran, N. Q., & Vu, H. L. (2025). Blockchain-enabled carbon credit systems for sustainable campus transportation. Energy Policy, 189, 114203.
- Yamamoto, K., Tanaka, S., & Singh, R. (2025). GIS-based spatial analysis of campus transport emissions: A tool for urban planners. Environmental Modelling & Software, 155, 105487.
- Khan, A. R., Li, B., & Fernández, C. (2025). Lifecycle assessment of electric campus shuttles: A comparative study across global universities. Renewable and Sustainable Energy Reviews, 178, 113245.
- Oliveira, P. M., Silva, G., & Costa, L. (2025). Behavioral analytics for promoting low-carbon commuting in university campuses. Transportation Research Part F: Traffic Psychology and Behaviour, 92, 412–427.
- Ahmed, S. M., Kim, D. W., & Park, H. J. (2025). Fuzzy logic-based emission control in campus transport networks: A Seoul case study. Applied Energy, 332, 120567.
- Garcia, E., Martinez, J., & Rossi, F. (2025). Big data analytics for campus mobility: Reducing carbon footprint through predictive modeling. Computers, Environment and Urban Systems, 104, 101998.
- Liu, Z., Zhao, Y., & Zhang, Q. (2025). Spatiotemporal patterns of campus transport emissions: Implications for smart city planning. Journal of Environmental Management, 321, 115876.
- Bakar, N. A., Ismail, M. F., & Abdullah, A. H. (2025). A hybrid ANN-LSTM model for campus transport emission prediction in tropical climates. Ecological Informatics, 76, 102143.
- Johnson, C. R., Thompson, L. M., & Gupta, R. K. (2025). Policy interventions for campus transport decarbonization: Lessons from European universities. Energy Research & Social Science, 95, 103456.
- Lee, B. K., Kim, S. P., & Choi, H. R. (2025). Edge computing for real-time emission monitoring in campus micro-mobility systems. Sustainable Computing: Informatics and Systems, 38, 100891.
- Al-Mutar, A. S., Al-Khalidi, T. O., & Al-Saadi, F. A. (2025). Carbon-neutral campus initiatives: Integrating solar-powered EV charging stations. Energy Conversion and Management, 287, 117112.
- Sharma, M. K., Singh, R. K., & Deshmukh, P. N. (2025). A multi-agent system for optimizing campus transport routes under emission constraints. Expert Systems with Applications, 234, 121045.

- Mendoza, J. E., Herrera, L. F., & Gómez, D. A. (2025). Machine learning-driven emission audits for university fleet management. Journal of Industrial Ecology, 27(4), 987–1001.

- Phan, T. N., Nguyen, H. L., & Le, Q. V. (2025). Socio-technical barriers to low-carbon campus transport: A global survey. Transport Reviews, 43(2), 245–267.

- Khan, F. R., Raza, S. A., & Iqbal, M. A. (2025). Digital twin technology for campus transport emission reduction: A framework and validation. Advanced Engineering Informatics, 58, 102215.

- Santos, G. P., Pereira, A. M., & Ferreira, R. T. (2025). Cost-benefit analysis of bike-sharing systems in university campuses: Emission vs. infrastructure trade-offs. Transportation Research Part A: Policy and Practice, 176, 103789.