Changes in CO2 Emissions in Online Student Learning Activities Due to the COVID-19 Pandemic in Indonesia and Japan

D P J Salamena1, Y Cong1, F Lin1, F Ardisa1, U Novella1, T Kurosawa2, M Sako2, Y Ohtani2, and I Fujiyama2
1Japanese Department Bina Nusantara University, Jakarta, Indonesia
2International Relation Division Wakayama University, Wakayama, Japan
faustina.ardisa@binus.ac.id

Abstract. The Covid-19 pandemic is impacting entire countries. One of them is having an impact on CO2 emissions in Indonesia and Japan. The research project is focused on the use of transportation and electricity by Japanese Literature students of BINUS and Wakayama University Japan students before and during the pandemic. Concepts and methodologies, looking at the situation before and during a pandemic, using quantitative methods and approaches based on carbon footprint analysis. This study provides results showing that the use of electronics and transportation which has CO2 emissions is drastically reduced both in Indonesia and in Japan. However, Japan has higher CO2 emissions when compared to Indonesia which is influenced by certain factors, such as transportation mileage.

1. Introduction
Sustainable Development Goals (SDGs) are a global action plan that has been agreed upon by world leaders, including Indonesia. The SDGs have the goal of ending poverty, reducing inequality, and providing environmental protection. SDGs has 17 goals and 169 targets to be achieved by the year 2030 [1]. The goal in SDGs is to achieve universal common goals to maintain balance between three dimensions of sustainable development, namely environmental, social, and economic dimensions [2].

Most countries have started the implementation of the SDGs with the total of 66 countries had reported progress within the first 18 months of implementation. Several developed countries had also published further research on their approaches to the SDGs and national progress. In its implementation, things that need to be maintained in sustainable development are categorized into three main categories, namely nature, life support systems, and community [3]. In general, the environment and nature are used to support human life. On the other hand, nature is also highly valued and is not to be seen as a tool of utilization for humans [4].

The Coronavirus pandemic, widely named as Covid-19, is still rampant and continues to create major impacts on people's lives. As such, leaving the house with a mask, maintaining a distance, and washing hands has become the mandatory procedure within the public area. Likewise, activities involving a great number of people had to be halted, and students’ face-to-face classes became difficult to maintain, resulting in schools changing its procedure to E-learning. E-learning is an education system that uses ICT to transform the learning process between educators and students [5]. Online learning has now become major, and for some students, an unpleasant experience, especially for new students who imagine a pleasant campus life.
The emergence of the Covid-19 pandemic leaves many negative impacts of human life, but there is also good news. For example, the Venice's canals are being cleared due to a decline in tourists. Meanwhile, in a campus environment, students can spend less fees on transportation because their classes have become online, and the students no longer need to go to campus to study.

This research is focused on one of the SDGs concepts that emphasize environmental sustainability, namely being able to maintain stable resources, avoid exploitation of natural resources and the function of environmental absorption. This research was conducted in collaboration between Japanese Literature students in Bina Nusantara University and students in Wakayama University, Japan to see how CO2 emissions change before and during the pandemic.

2. Concept and Method
In the period before the pandemic, the use of energy had always increased every year. The average energy consumption each year continues to increase [6]. While the trend of using electronic equipment and machines have significant contribution to the increasing of energy consumption, motorized vehicles is also a significant element [7]. One of the factors that increase the number of vehicles in society is the vehicles used by students [8].

Reducing CO2 emissions is one of the SDGs targets to improve environmental conditions. The world has taken important steps, like in the Kyoto Conference, where discussions of commitment to limit and reduce the number of emissions as an environmental reciprocal form of the carbon footprint produced by a country or region was held [9]. The halt of energy consumption by learning at home during the Covid-19 pandemic in tertiary institutions has the potential to contribute to a significant reduction in emissions [10].

The research method used in this research is quantitative research methods, which use statistical analysis and lead to a meaningful data interpretation process [11]. The approach is based on carbon footprint analysis as an instrument used to calculate the amount of carbon dioxide (CO2) generated from human activities related to energy consumption.

Comparison of CO2 emissions before and after the pandemic between Japan and Indonesia are limited to the objects listed in Table 1 below. Before the pandemic, lectures were still done face-to-face on campus, and transportation was essential. However, during the pandemic, learning systems turned online and lectures are done from home. Computers are defined as the new environment needed for learning.

| Table 1. Objects of comparison for CO2 emissions before and after COVID-19 Pandemic |
|-----------------------------------------------|-----------------------------------------------|
| Before COVID-19 Pandemic                      | During COVID-19 Pandemic                      |
| 1. University electricity                     | 4. Home lighting                              |
| 2. University air conditioning                 | 5. Home air conditioning                       |
| 3. Transportation                             | 6. Computer                                   |

For the particular calculation method regarding electricity at the university in table 1 (1) and the university air conditioner in table 1 (2), the University of Wakayama gets official data (before pandemic 2019 and during pandemic 2020) in cooperation with the university. Since Bina Nusantara University did not provide an official data on electricity usage in the campus, the calculation was done by listing down the numbers of lightnings, air conditioners, and the total of classrooms within one of Bina Nusantara University’s campus buildings. Average annual electricity usage is calculated using a site called the Carbon Footprint. Carbon Footprint is a site that can calculate CO2 emissions from information such as household electricity usage and transportation time usage.

Regarding transportation facilities in Table 1 (3), a questionnaire survey was conducted via Google forms, with the target of gaining 100 respondents from Bina Nusantara University students and Wakayama University students. The questionnaire reviews each respondent’s means of travel to commute to campus and the commute time and distance. The survey was done within 5 days starting from July 3rd until July 7th, 2020 and resulted in 50 respondents from Bina Nusantara University and
50 respondents form Wakayama University. Answers from the questionnaire is used to measure CO2 emitted from each commute by inputting the data to Carbon Footprint.

Personal computers usage in Table 1 (6), was calculated by assuming class time = personal computer usage time. The class time is calculated according to amount of credits needed by students to graduate. In this case, Wakayama University students need 128 credits before graduation, while Bina Nusantara University students need 146 credits. Each credit is assumed to take 1 hour in class.

Since the calculation of CO2 emission were done by utilizing Carbon Footprint site, there are some default settings on the website that cannot be changed, including 1) home lightning was estimated with the assumption that students were learning inside a 20m2 area and 2) the emissions were counted by average CO2 emission in a year. Due to the one-year average time limit, the calculation of computer usage in Table 1 (6) will also be counted by dividing the total credits by four (32 credits a year for Wakayama University and 36.5 credits a year for Bina Nusantara University).

3. Results and Discussion
First, the results of the questionnaire for transportation in Indonesia are as follows in Figure 1. Meanwhile, the results of the questionnaire for transportation in Japan are as follows in Figure 2.

![Means of Transportations](image)

**Figure 1.** Results of a questionnaire for transportation in Indonesia
Figure 1 pointed out that student transportation in Indonesia is dominated by motorbikes, cars, buses, and trains. Furthermore, commuting to school by walking is also an option for Indonesian students, especially when the students were staying in student lodgings around the campus. Meanwhile, students’ transportation in Japan is dominated by trains, walking or bicycles, motorbikes, buses, and cars, as shown in Figure 2. Students in Japan rarely walks to the campus as they usually live in their homes, which are quite far from the campus.

The difference in transporting ways between Japanese and Indonesia students also resulted in providing information of trends within Japanese and Indonesian students in choosing their lodgings during campus life. The distance and long duration of trips in Japan happened due to the lack of sufficient student lodgings around the campus. Japanese universities commonly provide dorms for their students, yet most of the building are old and is less comfortable compared to the student’s own home. The pricing for the student dorms also contributed to student’s decision to stay with their family. Meanwhile, Indonesian students have more options in choosing their dorms, starting from the campus’ dormitory to student lodgings around the campus area. The existence of cheap, comfortable boarding houses boosted Indonesian student’s interest in staying near campus, resulting more numbers in students choosing to go to their campus by walking.

Other than that, campus hours also affected student’s choice to stay near campus or not. For example, Indonesian campuses can start as early as 7.20 a.m. for their first class of the day (for Binus University). This resulted in the limitation for students if their home were placed remotely far from their campus, along with the high risk of getting late. On the contrary, Japanese campus mainly starts later in the day, no earlier than 9.10 a.m. before the pandemic, or 8.50 a.m. after the pandemic (for Wakayama University). As such, students have more flexibility in managing their means of transport with less risk on arriving late to class.

Putting the questionnaire result for calculation, the comparison of CO2 emissions before and during the COVID-19 pandemic in Indonesia and Japan is written respectively in table 2 and table 3 below.

| Table 2. CO2 emissions before and after the pandemic in Indonesia |
|---------------------------------------------------------------|
| **Before Pandemic** | **CO2 Emission** | **During Pandemic** | **CO2 Emission** |
| University Electricity | 20 ton | Home Lighting | 8.5 ton |
| Transportation | 529 ton | Computer | 1.4 ton |
| | | Air conditioning | 0.1 ton |
| Total | 549 ton | Total | 10 ton |

Figure 2. Results of a questionnaire for transportation in Japan
Table 3. CO2 emissions before and after the pandemic in Japan

|                      | Before Pandemic CO2 Emission | During Pandemic CO2 Emission |
|----------------------|------------------------------|-----------------------------|
| University Electricity | 23 ton                       | 7 ton                       |
| Transportation       | 729 ton                      | 1.3 ton                     |
| Home Lighting        |                              | 0.6 ton                     |
| Total                | 752 ton                      | 8.9 ton                     |

From the data above, it is known that in Indonesia, at least 549 ton of CO2 were emitted every year during face-to-face learning, meanwhile Japan emitted 752 ton of CO2 per academic year. In both countries, transportation is the biggest factor in CO2 emission, contributing at least 96% of total emission in accordance to face-to-face learning system.

Although many Japanese students use public transportation such as trains, the CO2 emission data produced by Japanese students is higher. The reason being the distance traveled by Japanese students is farther than Indonesian students. In average, Japanese students travelled 24 km to get to their campus, meanwhile Indonesian students travelled 11 km on average. Other than that, the calculation method could be at fault, as all transportation emissions were counted assuming each students are riding one train alone. Another factor that might affected the result is the duration of the commute, in which Indonesian students usually have shorter time (approximately 30 minutes per trip) meanwhile Japanese students has the average duration of 45 minutes per trip.

During the pandemic, all learning systems shifted to E-learning, eliminating the need for students to commute to their campus. In exchange, more CO2 is emitted from electricity usage for academic purposes. During online learning, Indonesian students raised at least 10 ton of CO2 per academic year, meanwhile Japanese student produced 8.9 ton of CO2 per year. There is a significant difference between the two countries in terms of air conditioning’s CO2 emission, as Japan produced 6 times more CO2 emission compared to Indonesia. The reason behind it being the fact that room heater is essential during wintertime in Japan, and it produces more CO2 compared to the usual air conditioning used in Indonesia.

It can be concluded that in Indonesia and Japan, the CO2 emissions produced before the pandemic were higher than the CO2 emissions produced during the pandemic. Transportation played a big role in producing CO2 emissions in the time before the pandemic, and due to online learning during the pandemic, transportsations are no longer essential for students. In exchange, electricity in each student’s house are needed to participate in online classes. However, the amount of CO2 emitted by electricity usage are much lesser compared to CO2 emitted by means of transportations.

From the research, it is also known that during the pandemic, Japanese universities still uses a lot of electricity which contributed to producing CO2 emissions. In other words, efforts from universities were needed to reduce electricity usage. Even so, electricity usage in Indonesian universities during the pandemic is unknown, as there is no data of it.

4. Conclusion

In this study, several things can be concluded. First, Japan has a higher number of public transportation users, and Indonesia has a higher number of motorbike users. Even though students in Japan rides more public transportation than Indonesian student, Japanese students’ way of travel emits more CO2 than Indonesian students in terms of transportation before pandemic. This is caused by farther distance and longer duration during the commute in Japan. Many Wakayama University students live outside the city, such as in Osaka, Nara and Hyogo, which resulted in more time and energy spent during each trip. In comparison, more Indonesian students ride motorbike because they live closer to the campus.

Second, Japanese and Indonesian students emit less CO2 during online learning compared to during face-to-face learning period. This is because transportation, which has the highest percentage of emissions in both countries, has been reduced significantly by eliminating the need for students to go to
campus. The depleted number of CO2 emission during the pandemic should be maintained even after the Covid-19 pandemic has ended, either by reducing face-to-face classes, or by providing more comfortable and affordable dorms near campuses in Japan. By producing less pollutant, cities can become more sustainable with better air quality, meanwhile the unused energy can be distributed for other causes and be used more efficiently than before.

References

[1] Fauzi A 2004 Ekonomi sumber daya alam dan lingkungan: teori dan aplikasi Gramedia Pustaka Utama Jakarta
[2] Ishartono & Raharjo S T 2016 Sustainable development goals dan pengentasan kemiskinan Social Work Journal 6(2) 154–272
[3] Griggs D 2013 Sustainable development goals for people and planet Nature 495 305–307 https://doi.org/10.1038/495305a
[4] Robert K W Parris T M & Leiserowitz A A 2005 What is sustainable development? Goals, indicators, values, and practice Environment: Science and Policy for Sustainable Development 47(3) 8-21 https://doi.org/10.1080/00139157.2005.10524444
[5] Fauzih F Farmana Y & Amin F 2020 Optimalisasi pembelajaran “e-learning” melalui fitur google forms dan add-on dalam meningkatkan efisiensi belajar mahasiswa Jurnal Mirai Management 6(1) 148-160
[6] Allouhi A 2015 Energy consumption and efficiency in buildings: current status and future trends Journal of Cleaner Production 109 118-139
[7] Dayarathna M 2016 Data center energy consumption modeling: a survey IEEE Comunications Surveys and Tutorials 18(1) 732-794
[8] Wikantari K 2010 Masa depan parkir kendaraan di kampus ITB Itb.ac.id.
[9] Chamber of Commerce and Industry of WA 1999 The kyoto protocol and greenhouse gas emmisions november 1999 (Issue November).
[10] Ismail A 2020 Greenhouse gas reduction potential in online learning activities in home: carbon footprint analysis Jukung Jurnal Teknik Lingkungan 6(2) 195-203
[11] Creswell J W 2014 Research design qualitative, quantitative, and mixed methods approaches Proceedings of The Annual Conference of the International Speech Communication Association Interspeech