Showing the carbon impact on the arrival of students to high school
Year 2020-2021

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1. The topic of the research

After a first phase of researching relevant criteria involving transporters and students, we developed a model of the carbon impact caused by the students coming to high school. After making the model, we focused on trying to find solutions to alleviate the CO2 pollution problem.

2. The results of the research

We started by creating a survey on google forms to receive information about the students' way to school.
We surfed the internet for information about the CO_2 emissions of different means of transport that could help us calculate the CO_2 released by each student and we got the following results:

Results for Colegiul Național Emil Racoviță: 0.27-0.41 kg CO_2/ person
Results for other schools from our city: 0.42-0.62 kg CO_2/ person
Final result :0.34-0.51 kg CO_2/ person

3. Our research work

1. The Survey
To begin with, we carried out a survey to help us collect information about the methods of transportation students use to go to school and the distance that they have to travel. We sent it both to the students from our school and the students from different schools. As a result, we received 149 answers which helped us calculate the CO_2 emissions.
The most important questions from our survey were:

What school do you go to?

We asked this question because we wanted to compare the CO_2 emitted by the students from our high school and the CO_2 emitted by the students from other schools.

What means of transport do you usually use to go to school?

We asked this question because we wanted to see which means of transport they use to go to school. Undoubtedly, each of them emits a different quantity of CO_2.

What time do you usually leave home in the morning?

We asked this question because we wanted to see at what time the emissions of CO_2 are the highest, so we can come up with a solution that will lower the numbers.

How far away is your school?

We asked this question because we wanted to see what's the distance between the school and the students' homes and approximately how many kilometers they travel on the road.

How long does it take for you to get to school using a polluting vehicle?

We asked this question because we wanted to see how many kilometers each student travels with a polluting means of transport so that we were able to calculate the CO_2 emissions.

Our survey:

SCAN ME

Image 1. QR code to our survey

The results of the survey:

Scan me!
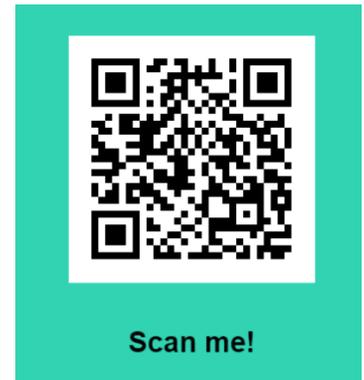
Image 2: QR code to the results of our survey

The link to the results of the survey:
https://docs.google.com/spreadsheets/d/1qS1pbhufseJw684FKbs553RQo6JOp7VQtnUomDNJbwM/edit?usp=sharing
The link to our survey questions: https://forms.gle/vvg5bPh4pwzrfahW7 *
*We removed, from the excel file, the column with the students' names to protect their personal data

2. The Sources

The site: www.co2nnect.org
https://www.co2nnect.org/help_sheets/?op_id=602&opt_id=98&nmlpreflang=en provided us with information about the CO_2 emissions of each means of   transport.

Figures denote kg CO_2 per km per passenger

- foot: 0
- bicycle: 0
- by animal transport : 0
- rickshaw/trishaw: 0
- moped: 0.073
- motorcycle: 0.094
- auto rickshaw: 0.061
- snowmobile: 0.094
- car electric: 0.043
- car small: 0.11
- car medium: 0.133
- car large: 0.183
- car hybrid: 0.084
- taxi: 0.17
- bus: 0.069
- mini bus: 0.055
- diesel train: 0.06
- electric train: 0.065
- underground/metro: 0.065
- electric tram/trolley bus: 0.042
- ferry: 0.115
- express boat: 0.57

➔ the distance of 1 km is travelled in about 5 minutes (we asked our acquaintances and people that have driving experience in our city how much it takes them to travel one km in the morning and this was the conclusion that we came up with)
➔ the rush hour is between 7:30-8:00
➔ the bus CO_2 emissions 0.069 kg/km/person
➔ the car CO_2 emissions are 0.133 kg/km/person
➔ the electric car CO_2 emissions are 0.043 kg/km/person
➔ the trolley bus /electric tram CO_2 emissions are 0.042 kg/km/person

Imagine 3: data used in our research
(https://www.co2nnect.org/help_sheets/?op_id=602&opt_id=98&nmlpreflang=en)

3. The Thought Process

First of all, we made sure that the answers were coherent. As an example, someone said that they live less than 5 km away from school, but they spend between 46 minutes to 1 hour on their way to it. Logically, that doesn't make sense, so we removed those kinds of cases from our calculations.

Then, we decided to study the responses that came from the students of our high school, Colegiul Național "Emil Racoviță", and the responses from the other schools separately. In this way, we compared the results and we created a model of the carbon usage. In order to have a better look at the responses, we created two spreadsheets, one for our school, and one for the other schools, in which we wrote the results. We cannot give full permission to the spreadsheets because they contain personal information, such as full names, schools, the buses used by the students.

Using the formula 1km = 5 minutes, we calculated how many kilometers each student covers using a means of transport. We did that by dividing the boundaries of the time that each person chose by 5. After calculating how many kilometers they travel, using the data that we found about how much CO_2 each means of transport denotes, we calculated how many kilograms of CO_2 are emitted by each student when they come to school.

Example:

Question	Response
What is your name?	Iulia
What school do you go to?	Colegiul Național "Emil Racoviță"
What means of transport do you usually use to go to school?	Polluting public transport (bus), non-polluting means of public transport (electric bus, tram, trolleybus), polluting car (fuel cars)
What time do you usually leave home in the morning?	Before 7 a.m.
How long does it take for you to get to school using a polluting vehicle?	16-30 minutes
How far away is your school?	5-10 km

Iulia's answers

SCAN ME

Imagine 4: QR code to Iulia's answers in the survey

The calculation of the amount of CO_2 emitted by Iulia:

If it takes between 16-30 minutes to get to school and the school is between 5-10 km away, knowing that the distance of 1 km is travelled in about 5 minutes=>

$16 \div 5 = 3.2\ km$

              => the school is *5-6 km* away

$30 \div 5 = 6\ km$

*Iulia said that the school is 5-10 km away

Knowing that a polluting means of transport emits 0,069 kg/km =>

$0.069 \times 5 = 0.34\ kg$

              =>the kilograms of CO_2 emitted by Iulia when she uses a polluting means of transport are between the interval [0.34, 0.41]

$0.069 \times 6 = 0.41\ kg$

Knowing that a polluting car emits 0,133 kg/km =>

$0.133 \times 5 = 0.66\ kg$

              =>the kilograms of CO_2 emitted by Iulia when she uses a polluting car are between the interval [0.66, 0.79]

$0.133 \times 6 = 0.79\ kg$

Knowing that *a* non-polluting means of public transport *emits 0.042 kg/km* =>

$0.042 \times 5 = 0.21\ kg$

              =>the kilograms of CO_2 emitted by Iulia when she uses the non-polluting means of transport are between the interval [0.12,0.25]

$0.042 \times 6 = 0.25\ kg$

To get to the final result, we calculated the arithmetic mean for both ends of the intervals.

$(0.34 + 0.66 + 0.21) \div 3 = 0.4\ kg \text{CO}_2$

$(0.41 + 0.79 + 0.25) \div 3 = 0.48\ kg\ \text{CO}_2$

This means that Iulia's emissions of CO_2 are between the interval (0.4 kg, 0.48) kg,

Explanation:

We took Iulia's case as an example. She goes to school with a polluting means of transport, a non-polluting means of transport, or with a polluting car, she leaves home before 7 a.m and she travels between 5 and 10 km in about 16 to 30 minutes.

So far, we know how much it takes her to get to school, how far away she lives from it, and the fact that the distance of 1 km is traveled in about 5 minutes. Because we wanted to shorten the distance interval we divided both 16 and 30 to 5 and we got 3.2 km and 6 km. But knowing that Iulia said that her school is between 5 and 10 km away, we had to remove the interval from 3.2 to 5 km, so we can consider that the school is between 5 and 6 km away. Then we took the information about each means of transport and multiplied those numbers by 5 and 6 to get the total kg of emissions for each means of transport.

Because we don't know which means of transport she uses most often, we considered that she uses all of them in an equal way and we calculated the arithmetic mean for both ends of the 3 intervals. This means that Iulia emits between 0.4 kg and 0.48 kg of CO_2.

However, we had easier cases as well, in which the student chose only one means of transport, so calculating the arithmetic mean wasn't necessary.

After identifying the carbon emissions of all students from our school, we calculated the final result using the arithmetic mean (average) for both ends of the interval that were identified for each student.
The same steps were repeated for the students from other schools.
Knowing that the CO_2 emitted by the students from our school is between the interval [0.27, 0.41], and the CO_2 emitted by the students from other schools is between [0.42, 0.62], we calculated the final results using the arithmetic mean for both ends of the intervals.
$(0.27 + 0.42) \div 2 = 0.34$
$(0.41 + 0.62) \div 2 = 0.51$
⇒on his way to school, a student emits approximately 0.34-0.51 kg of CO_2.

4. Conclusions

After analyzing all the results, we realized that the amount of CO_2 emissions emitted by the students from our school was lower than the emissions of the students from other schools. This is due to the fact that the students who attend our school live much closer to it and use public transportation more regularly.

After analysing the situation, we came up with some solutions to reduce the CO_2 emissions:
➔ We could find new ways to avoid the use of polluting means of transport, so we must promote walking, cycling, and other non-polluting means, like skateboarding or roller skating.
➔ The second solution implies that the education budget should be adjusted to meet the needs of students wishing to take classes online. By online schooling, the city wouldn't be so polluted in the morning, because there will be fewer cars.

➔ Another solution is that more school buses should be made available to students, because, in this way, cars wouldn't be so used and the carbon emissions would decrease.
➔ Some schools could think of starting their classes one or two hours later than the other schools because, in this way, the city will not be crowded during the rush hours
➔ Installing more bike lanes around the city centre.
➔ The city hall could give us free subscriptions for electric scooters.

Finally, after analysing the approach of the project, in the following years, we would prefer to ask questions without multiple answers, because, in this way, we could avoid some calculation errors. As a lot of students chose two or more modes of transportation, the results couldn't be exact.