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Evaluation of the carbon footprint of the Study and Information Centre of the University of Szeged

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Abstract. Measuring the CO_2 emission to the atmosphere has become significantly important due to the monitoring demand of pollutant emission based on the directives of the Kyoto Protocol. The carbon quota system has created strict regulations for measuring the CO_2 emission in certain industries, internalizing the negative external effect of pollution created by human activity. As the built infrastructure is responsible for 40% of CO_2 emission, this study focuses on the evaluation of the carbon footprint of the Study and Information Centre, which is one of the largest and most frequently visited main buildings of the University of Szeged [1]. The data collection used for the evaluation was conducted in the first quarter of 2020 and contains information for all three scopes (fuel combustion, company vehicles, fugitive emission – purchased electricity, heat and steam – purchased goods and services, business travel, waste disposal, transportation, investments). In the process of data collection, the eating habits, selective waste collection and travelling methods were covered in a visitor/employee survey as well. The results highlighted in this paper will provide a basis for further carbon reduction investments, protocols and events held for shaping the visitors' and employees' consciousness after the COVID 19 pandemic.

Keyword:

Environmental impact, carbon footprint, Bilan Carbone, higher education, travel, meals

1. Introduction

The Study and Information Centre (SIC) (which was the target of the CO_2 emission evaluation) is one of the main buildings of the University of Szeged that meets the requirements of five higher educational functions: a study place, an educational place, a meeting place, a conference place and an area for services. The building was opened in 2004, and has been operating on 25000 m^2 ever since. It welcomes 3.000-3.500 visitors on a daily basis and provides a hosting area for more than 250 events annually (in a non-pandemic period) [2]. The data gathering process for the CO_2 emission evaluation was carried out between January and March of 2020, and the evaluation was closed in August. Two methods were used for data gathering: online and offline surveys of the visitors' of the Centre (N=1754) and data processing of the building management's internal documentation. The online survey was sent to employees with internal email addresses, and to the billboard of the students' online platform used for contacting them. The CO_2 calculation was conducted according to the Bilan Carbone method, and all three scopes (direct emission, energy consumption, supply chain) were covered (Table 1). The Bilan Carbone analytical method was developed by the French Agency for the Environment and Energy Management (ADEME), and can be used for reporting within the framework of GHG Protocol [3]. (E.g., the French supermarket chain called Leclerc uses this method to calculate the carbon-dioxide emission of every purchase [4].)

Table 1. Operational levels used for carbon footprint evaluation

Scopes	Data recording categories (annual)	Type of emission
Scope 1	Natural gas consumption Diesel aggregator operations Vehicle fleet fuel consumption (With the proportion of the SIC)	Direct emission
Scope 2	Electricity consumption Electricity consumption covered from renewable energy	Indirect emission
Scope 3	*Input materials* Purchased goods: personal care products (paper towels, liquid soap) Purchased services: postage, subscription fees, technical and supervision fees, fixed-term employment (operation), cleaning, printing and photocopying, catering, insurance, training for employees, IT services, telecommunications, and unclassified costs	
	Purchasing goods Laptops, monitors, printers	
	Waste Municipal waste (to landfill), composted waste, recycled paper waste, recycled metal waste, other recycling, disposal and storage of hazardous waste, transportation related to generated waste	
	Business travelling non-company vehicle, train, airplane	
	Local and long-distance transport of employees and visitors Diesel car, petrol car, carpool, bus, trolleybus, motorbike, bicycle, on foot, LPG car, hybrid car, electric car, and scooter.	

Source: own editing

2. Result

2.1. Summary results

Having collected and placed the data required into the Bilan Carbone calculator, (which uses the Clim'foot equivalence factors) the results are highlighted in Table 2.

Table 2. Carbon footprint results

Operation of SIC and students' travels in 2019		
Operation of SIC	**CO^2-eq (metric tons)**	**%**
Energy	2556	48
Inputs	1465	28
Freight	1	0
Transporting people	114	2
Direct waste	164	3
Capital goods	2	0
Travel of employees	1016	19
Total	**5318**	100
Student' travel		
Students - long distance transportation 95%	112800	95
Students - local transportation 5%	5365	5
Total	**118165**	100

Source: own editing

The results clearly show that almost half of the carbon emission is produced by the energy sources (direct emission, and electricity usage; scope 1-2), and the rest is generated by purchases related to the supply chain of the building. If the system boundaries are restructured by removing the employees' travelling to work from the supply chain, the environmental impact of energy sources will increase to 59%. This result suggests that the resources available to reduce direct and indirect CO_2 emissions should be targeted to reduce the use of fossil fuels and electricity consumption, as institutional management intervention in these areas can reduce environmental impact to the greatest extent. When carbon footprint calculating methods are used, it is important to indicate that the more factors are taken into account, the higher the calculated footprint is going to be. It can be stated that in order to examine the time series data, it is necessary that the data collection method specified for the examined institution, does not change, and will not change compared to the first data collection period.

2.2. Students' and employees' daily commuting by car

In order to determine the annual environmental impact of commuting to work per capita, and the environmental impact of visitors' commuting to the institution, we needed an extensive survey of travelling patterns, categorized by transportation types. Then we compared these data with the annual numbers of visitors and employees, so that the average traffic distances associated with the operation of the building could be determined. 1754 people completed the questionnaire: 1334 students, 13 visitors of the institution, and 407 people among the university staff. Besides the questions related to demographic information and transport habits, the data collection also covered visitors' and employees' travelling habits, areas related to environmental impact (meals, personal waste management), and attitudes towards environmental awareness and climate change.

Data from employees who commute to the SIC by their own cars on a daily basis were analyzed separately. (We assumed that when they do not use their own vehicles, they would rather choose another, environmentally less polluting alternative.) The environmental impact from the kilometers travelled by the daily commuter employees in a vehicle with an internal combustion engine is shown in Table 3.

Table 3. The carbon footprint of the daily commuting employees in the sample

Environmental impact of daily commuters (n=49)		
Vehicle type	**kilometers traveled**	**CO_2-eq (metric tons)**
Petrol car	49520	12,8
Diesel car	10000	2,5
LPG	700	0,2
Hybrid	150	0,02
Total	**15482**	**15,52**
	Output per capita	**0,32**

Source: own editing

As 52% of the respondents stated that they commute daily, we assumed that this ratio is true for the total number of workforce of the institution (180 people). If 52% of the 180 people commute to work each day, and we multiply that by the sampled per capita emissions, a total of 29,95 metric tons of CO_2-eq is obtained from the daily commuting by car. This represents a 2,9% of total emissions from employees travelling to work.

We also examined the vehicle usage of daily visitors to the SIC separately, and – as expected – we obtained an extremely low number (Table 4), presumably due to the demographic composition of the visitors (99% of the visitors were students in the sample).

Table 4. The carbon footprint of the daily commuting visitors in the sample

Environmental impact of daily commuters among of visitors (N=182)		
Vehicle type	**kilometers traveled**	**CO_2-eq (metric tons)**
Petrol car	3274	0,8
Diesel car	3802	0,9
LPG	528	0,1
Hybrid	0	0
Total	**7604**	**1,8**
	Output per capita	**0,01**

Source: own editing

Since 14% of the respondents stated that they commute to the SIC daily, we also assumed that this ratio is true for the total number of the University students (20,813 people). If 14% of the 20,813 people commute to the SIC daily, and we multiply that with the emission value per person according to the sample, we get a total of 29,14 tons of CO_2-eq for the daily commuting by car. This is 0,5% of the total urban transport emission of visitors.

2.3. Conclusions on the environmental impact of daily commuters

Having examined both groups, it can be stated that, the environmental pollution resulting from daily commuting is below 3%. This is a moderate rate, but it is important to note that the CO_2 emissions connected to daily car users among the employees are higher by 0,81 tons of CO_2-eq than the CO_2 emissions connected to daily car users of the visitors. The striking difference is in the size of the groups: while among the employees cca. 94 people produce this emission value, in the case of the visitors, it is produced by cca. 2914 people.

2.4. Meals

In an environmental management toolkit, an important element can be the information of the environmental impact of employees' meals in proportion to the environmental impact of the managed institution. This aspect of the study can provide an opportunity to define areas of intervention: is it worth allocating resources to facilitate eating opportunities that have a lower environmental footprint in the managed institution? Under what number of employees and under what size of institutional footprint do the employees' eating habits have a marginal effect, and above what level can the intervention have a significant reducing effect on the environmental impact?

As methods of quantifying environmental impacts have evolved, more and more accurate calculations have been made in recent years to determine the environmental impacts of meals. The measurement of the carbon footprint provides an opportunity to describe the environmental impact of the institutional employees in this case study as well. As for the methodology of our study, we used a carbon footprint value associated with an individual daily meal from adequate literature and examined the proportion of the environmental impact of the meal purchased in the building based on the questionnaires completed. In our research, we compared the environmental impact of daily car users with the environmental impact of food consumed by the employees in the institution. The annual workforce of the institution is 180 employees. We assumed that these employees have full day jobs and calculated an average workday count per capita annually (considering days off as well).

The employees participating in the survey stated that 21% of their meals in the building comes from the food offered by the café in the SIC. (There are also coffee and snack vending machines in the building, but the frequency of their use are proved to be negligible among the workers: 66% of the respondents used them once in a month the maximum, the rest used them even less).

While analysing the responses, it was assumed that 21% of the employees' average caloric intake are supplied from food and beverages available at the workplace. The next step was to determine the daily caloric demand with a carbon dioxide equivalent. For this, we used a study by Sara González-García et al. [5]. in which, after examining 59 eating profiles, it was found that the average carbon footprint of a person's daily diet was 3.33 ± 1.87 kg CO_2 equivalent per 2,000 calories.

If 180 employees cover 21% of their daily meals from the offers of the café at the institution, then the annual work-related environmental footprint from meals can be approximated with the following calculation (considering the average amount of workdays and payed days off annually):

$$CO2eq_{employees'meal} = 180 * (250 - 25) * 3{,}33 * 0{,}21 = 28321{,}65\ kgCO2eq \quad (1)$$

Based on the approximation it can be stated that 21% of the environmental impact of the employees daily meal, 28,32 tCO_2-eq, is connected to the institution. From that it can be concluded that a minimum of 134,9 tCO_2-eq of the meals are generated from other sources on workdays annually. In context: this value is only 1,5 tCO_2-eq lower than the annual environmental impact of the daily commuters. From this point of view, it can already be seen that meals within the institution have almost the same environmental impact as the daily commuters using cars.

3. Conclusion

The case study presented in this paper summarizes the experiences related to the determination of the annual carbon footprint of the Study and Information Centre of the University of Szeged. Annual direct and indirect emissions related to operations were identified using the Bilan Carbone method. In addition, we examined the direct environmental impact associated with employees' and visitors' transports, and calculated the CO_2 equivalent associated with employees' meals at the workplace.

1) From the analysis of the data, it can be stated that almost half of the environmental impact of the examined institution (and factors) is caused by the use of energy sources, and slightly more than half of it comes from the supply chain purchases. Therefore, this suggests that the available resources should be used to reduce fossil fuel usage and electricity consumption in the first place by the management.
2) When examining the environmental impact of transport, it was found that the CO_2 emissions from employees' daily car usage are slightly higher (0.81 tCO_2-eq) than the CO_2 emissions from the car use of visitors on a daily basis, but there is a thirty-times difference between the size of the two populations in favor of visitors.
3) An analysis of eating habits revealed that 21% of employees' meals are provided by food purchased at the workplace. Considering average caloric requirements, it was found that the environmental impact of eating at the workplace is nearly the same as the usage of cars by the daily commuters.

When examining the environmental impact of the institution, it is important to state that the obtained values are minimum values, as defining system boundaries make it necessary to exclude the carbon footprint of certain factors in the calculation methodology. The awareness of system boundaries is extremely important if we want to perform a comparative analysis on time series data or the environmental footprint of other institutions. Further directions of our research target both tasks. However, there is a challenge that has to be solved: The COVID-19 epidemic significantly affects the relevance of time-series analysis of institutional data, which is worth considering for all researchers and statisticians in the future.

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