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ASSESSMENT OF CARBON FOOTPRINT AND THERMAL COMFORT IN WELDING AND CONCRETE LABORATORY

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Abstract:

Global warming is the phenomenon of global temperature increase from year to year due to the greenhouse effect. Currently, carbon dioxide concentrations are estimated to be most dominant in the atmosphere. Therefore, this carbon footprint study will be conducted in the institutional area to determine the actual amount of CO_2 present in Politeknik Kuching Sarawak institution. Research on ways to reduce carbon dioxide emissions will also be conducted indirectly. The objective of the study was to analyze carbon dioxide footprints in skill institutions that emit large amounts of gas emissions. Adaptive thermal comfort model is methods can be identified from previous readings to record or analyze data by using Air Quality Detector, Lux Meter and Anemometer. While to refer and compare the data obtained, we refer to the existing standards that are ASHRAE 55 standards and CIBSE Guide A. The result found is carbon footprint in concrete and welding laboratory in Politeknik Kuching Sarawak institution is still in the safe range but measures or proposals to reduce carbon emissions need to be initiated to maintain safety in terms of ventilation and environment in the institution.

Keywords:

Carbon Footprint, Welding And Concrete Laboratory, CIBSE

Introduction

The term "Carbon Footprint" refers to the amount of carbon dioxide released into the atmosphere. As a result of its activities, climate change and greenhouse gas emissions are

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accelerated. With an increase in the use of fossil fuels throughout the Industrial Revolution, the amount of CO_2 in the atmosphere rises directly in proportion.

The research focuses on creating a sustainable environment that may be inhabited with comfort. Our period is known for its climate change and greenhouse gas emissions. This is because industrial expansion directly raises CO_2 levels in the atmosphere. We decided to gather data on carbon footprint particularly in our institution, Polytechnic Kuching Sarawak, such as Concrete and Welding Laboratory. This research will examine the link between carbon footprint and thermal imaging. With this study, tenants of Politeknik Kuching Sarawak may become more mindful of their carbon footprint and thermal energy use. This study will collect data to ensure the environmental sustainability of an institution, especially Politeknik Kuching Sarawak. We will compare the data to ASHRAE 55 (Standard, 2010) standards and CIBSE Guide A (Environmental design, 2007) standards to provide the optimum solution for an institution's sustainability.

Research Objective

The purpose of this research to be conducted is to inspect the carbon footprint in Politeknik Kuching Sarawak institution building and to use the data collected in obtaining sustainable environment. The objectives of this research are:

i. Determining the carbon footprint in the concrete and welding lab by using air quality detector.
ii. Relation between carbon dioxide emission with heat thermal and to collect the correlation of the temperature, humidity, lux level and air velocity of the concrete and welding laboratory.
iii. Giving proper recommendation on ways to overcome problem related to environmental sustainability according to ASHRAE 55 standards and CIBSE guide A.

Literature Review

One of the most challenging problems of contemporary living has been dealing with climate change and its environmental implications. In reality, the aim of decreasing our total carbon footprint is intimately connected to the bulk of existing sustainable initiatives. Due to its position at the intersection of three main emitters: energy, transportation, and buildings, the built environment is by far the most important contribution to our society's overall carbon footprint. While commercial and residential buildings account for approximately 40% of total electricity-relate GHG emissions in the US, other emissions are produced by the substantial use of raw materials, industrial processes required to produce building goods, and subsequent transportation of these goods. Furthermore, the number of everyday activities add to the carbon footprint of the built environment, such as the mode of transportation used by individuals to travel to work, conduct domestic chores, or for leisure. 17 Within the sustainability triangle, time-use perspective can provide indicators for quality of life and thus serve to broaden the analysis of unsustainable production and consumption patterns (Smetschka,2019). In this time-use perspective, a good quality of life includes and emphasises the aspect of being able to care for all human and societal needs in everyday life, as well as its links to the economic (income) and ecological (carbon footprint) dimensions.

The phrase 'Carbon Footprint' is identified as the carbon released into the atmosphere in another word it is also called as carbon emission generally. It is also known as the main contributor to climate change and greenhouse gas emissions. This is due to the burning of

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fossil fuels in industrial revolution increases which resulting in directly increas1e of carbon dioxide levels in atmosphere. If there is a failure to recognize the factors behind emission's growth, it will lead to limitation in the ability to shift consistent pathway with 1.5℃ or 2℃ of global warming (Peters, 2019)

It is also stated that the failure to recognize the main factor behind increment of growth will eventually limit the ability of the world to shift a consistency pathway with 1.5 - 2℃ of global warming (G.P Peters, 2019). Regardless of the reduction in emissions in the United States and European Union over the past decade, the growth of emission in China, India and developing countries dominate the trend. The increasing of current environmental studies employed that the ecological footprint to measure the implication of human demand due to its nature's comprehensive and ability to capture both direct and indirect impact of consumption (Zahoor Ahmad, 2019)

According to the World Economic Forum's (WEF) Global Risk Report 2020 (Risk, 2020), the failure to mitigate and adapt to climate change is the greatest hazard confronting the world today (Rahman, 2020). Despite the fact Malaysia's greenhouse gas emissions are less than 1%, our responsibility in combating global warming remains critical, and we applaud the government's pledge to decrease carbon emissions by 40% by 2020. The National Climate Change Policy will continue to serve as a guide in integrating concerns related to climate change. Promote sustainable economic growth and human development, as well as environmental conservation, by incorporating climate into the design and execution of development programmes and decision-making processes.

Methodology

The adaptive thermal comfort method used in the research (refer clause 1.2.2 Thermal comfort: annotated definitions of main thermal parameters) (Environmental Design, 2007), parameter needed in this research are indoor air temperature, relative humidity and air speed. The research completely based on data collection by using devices such as Air Quality Detector, Lux Meter and Anemometer. The zone typically occupied by people within a space is considered 1.8m above the floor and more than 1.0m from outside walls or window and 0.3m from internal walls. Points of data collection are around 4 to 20 for locations, depending on the area of the locations accessed. To be specific the time accessed was approximately 15 minutes and more. Based on the devices that will be used, variables that are going to be collected for data are minimum and maximum temperature for hot and cold, lux level, air velocity, carbon dioxide level (ppm), TVOC, temperature and humidity. After all the data collected, the average of each variable will be calculated. After that, average data of temperature will be compared to average data of air speed to see the relation between both of data collected. Hence, the total calculated data will then be compared to ASHRAE 55 standard of thermal comfort, Occupational Safety and Health Department and Jabatan Kerja Raya (JKR) to give recommendations for sustainable environment.

The building area will be divided into few points approximately around 4-20 points based on the area of the space taken for data observation. Both are occupied buildings during the period of data collected which was taken in each point, for approximately 15 minutes each. (55, 2004)

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Result Analysis

Concrete Laboratory Thermal Analysis

The concrete laboratory is where students will do practical tasks such as mixing concrete, evaluating the quality and quantity of concrete, and fabricating precast concrete.

Table 1: Data Obtained in Concrete Laboratory

Location	Date	Point	Hot		Cold		Lux	Velocity	Co2 (ppm)	TVOC (mg/mg³)	Temp (℃)	Humidity (%)
			min	max	min	max						
Concrete Lab	10/11	1	29.4	34.5	29.8	34.6	320	0.1	426	0.079	26	77
		2	29.3	31.1	29.6	33.4	320	0.2	432	0.081	27	77
		3	29.5	30.8	28.7	33.2	385	0.2	762	0.143	27	76
		4	28.9	33.1	25.9	32.6	400	0.0	540	0.103	27	76
		5	28.0	29.9	29.1	33.2	428	1.4	538	0.101	27	76
		6	29.0	30.1	29.8	33.4	278	0.0	528	0.099	27	76
		7	29.0	35.5	28.5	34.4	325	0.0	506	0.095	27	76
		8	28.9	35.4	29.2	35.0	315	0.0	432	0.081	27	74
		9	27.8	35.1	29.1	33.6	240	0.0	549	0.103	27	74
		10	29.0	29.8	28.6	32.7	222	0.0	549	0.103	27	75
		11	29.0	32.4	29.0	35.8	300	0.0	432	0.081	27	95
		12	28.5	28.1	28.1	33.9	117	0.0	538	0.101	27	74
Average			28.9	32.2	28.8	33.8	304.17	0.16	519.33	0.089	26.92	77.17

Based on **Table 1**, the concrete laboratory has an average minimum and maximum hot temperature of 28.9 degree Celsius and 32.2 degree Celsius, respectively. Aside from that, it has a minimum cold temperature of 28.8 degree Celsius and a maximum cold temperature of 33.8 degree Celsius. The average lux intensity obtained from Lux Light Meter is 304.17 lx. Other than that, the average velocity obtained from Anemometer is 0.16 m/s. According to the data obtained through Air Quality Detector, it has a carbon dioxide level of 519.33 ppm and TVOC of 0.089mg/m^3 with a temperature of 26.92 degree Celsius, as well as humidity level of 77.17 percent.

Welding Laboratory Thermal Analysis

The welding laboratory provides a hands-on learning environment where students may practice arch welding, mig welding, and other welding techniques. Despite being situated in the same structure, this welding laboratory includes number of distinct rooms.

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Table 2: Data Obtained in Welding Laboratory

Location	Date	Point	Hot		Cold		Lux	Velocity	Co2 (ppm)	TVOC (mg/mg³)	Temp (˚c)	Humidity (%)
			min	max	min	max						
Welding Lab	14/11	1	29.8	34.2	30.3	35.8	150	0.1	410	0.072	27	76
		2	28.8	30.0	30.2	33.7	155	0.0	549	0.103	27	76
		3	28.3	30.3	29.4	31.8	157	0.0	400	0.075	27	77
		4	29.2	30.2	29.6	33.7	163	0.0	410	0.077	27	78
		5	29.5	34.7	29.6	35.0	155	0.0	410	0.077	28	75
		6	27.8	29.9	29.6	36.1	142	0.1	528	0.099	28	75
		7	29.2	30.1	29.3	34.1	144	0.0	528	0.099	28	77
		8	29.2	30.4	29.5	34.4	159	0.0	506	0.095	28	78
		9	30.8	39.4	30.7	33.5	30	0.0	517	0.097	28	73
		10	29.5	32.7	31.0	28.7	24	0.2	517	0.097	28	73
		11	28.9	30.9	30.2	33.4	14	0.0	549	0.103	28	74
		12	29.7	31.3	30.6	34.0	52	0.0	506	0.095	28	75
		13	30.5	47.4	30.4	40.5	28	0.0	528	0.099	28	77
		14	30.4	46.3	30.5	40.7	45	0.0	528	0.099	28	79
		15	30.6	32.4	30.3	30.4	50	0.0	421	0.079	29	73
		16	30.4	32.0	30.2	41.4	75	0.0	528	0.099	29	73
		17	30.2	45.6	45.6	45.6	35	0.0	432	0.081	29	73
		18	30.4	40.3	46.3	43.0	38	0.0	432	0.081	29	72
		19	30.9	40.3	40.3	63.6	38	0.0	517	0.097	29	77
		20	30.5	39.1	39.1	41.7	35	0.0	410	0.077	30	73
Average			29.7	35.4	32.6	37.6	84.45	0.02	481.3	0.09005	28.15	75.2

Based on **Table 2**, welding workshop has an average minimum and maximum hot temperature of 29.7 degree Celsius and 35.4 degree Celsius, respectively. Aside from that, it has a minimum cold temperature of 32.6 degree Celsius and a maximum cold temperature of 37.6 degree Celsius. The average lux intensity obtained from Lux Light Meter is 84.45 lx. Other than that, the average velocity obtained from Anemometer is 0.02 m/s. The carbon dioxide level of 481.3 ppm and TVOC of 0.09005 mg/m^3 with a temperature of 28.15 degree Celsius, as well as humidity level of 75.2 percent.

Discussion

According to Occupational Safety and Health Department regulations, carbon dioxide levels between 1000 and 2500 parts per million (ppm) may produce general drowsiness. Ventilation rates should be maintained below 1000 parts per million of carbon dioxide to ensure acceptable indoor air quality conditions for the vast majority of individual. In terms of the concrete laboratory and welding laboratory, it complies with the Occupational Safety and Health Department requirements for levels that are regarded acceptable.

According to ASHRAE 55-2010, the air speed for a space is stated as the comfort zone for an environment that fits the standards and has air speeds of less than 0.20m/s. This information is available on Figure 1. (American Society of Heating, Refrigerating, and Air Conditioning Engineers, ASHRAE Standard 55-2010, 2011) Both the concrete and welding laboratory have air velocity of less than 0.20m/s, having previously been 0.16 m/s and 0.2 m/s, respectively. The average air speed estimated for both accessible sites meet the ASHRAE 55 guideline, indicating that the facilities are appropriate for occupation. Based on ASHRAE 55 Parameter as plotted in cross-sectioned below, the temperature of the concrete lab is 26.92℃ with air velocity of 0.16 m/s, and for welding workshop the average temperature is 28.15ºC and air velocity is 0.02.

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Both buildings did not meet the requirement standard of ASHRAE 55 thermal comfort as they are considered too hot. The yellow colour line indicates the thermal comfort for concrete laboratory while the blue coloured line indicates the thermal comfort of welding laboratory.

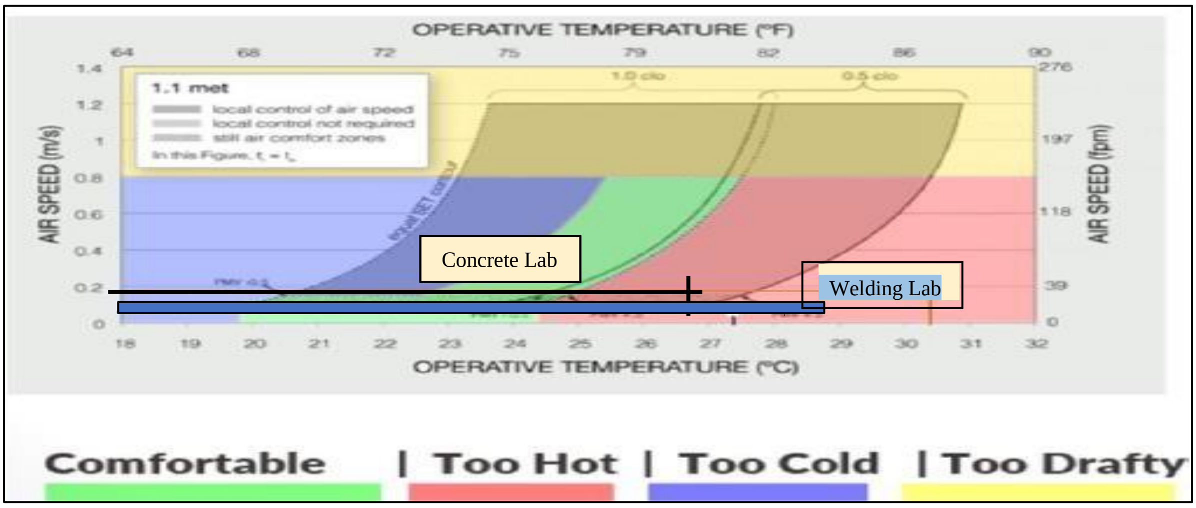

Figure 1: Thermal Comfort Chart Using ASHRAE 55 Parameters
Source: (ASHRAE 55)

Conclusion

As a conclusion, this study clearly shows that the heat thermal energy, air velocity and humidity does contribute to carbon footprint. The results revealed that the average carbon dioxide level of the concrete lab 0.089 is 519.33 ppm and welding laboratory is 0.09 mg/m^3 is 481 ppm. Refer to air quality index the value ppm acceptable is below than 500-1000ppm. Both accessible sites had calculated average air speeds that match ASHRAE 55, suggesting that the places are suitable for occupancy. Air velocity in both laboratories was less than 0.20m/s respectively. Therefore, overcoming this issue is crucial to build a sustainable environment for future generations.

It is important to keep in mind that the definition of green buildings emphasizes integrated mechanical, electrical, architectural, and other system design. A green/sustainable building design is one that achieves high performance over the entire life cycle, such as minimizing emissions that have a negative impact on our global atmosphere and, ultimately, the indoor environment, particularly those related to indoor air quality (IAQ), greenhouse gases, global warming, particulates, or acid rain, as well as reducing negative impacts on the construction site (Health, 2004).

Acknowledgment

Assessment of Carbon Footprint and Thermal Comfort in Welding and Concrete Workshops has impacted the Kuching Sarawak Polytechnic community regarding the importance to the environment, the research group is very grateful to the Head of the Civil Engineering Department who has provided full support for the larger project from which this paper grow Contribution in terms of the use of equipment and permission to use students in data collection is greatly appreciated. The findings of the study can not only be used in the department but also used as a scientific partnership on the Education platform and also used for Polygreen

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Politeknik Kuching Sarawak. Finally, I am pleased to appreciate the contribution of my group members who worked hard to make this research a success

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