

Investigating the Carbon Footprint of an Institution: The Case of BUIITEMS

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ABSTRACT

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Climate change has made it important for institutions to estimate and minimize their greenhouse gas (GHG) emissions. This study estimates the carbon footprint of Balochistan University of Information Technology and Management Sciences (BUIITEMS) for the period of 2023-2024. The main aim was to use a multi-regional input-output model and to estimate the influence of energy-saving measures. The study was implemented at BUIITEMS Takatu campus, located in western Quetta, which covers an area of 100-150 acres. Data were systematized based on GHG etiquette into Range 1 (direct emissions), Range 2 (indirect emissions for electricity purchase), and Range 3 (other indirect emissions, including transport and waste). Emissions coefficients from IPPC guidelines and pre-existing studies were used to evaluate the emissions. The Study findings demonstrated that Range 1 emissions were the maximum observed, 591,613,018 kg CO₂e. Although Range 1 and 2 were minimal. The limitation is 500 kg CO₂e per student annually. Buitems Emissions was below the limit, and its carbon footprint was below the average among the universities in Pakistan. This research highlights BUIITEMS' sustainable activities that align with the United Nations Sustainable Development Goals (SDG 12 and SDG 13).



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Introduction

A carbon footprint can be analyzed as the estimation of greenhouse gas emissions that are direct or indirect that resulting by a variety of activities shown in carbon dioxide equivalents. (Weidmann and minx, 2007). The concept of carbon footprint was introduced by Wackernagel and William Rees in 1990, where it became famous in the 2000s and started carbon initiatives like "Carbon footprint calculator". In Saudi Arabia, the province of Qassim, Qassim University evaluated the carbon footprint of the university, which is educating more than 60,000 students at different campuses, where they estimated the carbon footprint through electricity, annual water consumption, number of cars for students, faculty, staff, number of trees, and amount of waste on an annual basis. (Fahad and Irfan, 2016). In Pakistan, the largest public university in Bahawalpur (the islamia university of Bahawalpur) with the population of 40,000 where it has three campuses Baghdad, Abbasia, and Railway. They also started new initiatives such as green campus project to calculate and estimate the ecological footprint of the teaching and nonteaching faculty and it is the first study in Pakistan to identify environmental resources. (Abid et al, 2022). Balochistan being the largest province of Pakistan as Quetta being its capital city located 1,680 above the sea level with variations in season. The university of Balochistan (UOB) providing quality education estimated their carbon footprint by using UI green metric Performa by using the website link <https://www.carbonfootprint.com>. Where they gathered data from engineering, works and Transport section of the university from which they replaced most of the traditional supplies to energy efficient supplies. (Sajjad et al, 2023). Research on carbon footprint in Balochistan specially in Quetta is limited because they lack comprehensive data on emission resources. Lack of awareness, not having understanding of the importance of carbon footprint assessment among university and other reason is adequate data collect methods and tools for estimating the emissions make it tough and challenging to conduct assessments. Universities prioritize

academic and infrastructure needs instead of environmental studies. Carbon footprint has its importance such as understanding carbon footprint helps quantify greenhouse gases that is crucial for climate change. Promotes sustainability by introducing high emission activities and encouraging reductions. By getting data of carbon footprint, it can inform about governmental policies and regulations which has an aim of the reduction in carbon emissions. The purpose of this Research is to identify carbon footprint of the major institutions in Balochistan Quetta.

Review of Literature

A carbon footprint evaluates the cumulative amount of greenhouse gases, direct or indirect by any institution. With these thoughts, universities should have a significant impact and promote movements and campaigns that are useful in achieving the desired changes. (Varón et al., 2021).

This research was the first to estimate the carbon footprint of the University of Balochistan (UoB), located in Quetta, Pakistan. The assessment found that the institution emits 19.12 metric tons of carbon, with electricity consumption being the primary reason for these emissions. Therefore, they took sustainable initiatives to minimize carbon emissions, which included wastewater treatment and tree plantation. (Sajjad et al., 2023).

This research was conducted on UTP's where they produced 8969 tCO₂-eq which was from range 3 emissions. It indicated that the carbon footprint of this institution was minimal that other institutions. Even though it was minimal but they still took initiatives to minimize the carbon emissions. (Varón et al., 2021).

This research was in Qassim university in Saudi Arabia which was the first initiative to conduct this research. The total results were lower than other institutions and many initiatives were taken to minimize the amount of carbon emissions such as renewable energy. (Almufadia and mohammad, 2016).

This research was on the University of Talca(UT) in Chile, where they have been analyzing their carbon footprint in the campuses and they

summed up that the range 3 (transportation) was the main reason to contribute in carbon emissions (Pablo et al., 2019).

Objectives

1. To Investigate the Carbon Footprint of BUIITEMS for the Year 2021-2024 using A Hybrid Multiregional Input-Output Model.

2. To evaluate the Impact of the Energy-Saving Measures introduced by the university.

Materials and Methods

The research is about BUIITEMS which is an SDG-aligned institution. (Berners-Lee et al., 2011; Huang et al., 2009; Weidman et al., 2009)

Table 1: *System Boundary of the Study*

Scope 1 Emissions	Scope 2 Emissions	Scope 3 Emissions
generators	Purchased electricity	
BUIITEMS transport		Solid wastes
Natural gas		travel of students and staff
IT equipment		
Food service		
Water		
Chemicals		

There are 3 ranges of emissions, where Range 1 shows the direct emissions and Range 2 shows indirect emissions from electricity, and Range 3 shows the waste and travel of staff and students. (WRI AND WBCSD, 2004).

Study Area

The study was conducted at the Balochistan University of Information Technology, Engineering and Management Sciences (BUIITEMS), located on Airport Road, Quetta,

Pakistan. BUIITEMS is a leading higher education institution in the region, with a campus area of approximately 70-110 acres and a population of over 11,000 students, faculty, and staff. Its academic, administrative, residential, and recreational facilities provide a comprehensive environment for research related to energy consumption, waste generation, transportation, and other sustainability factors, making it an ideal case study for environmental assessment and carbon footprint analysis.

Figure 1: *Map Area of the Study*



Scope-1 GHG Emission Sources

LPG consumption in BUIITEMS:

Canteens, hostels, and residential colonies use liquefied petroleum gas (LPG) in the on-campus canteens.

BUIITEMS Transport:

BUIITEMS transport consists of 16 large diesel buses, two mini-coaster buses. Fuel consumption data were provided by the transport department.

Diesel Consumption in Generators for on Campus Power Generation:

BUIITEMS has installed generators to provide electricity during the power cuts. (Ihsan et al, 2020)

Electronic Equipment and Internet Devices:

Various electronic devices are used across BUIITEMS for activities such as desktop computers, internet devices, printers, photocopiers, and personal laptop of staff.

Water Consumption at BUIITEMS:

Water at BUIITEMS is used for drinking and sanitation purpose. Data on the water consumption was provided by department PCRWR.

Food and Catering Services:

BUIITEMS has 7 canteens and 3 tuck shops. The tuck shop sells fast moving consumer good (FMCGS) such as packaged juices and mineral water, while the canteen serves fast food and meals.

Scope-2 GHG Emission Sources

Electricity is purchased from the national grid. The university has electricity meters which is regulated by (QESCO, under the authority of WAPDA, Pakistan.

Scope-3 GHG Emission Source

Solid Waste Generated at BUIITEMS:

BUIITEMS consists of diverse solid waste. The waste is categorized into five types: plastic, paper, glass, aluminium scarp and bio-waste.

Commuting of Students, Staff, and Faculty:

Commuting activities of the students, staff and faculty were surveyed where the respondents replied with the types of vehicles used for the commute which includes cars. Motorcycle, local buses, green bus, rickshaws, Suzuki's etc. The fuels consumed were petrol, diesel and CNG.

Table 2:

S No	Resource Inputs	Unit	Quantity	Carbon Footprint
1	Fossil fuels consumed by buitems owned transport	L		
2	Gas used in BUIITEMS	KWh		
	Subtotal			
3	Different IT equipments in BUIITEMS			
	3.1 computers			
	3.2 printer			
	Subtotal			
	Food and catering			
4	4.1 tea			
	4.2 coffee			
	4.3 fruits and vegetables			
	4.4 eggs	kg		
	4.5 dairy products			
	4.6 meat	kg		
	Subtotal	kg		
	Water used in Buitems			
5	Total of scope 1 emissions	L		

Scope 2 Emissions

S No	Resource Inputs	Unit	Quantity	Carbon Footprint
1	Purchased electricity	kWh		

Scope 3 Emissions

S No	Resource Input	Unit	Quantity	Carbon Footprint
1	Varieties of waste in BUITEMS			
	1.1 General Waste	Tons		
	1.2 biowaste	Tons		
	1.3 glass waste	Tons		
	1.4 paperboard waster	Tons		
	1.5 E-waste	Kg		
2	Subtotal			
	Fossil fuels Consumption			
	2.1 petrol consumed in cars			
	2.2 diesel consumed in cars	km		
	2.3 petrol consumed in motorcycle	km		
	Subtotal	km		
	Total of scope 3 emission			

Results and Discussion**Calculation of Carbon Footprint**

To evaluate the GHG emissions there are many calculators available online. The carbon footprint of BUITEMS has been calculated by <https://www.carbonfootprint.com/> and <https://360carbon.org/en-gb/>.

Results

The total carbon footprint of BUITEMS Takatu campus was 223,075.15 kg Co₂e as its mentioned in table 1. The total carbon footprint of Buitems

contains three types of GHG emissions where scope 1 emissions is the total of 85.92% (191,613.03) then followed by scope 2 emissions which amounted 8.85% (19753.8) and scope 3 was responsible for 5.25% (11,708.32) emissions during the year 2023 to 2024. Major of the GHG emissions were due to scope 1 emissions which included fossil fuels consumed by fleet, gas used in canteens, different electronic equipment, food and catering and water consumed. The results were aligned with different institutions such as University of Alberta had 52% of emissions overall (Varon et al., 2021).

Table 3: Resource Inputs and their Associated Carbon Footprint**Scope 1 emissions**

S No	Resource Inputs	Unit	Quantity	Carbon Footprint
1	Fossil fuels consumed by buitems transport	L	680	1570.80
2	Gas used in of BUIITEMS	KWh	49273	9063.23
	Subtotal			10,634.03
3	IT equipment in BUIITEMS			
	3.1 computers			
	3.2 printer		400	119,000
	Subtotal		330	56,430
	Food and catering			175,430
4	4.1 tea			
	4.2 coffee		900	45
	4.3 fruits and vegetables		50	10.5
	4.4 eggs	kg	77	38.5
	4.5 dairy products		180	4680
	4.6 meat	kg	100	320
	Subtotal	kg	70	455
	Water used in Buitems			5549
5	Total of scope 1 emissions	L	203.2	101.6
				191,613.03

Scope 2

S No	Resource Inputs	Unit	Quantity	Carbon Footprint
1	Purchased electricity	kWh	48180	19753.8

Scope 3 Emissions

S No	Resource Input	Unit	Quantity	Carbon Footprint
1	waste in BUIITEMS			
	1.1 general waste	Tons	6	2400
	1.2 biowaste	Tons	6	2400
	1.3 glass waste	Tons	0.3	120
	1.4 paperboard waster	Tons	3.0	1200
	1.5 E-waste	Kg	1350	5400
2	Subtotal			11,520
	Consumption of fossil fuels in BUIITEMS			
	2.1 petrol consumed in cars			
	2.2 diesel consumed in cars	km	730	168.68
	2.3 petrol consumed in motorcycle	km	45	10.40
	Subtotal	km	40	9.24

Total of scope 3 emission

188.32

11,708.32

Total of all Scope Emissions

223,075.15

Scope 1 electronic equipment (computers and printers) were the highest contributors of GHG emissions 91% which was followed by gas used in Buitem's which is 4.73% of the emissions. Fossil fuels consumed by Buitem's transport contributed about 0.82% of the all emissions. Whereas other activities were responsible for minor emissions as it is mentioned in figure 3. Cups of tea and coffee were contributing around 0.02% as tea and coffee is the major component of the breakfast, lunch and evening time. Fruits and vegetables were

around also the same as tea and coffee around 0.02%, eggs were 2.44%, dairy products 0.18% and meat contributing around 0.24% of the all emissions. These food items were consumed in Buitem's university as it is summarized in table 1. Water consumed in Buitem's was also 0.053% of the emissions as there are 3 tubewells and all of them are open around 24hrs and 14hrs with 2.5inch of water. Likewise, electricity purchased from QESCO also contributed to the emissions around 8.85%.

Figure 2: GHG Emissions Ranges

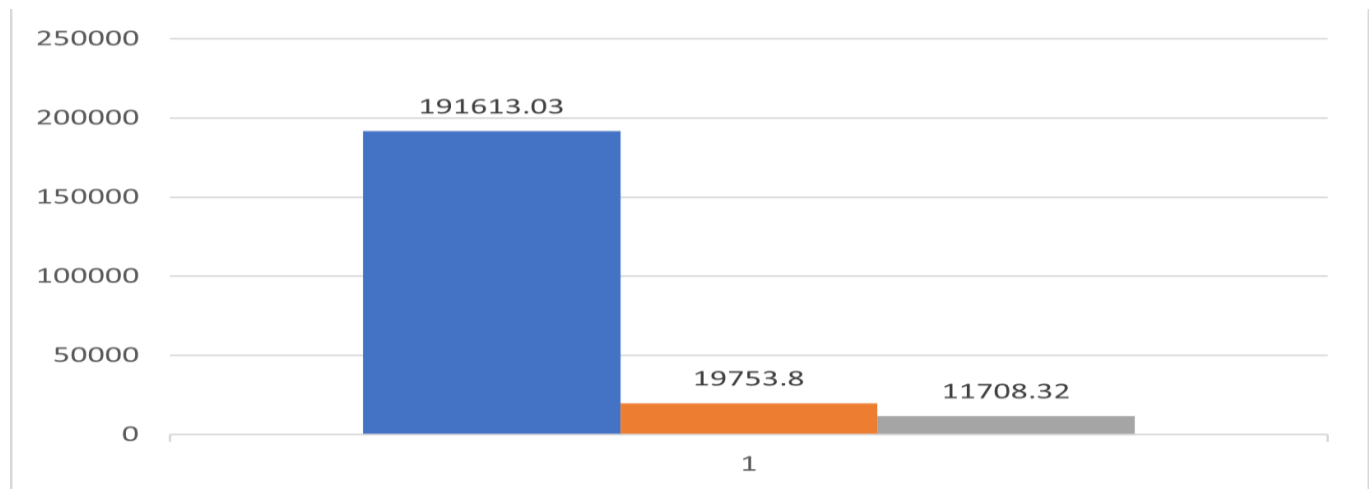


Figure 3: Scope-1 GHG Emissions

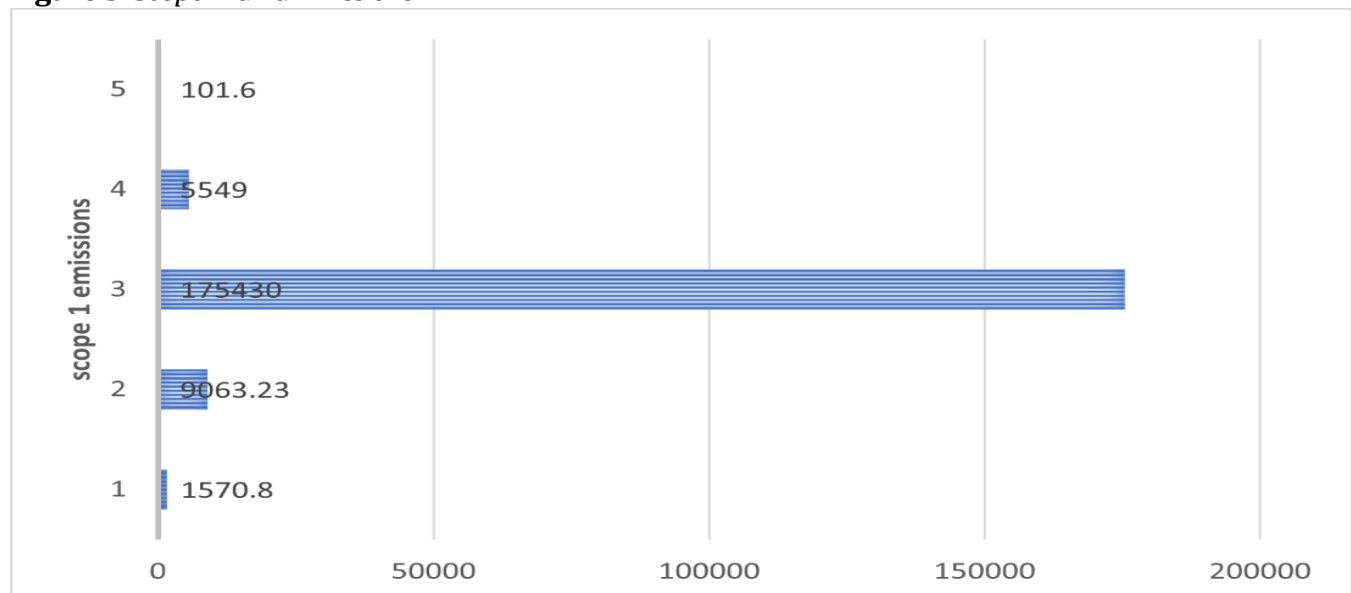


Figure 4: *Emissions from Food and Catering*

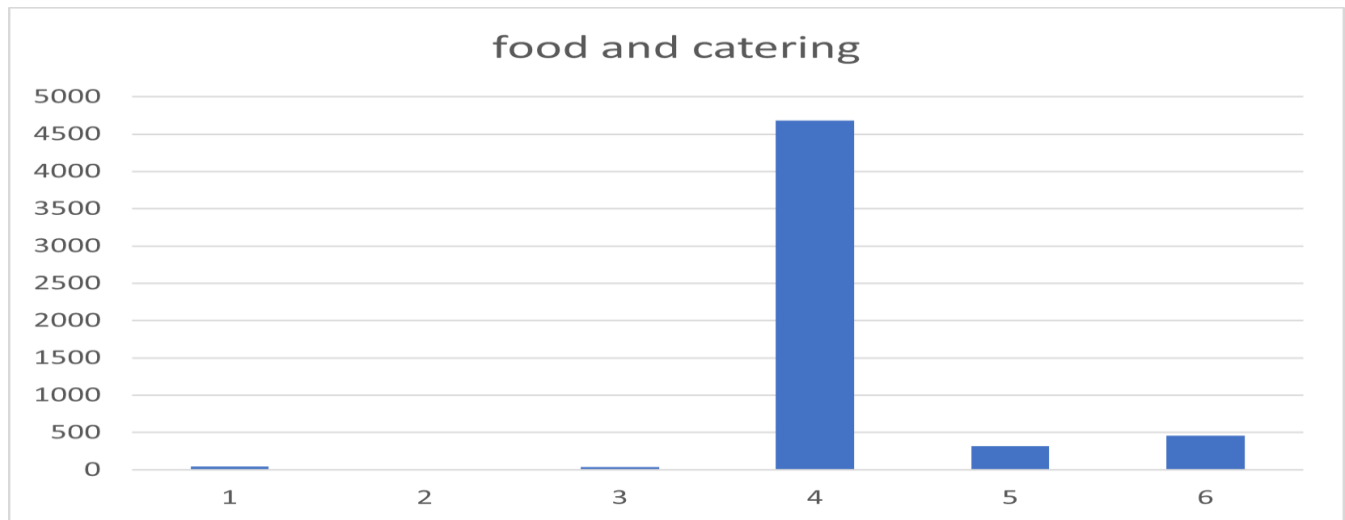
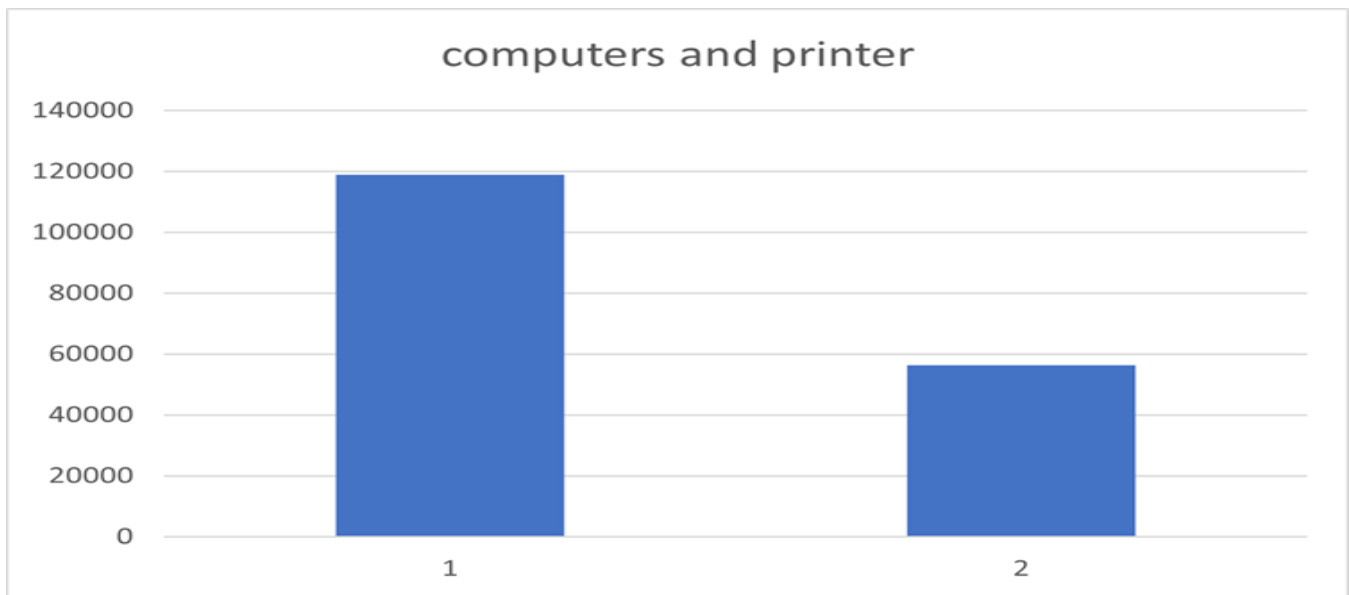
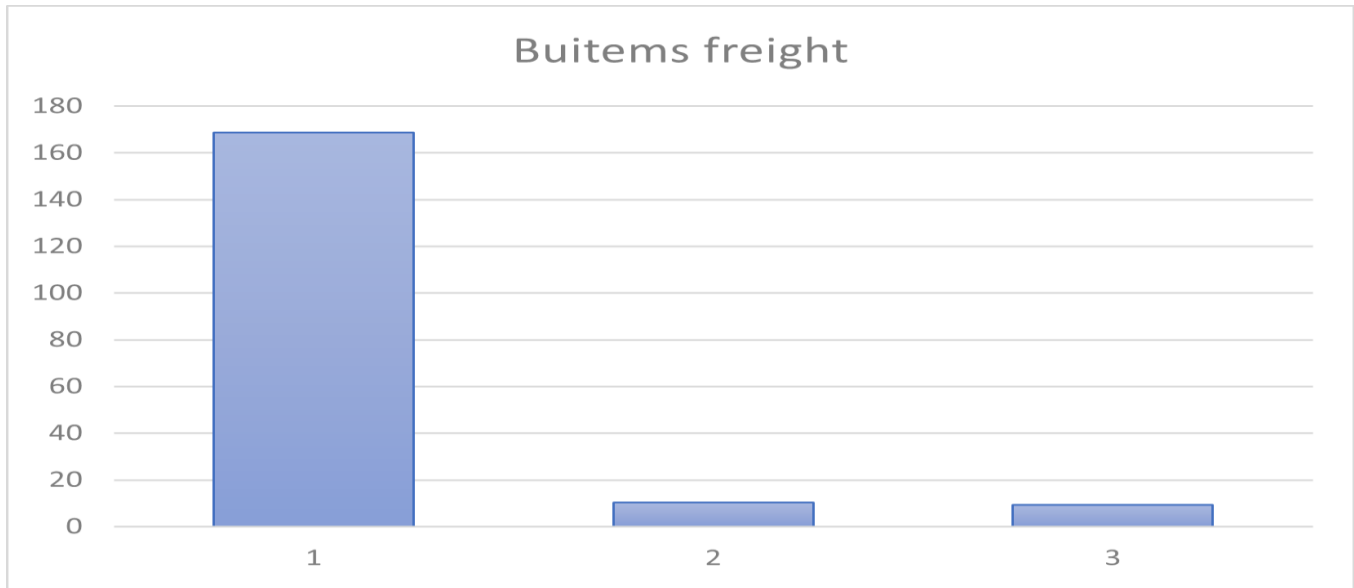
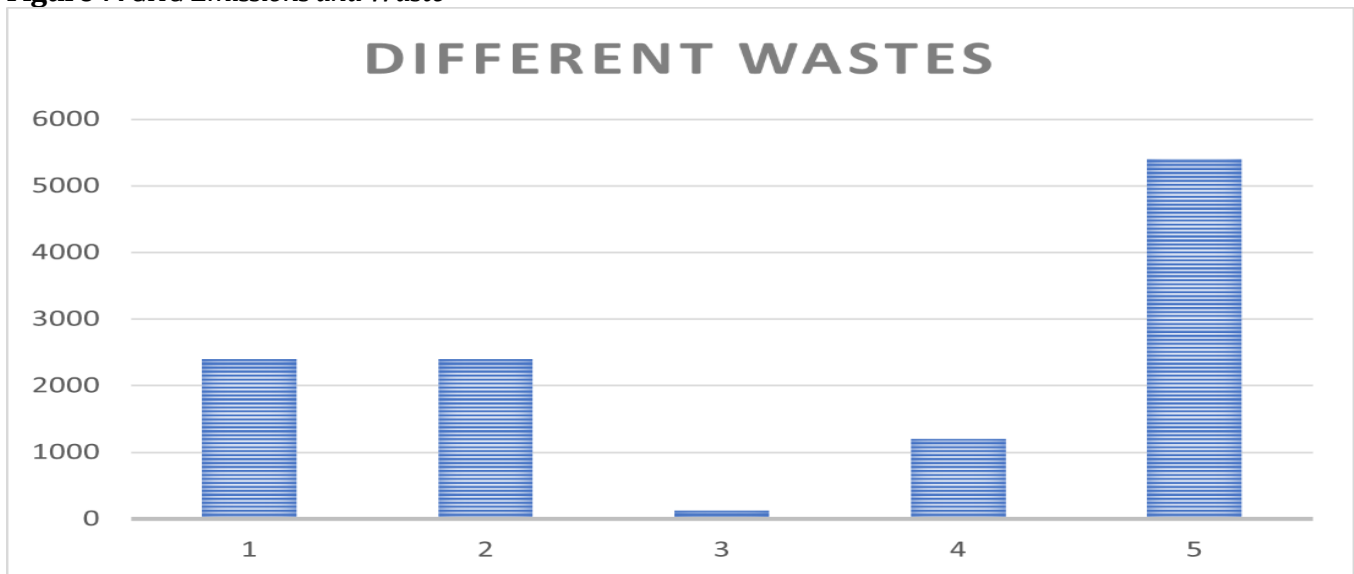


Figure 5 *Emissions from IT Equipment's*



Buitems was contributing in the generation of different types of waste where the total waste was contributing around 5.16% of the GHG emissions in which different types of waste were responsible such as biowaste, paperboard waste, glass waste and e-waste and it was estimated on the daily

basis. Among the Buitems freight activity different vehicles were taken where most of them were using petrol. This contributed around 5.25% of GHG emissions and most of them were students and staff commuting on daily basis as seen in figure 5.

Figure 6: GHG Emissions from Buitems Transport**Figure 7: GHG Emissions and Waste**

Conclusion and Recommendation

The Balochistan university of information technology, Engineering and management sciences (BUITEMS), A public university located in Quetta, Balochistan, Pakistan, conducted a detailed study to assess its carbon footprint for the academic year 2023-2024. The total greenhouse gas (GHG) emissions were calculated to be 223,075.15 kg Co₂e.

According to global sustainability standards, the ideal carbon footprint for a university is 500 kg Co₂e per student per year. With over 11000 students and 700 faculty members, the ideal

estimated carbon footprint for Buitems should be:

$$500 \times 11,000 = 5,500,000 \text{ kg CO}_2\text{e/year}$$

This comparison shows that the university's actual emission of 223,075.15 kg Co₂e are significantly below the ideal threshold and far below of those many other universities in Pakistan.

1. University of Haripur: 578,898 kg Co₂e annually
2. NED university, Karachi: 21,500,000 kg Co₂e annually
3. University of the Punjab, Lahore: 18,360,600

kg Co2e annually

These data highlights that BUITEMS maintains a much smaller carbon then these institutions.

However, several limitations affected the accuracy of this assessment. A lack of availability of data especially in the key areas such as laboratory, fertilizer application, and waste management, restricted the scope of the study. These data gaps pose challenges in calculating a comprehensive carbon footprint.

To align with the United Nations Sustainable Development Goals (SDGS), particularly SDG 12: responsible consumption and production, it is recommended that BUITEMS:

- Conduct Carbon footprint assessment annually
- Improve data collection mechanism across department
- Implement a zero-waste strategy
- Adopt sustainable procurement practices

By taking these steps BUITEMS can continue to lead by example in environmental sustainability among Pakistan higher education institutions.

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Declaration of Conflicting Interest

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