

Carbon Footprint Assessment For Academic Institution: A Ui Greenmetric Approach

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Abstract: Climate change is a worldwide issue, caused by the emissions of Greenhouse Gases (GHG) of which the dominant contributor is Carbon Dioxide (CO₂). The amount of GHG produced by any higher institution can be quantified using carbon footprint (CF) estimation, of which the most established is UI GreenMetric carbon footprint approach. This study determine the CF at University Malaysia Terengganu, one of the public universities in Malaysia by quantifying 6 categories that are Setting and Infrastructure (SI), Energy and Climate Change (EC), Water (WR), Waste (WS), Transport (TR) and Educational (ED). Data was collected utilising primary and secondary data collection whereby primary data collection involves TR indicator for traffic volume. Other categories data were provided by the relevant authorities of UMT. Result shows a decreasing emission of CF for academic year 2017/2018 and 2018/2019; from 1212145.524 metric ton to 1209743.2 metric ton, respectively. This positive improvement is made possible by 2 approaches: employing correct technique of measurements plus verification of data and UMT top management sustainability plans and actions. However, there are 2 categories that need more attention for improvement i.e. WR (19%) and EC (17%). The findings from this study show a better achievement compared to previous year because of overestimated for TR indicator and unverified data calculation during secondary data collection. Outcome from this study increases UMT ranking from 13 to 6, out of 18 participated universities in Malaysia and the most important, it enables the university leaders to set up the eco-accommodating strategies and oversee social changes among the academic community.

Index Terms: Carbon dioxide, carbon footprint, climate change, greenhouse gases, higher institution, Malaysia, sustainability

1. INTRODUCTION

Intergovernmental Panel on Climate Change (IPCC) stated that the limiting global temperature rises to below 2°C require reduction of greenhouse gases (GHG) of 10-40% below 1990 level for year 2020 and also 40-95% reduction emission of GHG for 2050 to achieve the current goal. Universities were preliminary a platform to attain sustainability due to their size and also impact from university activities toward society and environment which is university can be termed as “small cities” [1]. This is because every university policy makers and planners realize the impact from operation and activities in universities toward environment campus sustainability. Sustainability can be defined as a get-together the needs of the present without compromising those of the future generations and was later extended to include the ideas of economic sustainability and social equity besides social boundaries and planetary boundaries not be crossed [2,3,4]. All universities in the world can submit their data to be involved in the ranking as long as they have strong commitment to sustainability issues. UI Green Metric WUR system was used to measure the campus sustainability especially carbon footprint (CF). CF can be defined as measure

of the GHG emission directly and indirectly caused by the combustion besides the emission gathered over the life stages of a product or service, expressed in carbon dioxide equivalents [5,6]. There are 18 GHG stated in IPCC but under the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol, carbon dioxide (CO₂), Hydrofluorocarbons (HFCs), Methane (CH₄), Perfluorocarbons (PFCs), Nitrous Oxide (N₂O) and Sulphur hexafluoride (SF₆) are the GHG and the main contribution emission that related to climate change is CO₂. The aim of this study is to assess the carbon footprint in UMT and UMT's research area using UI Green Metric WUR.

2 MATERIALS AND METHODS

2.1 Site Selection

The study was conducted at University Malaysia Terengganu (UMT) area as shown in Table 1 and Figure 1. In year 2018, there are 10,011 total students that included 1114 postgraduates' students and 8897 undergraduate students. UMT also employed 1081 administrative staff and 654 lecturers with different education background that include sciences, technology, management of natural resources and others.

TABLE 1
SITE SELECTION

Location	Longitude/ Latitude
Main campus	5° 24.432'N, 103° 5.281' E
Kenyir Lake Research Centre	5° 8.829' N, 102° 46.281' E
Chagar Hutang Research Sanctuary	5° 48.702' N, 103° 0.498' E
Pulau Bidong Marine Research Park	5° 37.272' N, 103° 3.496' E

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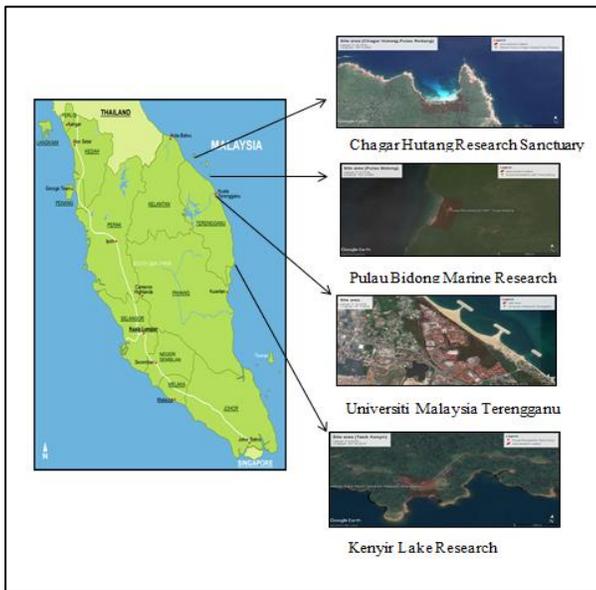


Fig. 1. Study area

2.2 Indicator Selection

The collected data were analysed by assigning the numeric score. Criteria that select for this study contain six categories for evaluation on both factors which is internal and external factors [7]. The categories and weighting of points were considered as shown in Table 2 [8].

TABLE 2
CATEGORIES USED IN THE RANKING AND THEIR WEIGHTING

Categories	Indicators	Percentage
Setting & Infrastructure (SI)	The ratio of open space area, area on campus covered in forest, Area on campus covered in planted vegetation, Area of campus for water absorbance, Total open space area divided by total campus population, University budget for sustainable effort	15%
Energy and Climate Change (EC)	Energy efficient appliances usage, Smart building implementation, Number renewable energy sources in campus, Total electricity usage divided by total campus population, The ratio of renewable energy produced towards energy usage, Element of green building implementation, Greenhouse gases emission reduction program, The ratio of total carbon footprint divided campus population.	21%
Waste (WS)	Recycling program for university waste, Program to reduce the use of paper and plastic, Organic waste treatment, Inorganic waste treatment, Toxic waste treatment, Sewerage disposal	18%
Water (WR)	Water conservation program implementation, Water recycling program	10%

	implementation, Used of water efficient appliances, Treated water consumed	
Transportation (TR)	The ratio of total vehicles divided by total transportation, Shuttle services, Zero Emission Vehicles (ZEV) policy on campus, Ratio of ZEV divide by total campus population, Ratio of parking area to total campus area, Transportation Program design to limit or decrease the parking area in campus, Number of transportation initiatives to decrease private vehicles on campus, Pedestrian path policy	18%
Educational & Research (ED)	The ratio of sustainability courses towards total course subjects, Ratio of sustainability research funding towards total research funding, Number of sustainability publication (avg for past 3 years), Number of sustainability event(average for past 3 years), Sustainability student organization, Existence of university run sustainability websites, Existence of published sustainability report	18%

2.3 Data Collection and Analysis

All Reliability and accomplishment of this study depend on quantity of the data collection. The data were collected from the Corporate Communications Center UMT for each indicator. Data collection allows us to know the emission component in contributed CF in university area. UI Greenmetric System determine critical component by the Equations (1)-(3):

$$CO_2 \text{ emission from electricity} = (\text{electricity usage per year in Kwh} / 1000) \times 0.84 \tag{1}$$

Where, 0.84 is the coefficient to convert Kwh to Metric ton.

$$\begin{aligned} \text{Transportation Per Year (Bus, Car, Motorcycle)} = & \tag{2} \\ & \text{Number of cars entering your University} * 2 \\ & * \text{approximate travel distance of a vehicle each day} \\ & \text{inside campus only} \\ & (\text{in kilometers}) * (240/100) \end{aligned}$$

Where, 240 is number of working days per year. x is the coefficient (source : www.carbonfootprint.com) to calculate the emission in metric ton per 100 km for vehicles.

$$\begin{aligned} \text{Total Emission Per Year} & \tag{3} \\ = & \text{total emission from electricity usage} \\ & + \text{transportation (bus, car, motorcycle)} \end{aligned}$$

3 RESULTS AND DISCUSSION

One of a critical component for overall categories that have been measured in this study is water which is contribute carbon emission of 19%, followed by the energy and climate change which is 17% and others contribute 16% for each

category as shown in Figure 2. This is because UMT has lack of conservation programs among the criteria that evaluated for water indicator. Conservation programs that measured in the WR weighting are water recycling program, water efficient appliances usage and also treated water. WR category can increase the CF due to the increase in water demand in the future and energy-intensive water treatment and technologies. WR categories can increase unless water management policies are implemented that support sustainability [9]. Energy and climate change is the second highest contribution for all emission categories in campus area causes by less concern for particular area such as implementation of smart or intelligent buildings, energy conservation, climate change adaptation and mitigation programs, greenhouse gas emission reductions policy and major contribution towards large emission of carbon footprint in energy efficient appliances and also the electricity consumption. Numerous considerations to achieve a better goal such as by university profiling with creates a profile based on unique missions, objectives, typological features, and context. TR weighting is much less in UMT because there is an environmentally friendly program that implements reducing entering of vehicles in campus area such as Car Free Day that conducted in university every Thursday. Figure 3 shows the weighting for each category that contributed the emission of carbon footprint in the UMT area which has been improved since 2018. Weighting by categories has uniquely identified by category code and number such as Setting and Infrastructure (SI), Energy and Climate Change (EC), Waste (WS), Water (WR) and Education (ED). Critical categories are Energy and Climate Change (EC) (4%) followed by Waste (WS) (6%) and through the validation calculation, UMT can achieve better weighting which EC(11%) and WS (10%), respectively. This shows that evidence that previous study provided less convincing and strong evidence to be accepted by UI Green Metric Secretariat for the year 2017 and 2018 data [7]. All of the categories have a decreasing point as results and from this study, which actually we can get a better point by provided the accurate and more detailed pieces of evidences. Others categories show better contribution about reducing CF by getting high weighting which shows UMT has a particular concern about the indicator and categories that includes in this study which can generate beneficial environmental impact. Finding in this study shows that campus area can be achieved up to 14% out of 15% for SI category because there are a few indicators that overestimated and not include in the previous calculation. There are few indicators which can be improved, and most of the categories such as WS, WR, TR and ED show that the finding can get a better weight as compared to the previous result. Previous weighting that has been submitted to evaluate by UI Green Metric Secretariat caused by overestimated of the indicator with lack of evidence. In 2018 University Malaysia Terengganu is ranked thirteen out of eighteen ranking universities in Malaysia that participating in GreenMetric and 371 out of 720 universities in the world). Finding of this study proved that we can achieve better ranking by the improvement of data collection and arrangement of the evidences which as shown in terms of the comparison weighting for result submitted data and calculated data. Figure 3 shows that we can reduce the emission of CF if the data that submitted has undergo the assured assurance process (validation).

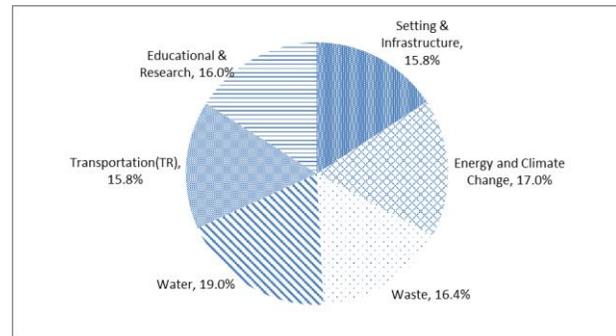


Fig. 2. Comparison overall categories in UMT

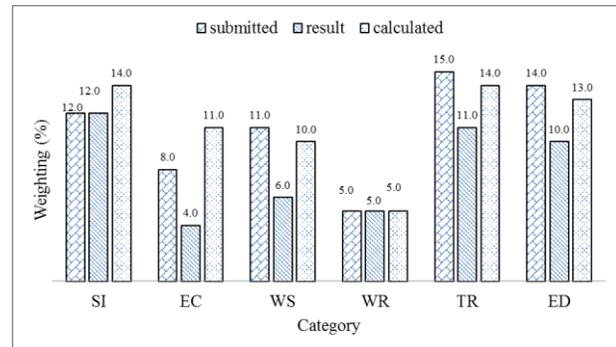


Fig. 3. Comparison for each category by weighting

4 CONCLUSION

Reduction emission CF proved by the improvement amount emission which was 2402.324 metric tons lowers than the previous year. This is caused by two factors which are by employing the correct technique of measurements and UMT top management sustainability plans and actions. Indicators used during weighting the CF emission can be used as a guideline to improved CF emission in UMT area. Finding from this study proved that electrical, water consumption and waste management are related to sustainability because these three components contributed the high percentage in the calculation of CF in the university area.

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