Carbon Footprint Assessment Among Staffs In A Higher Public Institution

Samsuri Abdullah, Nafatila Abdul Halim, Amalina Abu Mansor, Nur Nazmi Liyana Mohd Napi, Ali Najah Ahmed, Marzuki Ismail

Abstract: Higher education institution is often being addressed as sustainability shifting models, which have an important role towards promoting low-carbon lifestyles. This study investigates the lifestyles pertaining to personal carbon emissions of employees of higher education institutions related with households, transport, travel, food, products and services, in order to conceptualize the emission of Greenhouse Gases (GHG) and usually expressed in equivalent tons of carbon dioxide. This study is significance in reducing the employees' personal carbon footprints, next reducing the nation average carbon footprint. Survey was conducted via questionnaire in Universiti Malaysia Terengganu (UMT) at 90% confidence level (n=65). Results showed that emissions were increasing with the wage (MYR1500 - MYR13001) and decreasing with education level. Finding of this study indicated that half of the respondents exceeded the nation standard average carbon footprint per person (7.7 metric tons per capita) which 26.23 metric tons was recorded to be the highest carbon footprint of UMT staff. In conclusion, employees of higher education institutions need to properly understand their personal carbon emissions along with reduction mechanisms, in order to promote such the sustainability in higher education institutions.

Index Terms: Carbon footprint, greenhouse gases, higher education institution, Malaysia, sustainability.

1 INTRODUCTION

Carbon footprint is familiarised as a tool to led the relevant emission, make it easier for the understanding of the risk of global warming at the very first stage. Carbon footprint has become a prominently used concept in general public on responsibility and abatement measures against global warming over recently [1]. Carbon footprint is defined as measurement of GHG emissions, directly and indirectly by a person, an organization, event or product and is expressed as a carbon dioxide equivalent (CO_{2e}) [3][4][5]. There are 18 GHG with different potentials as stated in IPCC (1990), but under the UNFCCC and Kyoto Protocol, the carbon dioxide (CO_2), Hydrofluorocarbons (HFCs), Methane (CH4), Perfluorocarbons (PFCs), Nitrous Oxide (N_2O) and Sulphur hexafluoride(SF6) are the GHG and the main contribution emission that related to climate change is CO_2 [6][7]. CO_2 and other gases become obvious from anthropogenic activities done by humans. Hence, minimizing GHGs emissions in order to lessen the coming climate change besides reacting to the inescapable impacts that our past emissions causing, must be the top priority. The United Nations Environment Program (UNEP) issued that a worldwide and collaborative initiative to minimize the carbon footprint is the only way out from the effect of global warming [8]. Research looking at household consumption is one of the sustainable consumption which to determine its impact towards environment and the influence towards individual consumption patterns and levels [9][10].

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Carbon footprint emission is initiated by our daily routine which has relationship as a vicious cycle of work and consumption, with substantially caused the environmental and social effects [9][11][12]. We distributed the questionnaire which directly acquiring the data from the university staffs for the evaluation of carbon footprint emission [13]. This study is limited to only CO_2 emissions and the other greenhouse gases (GHG) converted to the carbon dioxide equivalent factor.

2 MATERIALS AND METHODS

2.1 Study Area

University of Malaysia Terengganu (UMT) is selected for the data collection considering the sufficient data availability to enhance the accuracy of the results. University Malaysia of Terengganu (5.41° N, 103.09° E) (Figure 1) which on low lying areas and close to coasts and so are potentially more vulnerable to sea level rise or storm surge. Indeed, coastal cities contain large human populations and are the centre of nationally important socioeconomic activities [14].

2.2 Data Collection

Primary data were collected which several carbon emission factors were identified and being developed as a questionnaire. To determine the carbon emission factors, a survey was conducted from the UMT staffs, which categorised into two groups, academic and non-academic staffs. Selection of respondents were based on five main income cohorts (MYR 1501-4500, MYR 4501-7500, MYR 7501-10500, MYR 105001-13000, and more than MYR 13001) and assorted by using random number generator. Based on the formulation at 90% confidence level, (n=65) which means 65 total number of respondents were required to conduct the survey as primary data in this study. The survey conducted in collecting the quantitative data on the respondent background, energy consumption from the household, distance travelled from the transportation and travel, also dietary choice which to identify the correlation on the most critical emission component of carbon [15]. The questionnaire was written in bilingual, Malay and English. Most of the raw data collected from the survey were feed as input in the verified online calculator engine by

UI Greenmetric approach (https://www.carbonfootprint.com/calculator.aspx) and special requirement for the dietary consumption (https://www.resurgence.org/resources/carbon-calculator) . A questionnaire including the personal details of the respondents was to estimate the GHG emissions due to electricity, food consumption, goods and products spending and transportation.

Fig. 1. *Study area.*

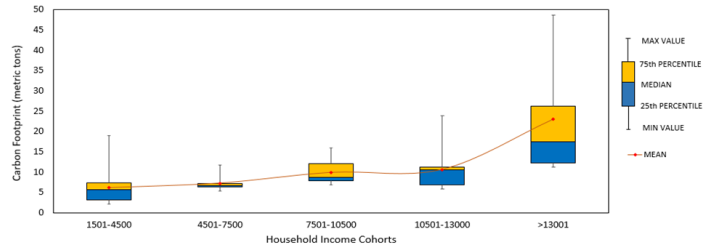
2.3 Data Analysis

The amounts of carbon footprint among the staffs were determined by using box and whisker plot. The box and whisker plots were constructed and the result showed the minimum, maximum, median, and the mean of the carbon footprint with demographic factors (income, educational level and age) of the staffs. Correlation is a statistical technique used to measure the strength of association and the direction of the relationship between two variables. In terms of the strength of relationship, the value of the correlation between anthropogenic carbon emissions and demographic factors vary between +1 and -1. A value of ± 1 indicates a perfect degree of association between both variables. As the correlation coefficient value goes towards 0, the association between the two variables is weaker. The direction of the relationship is indicated by the sign of the coefficient; a + sign indicates a positive relationship and a – sign indicates a negative relationship. Spearman Correlation was selected in this study.

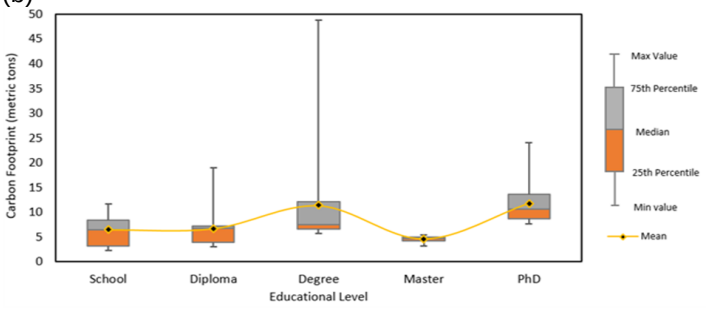
3 RESULTS AND DISCUSSION

The result of this study indicated that within the household income cohorts, there was a significant correlation between income and carbon footprint. In other words, generally by elevating the household's wages, their total carbon footprint also elevated. Figure 2(a) shows the box and whisker plot of household income and carbon footprint. It indicates how elevation in wages would result higher carbon footprint. The significant increments were obviously indicated by the household income in the range of MYR7501-MYR10500 and began to escalate as income rose beyond MYR13001. The findings from this study showed that within the five educational level obtained by the employees, there was a significant correlation between education level of the employees and carbon footprint. Figure 2(b) shows the education level and carbon footprint. It indicates how fluctuation in the average amount of carbon footprint which influenced by the education level. The significant increment average of annual carbon footprint was obviously indicated by the employees from diploma holder to degree holder and began to taper off as education level increased to master holder. Next the average amount of carbon footprint continues to escalate from master holder to doctoral degree. By other means, generally educational level did not play a big role in the increment of carbon footprint. The outcomes from this study pointed out that within the age groups of the employees, there existed a weak correlation between the age groups of the employees and annual carbon footprint. Figure 2(c) specify the age groups and carbon footprint. It indicated how weak fluctuation in the average amount of carbon footprint which influenced by the age groups. The significant increment average of annual carbon footprint were obviously indicated by the employees from the age group (50-59 years) and followed by the age group (30-39 years) as the second highest average annual carbon footprint among these age groups. Note that, income did increase with the as the age is a telling predictor of carbon emissions.

(a)



(b)



(c)

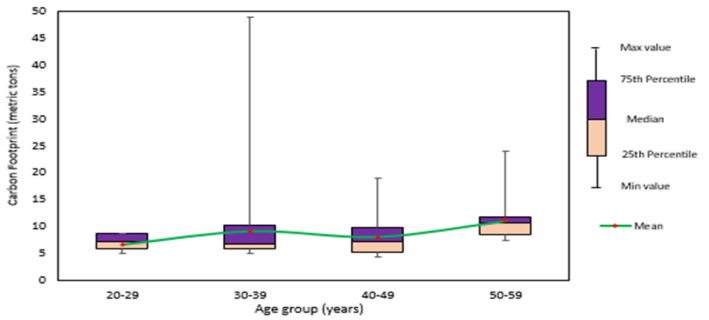


Fig. 2.

(a) Boxplot analysis of annual carbon footprint by the influence of household income cohorts
(b) Boxplot analysis of annual carbon footprint by the influence of educational level.
(c) Boxplot analysis of annual carbon footprint by the influence of age groups.

Relationship between total carbon footprint (TCF) and the others nine contribution of carbon footprint emission was conducted using multivariate correlation. Analysis was conducted in Statistical Packages for Social Sciences (SPSS®) version 23 which all variables were tested to check the variables can fit the normal distribution or not. The result revealed that the Shapiro-Wilk p-value for all variables lower than 0.05 [16]. This shows most of the variables not fit well with normal distribution (Wang et al., 2019; Griffiths & Needleman, 2019). This caused two-tailed Spearman correlation analysis was employed to determine relationship between TCF and the nine variables that measured. Table 1 shows that there exists strong correlation between total carbon footprint with car (r=0.849, p<0.01), secondary expenditure (r=0.506, p<0.01) and income (r=0.526, p<0.01). There were also intermediate correlation between total carbon footprint with household (r=0.389, p<0.01), flight (r=0.407, p<0.01) and education level (r=0.358, p<0.01). Car travel turned out to be the major hotspot which indicated (r=0.849, p<0.01) among other indicators as well. The use of car vehicle is dominant for all age groups and household income cohorts as well. The major cause for this were because majority of the employees owned basically minimum of two cars and the mileages for the car running up to 30,000 kilometres annually. One of the reason they preferred travel by car on their daily use because most of their driving was associated with driving to work, the weather condition, long distance travelled for family leisure time. In addition, car travel use varies by age. For instance, the US National Household Travel Survey (2011) reported that prime working age individuals drive the most on average. Drivers aged 35 to 54 years logged about twice distanced per year compared to teenagers and retirees in 2009, and has been about constant since 1990. Since burning fuel creates CO_2 emissions, car vehicle could be the mechanism relating the age distribution to emissions also. This study revealed that, the highest carbon footprint in this study belongs to those who were with household income more than MYR13001. The total carbon footprint of the staff obtaining household income more than MYR13001 is 48.74 metric tons which is higher than the country's average, which is 7.7 metric tons. Income factor correlated with strong relationship which (r=0.526, p<0.05). One of the most important reasons of high carbon footprint by staffs in UMT was the utilization of personal vehicles, which indicated the lack infrastructure in terms of public conveyance. On the other hand, the source of pollution is usage of electricity, mostly because of using air conditioners and low efficiency appliances at home. Income is a key aspect to households' lifestyle, as income increases, employees try to develop their living ideals by purchasing better appliances, more garments, new cars which in Malaysia's case is usually more than one car per household. People will eat more meat and dairy in their intake. They will purchase new houses and are less concerned in using public conveyance. Furthermore, have more amusements and yield more carbon by their daily activities. Also, individuals at different salary levels have different lifestyles; therefore, different patterns of consumption are related to CO_2 emissions. The correlation between total carbon footprint and education level in the weakest compared to the others which is (r=0.358, p<0.05). Education has been found to be one of the best mode for encouraging lifestyles transformation, but only under certain settings [17][18]. The environmental learning literature proposed some insight into the links between education lifestyles transformation and it also offers help on how to boost pro-environmental lifestyles [19][20]. The concept that understanding assists to awareness and with studies that filed understanding can transform into better lifestyles [21]. More personal aspects are needed such as a profound connection to environment, personal significance to the issue and educational research programs towards projects that not only focus on information but also stimulate the personal potentials that can nurture sustained act.

TABLE 1
CORRELATION ANALYSIS OF ANNUAL CARBON FOOTPRINT COMPONENTS

Parameters	*HH*	*Flights*	*Car*	*MB*	*PT*	*SE*	*Age*	*Income*	*EL*	*TCF*
HH	*1.000*									
Flights	*.417***	*1.000*								
Car	*.245*	*.186*	*1.000*							
MB	*-.218*	*-.115*	*-.087*	*1.000*						
PT	*.142*	*.518***	*-.003*	*.000*	*1.000*					
SE	*.299*	*.276*	*.152*	*.024*	*.150*	*1.000*				
Age	*-.094*	*.080*	*.126*	*.095*	*-.286*	*.018*	*1.000*			
Income	*.476***	*.456***	*.405***	*-.154*	*.027*	*.470***	*.183*	*1.000*		
EL	*.449***	*.462***	*.212*	*-.117*	*.206*	*.346***	*.018*	*.546***	*1.000*	
TCF	*.389***	*.407***	*.849***	*.017*	*.124*	*.506***	*.128*	*.526***	*.358***	*1.000*

***. Correlation is significant at the 0.01 level (2-tailed).*

Notes: HH= household,MB= Motorbike,PT= Public Transport,SE= Secondary Expenditure,EL= Education Level,TCF= Total Carbon Footprint

4 CONCLUSION

The highest amount of annual carbon footprint among the staffs at the University of Malaysia Terengganu calculated was 48.7 metric tons (more than MYR13,000), while 1.3 metric tons (MYR1501-4500) was recorded as the lowest carbon footprint. There exists strong significant correlation (p<0.01) between transportation (r=0.849, p<0.01), income (r=0.526, p< 0.01) with total individual's carbon footprint. The result showed that Malaysians' annual carbon footprint was the lowest with 7.7 metric tons per capita among the UMT staffs average which was 8.9 metric tons per person and the world population average which was 4.0 metric ton per capita. The carbon footprints are increasing over years. Thus, it is important to properly understand and calculate how anthropogenic emission can lead to high carbon footprint thus, bring to big scale of climate change through global warming. The following were recommendations that would improve the understanding of carbon emissions from anthropogenic activities in Malaysia.

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