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Determining the Ecologic and Carbon Footprints of Adiyaman University Faculty of Engineering Students

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----------***ABSTRACT:*** ----------
Ecologic footprint is a tool that is numerically expressing the negative impacts we have on earth and guiding us to make positive changes on our behaviours and attitudes towards the environment. Keeping in mind that achievements and awareness gained during university years can kick-start a lifelong change, this study has been conducted to get the faculty of engineering students of a university located in south-eastern Turkey to measure ecologic footprint and carbon footprint. The study took place during the 2018-2019 academic year, involving 141 engineering students who have been subjected to individual Ecologic Footprint Survey. The survey provided general briefing to each participant about ecologic footprint and carbon footprint and suggestions have been made with regards to methods of reducing individual footprint. At the end of the study, the ecologic footprint and carbon footprint changes of the faculty of engineering students have been assessed, on the basis of their department, gender, age and the number of individuals in their families.
Keywords: *Ecologic footprint, carbon footprint, ecologic awareness, sustainable life*

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I. INTRODUCTION

The concept of ecologic footprint is one of the indicators of environmental sustainability, that helps us to reveal the impact of man's production and consumption activities on nature through quantitative data. Ecologic footprint can be defined as an ecologically productive area (irrigable land, forestland, grassland, sea) with established borders, where the sources required by individuals who possess a certain quality of life and consumption abilities and also where the resulting waste are made harmless and carbon dioxide is absorbed (Wackernagel & Rees, 1996; Wackernagel et. al, 2005). Ecologic footprint analysis is measuring the impacts of human activities on nature by asking the question "Compared to the nature we own, how much of it are we making use?", which is the main obstacle for a sustainable development (Bond, 2003). The first study on ecologic footprint has been performed by William E. Rees in 1992 (Rees, 1992). Then the first study on concept and concept related calculation methods has been conducted by Dr. Mathis Wackernagel for his doctorate thesis. The scale obtained in his study has been named Ecologic Footprint. In their book published in 1995, Wackernagel and Rees explained the Ecologic Footprint concept and the relation with sustainable development and detailed the calculation methods (Wackernagel and Rees, 1995). With this aspect, ecologic footprint appears as an important indicator that provides clues for a sustainable life and reveals the burden placed by man on this planet.

Ecologic footprint is a quantitative calculation technique that indicates the amount of biologically productive area at a global level, as well as the size of land and water area needed to dispose of waste, the amount of biologic productive areas used by nations, towns, families or individuals and the amount of planets they require for the future (Rapport, 2000:367).

The consumption variable used for ecologic footprint calculation is considered as the usage scale of commodities. For instance, such as the weight of consumed meat in kilogram, value of consumed electricity in joule, or the weight of consumed wood in tons. It is being separately calculated for different groups such as food, accommodation, transport, consumables and services. For instance, if 2300 kg of carrot is grown in 1 decare, then the production area for carrot is 2.300 kg/decare (Özer, 2002:83).

Another technique used along with ecologic footprint is the calculation of CO_2 footprint, caused by fossil fuels. The impact on the nature by all types of our consumption activities to meet our needs and the share in global warming is called "carbon footprint" (Lynas, 2009). Carbon footprint is the total amount of carbon dioxide emissions that is accumulated directly or indirectly throughout the lifespan of a product created through human activities (Wiedmann and Minx, 2008). Fossil fuels such as coal, petrol and natural gas are extracted from earth's crust but cannot be reproduced. Burning of these fuels leads to carbon dioxide accumulation in the atmosphere and by exerting pressure on biosphere it causes global warming. A global hectare productive area

can absorb the amount of carbon dioxide formed by the consumption of 1 450 litre gasoline in a year. CO2 foot print indicates the deficiency of the ecologic capacity required for combatting carbon dioxide emission and also points to the significance of reducing emission. Ecologic footprint calculation is based on an estimation regarding how much of the human-induced carbon dioxide can be absorbed and cleaned by earth's forests. As the amount of biologic productive forestland increases, the amount of carbon dioxide released to atmosphere decreases (Wackernagel et. al, 2005).

The demand for natural resources is increasing due to unsustainable consumption of sources, and the rise in pollution and carbon dioxide emission. Organismal Planet Index has pointed out that a 33% reduction took place in world's natural welfare since the 1972 Stockholm Human and Environment Conference and an increase of over 50% in man's ecologic pressure, which is beyond the self-renewal capacity of biosphere (Bond 2003). Our ecologic footprints need to be reduced for a sustainable future. And the way to reduce our ecologic footprint is related to measures such as gaining conscious consumption habits, using our own resources instead of external resources, being non-lavish in our energy use (Kutu 2007).

Individuals need to develop an awareness about ecologic footprint, which is an important concept for sustainable development. There are several studies already conducted in this field in Turkey, such as the one explaining the global importance of ecologic footprint (Dinç 2015), another one where ecologic footprint is recommended as an environment education tool for changing the awareness, attitude and behaviours of prospective teachers and engineering students towards a sustainable life (Keleş et. al. 2008; Erdoğan and Tuncer 2009; Keleş, 2011; Coşkun 2013; Eren et. al. 2016), and another one containing ecologic footprint calculations based on the awareness and consumption habits of university workers (Eren et. al., 2017; Başoğul, 2018). Literature review in this field has revealed that the number of studies targeting engineering students in Turkey is very few (Eren et. al., 2016). Wİth this in mind, the purpose of this study was to make use of the possibility that achievements and awareness gained during university years could start a lifelong transformation to increase the environmental awareness of university students by getting the Adıyaman University Faculty of Engineering students to avail of the findings of ecologic foot and carbon footprint calculations.

II. MATERIAL AND METHOD

Research type

This study is a descriptive, cross-sectional research. Target population of this study consists of 840 students studying in Adıyaman University Faculty of Engineering. No sample selection has been performed, but rather face to face interviews have been conducted with 141 students who agreed to take part in the study. 141 students from the Faculty of Engineering have been divided into 5 groups, namely mechanical engineering, environmental engineering, food engineering, civil engineering, electrical and electronics engineering.

Data Collection Analysis

During the study, students from the Adıyaman University Faculty of Engineering filled the Ecologic Footprint Calculation Survey. The survey consists of two sections. The first section consists of questions related to demographic characteristics (age, gender, department etc.) while the second section consisted of multiple-choice questions related to lifestyle habits oriented to defining ecologic footprint.

Titles included in the survey are;

Gıda (4 questions), transport (7 questions), accommodation (6 questions), consumer goods and services (6 questions).

Example questions from each section are given below:

"How frequently do you purchase organic meat, vegetable and dairy products?"

"How many hours do you spend in a week a vehicle, including your commute to work?"

"Which one of these energy saving systems do you have at home?"

"Which one of the following wastes do you recycle and/or separate?"

Data Collection and Analysis

Face to face interviews have been held with students from 5 departments of faculty of engineering in November 2018 and data have been collected (22 civil engineering, 51 mechanical engineering, 54 electrical and electronics engineering, 7 food engineering, 7 environmental engineering). Students have been informed prior to data collection and the study was held on a voluntary basis. Students refusing to take part in the study and students not attending school on the day of data collection were not included in the survey. Surveys did not ask for the names of the students. The ecologic footprint calculation engine program developed by the World Wide Fund for Nature (wwf.org.tr) has been used to calculate the ecologic footprints of faculty of engineering students. Collected data have been assessed in ecologic footprint calculation engine to calculate the ecologic and carbon footprints of faculty of engineering students. Individual measurement is based on an individual's

consuming habits and the biologic productive area that provides for his consumption. The age, gender, family member distributions of the obtained findings are given in tables.

III. FINDINGS AND DISCUSSION

Demographic Characteristics

The demographic characteristics of the Adıyaman University Faculty of Engineering students who took part in the survey are given in Chart 1. Chart indicates that the average age of the students is 22,17 and the average number of individuals in their family is 6,9.

Chart 1. Demographic characteristics of the students

	Minimum	Maximum	Standard deviation	Average
Age	19	37	2,67	22,17
Number of individuals in family	3	10	2,08	6,9

Ecologic Footprint Assessment

Chart 2. Ecologic footprint averages of students per department

Footprint/ Departments	Environmental engineering	electrical and electronics engineering	Food engineering	Civil engineering	Mechanical engineering	Average
Ecologic footprint (kha/ind.)	3,44	4,23	4,18	4,02	3,83	3,94

The ecologic footprint averages of the students has been calculated as 3,94 kha, as indicated in Chart 2. According to World Wide Fund for Nature (WWF) 2012 data footprint per capita in Turkey is 2,7 (kha). This figure is higher than the World average (WWF 2017). According to a study by Akyüz et. al (2016), the ecologic footprint average of academicians in a university in Turkey is 3,17 kha. In another study by Akıllı et. al. (2008), the footprint average of individuals in a faculty has been reported as 4,83 kha. Based on these figures, the average ecologic footprint of the engineering students obtained in this study is higher than the average in Turkey. Looking at the footprints of faculty of engineering students in Chart 2, the department with the lowest ecologic footprint is the department of environmental engineering (3,44 kha). It is followed by the department of mechanical engineering (3,83 kha), department of civil engineering (4,01 kha), department of food engineering (4,18 kha) and department of electrical and electronics engineering (4,22 kha). The highest ratio of ecologic footprint among five all five groups has been observed in the department of electrical and electronics engineering by 4,22 kha. In a study by Eren et. al. (2016) on faculty of engineering students, the highest ecologic footprint has been observed in the department of geophysics engineering by 3,5 kha, and the lowest footprint was observed in the department of civil engineering by 2,37.

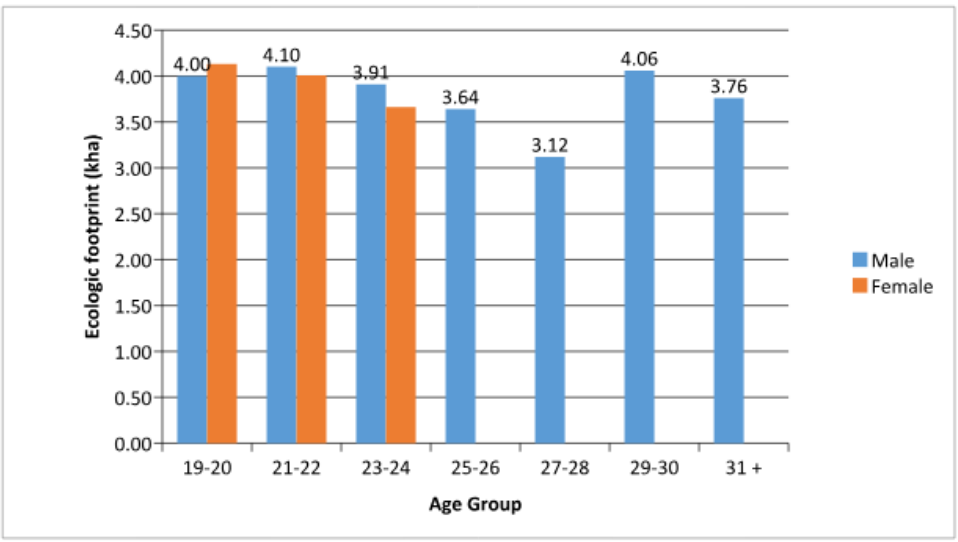

Figure 1. Ecologic footprint averages of students per age group

The ecologic footprint analysis of male and female faculty of engineering students as per their age groups is given in Figure 1. Among female students, 23 year olds are the most eco-sensitive ones in terms of ecologic footprint while the 19 year olds are least sensitive ones. Looking at the ecologic footprints of male participants as per their age groups, the 28 year olds are the most eco-sensitive ones in terms of ecologic footprint while the 30 year olds are least sensitive ones.

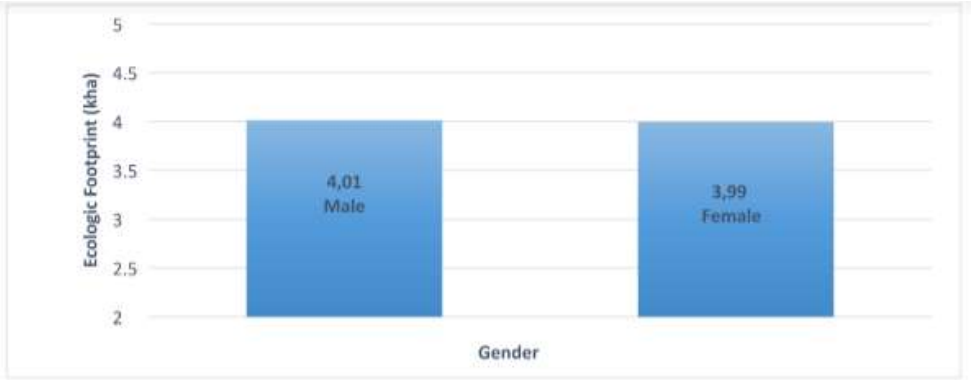

Figure 2. Ecologic footprint averages of students per gender

The gender-based ecologic footprint averages of faculty of engineering students is given in Figure 2. As the figure indicates, ecologic footprint average of female participants is 3,99 kha, and the average of male participants is 4,01 kha. Male participants are observed to have a higher ecologic footprint than the ecologic footprint of female participants. In a study conducted by Eren et. al. (2016), the female faculty of engineering students had an ecologic footprint average of 2,79, male students had an average of 2,64 while the overall average was 2,71.

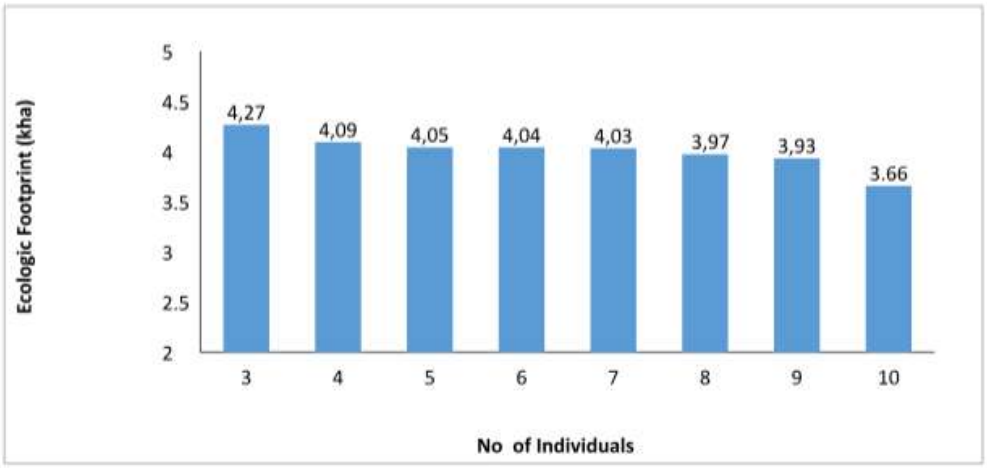

Figure 3. Ecologic footprint averages of students as per the number of individuals in their families

The ecologic footprints of faculty of engineering students based on the number of individuals in their families is given in Figure 3. As the number of individuals increases, ecologic footprint per capita is decreasing. Looking at Figure 3, ecologic footprint in a family of 3 individuals is 4,27 kha while in a family of 10 individuals the figure for ecologic footprint is 3,66 kha.

Carbon Footprint Assessment

Chart 3 Carbon footprint average of the students as per department

Footprint/ Departments	Environmental engineering	Electrical and electronics engineering	Food engineering	Civil Engineering	Mechanical Engineering	Average
Carbon footprint (ton/ind.)	10,26	12,25	12,94	10,79	10,91	11,43

As seen in Chart 3, the survey on faculty of engineering students yielded a carbon footprint average of 11,43 ton. The same Chart also indicates that the environmental engineering department has the lowest carbon footprint (10,26 ton). It is followed by the department of civil engineering (10,79 ton), department of mechanical engineering (10,91 ton), department of electrical and electronics engineering (12,25 ton) and department of food engineering (12,94 ton). Among the five departments, the one with the highest carbon footprint is the department of food engineering by 12,94 ton. Students of the department of food engineering can be said to be less eco-sensitive.

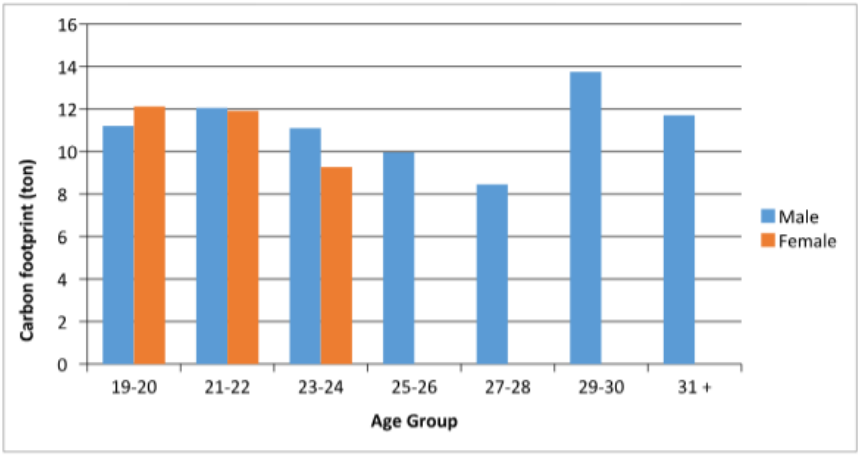

Figure 4. Carbon footprint averages of students as per age groups

The age-group based carbon footprint analysis of male and female students from the faculty of engineering is given in Figure 4. Looking at Figure 4 with regards to the carbon footprints of female students, the 23 year olds are the most eco-sensitive group in terms of carbon footprint, while the 20 year olds are least sensitive. Looking at the same figure for carbon footprint figures of male students, the 28 year olds are the most eco-sensitive group in terms of carbon footprint, while the 37 year olds are least sensitive.

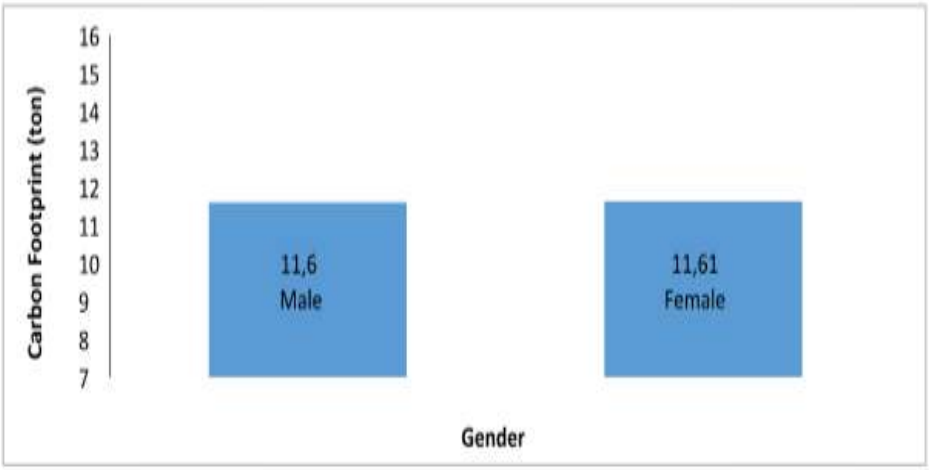

Figure 5. Carbon footprint averages of students as per their gender

Figure 5 indicates the gender-based carbon footprint average of faculty of engineering students. The average for female students is 11,61 ton and the average for male students is 11,60 ton. Female participants have a higher carbon footprint than the carbon footprint of male participants.

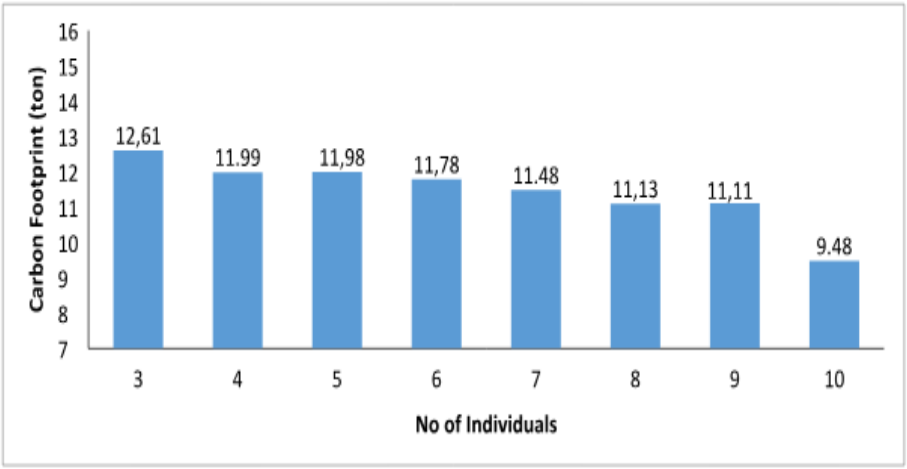

Figure 6. Carbon footprint average of students based on the number of individuals

Carbon footprint of faculty of engineering students as per the number of individuals in their family is given in Figure 6. As the number of individuals increases, carbon footprint per capita is decreasing. According to the chart, carbon footprint in a family of 3 individuals is 12,61 ton while in 10 individuals carbon footprint is 9,48 ton.

IV. CONCLUSION AND RECOMMENDATIONS

In this study, ecologic footprint and carbon footprints of 141 students from Adıyaman University Faculty of Engineering has been calculated. In conclusion; Faculty of Engineering students are observed to have an ecologic footprint of 3,94 kha and a carbon footprint of 11,43 ton. The components that comprise the ecologic footprint of faculty of engineering students have been analysed in terms of food, accommodation, travel and other (consumer goods and services). Examining the faculty of engineering with regards to its departments, students of environmental engineering have lower ecologic footprint and carbon footprint values than the students from the other departments, therefore this department is considered to be the most eco-friendly and carbon emission and ecology sensitive department within the faculty of engineering. Reducing ecologic footprints is highly important and consumers are clearly required to consume responsibly. Therefore sustainable and eco-friendly consumption needs to be adopted; consumers need to be informed and awareness must be raised about their own purchasing power and their role in maintaining environmental order. Consumers need to make an assessment of the environmental impacts of individual or collective consumption before, during and after consumption (Özgen and Aksay, 2017).

Some proposals may be put forward to reduce ecologic footprint and carbon footprint values and to leave a cleaner nature for future generations. These proposals are;

- Wastes around dormitories, homes and faculty should be separated and prepared for recycling.
- Use of public transport need to be encouraged.
- Energy-saving measures need to be taken at homes and offices.
- Water must be prevented from being wasted.
- Natural resources need to be used within ecologic limits and the amount of preserved areas need to be increased.

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