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CASE STUDY

Environmentally friendly behaviors and commuting patterns among tertiary students: the case of University of Tehran, Iran

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Abstract
The environmentally friendly behaviors (EFBs) play a conspicuous role achieving sustainable development due to encouraging citizens using green transportation modes. Assessing EFB among university students is one of the little-known subjects and important research area since they are not only likely to have leading roles in the future society, but also are potentially influential actors in encouraging policy makers to develop the green transportation infrastructure. The present study illustrates the empirical results of a survey of commuting behaviors and the degree of environmental awareness in a target community of students in a campus (Pardis) of University of Tehran, Iran. This paper aims to investigate linkage between students' environmental attitudes and their commuting patterns to the campus. The research method strategy is quantitative and questionnaire, and statistical analysis are deployed to assess the environmental awareness on travel behavior among postgraduate students of the university. Despite a high reliance on the use of public transport, empirical results document a relatively low level of EFB. These findings suggest how national policies should promote a higher level of environmental awareness in university students, stimulating a more environmentally sustainable performance of local systems. Surveyed students in Pardis campus recommended provision of a better functioning public transportation system, including a sharing-bike scheme as an alternative to private transportation.

Keywords Higher education · Environmentally friendly behavior · Sustainable commuting · Statistical analysis · Middle East · University of Tehran

1 Introduction

Fortifying people's awareness toward the environment is a necessary step when tackling with global ecological issues such as air pollution, climate change, or biodiversity loss. Governments, universities, and practitioners worldwide have increasingly realized the

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importance of including environmental education into tertiary curricula (Kagawa, 2007; Moore, 2005). In this perspective, university students' environmental knowledge and awareness have been investigated as a response to increased concerns about ecological degradation (Irawan & Darmayanti, 2012; Ivy et al., 1998; Singhirunnusorn et al., 2012). A refined knowledge of the impact of students' daily activity on the surrounding environment contributes to formulate effective actions and stimulate appropriate individual behaviors toward sustainability. As a key daily activity, commuting plays an essential role in urban traffic (Khattak et al., 2011; Limanond et al., 2011). However, studies related with commuting patterns of university students were relatively scarce, since travel behaviors of this population segment were investigated jointly with other social groups in both official statistics and dedicated surveys. Moreover, because of the distinctive characteristics of students and significant impacts of the location and physical characteristics of each university campus, different travel behaviors are expected in respect with general commuting patterns at both urban and metropolitan scales. Based on these premises, students' travel behaviors should be investigated separately from other population cohorts (Richardson et al., 2012; Rissel et al., 2013; Rose, 2008).

The present paper illustrates the results of an empirical study quantifying the level of environmental knowledge and performance among students of University of Tehran, the oldest university in Iran and one of the most prestigious in the Middle East region. A specific survey was directed to students of the Central Pardis Campus, the oldest university campus located in downtown Tehran, along Revolution (*Enghelab*) Street. Our study is aimed at investigating the association between students' environmental attitudes and their commuting patterns to the campus. More specifically, three main research questions are addressed here, as follows: (i) what are the students' environmentally friendly behaviors (EFBs) in different settings (e.g., campus, home, shopping, transport and commuting)?; (ii) How can travel patterns of university students be described?; and, finally, (iii) what is the potential association between EFB and travel patterns in University of Tehran students?

The research findings were used to figure out the differences of university students' travel characteristics among varying geographical settings which, in turn, reflect intrinsic differences in cultural issues and transport infrastructure provision. To our knowledge, the present study is the first in Iran to link environmental concerns among university students with their travel behaviors and commuting patterns. The structure of the paper is indicated as follows. By reviewing the recent literature, Sect. 2 formulates a theoretical framework of the study discussing importance and characteristics of commuting in a population of university students, together with students' environmental knowledge. Section 3 presents information on the case study, and data collection process. Section 4 describes the results of data analysis and gives justifications for the findings of the research. Finally, Sect. 5 discusses the significance of our research, and proposes policy implications and future studies relevant to the field of investigation.

2 Literature review

2.1 Environmentally friendly behaviors among university students

Review of the related literature shows that the environmentally friendly behavior (EFB) is under influence of variety of factors (Amézaga et al., 2021; Correia et al, 2021; Fang, 2021; Fedi, et al., 2021; Hansmann et al., 2020; Hoffmann et al., 2022; Maleksaeidi, 2020;

Naz et al., 2020; Shafiei and Sigit et al., 2021). A study by Irawan and Darmayanti (2012) investigated the factors influencing university students' green purchasing behaviors in Jakarta. The study showed that perceived environmental responsibility, perceived seriousness of ecological problems and environmental concerns are the most significant variables influencing green shopping behavior. They also found that gender is an insignificant factor when predicting green purchasing behaviors. A similar study by Aslan and Çınar (2015) on students' environmental preferences in Turkey confirmed the low level of green marketing approach among the students (Seyrek & Gül, 2017). An earlier study of Turkish students conducted by Hussein and Cankül (2010) showed that even though most of the students are aware about green industries and environmental concerns, their personal shopping behavior and consuming products hardly reflect their level of environmental knowledge (Seyrek & Gül, 2017). In a further study revealing environmental awareness of university students and factors affecting purchasing decisions, Hello and Al Momani (2014) collected data from students at King Abdul-Aziz University at Jeddah, Saudi Arabia. While students showed a positive attitude toward buying green products, no statistical correlation was found between age, income, and green marketing awareness.

Students' environmental knowledge and appreciation have been widely studied as a response to the heightened concerns about ecological degradation processes. Research indicates that tertiary students are more concerned about environmental problems because of their irreplaceable role in creating an integrated and sustainable development for university environment (Christensen et al., 2009; Fang, 2021; Hansmann et al., 2020; Yuan & Zuo, 2013). Notably, improving students' awareness of the environment is vital (Amézaga et al., 2021; Beringer, 2007; Hansmann et al., 2020; Sigit et al., 2021) because it helps to formulate their active involvement in environmentally friendly actions. Consequently, the willingness of changing lifestyles toward an environmentally sustainable way would become more popular among students (Tuncer, 2008). Moreover, Sigit et al. (2021) reported positive relationship between environmental knowledge and EFB. Environmental awareness as another factor had positive relationship with EFB in their study of biology students. Accordingly, Amézaga et al. (2021) provided similar empirical evidences in their study of university students of the Northwestern Mexico. They concluded that environmental knowledge and attitude explain meaningful part of behaviors favorable to sustainable development. In another research, Fedi et al. (2021) investigated affecting factors on intention to adopt EFB among university students. Their results revealed the significant influence of attitudes and perceived behavioral control on intention to use a refillable water bottle. Another research by Shafiei and Maleksaeidi (2020) explained the significant role of environmental attitude, self-efficacy, perceived costs of pro-environmental behavior and perceived intrinsic and extrinsic rewards of current environmentally unfriendly behaviors in explaining a meaningful portion of the variance in pro-environmental behavior among students. In contrast, Correia et al. (2021) reported that the students' environmental attitude and knowledge have no significant impact on their pro-environmental intention, while the students' subjective norm and perceived behavioral control have a strong positive impact on their EFB.

In order to recognize affecting factors on the consumers' behavior in purchasing eco-friendly products, Naz et al. (2020) conducted research by collecting data from 1185 university students in Hungary. Their results confirmed the significant role of willingness to pay (WTP), green purchase intention (GPI) and environmental knowledge. In this research the influence of age, gender, or qualification in the behavior of young students was not meaningful. Additionally, Hansmann et al. (2020) concluded that the level of pro-environmental behavior was generally higher among members of strongly environmentally

oriented university subsections as compared to other sections. In their research, female gender, age, and position (from bachelor's student, master's student, doctoral student, post-doc/senior scientist to professor) showed a significant positive correlation with positive behaviors as measured by a pro-environmental behavior scale developed for this study.

Simultaneously, environmental awareness is intended as the level of knowledge about ecological issues and the negative effects of human beings on environment (Ergen et al., 2015). Tertiary education is a convenient way to foster environmental knowledge and appreciation of its importance since ecological concerns are becoming more and more popular at all levels of education, and especially at the university (Fernández-Manzanal et al., 2007). The United Nations Economic Commission for Europe (UNECE) documented the role of higher education in formulating sustainable development practices (Clark & Zeegers, 2015).

2.2 Travel behaviors of tertiary students

Educational commuting includes trips that are "made by students to an institution of learning" (De Guzman & Diaz, 2005), possibly accounting for a high proportion of daily trips within urban areas (Gonzalo-Orden et al., 2012; Hamad et al., 2021). There is a growing research addressing the intimate characteristics of travel behaviors of university students (Anantamongkolkul & Kongma, 2020; Bonham & Koth, 2010; Danaf et al., 2014; Hamad et al., 2021; Mitra & Nash, 2019; Rissel et al., 2013; Truong & Nguyen, 2022). It is evident that university students are population segments with distinctive characteristics, engaging in a variety of activities apart from their study commitments, and they exhibit flexibility in choosing transportation modes—especially alternative travel modes (Hamad et al., 2021; Lyth et al., 2015; Mitra & Nash, 2019; TPS, 2015). Literature review outlined the systematic lack in mobility studies of tertiary students, that have been underrepresented in various travel surveys, in the USA (Khattak et al., 2011), as well as in Australia (Lyth et al., 2015), and China (Zhan et al., 2015). Additionally, the empirical findings of these studies document the differences between students' travel behavior as compared to other population segments (Eom et al., 2009; Khattak et al., 2011; Volosin, 2014; Zhou, 2014).

The factors that impact the modal choice of students have also been clearly justified through a number of studies such as Whalen et al. (2013), dell' Olio et al. (2014) and Zhan et al. (2015). Richardson et al. (2012) using web-based survey (via student's emails)—social media (Dal Sticky Notes) at Dalhousie University, Canada, found that walking (53%) is the most popular mode of campus commuting. This is followed by public transport (22%), bicycle (14%), and car (less than 10%). One reason of using non-car modes was short travel time, as 10 min or less was the most frequent pattern, followed by 11–20 min of travel due to the fact that most students resided nearby the campus, led to a shorter travel time. The latter study carried out in three distinct campuses showed that the average commuting distances were different by campuses: Carleston: 16.2 km; Studley: 9.1 km; and Sexton: 10.5 km. The total distance commuted by students for those three campuses were 1885, 4441, and 1786 km, respectively. The relatively high share of non-car modes was achieved while 60% of the surveyed students owned a car and 53% of surveyed people owned a bicycle. The research result of Truong & Nguyen (2022) shows that travel time has significant impact on travel mode choice of students.

In an online study of higher education students of East Melbourne (Australia), a sample of 722 students from three different academies were investigated. The percent share of each travel mode in total travels is car (as driver or passenger) 57%; train 39%; and

bus 36%. The travel time for each mode was reported as 16–30 min (car trips); 1–2 h (rail/bus trips); and 16 min–2 h (active travel – walking/cycling). According to students' viewpoints, the main reason for using car was the lack of efficient public transport in the north–south links, being an incentive for car use in the south arterial road. To increase the share of bicycle usage, establishing direct paths, integration with public transport, and improved safety were recommended (Booz Company, 2012). Another Australian study by Rissel et al. (2013) for the University of Sydney documented public transport (60%), car (18%), and walking/cycling (22%) as dominant travel modes. About 10% of students used free parking facility on the campus. The study also showed that the parking cost, gender, educational background, and age were the most significant factors affecting modal choice. Hardwick (2013) investigated students attending the central campus of the University of Sheffield, UK. The study found 53% of students using car either shared or driving alone. Another 22% used public transit (bus, tram, train), and the rest of students walked or cycled. According to this survey, those who used public transit traveled between 8.3 and 113 km on average, while those who used a car traveled between 12 and 46 km. The average walking/cycling distance was reported between 4 and 6.9 km. Some 38% of students were reported to own a car while no data on bike ownership were reported. Three areas were used for car parking: on-street parking (40%), university car parks (37%), and private car park (14%). The key reasons of using a car were the length of journey to campus, flexibility of car usage, and no availability of alternative modes of transport.

Danaf et al. (2014) developed an online survey in the American University of Beirut, Lebanon, and found that the majority of students (63%) traveled by private car, 10% by bus, and 26% by shared taxi. According to this study, travel time, travel cost, income, gender, car ownership, and parking costs are among the most significant factors influencing modal choice. The study by Lyth et al. (2015) on travel patterns of students at the University of Tasmania, Australia, showed a lower dependency on private car for commuting to campus. Driving alone had a share of only 39% while non-car modes included bus, cycle, and walk represented 46% of total travels. Evaluating at the same time a sample of students from Northumbria University, UK, the share of different modes was reported as public transport (40%), walk/run (34%), car (driver/passenger) 22%, and other (4%). The share of travel time for different segments were reported as 33% for travel time between 15 and 30 min; 27% up to 15 min, and 40% for more than 30 min. The students reported three factors as the main reason of using car: convenience (34%); no reliable alternative (24%), and shorter travel time (20%). According to the research by Hamad et al. (2021), most of the student of the Sharjah University City, UAE, drive alone. Furthermore, there is a significant difference of modal choice between male and female students; females tend to use the bus significantly more than male students. On the other hand, male respondents use more active transport modes compared to female respondents. The main obstacles toward sustainable transportation at the campus were the harsh weather conditions and the inconvenient bus services; some students indicated that they ride the bus because of economic need rather than a sustainable mode of transport.

In the study by Mitra and Nash (2019), travel behavior of > 10,000 students of four universities in Toronto, Canada, was analyzed. According to the some parts of the result, men had higher cycling rates than women, for both commute and non-commute trips. Access to bicycle lanes or cycle tracks was found to increase the odds of female commuter cycling. Further, high-speed traffic was a significant barrier to cycling among female commuters.

2.3 The linkage between Environmentally friendly behaviors and travel patterns

A limited number of studies investigated the role of environmental knowledge and attitudes affecting travel behavior of students. An Australian study on the tertiary students of two universities (Melbourne and Deakin) explored the relationship between psychological and context factors delineating students' travel behaviors. Using regression analysis, this study concluded that factors such as travel time, travel cost, travel distance, and environmental awareness all together affected the modal choice of students (Collins & Chambers, 2005). A similar study by Whalen et al. (2013) across the campuses of McMaster University, Canada, used a web-based survey distributed via student's emails during study semester time (February to March). The objective was to describe mode choice of students and its influential factors. The results showed cost, individual attitudes, and environmental factors as the most significant factors affecting modal choices. Kagawa (2007) noted that students tend to reduce the use of private cars and shift to choosing more sustainable modes of transport, such as public transport, walking and cycling, in order to contribute to reducing carbon emission from transport. In fact, the students' knowledge and consideration toward environmental issues can have significant impacts on their lifestyles, thereby creating a change in their behavior (especially travel behavior) toward environmental protection (Molina-Garcia et al., 2010).

3 Solution methodology

3.1 Study area

The study area is located in the sixth district of Tehran, Iran, corresponding to the Central Business District of the city. In view of its central location, this district is an important urban node for transportation, education, administration, services, and facilities (See Fig. 1). District 6 covers an area of 21.5 square kilometers, about 3.2% of the Tehran area hosting a population of about 280,000 inhabitants, about 3.5 percent of Tehran population. Most of the high-rise buildings (more than 6 floor buildings) in Tehran are located in this district. Having a 75 percent residential density, District 6 displays the highest residential density in Tehran. About 30 percent of the area is dedicated to transport and street networks. The district travel production rate is 1.85 percent and the travel attraction rate is 4.8 percent, which means that this district attracts a high percent of educational, administrative, and business travels from the rest of the city. The present population reaches more than 1.5 million people on a per day base. More than 38% of the total inflows are business trips, 25% educational trips, 17% shopping trips, 11% recreational trips. Four major universities of Tehran are located in this district, including University of Tehran, Amir Kabir, Kharazmi, and Tarbiat Modarres. One of the main problems in this district is the lack of parking. According to official statistics, there are only 8 public car parking in the area with a total capacity of 1820 cars per day. A small number of surface parking in the campus of the University of Tehran has a total capacity of 900 cars. Narrow streets with limitations on street parking further reduced parking availability in the district. There are 9 bus routes within the district, two of which cross the central campus of University of Tehran to the dormitory. There is also a special bus service for students of the University of Tehran, with a bus circulating from the campus

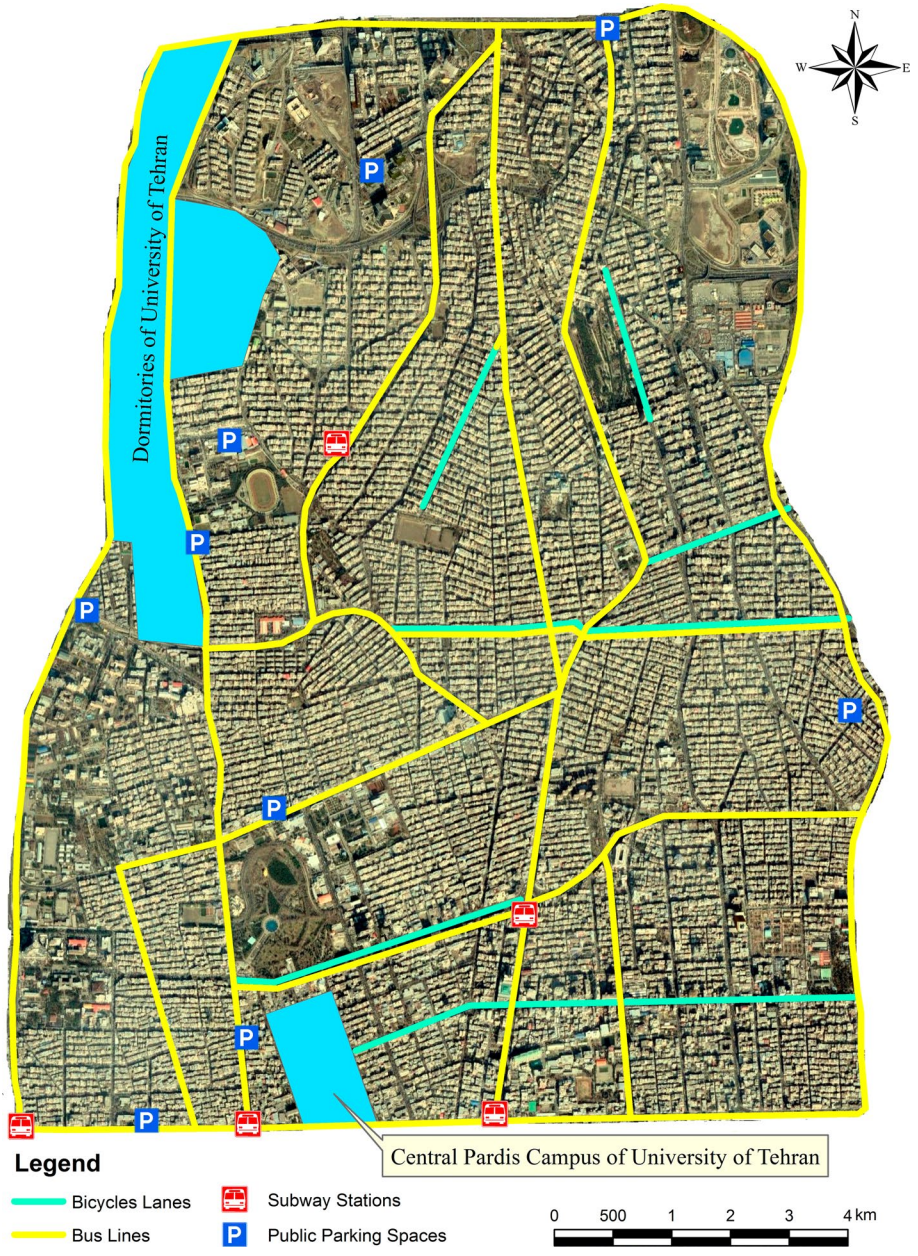

Fig. 1 Study area location in downtown Tehran, Iran, and basic transportation modes therein

to the dormitory every 15 min, and taking students at fixes stops along the route. More than 80 percent of students travel from the dormitory to Central Campus using this bus service, and 20 percent travel by other means like taxi, urban buses, or personal car (according with Tehran municipality data referring to 2018). While having no metro

lines in the district, there are a total of 7 km of cycling routes, which is expected to increase to 25 km in the next five years.

3.2 Questionnaire preparation and data collections

The objective of this study was to investigate student behaviors and current trends toward the environment, specifically exploring the potential impact of environmental awareness on travel behavior. In other words, the study understands whether there are differences between students in terms of their self-reported environmental behaviors based on their demographic background and whether this phenomenon was associated with their patterns of commuting. In doing so, field survey using quality assessment tools (questionnaire) was deployed as one of the very prevalent methods in the exploratory studies that many researchers have used in order to assess individual perceptions on environmental issues (Bouscasse et al, 2018; Ciommi et al, 2019; Corcoran & Wals, 2004; Danaf et al, 2014; Whalen et al., 2013). According to Bilotta et al (2014), there are three criteria that any quality assessment tool should have in order to be reliable including (1) be able to prove construct validity, (2) be applicable across study designs, and (3) be quick and easy to use. Regarding to these criteria and the reliability of questionnaire in association with Likert scale rating system in the existing literature, questionnaire that we used to obtain the study objectives. Based on a field survey directed to tertiary students of University of Tehran, results of this study may indirectly demonstrate how higher education institutions could be innovative in their sustainability curricula. The design of the survey questionnaire and the broad number of respondents contacted online enabled a robust statistical analysis of the collected responses.

The survey questionnaire was organized into three sections. The first section was about personal and household information and includes basic questions on age, gender, duration of study, level of education, type of household, home ownership, family income, driving license, and car and bike ownership. The second section was about characteristics of commuting to campus including travel time, mode, and distance. The third section included personal attitudes and environmental awareness. In this section, we listed three questions on the general viewpoint of the students toward the environment and sustainability, asked respondents to compare their current level of knowledge about environmental issues with classmates/peers. Then, students were asked to rate their environmentally friendly behavior by answering 21 questions about specific areas at campus (six questions), home (five questions), supermarkets (five questions), transport, eating out, commuting, and other issues (five questions). The rating system was based on a five modalities, Likert-type scale ranging from 1 (Never) to 5 (Always). The selection of these questions was based on a comprehensive review of similar studies incorporating several components of the human–environment interrelationship. It was assumed that answers to these questions altogether will represent the level of environmental consideration and readiness to cope with sustainability concerns. In order to examine the reliability of the questionnaire, we used Cronbach's test for which the alpha indexes were all over 0.7. This result indicates a satisfactory reliability of responses (alpha values for EFB on campus, at home, when shopping and on transport and commuting, were, respectively, 0.768, 0.814, 0.795, and 0.717).

The target population was tertiary students studying at Pardis campus, University of Tehran (TU). The questionnaire was distributed in March 2018 and resulted in 100 usable questionnaires. The questionnaire was only distributed to postgraduate students studying different fields at TU. The choice of postgraduate students was thoughtful because the

study assumes that postgraduate students' behavior indirectly affects the behavior of undergraduates and junior students. Furthermore, as previous research confirmed, there is a positive correlation between increased level of education and increased level of concern about the environment (Gonzalo-Orden et al., 2012; Kagawa, 2007; Tuncer, 2008).

The survey flyers were randomly distributed across the campus, asking postgraduate students to participate voluntarily in the survey. Table 1 illustrates selected characteristics of respondents. Data showed that approximately half (54%) of the respondents were males. Approximately half of students (53%) aged between 20 and 29 years. Two other major age groups were 30–34 and 35–39 years of age: 32% and 10%, respectively. The dominant age group of 25–29 was associated with the fact that most respondents were at master's degree level. The age groups of respondents over 40 years of age represent only a small percentage (5%) of students, reflecting the age pyramid of the reference population. Less than half respondents (47%) in the campus were long-term students (with over 2 years' tenure). About one-third students (31%) were less than two years but over one year (30%). The remaining respondents were less than a year but over six months (12%), and new students (0–6-month tenure) accounted for 8% of the total.

Regarding family income, a minority (4%) was on the category of monthly income less than 4 million Iranian Rial (the national currency), and 15% had a family income of 50 million Rial or more per month. The other income groups included 20–30, 30–40 and 40–50 million Rial with shares of 21%, 33%, and 27%, respectively. Three information about the home structure, household type, and home tenancy, were also detailed in the table, which generally shows that the majority of respondents lived in the university dormitory (57%), and the dominant residence type was apartment (59%). With regard to the level of study taken, approximately two-thirds of the students (72%) were taking a master's degree, and 28% were doctorate students. About a quarter of students (22%) had a bicycle while only 18% reported to have access to a car. However, the share of driver license possession was relatively high (61%). To answer the research question, we applied comparative description to explore students' environmental behavior, by examining the statistical association between students' attitudes and travel's modes.

4 Results

4.1 Commuting patterns to the campus

The questionnaire asked students which mode they use to go to campus. The share of every mode was: bus and other public transport (63%), car (9%), taxi or shared-mobility taxi (7%), walk (11%), bike (4%), motorcycle (3%), and others (3%). These figures show that public transport is the main commuting mode among the graduate students of Pardis campus. The popularity of public transport is mostly due to the lower fare cost, higher safety, shortage of car parking space or other restrictions for car usage such as the Limited Traffic Zone within downtown Tehran, and appropriate coverage of the campus by public transport network. Cycling is not popular among students of University of Tehran for several reasons including lack of safe infrastructure, not allowing female students to bike in public, and the lack of sharing bike schemes within the university campus.

The students were asked to report their travel distance in both kilometers and time. The distribution of data shows that a significant proportion of students (21%) lived over 15 km from campus. Further, about 11% lived between 10 and 15 km. However, a considerable

Table 1 Basic characteristics of the surveyed students

Index	Values	Percent
Gender	Male	54
	Female	46
Age	20–24	8
	25–29	45
	30–34	32
	35–39	10
	40 and over	5
Time of being a student in the campus	Less than 6 months	8
	0.5–1 year	12
	1–2 years	31
	2–4 years	38
	Over 4 years	9
Average monthly family income (million Rial)	Less than 30	4
	30–40	21
	40–50	33
	50–60	27
	60 and over	15
Home structure	Separate house	12
	Multistory house	24
	Semidetached	3
	Apartment	59
	Other	2
Household type	Living alone	18
	Two people	16
	Three people	23
	Four people	34
	Five people or more	9
Tenancy	Owner	22
	Rented	21
	University dormitory	57
Level of study	Master's degree	72
	Doctorate degree	28
Bicycle ownership	Yes	23
	No	77
Car ownership (or access)	Yes	18
	No	82
Driving license	Yes	61
	No	39
Sample size	-	100

share of respondents (14%) lived only 400 m from the campus within the dormitory area. This share had the highest chance to walk or cycle to the campus. In contrast, about 56% of students were located over 20 km from the campus which makes cycling and walking

problematic. Based on the mode of travel, travel time differs among the students even for those who lived at similar distances to the campus. According to the self-reported travel time, 36% of students lived at a distance of less than 20 min; while 32% lived over 30 min from campus. These figures show that campus' location is accessible for one-third of students if they wish to use non-motorized transport. As described earlier, public transport is the most favorable mode for over 60% of students, while car usage was only 9%.

4.2 Environmentally friendly behavior (EFB) among students

As far as environmental issues, most of students were pessimistic (58%) while only 9% were optimistic about the future. Only 14% of students believed they had a higher level of environmental knowledge compared to their classmates/peers; 43% stated that they felt having appropriate level of environmental knowledge, while over one-third (36%) believed that their level of environmental knowledge was low or needing improvements.

The sampled students were asked to report three sources of environmental information: the internet (30%), social media (27%), and TV (13%) which show the dominant role of the virtual world in shaping the thoughts of students and the requirement of diversified and attractive learning materials especially in home language (Persian). The implication of the above results is that media and informal education would be expected to be more effective in influencing changes in behaviors, as their role on personal life will become more important in the future. However, it does not mean that other measures such as holding behavioral campaigns are less successful in changing environmentally friendly attitudes and behaviors. The success of informal learning and media can be reinforced by regulations, law, and social pressure.

The survey results to environmentally friendly behaviors and actions in four categories are summarized in Fig. 2. This graph shows that students do better when they are on campus (3.6). Their actions in other cases, including when they are at home (2.7), shopping (2.6), and doing other activities (2.5), are similar and only half of the desirable action. Among the activities on campus, "turning off the lights when leaving the room" and "turning off computer after use" were scored highest: 4.5 and 4.2, respectively. The lowest score belonged to "using refillable printer cartridges" (2.3). Among doing environmentally friendly activities at home, the highest score was allocated to "saving resources and energies" (3.9) and "recycling household waste" (3.3), while the lowest score was for "using solar electricity or solar water heater" (1.7). For environmentally friendly activities taken when doing shopping, the highest scores were for "avoid buying disposable or single-use items" (3.8). The lowest popular activity was "shopping with my shopping bags " (1.9). Finally, for activities undertaken when taking transport, community work and other activities, the highest score was for "using public transport, cycling, walking" (3.3), while the lowest score was allocated to "doing political and community work on environmental issues" (1.7), and "donating money or membership to conservation organizations" (1.5).

In reporting the main reasons of not taking environmentally friendly actions, the inappropriateness of facilities and unfriendly physical environment was reported as the main source of failure (35.1%). The other significant reasons were lack of knowledge on the impact of environmentally friendly behaviors in reducing negative environmental impacts (13.1%) and not being familiar/aware of environmentally friendly performances (12.8%). This finding shows that built environment and associated facilities (such as location of bins, distribution of environmentally friendly resources) were the most significant reasons

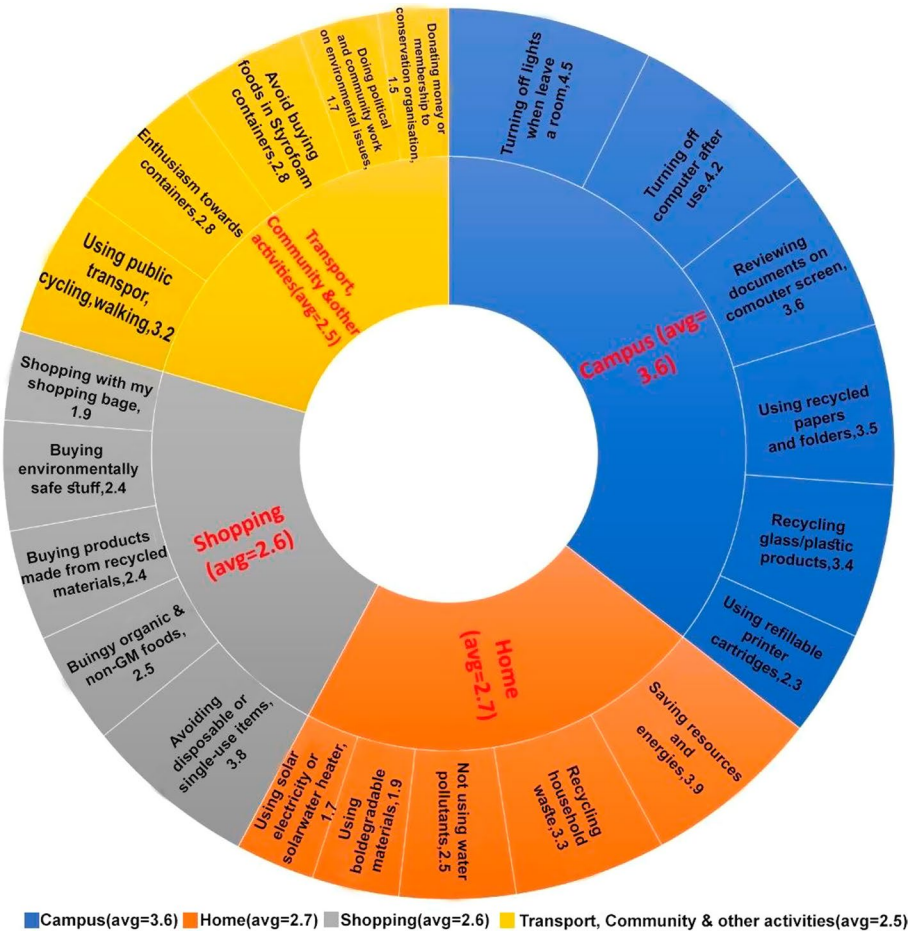

Fig. 2 A kaleidoscopic illustration of environmentally friendly behaviors (EFBs) of University of Tehran students by analysis' dimension

of applying environmentally friendly behaviors. However, more research is required in order to identify effective strategies for influencing each of these aspects.

4.3 Exploring the linkage between environmentally friendly behaviors (EFBs) and socio-demographic characteristics of the sample

To examine the association between socio-demographics and EFB in four different contexts (campus, home, shopping and transport, community and other activities), we employed a Chi-square analysis as many demographic variables were measured on nominal (gender, home tenancy, home structure) or categorical (age, study duration, level of education, family monthly income) scales.

The results of the analysis are summarized in Table 2. Female students were more environmentally conscious compared to male students. This finding was significant

Table 2 Results of a Chi-square analysis applied to the survey results in University of Tehran

Socio-demographics		EFB			
		EFB on campus	EFB at home	EFB when shopping	EFB on transport, community, and other activities
Gender	$\chi 2$	25.6	30.8	19.1	25.3
	p-value	0.015	0.034	0.041	0.058
Age	$\chi 2$	43.7	42.2	50.2	37.6
	p-value	0.074	0.105	0.114	0.216
Study duration	$\chi 2$	39.2	126.1	42.5	38.9
	p-value	0.043	0.084	0.148	0.266
Level of education	$\chi 2$	32.7	92.5	36.7	40.8
	p-value	0.546	0.627	0.572	0.509
Household tenancy	$\chi 2$	28.9	90.3	38.7	45.2
	p-value	0.075	0.039	0.046	0.059
Home structure	$\chi 2$	89.2	57.0	89.1	54.7
	p-value	0.429	0.027	0.501	0.668
Family weekly income	$\chi 2$	45.2	38.1	35.2	83.9
	p-value	0.255	0.147	0.050	0.108

Level of confidence = 95%

in two particular settings: at home ($x^2(2, 96) = 30.8, p < 0.05$) and when shopping ($x^2(2, 96) = 19.1, p < 0.05$). This is consistent with the former literature (Laroche et al., 2001; Anderson & Hansen, 2004; Furlow & Knott, 2009; Florenthal & Arling, 2011). Age did not show a significant association with EFBs, while earlier research documented how younger people are more sensitive to the environmental issues, thus being more likely to exhibit EFB (Diamantopoulos et al., 2003). One explanation for this results is that the sampled students were partially homogenous and not widely diverse in age profile.

Education level did not show a significant association, since our sample consisted of only postgraduate students. However, study duration was a significant factor in adopting EFBs at the campus ($x^2(2, 98) = 39.2, p < 0.05$). As found in the literature, those respondents with a higher degree of education were more likely to exhibit EFBs (DoPaco et al. 2009).

Household tenancy ($x^2(2, 95) = 90.3, p < 0.05$) and home structure ($x^2(2, 98) = 57.0, p < 0.05$) were significant factors affecting EFBs among students. Income level was found to have a significant association with EFB ($x^2(2, 93) = 35.2, p < 0.05$) while shopping. This is consistent with the literature as Do Paco et al. (2009) in Portugal found that students from higher income families were more likely to buy green products. A similar result was achieved in Switzerland, confirming that students from affluent families were prepared to pay for environmentally friendly goods (Meyer & Liebe, 2010). Similarly, in both the USA and India, family income has a positive and direct impact on the environmental behavior of students (Hassan & Ratnakar, 2012; Newman & Fernandes, 2016).

Table 3 Results of bivariate correlation analysis applied to the survey results in University of Tehran

Socio-demographics	EFB			
	EFB on campus	EFB at home	EFB when shopping	EFB on transport, community, and other activities
Public transport	$r = 0.127$: $p < 0.012$	$r = 0.305$: $p < 0.004$	NS	NS
Car	NS	NS	NS	NS
Walk	NS	NS	NS	NS

Level of confidence = 95% NS = not significant

4.4 Exploring the relationship between environmentally friendly behaviors (EFBs) and travel patterns

Using three modes of commuting that include public transport, car, and walking (85.7% of total modes) was examined against undertaking EFBs within four distinct settings: campus; home; shopping, and transport/community (Table 3).

According to the results, adopting EFB on campus ($r = 0.127$; $p < 0.012$) and at home ($r = 0.305$; $p < 0.004$) were both correlated with public transport usage. The finding is consistent with the literature as people who have a high environmental consideration perceive public transport use as more convenient, more beneficial, and more enjoyable than those trip-makers who do not have those environmental feelings (Bouscasse et al., 2018). However, no significant correlation was found between adopting EFBs and using two other modes: car and walking. This finding confirms that mode choice habits are related to environmental concern as the correlation is partially mediated by perceptions and attitudes toward public transportation but not significantly by symbolic and affective motivations for car usage (Bouscasse et al., 2018). In fact, having positive feelings and consideration toward the environment foster the usage of public transport. As the statistical test showed, however, the association between EFB and car usage habits is not strong. This result should be interpreted with caution because of the locational accessibility of the Pardis campus, which makes the public transport as the most efficient and affordable alternative for the students.

5 Discussion

This study illustrates the results of an original survey undertaken in central Pardis campus of University of Tehran (TU) to investigate knowledge and performance of environmentally friendly behaviors of students toward the environment. The choice of students as the main research target at this university was crucial to carrying out an in-depth study about this special population segment in relation to its perceptions and behaviors. Indeed, tertiary students with their knowledge, predisposition, and passion for doing environmentally friendly activities are identified as one group of stakeholders that could significantly contribute to the formulation of sustainable development for both university environments and for the whole society (Emanuel & Adams, 2011; Lidgren et al., 2006). Furthermore, the growing interest in studying the impacts of having environmental education in the curriculum of an

academic institution, especially for higher education, has resulted in substantial changes in students' perceptions and behavior toward the environment (Blewitt & Cullingford, 2004; Clark & Zeegers, 2015; Sterling et al., 2013; Tuncer, 2008). Accordingly, this study on environmental knowledge and behavior of students in TU may inform this research field.

The empirical results demonstrate that students' environmental behavior in different situations (campus, home, shopping, transport) is highly dependent on their socio-demographic characteristics (gender, duration of study, household size, home tenancy, home types, household size, and family income). These research outputs are similar to some extent to the findings of earlier studies. For instance, we found that female students had better environmental performance at home and shopping than male students: This is consistent with findings of Fernández-Manzanal et al. (2007) and Tuncer (2008). Our study also demonstrated that EFBs can vary based on locational factors; for instance, income was found to be strongly related to some environmentally friendly actions of the students specifically when they are at home or did shopping. Differential EFB levels across different locational contexts need more investigation to find out which particular spatial features encourage (or discourage) EFBs and how effective they are. These findings would be essential for policy actions improving knowledge and behavior of students toward the environment across Iranian universities. Campus planning and design practice should increasingly consider individual variables such as students' residence location, context of the routes between residential area and the campus, and the dominant socio-demographic characteristics of students.

Increasing awareness about the impacts of environmental actions makes the study of university students' behaviors of growing importance. It is beneficial to understand how students' behaviors are influenced by demographic factors within different locational contexts. As the students at Pardis campus showed a significant awareness of the environment and engaged in diverse activities supporting environmental stewardship in different scenarios in their daily life, this could be a positive sign reflecting initial success of environmental knowledge and awareness in the university curricula. Therefore, the necessity of having long-term strategies to continue providing environment knowledge for university students in this campus should be considered with the aim at establishing modern and sustainable university models. Equally important, it is worthwhile to note that the exploration of the linkage between socio-demographic characteristics of students and their environmental behavior is essential. Policy actions could be implemented to maximize the involvement of students' groups who are more likely to support environmental protection activities. Appropriate policy would be also proposed for those who are currently less likely to support environmental actions. By targeting tertiary students, because they are likely to have leading roles in their respective fields in a future society, that are potentially influential in securing societal wide changes improving the level of environmental stewardship.

To expand the achievements of this research, future work should develop a truly comprehensive and comparative investigation of students' environmental knowledge and behavior toward the environment at other campuses of Iranian universities. Additional research is especially required to understand the relationship between different aspects of environmental literacy. As noted by van Weenen (2000), Cortese (2003), Lozano (2006), and Wright (2010), other key stakeholders who constitute the complexity of the university environment, such as university staff, employers, faculty, alumni, or even student's parents (Yuan et al., 2013) could be recruited to participate in a future survey and comparison would be made to clarify the differences between characteristics of environment behavior of all these targets. Accordingly, distinct characteristics of a typical university campus, and universities, in terms of their environmental stewardship performance, can be profiled to

allow international comparisons that could inspire universities to improve their environmental credentials and demonstrable care for the environment.

6 Conclusions

This research aimed to investigate commuting behaviors and the degree of environmental awareness among postgraduate students of the Tehran University using qualitative research strategy. Similar to any scientific research, the present study had its own limitations as it was conducted within only one university campus using a medium-size sample; henceforth, the empirical findings cannot be fully transferred and generalized to all Iranian (or Middle East) academic institutes. Several psychological variables mentioned in the behavioral science literature that could affect student' environmental behavior was not directly included in this survey. Moreover, the influential variables which we obtained derived from a posteriori statistical reflection of factors that intermingle with each other to generate influences. The assumption was that those factors reflect the sample from where the data were collected. The sample is composed mostly of postgraduate students living in university dormitory. It is expected that different forms of interactions between variables will appear when applying the same statistical approach to broader samples of students from various backgrounds. Furthermore, it would be beneficial to examine specific behaviors among the student population and not just general statements. These considerations need to be taken into account in future studies.

The contribution of the findings of this study to the current literature is that it is giving new insights from the level of environmental knowledge among tertiary students of Tehran University as the first and one of the most prestigious universities in the Middle East. Furthermore, the study revealed that there is a direct and inextricably link between socio-demographic characteristics of tertiary students and their EFBs and this important linage should be addressed in environmental policy making of the university. Finally, the findings of the paper have provided an EFB profile of Tehran university students so that it can now be used to international comparisons in further research.

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Declarations

Conflict of Interest The authors declare no conflict of interest.

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