



Journal of Sustainability Perspectives

journal homepage: <https://ejournal2.undip.ac.id/index.php/jsp/>



Sustainable Transportation Managing in University Campuses: The Case of Middle East Technical University

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Article Info

Received:
14 March 2022
Accepted:
25 May 2022
Published:
1 August 2022

DOI:
[10.14710/jsp.2022.15525](https://doi.org/10.14710/jsp.2022.15525)

*Presented in the 7th
International (Visual)
Workshop on UI
Greenmetric World
University Rankings
(IWGM 2021)*

Abstract. As the level of income of countries rises, sustainability-related issues are improved in general; however, problems regarding the increase in the amount of waste and carbon emissions worsen. The increasing level of wealth in both developing and developed countries, as well as cultural transformations that encourage the use of personal vehicles, threaten sustainability on a global scale. Generally, higher education institutions are places of great mobility thanks to their students, personnel, and visitors. For this reason, creating eco-friendly ways of transportation in these places is one of the most important aspects of having sustainable campuses. The reason why it is crucial is that creating a livable environment by providing sustainable transportation alternatives on campuses leads students to potentially continue with these practices in their lives afterward. Although there are various widely accepted practices of managing sustainable transportation implemented in higher education institutions, it is of great importance for these institutions to conduct a comprehensive situation analysis first so that their sustainable transportation policies can be shaped correctly. In this way, it can be possible for the universities to evaluate their current situations thoroughly and thus implement their own practices in accordance with their conditions. This study endeavors to examine the issue of eco-friendly transportation for sustainable campuses, evaluate the practices of Middle East Technical University in this respect, and raise suggestions for higher education institutions.

Keyword:

Sustainability, Transportation Management, University Campus

1. Introduction

As a result of urbanization and population growth, a significant increase in the use of resources and the amount of waste have been observed on a global scale. This has led to the

emergence of serious environmental problems, and therefore the concept of sustainable development has become more important than ever [1]. Higher education institutions, which undertake a critical responsibility in the development of countries and increasing their level of welfare, have a significant role in reaching sustainable development goals as well. Resembling small cities on their own with their large campuses and populations, universities have both direct and indirect effects on the environment [2]. Therefore, higher education institutions need to integrate the Sustainable Development Goals (SDGs) into their own strategic plans and policies as well as reflecting them in their practices. Universities must be the guides of society with their practices in order to increase the awareness of sustainability. In this context, ranking systems such as GreenMetric IU and Times Higher Education (THE) Impact Ranking have been making significant contributions to increasing the awareness level of universities. As such systems evaluating higher education institutions in this respect become widespread, universities find a chance to see their strengths and weaknesses in terms of sustainability.

As the income level of countries rises, sustainability-related issues are improved in general; however, problems regarding the increase in the amount of waste and carbon emissions worsen [3]. Transportation provides significant opportunities for the social and economic development of societies. However, transportation systems in both developing and developed countries have vital issues and thus pose a threat to global sustainability [3]. Generally, higher education institutions are places of great mobility thanks to their students, personnel, and visitors. For this reason, creating eco-friendly ways of transportation in these places is one of the most important aspects of having sustainable campuses. The reason why it is essential is that creating a livable environment by providing sustainable transportation alternatives on campuses leads students to potentially continue with these practices in their lives afterward.

In this study, examples of sustainable transportation managing practices on the campuses of higher education institutions are examined, the practices of Middle East Technical University in this respect are evaluated, and suggestions for higher education institutions are put forward.

2. Sustainable Transportation Management in Campuses

Sustainable transportation is generally defined as the capacity to meet the need for mobility of people in such a way that causes minimal damage to the environment while not hindering the mobility needs of future generations [7]. There are certain difficulties leading individuals to prefer sustainable transportation alternatives while the cultural transformations and increasing level of wealth in both developing and developed countries encourage them to use personal vehicles. Nevertheless, it is still possible to achieve this on a large scale with the help of effective policies and practices. There are some common practices and strategies carried out by higher education institutions with regard to the management of sustainable transportation. The management of parking lots, improving pedestrian and bike lanes, promoting the use of public transport and shared vehicles, reducing the number of fossil fuel vehicles, and reducing the overall consumption of fuel can be listed as some of them [8-11]. Even if there are various widely accepted practices in this regard, to adopt the right policies on sustainable transportation, the institutions need to conduct comprehensive situation analyzes on subjects such as the number of vehicles entering the campus daily, the amount of time these vehicles stay on campus, busy periods

of time, emission measurements, land structure, distribution of population density on campus, and alternative modes of transportation. In this way, it can be possible for the universities to evaluate their current situations thoroughly and thus implement their own practices in accordance with their conditions.

Even though some higher education institutions have various alternative transportation methods to the campus, this alone does not suffice to create an eco-friendly transportation system. In order to ensure sustainable transportation on campuses, an effective, sustainable transportation management must be established by taking into account such dimensions of the issue as behavioral factors, infrastructure, motivation, security, and education. By adopting the right policies, universities can change their campuses in terms of sustainable transportation and thus guide society in this regard.

Managing Parking Lots. There are various studies indicating that the use of public transportation is more common in areas with business centers offering limited parking spaces [12]. This approach of offering limited parking lots to reduce the use of personal vehicles is quite a common practice among many universities. However, it is not possible to suggest that this approach will be effective for all institutions. There are several unforeseen disadvantages such as regional air and noise pollution caused by a large number of vehicles gathered in a small area, extra fuel consumption, and extra emission due to vehicles touring around in search of a vacant parking space. The study of Guo et al, which aimed at analyzing the environmental costs of looking for a parking lot at the North Campus of the University at Buffalo, indicated that cars waste approximately 120 gallons of gasoline per hour during their search for a vacant parking space. This means that 250,000 gallons of gasoline are wasted this way per year [13]. For this reason, alternative solutions can be sought such as creating shared parking lots by grouping the buildings in a balanced way in universities with a large enough campus area, and creating parking lots at a certain distance from the buildings where people can walk or take a shuttle bus after parking their cars. However, it is also important to have a balance in this regard as increasing the number of available parking spaces would lead to an increase in the use of personal vehicles. Therefore, an approach specifically in accordance with the conditions of the university should be formulated.

Another common practice of parking lot management adopted by many universities is to charge the people who come to the campus by a personal vehicle with a certain parking fee. Various studies on this subject have shown that this method is effective and results in a decrease of up to 30% in parking space demand [14]. While some universities adopt the approach of charging different parking lot fees for students, academic staff, and guests, there are also some universities that charge first-year students with the highest fees as well as limiting parking spaces available for them so that they will form a habit of using alternative transportation methods from the beginning [11].

On campuses, the effective management and structure of parking lots are as crucial as their number, capacity, and spatial distribution. In this context, practices such as checking the occupancy rates of parking lots, allocating some parking spaces to prioritized groups, preventing parking violations, keeping the parking space capacities limited in densely populated areas, or charging higher fees in these areas can be adopted.

Improving Pedestrian and Bike Lanes. Encouraging walking and the use of bicycles is one of the most effective ways to reduce the use of traveling by motor vehicles. Factors such as the condition of pedestrian and bike lanes as well as pavements, the width of the roads, the slope of the land, traffic density, and safety measures implemented in traffic have either

positive or negative effects on the rate of pedestrians and bicycle riders. In order to increase the interest in walking, first of all, the issue of walkability needs to be evaluated thoroughly [15]. In their study, Gori et al. assess walkability for a pedestrian-friendly design based on connectivity and quality of the roads, and proximity indicators [16]. In this context, some of the important factors in terms of evaluating walkability are as follows: quality and continuity of the roads, inclusion of shortcut routes, shading, safe and proper lighting, accessibility, markings on the roads, and safety measures in effect [15]. Furthermore, providing pedestrians with campus maps placed at appropriate points on campus in order to minimize time loss and make their walks as efficient as possible will have positive effects on growing walking habits. On the other hand, factors such as socio-economic status, age, gender, safety concerns, the distance to be covered, quality of the bike lanes, and whether or not there are enough destinations that can be reached by bicycle are among the important points that determine how commonly bicycles are preferred [17].

Reducing the On-Campus Transportation Demand. Students and personnel at universities create significant mobility on campus for numerous reasons. Reducing this mobility as much as possible and encouraging non-motorized methods to be preferred are two of the vital factors for *achieving* sustainable transportation. To reduce the mobility, some of the suggested practices that can be implemented in universities are as follows: the buildings of units that may be related to one another can be positioned closely; the number of cafeterias and canteens should be sufficient, and they should be placed appropriately on the campus; administrative operations that can be carried out online should be increased; some meetings and common classes can be held online.

Reducing the Consumption of Fuel and the Number of Fossil Fuel Vehicles. Fossil fuel vehicles have great adverse effects on the environment. Instead, the use of renewable energy-based vehicles must be encouraged in order to ensure sustainable transportation. In this context, some universities replace their service vehicles with those based on clean fuel technologies while providing free and/or prioritized parking spaces for clean fuel vehicles. However, this process will take time since replacing the existing vehicles with clean fuel ones entails a high cost for the universities.

Promoting Public Transportation. Promoting the use of public transportation is one of the most effective ways to decrease the number of personal vehicles and thus reduce emissions on university campuses. Promotion strategies with this aim should take into consideration not only the in-campus mobility but also transportation from and to the campus. Universities follow various strategies to promote public transportation. Some of these strategies are as follows: increasing the number of public transportation vehicles as well as the diversity of routes and destinations; providing low-cost or even free of charge transportation; improving the comfort and safety levels of public transportation vehicles; announcing the departure times, stops and details of routes displayed at the stops/stations and on mobile applications for easy predictability; providing public transportation users with free parking on certain days / during certain periods.

3. Practices of Sustainable Transportation at Middle East Technical University

Middle East Technical University (METU) is located in Ankara, the capital and second most populous city of Turkey. As of today, the population of Ankara is approximately 5.6 million. Having one of the largest university campuses in Turkey, METU aims at creating a modern on-campus transportation system in line with the principles of sustainable

transportation. The goal is to improve the campus transportation system in an eco-friendly, energy-efficient, smart, unimpeded, accessible, and safe way; to provide the necessary infrastructure to encourage traveling on campus by bicycle and on foot; to reduce the use of personal vehicles by improving the quality of public transportation alternatives [18]. METU has a total enrollment of approximately 22,684 students, over 2,736 academics (1,235 of which are research assistants), 2,618 administrative staff. METU campus has an area of 4,500 hectares, of which 3,403 hectares are covered by forest. The built environment covers an area of approximately 220 hectares (See Figure 1). There are 7 gates on the campus, 3 of which are actively open to people's entry and exit. The A1 Gate provides access to all public transportation vehicles such as metro, bus, and minibus. For this reason, it is the gate with the highest traffic density. The A4 Gate is also one of the busiest gates because it is located close to areas where many students reside. The A7 Gate is mostly preferred by the personnel of the Technopark and residents of the relevant region of the city. From the very beginning, the campus was designed as pedestrian-friendly as possible by separating pedestrian traffic and vehicular traffic strictly, and there are also certain restrictions of entry at the gates. In time, with the newly opened units, increasing campus population, and increasing use of personal vehicles, a significant rise has been observed in the number of vehicles entering the campus daily [14,15].

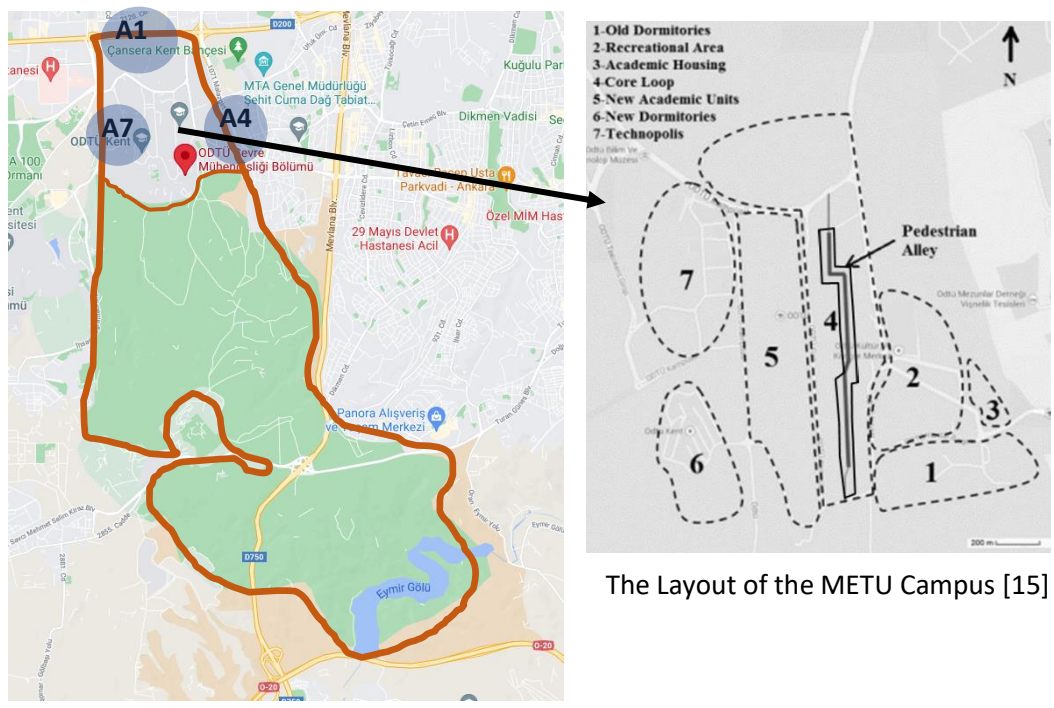


Figure 1. The Location of METU Campus

Although it varies daily and seasonally, the average number of vehicles entering the METU campus per day is 1,169. The results of the studies carried out by Altıntaşı show that approximately 45% of the vehicles entering spend less than 15 minutes inside the campus, while approximately 22% of the vehicles spend 1 to 5 hours inside. There are approximately 1,000 vehicles on a daily basis traveling from one destination to another inside the campus [14]. Emission measurements, such as how many vehicles enter the campus, how much distance they cover, and their average speed while traveling inside the campus, were carried out. The evaluations showed that reducing the number of personal vehicles traveling across

the campus could significantly reduce the emissions accordingly [14].

In the study conducted by Karataş in 2015, several measurements and surveys were carried out to determine the quality of the pedestrian lanes on the METU campus. According to the surveys, most students found the walking areas of the campus sufficient; however, some of them stated that the infrastructure of the pedestrian lanes needed to be improved against weather conditions [15]. Moreover, the study indicated that students had positive evaluations of the presence of the trees on the sidewalks despite the fact that the trees narrowed the walking areas [15]. Taking these into account, the sidewalks were redesigned and started to be improved without giving up the trees.

In a study carried out by Genel in 2020, the use of parking lots and parking violations in the campus were analyzed. As a result, a parking lot management strategy was proposed to address the problems caused by parking violations such as reduced road capacity, traffic safety risks, and increased fuel consumption [14]. Genel suggests that with proper strategic planning, parking lots can be benefited from more efficiently without having to provide more parking spaces.

METU considers the issue of sustainable transportation among its priorities; therefore, there are various studies being conducted and practices being used in this area. While shaping the policies of sustainable transportation at METU, scientific studies conducted on the university campus are benefited from in addition to administrative analyzes [14,15,18-21]. In total, there are 56 parking lots with varying capacities on the campus. Since the rising population of the campus over the years has led to the inadequacy of these parking spaces, several alternative policies have been developed to benefit from the parking lots as effectively as possible and to reduce the traffic stemming from personal vehicles. The fact that a significant percentage of the vehicles entering the campus do not spend much time inside and leave shortly afterward makes it easier to manage the parking lots at METU. Some of the parking lots at METU are relatively distant from the center of the campus; therefore, people can either walk or take a shuttle bus after parking their vehicles there. One of these parking lots is at the entrance of the A1 Gate. The reason why this parking lot is located here is to encourage the people to go to their destination on the campus on foot or by taking a shuttle bus after leaving their vehicles here. Only vehicles with stickers are allowed to enter the campus. In order for those who do not own a sticker to enter the campus with their private vehicles, they must leave their ID cards at the gate security and get a visitor card. Even though the stickers allow drivers to enter the campus, it does not mean that they can leave their vehicles at any parking lot on the campus. There are different parking areas allocated for different sticker owners. There is an annual fee required for the stickers, and different fees apply for guest vehicles, alumni vehicles, academic and administrative staff vehicles, and vehicles of Technopark personnel. Moreover, additional measures are implemented to keep the traffic density on campus under control. Technopark, which is located on campus, has a significant number of employees. In order to discourage the Technopark personnel from entering the campus via A1 and A4 gates, where the vehicle density is normally quite high, the sticker fees for Technopark personnel that allow entering the campus through these gates are four times more expensive than regular stickers. In this way, the distance that Technopark personnel needs to cover on the campus is also shortened, which contributes to the reduction of emissions. Besides the already existing measures to prevent unauthorized parking and on-street parking violations, relevant university personnel also carry out regular inspections.

As a pedestrian-friendly university, METU has strictly separated vehicle and pedestrian

traffic to encourage walking and the use of bicycles. There are pedestrian and bike lanes in between many buildings, isolated from vehicular traffic. The buildings are not located far away from one another so that one can walk without problems. The roads and pavements are barrier-free, safe, and marked properly. There is a project that is still in the works aiming at creating a shared fleet of bicycles free of charge for the students.

Traffic on the campus is one of the vital elements of safe sustainable transportation. Kundakçı et al. conducted a "METU Campus and Transportation Survey" for METU students covering issues such as sustainable transportation, access to campus, on-campus access, and campus traffic safety [20]. The results of the survey showed that nearly 90% of the participants stated that they felt safe in traffic on campus. Regarding the issue of speed, which is one of the most important elements of traffic safety, 83.9% of the participants stated that the speed limits on campus are convenient, while 85.5% found the speed bumps on the campus effective and necessary. 88.2% of the participants of the survey stated that they knew the traffic rules on the campus; however, 22.9% of them found the traffic signs and markings insufficient [20]. Furthermore, Güllüoğlu conducted studies examining the population densities of the several regions on the METU campus [21]. Upon the results obtained from the studies of Kundakçı et al., and Güllüoğlu, a number of improvements were made such as increasing the number of crosswalks, marking the pedestrian-priority zones to make them more visible, increasing the number traffic signs, and some additional regulations to enable pedestrians to see the vehicular traffic more easily as well as enabling drivers to see pedestrians more easily as they get closer to crosswalks.

Several economic methods of public transportation are available to reach METU campus such as metro, buses, and minibusses operated by both the municipality and private enterprises. Every day, an average of 1200 personnel (23% of the total staff) use the university's personnel shuttles, which cover 42 different regions of the city, to commute to the campus. With an agreement signed between the Municipality of Ankara and METU in 2020, the municipality has been providing free shuttle buses on weekdays taking passengers from the campus entrance to the units inside the campus and back every 15 minutes. Furthermore, there is a student discount on bus, minibus, and metro fares in order to encourage public transportation. In addition, for the same purposes, the university administration remains in communication with the units and organizations responsible for operating public transportation services in order to provide the best possible conditions in terms of the overall comfort and accessibility of the vehicles, the time interval between each service, diversity of the routes, planning of stops and so on. Furthermore, information such as routes of public transportation vehicles and departure times are shared at stops as well as on mobile applications.

By making sure vehicles are not left idling while waiting at the stops, unnecessary fuel consumption is prevented. Thanks to a mobile application called ODTÜ Pass, the necessary information of guests is shared with the security personnel at the gates before the guests arrive at the campus, which shortens the time spent at the gates waiting and thus reduces unnecessary fuel consumption. Excluding the shuttle buses for personnel, the number of service vehicles operated by the university is kept to a minimum. As of today, there are 46 vehicles being operated for various purposes. Illuminations and visual markings on the streets of the campus are made in accordance with the traffic rules.

There are 19 dormitories at METU, with a total capacity of 7,358. Approximately 40% of the students stay in the dormitories, while approximately 12% of the personnel live in the staff houses. Some administrative meetings and common classes are held online. Various

alternatives of social areas such as restaurants, cafés, sports fields, etc., are located on the entire campus appropriately. These aforementioned factors play a vital role in keeping the use of personal vehicles and the need for vehicle mobility inside the campus. The first charging station for electric vehicles at METU was established in 2019 to encourage the use of zero-emission vehicles among staff and students. Moreover, staff and students are also encouraged to share their vehicles.

Thanks to all these effective practices, despite the increasing campus population, METU managed to reduce the number of vehicles entering the university by approximately 30% and to increase the use of shuttles by 20.5% in 2019.

4. Discussion

Ensuring eco-friendly transportation conditions on campuses is of great importance because not only the damage caused to the environment is reduced to a minimum, but also universities can play a guiding role for the society, and the students at these universities can reflect their experiences in this regard to their practices in the future. Although there are various widely accepted practices in sustainable transportation management in higher education institutions, it is still significant for the institutions to formulate their own unique, sustainable transportation policies by making a comprehensive situation analysis of their campuses. METU, the subject of this study, has managed to significantly reduce the number of vehicles entering the campus and increase the use of public transportation with the effective policies it implemented by taking into account various dimensions of sustainable transportation such as behavioral factors, infrastructure, motivation, safety, and education. It is vital for universities to constantly review their practices by examining the results of the policies they adopted and accordingly the changes on their campuses.

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