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Spatial Assessment and Number of Bicycle Stations in an Educational Setting (Case Study: Iran University of Science and Technology)

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Abstract

Universities are scientific and educational spaces with a focus on young influentials. In this regard, the importance of attention and design for this group of society is obvious to everyone. Moreover, due to today's neutral and sedentary lifestyle which causes many harms and problems for individuals and society, the need of creating mobility and motivating people to do sports activities is of great importance. For this purpose, according to the capability of the available space on the campus and the above-mentioned issues, it was decided to study the grounds for establishing a bicycle station at the university. This study aimed to provide a suitable location for bicycle stations in the university and determine the appropriate number of bicycles for students to use. Data was collected through articles, questionnaires, field observations, and LMS (e-learning management system). The questionnaire was conducted in two stages. In the first stage, 217 students participated to assess the need for a bicycle station, and the second phase of the survey was conducted by 4 experts (Industrial Design Professors) to classify the criteria related to determining the location of stations. During the studies and questionnaires, 13 spots were determined for the stations in which 6 bicycles can be positioned in each station.

Keywords

Positioning, Bicycle Station, Needs Assessment, Capacity Determination.

Introduction

The growth of urbanization and the consequent increase in personal vehicles have led to problems such as noise, traffic congestion, and air pollution (Ma et al., 2020). However, we see a lack of researchers' attention to the dynamics and urban life (Daneshpour et al., 2021). Using the potential of design and understanding the scope of its activities can lead to social changes in various fields (Jonas, 2020).

The planet faces environmental hazards such as rising greenhouse gases. Transportation, especially road transport, can have a huge impact on this, producing about 23% of the world's CO2 (Amatuni et al., 2020). It is worth noting that the importance of sustainability is such that despite its short history, much research has been done in this field (Moradi et al., 2013). Transportation is one of the most important factors in big cities. The services provided by public transportation providers reflect the attractiveness, competitiveness, and quality of urban life in the region (Croci & Rossi, 2014).

Nowadays, many benefits of cycling are known and the use of bicycles is increasing day by day. It is also a part of the transportation system, being of the basic components of a city, and existing along with other transportation options (Strauss & Miranda-Moreno, 2013). Encouraging people to participate in physical activities is an important factor in making neighborhoods safer and also improving the health of residents (Bigdeli Rad et al., 2019). One of the benefits of cycling is its impact on health, which can reduce the risk of obesity, diabetes, stroke, cancer, and cardiovascular diseases (Lusk & Li, 2015). Also, cycling itself is used as a recreational activity and in some cases has economic benefits (Chakraborty, 2019).

The use of bicycles has been well received over the past 30 years, with an estimated 100 bicycle-sharing systems being implemented in approximately 125 cities around the world employing more than 139300 bicycles (Shaheen et al., 2010). In universities, transportation has been considered an important issue. The attention to bicycle-sharing programs in universities is due to the fact that students, faculty, administrators, and staff can benefit from healthy and sustainable transportation (Khadem et al., 2019).

In general, innovative approaches can be effective in solving the problems and challenges of higher education institutions (Akgul et al., 2021) The effects of using shared bicycles as clean transportation in the university include physical activity, increasing the speed of movement, and the impact on students' learning. The bicycle-sharing system which was first introduced in the Netherlands in 1961, has evolved over four generations. In the first generation, known as the white bicycle, the bicycles were unlocked and scattered randomly across the city. Another point was that in the first generation, the use of bicycles was free of charge, making theft of bicycles a problem that this generation faced. In the second generation, there was a lock for bicycles and the use of bicycles was possible by paying coins. The third generation also used advanced technologies such as magnetic stripe cards, smart cards, and mobile phones to make it easier to get in and out of the station and prevent bicycle theft. The latest generation of shared bicycles, in addition to the features of the third generation, also helps in balancing the number of bicycles in each area by making every station available for bicycle pick-up and drop-off (Chen et al., 2015).

It should be noted that the success of a shared bicycle system depends on several factors, including the proper positioning of stations. Communication with the three factors: attraction centers, public transportation, and passengers is of great importance (Kabak et al., 2018). The appearance of the city, including buildings and urban furniture, is the first thing that catches a person's attention, so the right selection and proper arrangement of the urban furniture can create a beautiful appearance and reduce disorder (Pahlavani, 2021).

The purpose of this paper is to determine the best place for establishing bicycle sharing stations at the Iran University of Science and Technology. In this research, while examining the existing facilities of the studied university, a location model has been provided.

Literature Review

In this section, we introduce a number of articles used in this field.

Due to the importance of this issue, various research have been conducted on this issue. In three separate studies conducted by Frade and Ribeiro (2015), Zuluaga et al. (2018), and Hu et al. (2019), in addition to determining the location of bicycle stations, the issue of increasing demand has been given great attention. In the study of Frade and Ribeiro (2015), the result of the research, considering the budget, showed that the stations should be located at a minimum distance of 500 meters or more.

In other pieces of research by Kabak et al. (2018) and Jahanshahi et al. (2019), to obtain a better result regarding the determination of future stations, they evaluated the current condition of bicycle stations. The method used in this research is the Analytical Hierarchy Process method. In the research of Jahanshahi et al. (2019), seven criteria were considered to determine the stations and 22 stations were determined. While in the research of Kabak et al. (2018) the status of current stations and future stations were compared.

Other studies in this field, in addition to the location of bicycle stations, paid attention to other issues. Martinez et al. (2012) worked on an algorithm that simultaneously covered the location of a shared bicycle station, the size of the transport fleet, and the amount of bicycle movement, and finally led to the design of a new service. Yan et al. (2017) also investigated bicycle routing. Caggiani et al. (2020) who used the three variables of cost, distance, and the number of bicycles, in addition to determining the number and location of two-cycle stations, also determined the capacity of each station.

In the mentioned studies, the existing conditions were different for each research, as a result, in each research, different aspects of the project were discussed according to the existing needs, and the methods used were different. This research has its conditions, one of its characteristics is the location of the station in the educational environment where there was no bicycle station before. According to the similarity of this research and the research done by Jahanshahi et al. (2019) and the absence of a bicycle station in the university, it was necessary to specify criteria and according to the selected criteria, positioning should be done in the best way.

Materials and Methods

In this study, students' needs were assessed using a questionnaire, and then high-traffic areas were identified. Some of the required information was obtained through the LMS system. In the continuation of the article, the required capacity and number of stands were determined. The next issue was the location of each station, which was determined according to the criteria discovered from other articles and their ranking was done using a questionnaire from four experts among Industrial Design professors.

1. *Questionnaires*

Some of the necessary information was obtained through questioning in social networks. 217 people completed this questionnaire, of which 98% of the respondents were students of Iran University of Science and Technology at different levels. The questions were designed to assess students' needs for both demand and location.

2. *High-Demand Places*

Some places are a destination for many students because of their potential and are naturally among the most sought-after places. Among them are the dining halls which are open every day from morning to evening. Lunchtime is when this location is the busiest. Mosques and libraries have always been the destination of students seeking knowledge. Stadiums and dormitories also have a high share of students' traffic.

Figure 1: *Busy Places; 1. Main door, 2. The dining halls, 3. Faculty of Basic Sciences and Education, 4. Stadium and 5. Dormitories (https://admission.iust.ac.ir/campusiust-plan/).*

3. *Benchmarking*

In this part of the study, according to the studies conducted in the field of existing standards on the location of bicycle stations, several specific criteria were obtained, including accessibility, proximity to the entrance and exit doors, flat ground, no pedestrian crossing barrier, no damage to vegetation, no endangering personal safety, exposed to the view of passers-by and the adjacent building, and not blocking the field of view, sidewalks, and paths[1]. Design criteria establish a link between general planning policies and executive regulations (Behzadfar & Shakibamanesh, 2011).

Then, according to the different degrees of importance of the obtained criteria and the location of these stations in the university environment which has its characteristics and requirements, these criteria were ranked by four experts utilizing a questionnaire.

At first, the primary criteria were selected through library studies, then four experts were helped to rank and prioritize them, and finally, the top four criteria were selected.

4. *The Number of Stands of Each Station*

In order to determine the number of bicycles required for the whole university, available information and data received from different articles have been used. The shortest amount of time that students spend on campus is for two-hour classes. Based on a random time (Monday evening), the average number of classes held on the LMS website was between 35 and 40, which we have considered 38 in this study (from May 2, 2020, to May 9, 2020). Since the Islamic Education classes are held on Fridays only (due to COVID-19 restrictions), we added an average of three classes to the previous 38. We also considered five laboratory and workshop classes at the same time, which made us reach the number of 46 classes being held simultaneously at a specific time.

Considering the difference in the number of students in different levels, as well as general and specialized classes and workshops, which varies from four to about 40 people, we considered 18 people as an average number of students in each class, as a result:

$$(38+5+3)\times 18=828$$

The total number of students in the university was 828. According to the information from the initial questionnaires that were taken from 216 students, 93% of them were willing to use bicycles, so we calculated 93% of this population.

$$\frac{93}{100}=\frac{x}{828}\rightarrow x\ =770$$

[1] Comhairle Cotea County Concil (2018). Standards for Cycle Parking and associated Cycling Facilities for New Developments. Retrieved from https://www.dlrcoco.ie/en/search?search-phrase=standards%20cycle%20parking%20standards

At this stage, according to the Parking Standards[1] in the college and the educational space, one parking space is considered for every ten people, so 77 is a suitable number for bicycle spots throughout the university.

Results and Discussion

In this research, previous investigations in this field, information from the e-learning management system, and a two-step questionnaire were used. The primary questionnaire was provided virtually to the students on a large scale and the primary information including their needs was collected. The second questionnaire was completed by professors and university experts and the criteria classification was done by this method.

According to the survey, 52.7% of respondents were male and 47.7% were female and 88.9% of the respondents were undergraduate students who attend university for a minimum of three days and a maximum of five days a week.

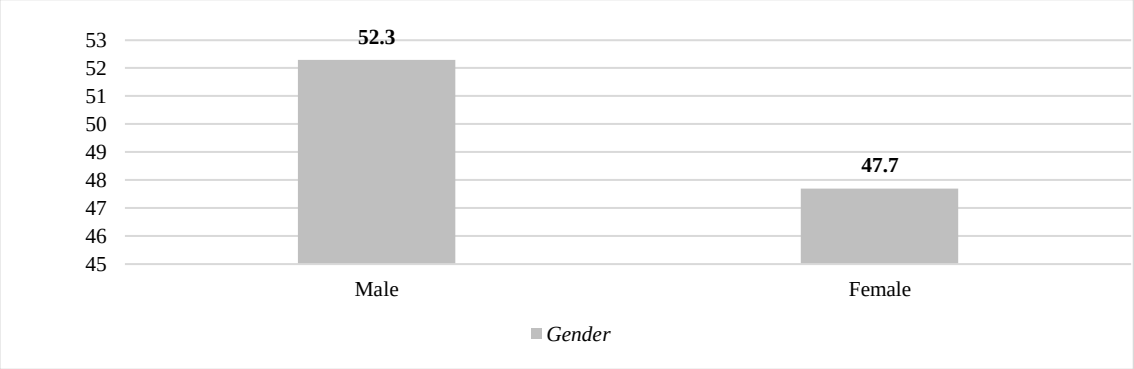

Figure 2: *A diagram of the respondents' gender.s*

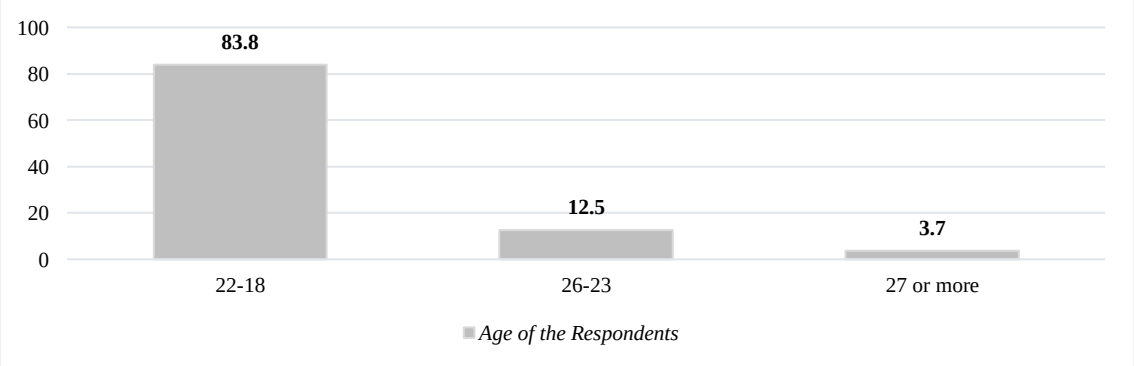

Figure 3: *Graphs related to the age of the respondents.*

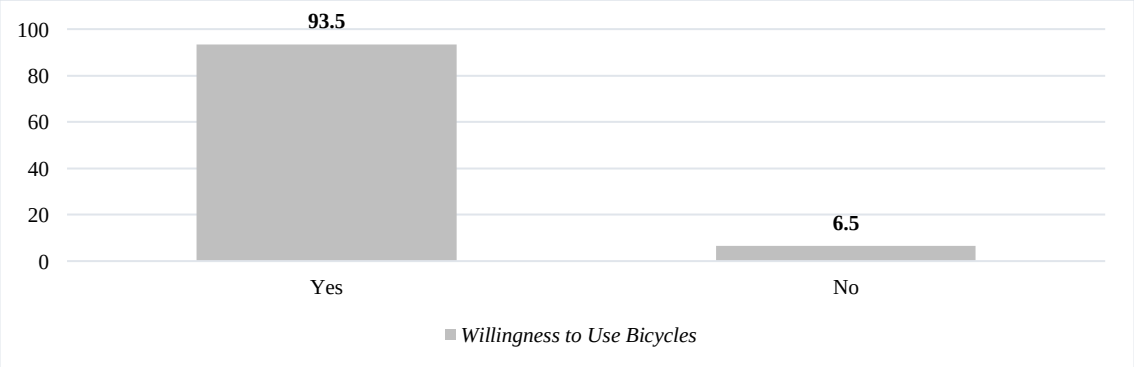

Figure 4: *Graphs of respondents' willingness to use bicycles at the university level.*

[1] Department of the Environment (2019). Parking Standards. Retrieved from https://www.infrastructure-ni.gov.uk/publications/parking-standards

The busiest route was related to the Islamic Education Center with a 61% demand, in continuation, the university entrance, the route from the schools to the mosque and library, the route from the schools to the dining hall, and the route from the schools to the dorm were ranked, respectively. These results confirm what has been previously mentioned about the most in-demand locations of the university.

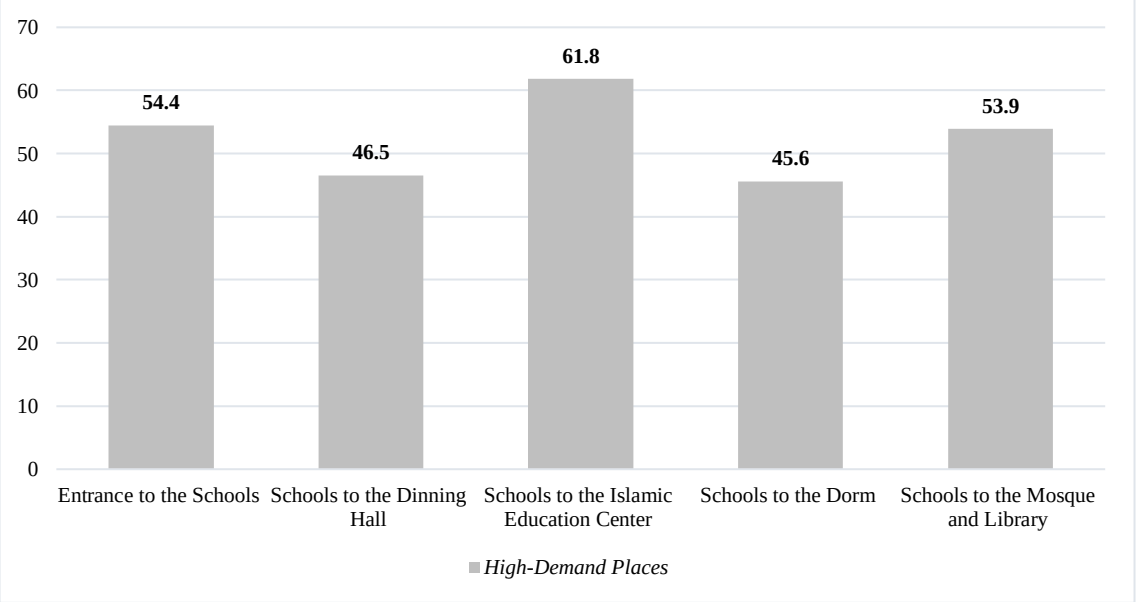

Figure 5: *Chart of High-Demand Places According to the Survey Results.*

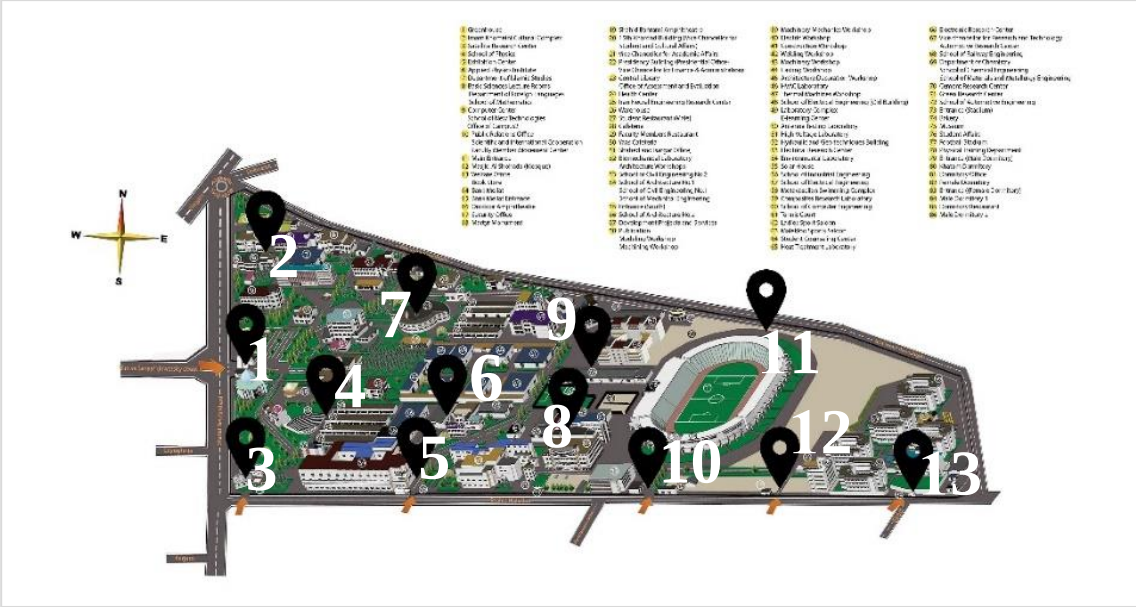

Figure 6: *Designated spots for bicycle stations on campus; 1. Main Door, 2. Faculty of Basic Sciences and Education, 3. Door(2), 4. The Dining Halls, 5. Door (3), 6. Faculty of Architecture, 7. The Dining Halls, 8. Faculty of Computer, 9. Faculty of Electricity, 10. Door (4), 11. Door (7), 12. Dormitories and 13. Dormitories (https://admission.iust.ac.ir/campusiust-plan/).*

According to the results of a survey taken by four Industrial Design professors, the criteria for not crossing the pedestrian crossing have 38 points, not endangering personal safety (maintaining personal safety of individuals) have 37 points, not damaging vegetation have 34 points, not blocking the sidewalks and roads have 34 points, and accessibility with 34 points were identified as the five most important features for determining the location of bicycle stations, of which 13 designated stations (according to field observations) were placed on the map according to these criteria.

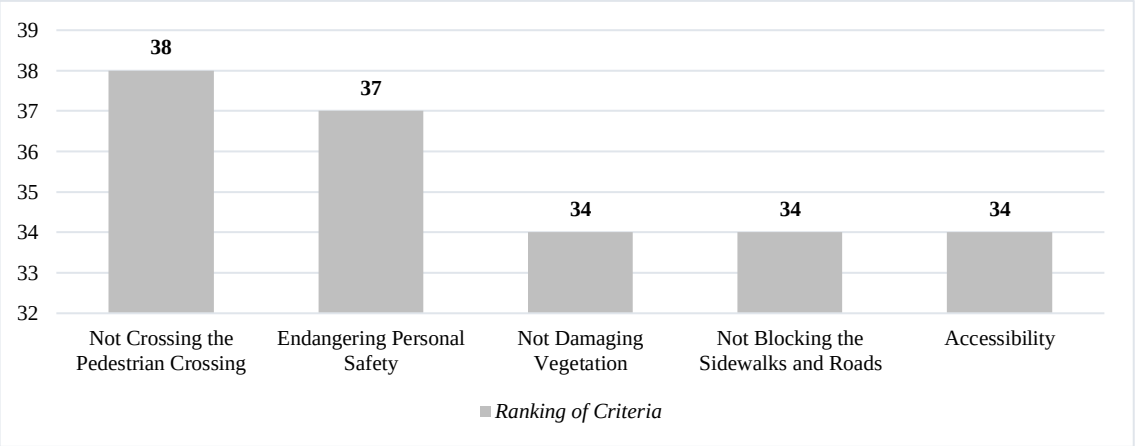

Figure 7: *The result of ranking criteria from the perspective of experts.*

Conclusion

Due to the cultural, scientific, and educational atmosphere of the university, the large environment, and the presence of young people in this place there was a potential to work at the bicycle station. This shows the importance of working on this issue.

Assuming a uniform distribution of students, according to the available results, there were a total of 13 bicycle stations, which included a total of 78 bicycles, which resulted in the average number of units per bicycle station being six. Nonetheless, in practice, there are changes in terms of per capita and student behavior at different times. Following that, the central library, dining halls, and entrances need more bicycle installation units if there is a suitable space; for example, two or three sets of six depending on the location.

In future research in this area, it is possible to cover the radius of each station and its distance to the next station.

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