

## EXPLORING AND ASSESSING USER PERCEPTION AND PREFERENCES FOR OPEN SPACES IN A UNIVERSITY CAMPUS: A CASE STUDY OF IIT ROORKEE, INDIA

 Nazish Abid\*,  Mazharul Haque

Department of Architecture and Planning, NIT Patna, India

**Abstract.** Public open spaces on an educational campus are one of the most important types of spaces because they play an essential role in developing an active campus environment, having a significant effect on student behavior by affecting their feelings regarding space quality and assessment of the campus environment. This paper investigates the factors that affect students' perception of the quality of the open spaces on campus. An online survey was conducted to document the students' activities and behavior preferences, who are the most frequent users of these open spaces in the campus. The data have been collected through google form, Chi-square correlation analysis and Descriptive statistics analysis was conducted using SPSS. The Indian Institute of Technology (IIT) Roorkee campus was selected as a case study; is the oldest engineering institution in India and the first engineering college in Asia was founded in 1847. The data revealed that the Positive significant associations exist between the variables time spent in university, time spent outdoors, frequency of time spent outdoors, while in outdoors, preferred outdoors and location of outdoors whereas strongly detrimental associations were discovered for shade, thermal enjoyment and crowding. The study emphasis that a correlation between the location, microclimate conditions and the use of outdoor open spaces along with student's preferences and perceptions. The study has outlined the framework to inculcate the social and contextual factors while planning and designing outdoor open spaces in the university campus to achieve quality of outdoor open space.

**Keywords:** Public spaces, educational campuses, space quality, student's perception, behavior pattern.

\*Corresponding Author: Nazish Abid, Department of Architecture and Planning, National Institute of Technology, Patna, India, Tel.: +918210030470, e-mail: [nazisha.phd21.ar@nitp.ac.in](mailto:nazisha.phd21.ar@nitp.ac.in)

**Received:** 27 August 2023;

**Accepted:** 17 January 2024;

**Published:** 2 August 2024.

### 1. Introduction

The public places within an educational campus are one of the most essential forms of spaces, which play a critical role in establishing an vibrant campus environment. Campus-public spaces are most remembered as (a) outdoor spaces primarily used as an interactive environment, where people congregate to walk, talk, study and relax and as (b) incidental spaces where people encounter socio-cultural as well as leisure activities (Mogra & Furlan, 2017). Outdoor spaces are defined as open spaces predominantly influenced by the interplay between human engagement within the area and its connection to the surrounding outdoor environment (Tudorie *et al.*, 2020). The construction of campuses in developing countries has seen a rapid increase, but it is now moving into a phase of gradual advancement. The number of recently constructed campuses is decreasing and the construction focus is shifting from "speed first" to "quality first"

#### How to cite (APA):

Abid, N., Haque, M. (2024). Exploring and assessing user perception and preferences for open spaces in a university campus: A case study of IIT Roorkee, India. *New Design Ideas*, 8(2), 412-432 <https://doi.org/10.62476/ndi82412>

(Dong *et al.*, 2023). Several researchers argued that the spatial configuration and layout of campus spaces can hasten the interactions and active connections in public space (Peker & Ataöv, 2020; Schwander, 2012), whereas several studies highlight the campus environment significantly influences student behavior, shaping their perceptions of quality of space and their evaluation of the overall campus setting (Alnusairat *et al.*, 2021). While investigating the perceptions of public space in the current scenario, observed that research articles are predominantly focused on spatial and physical aspects within the campus environment (Abdelaal, 2017; Farag *et al.*, 2019). Preliminary research on university campuses concentrated on the comprehensive design of the campus, examining it from a perspective of morphology and typology (Dong *et al.*, 2023). Several scholars suggested a reconsideration of university campus planning by incorporating urban planning theories and methodologies, advocating for the integration of urban development concepts. These studies offered a theoretical framework and design strategies that have influenced campus and building planning and design for years.

The study was sparked after a review of earlier research identified several major gaps.

a. First off, while it is generally agreed that these important factors should be considered when designing outdoor spaces, little attention has been given to the experiences and feelings of the students within the space (Dong *et al.*, 2023). University campuses should offer outdoor educational and social programs.

b. Secondly, there is a dearth of research about how individuals use the outdoor environment in a campus setting (Dong *et al.*, 2023) although, outdoor spaces are one of the factors that determine the perception of the campus by both students as well as faculty members. The public space in universities is used for learning, sharing, social interaction and leisure activities, contributing to both academic and personal development. Additionally, these spaces play a critical role in improving the overall quality of life within the educational institution (Bahriny & Bell, 2021; Działek *et al.*, 2023). Hence, it is crucial to comprehend the relationship between open spaces and the student's personal needs, especially concerning elements that render outdoor spaces appealing and meaningful for university students.

c. Thirdly, in previous research, Outdoor spaces have been studied and analyzed in an urban context or city level in Indian cities i.e., Chennai (Meenatchi Sundaram, 2011), Bengaluru (Bharath *et al.*, 2018; Nagendra *et al.*, 2012), Pune (Budruk *et al.*, 2009), Nagpur (Ahirrao & Khan, 2021) from various perspective, yet no studies have been conducted on a local scale (Indian university campus level). However, significant concern arises about how much impact university campus design features and layout has on users. Furthermore, failing to consider the active roles of users' preferences and expectations has frequently been a significant shortcoming and limitation in university campus planning and design. However, the student's perception of open spaces in the Indian context remains unexplored.

d. Fourthly, India, a country that is home to the second-largest student population pursuing Higher education. As per the UGC April 2023, there is 1070 universities in India and 23 IITs across India, known for their excellence in education, these institutions are under the ownership of the Ministry of Education within the Government of India. According to a report from the UK India Business Council, India is projected to have the highest number of individuals in the college-going age group by 2030, reaching 140 million people. Currently, out of the 1,113 higher education institutions, 1,070 universities are educating 41.4 million individuals (PIB). To meet the increasing demand

while enhancing quality, India requires a minimum of 1,500 institutions (Panjwani, 2017). The impact of the design standards and considerations, encompassing both physical and psychosocial aspects, as well as quantitative and qualitative factors, on students' perceptions and responses remains unexamined in the Indian context. A significant fault in the planning and design of university campuses has been the failure to consider the active roles of users' preferences and expectations.

Considering these research gaps, there is a need for research to explore the effects of the university campus environment on users' behavior, which further affects the perception of students' experiences and their assessment of the overall campus environment. To conduct this study, the campus of the Indian Institute of Technology (IIT), Roorkee is chosen.

The aim of this study is to explore the factors that affect student's perception of the quality of the open spaces on campus. The objectives are as follows:

- i. Identifying open spaces and the preferences of the students for using open spaces.
- ii. Identifying the factors for such preferences.
- iii. Assessing the impact of user preferences and behavior for the used open spaces.

The students' experiences in the university campus open spaces are persuaded by a variety of elements, including the layout, physical attributes, outdoor thermal conditions, and the needs and behavior of the students (Alnusairat *et al.*, 2021; Peng *et al.*, 2021). Table 1 outlines these characteristics. Additionally, factors like safety and security, activities, engagement, administrative concerns, time and distinctiveness also play a role in shaping experiences in open spaces (Alnusairat *et al.*, 2021; Tudorie *et al.*, 2020). This research highlights the key factors that impact the quality and significance of open spaces within university campuses, examining them through the student's perspective.

It delves into the elements that shape students' attitudes toward the utilization of outdoor open spaces in university campuses, encompassing urban layout, physical attributes, outdoor thermal conditions and the students' needs and behavior. The study identifies the conditions and factors deemed most comfortable and favorable based on students' perceptions.

**Table 1.** Literature explores the key elements that influence students' experience with outdoor open spaces

Elements	Features Affecting Students' Experience of Outdoor Open Spaces in Universities	Studies
<b>The urban layout and physical features</b>	Greenery, vegetation, campus landscape with natural elements, green elements	(Beyer <i>et al.</i> , 2014; Gascon <i>et al.</i> , 2015; Grahn & Stigsdotter, 2010; Lu & Fu, 2019; Malekinezhad <i>et al.</i> , 2020; Scholl & Betrabet Gulwadi, 2015; Wang <i>et al.</i> , 2021; Xie <i>et al.</i> , 2023)
	Physical environment and its users' behavior and activities	(Sung & Lee, 2015; Göçer <i>et al.</i> , 2018; Xie <i>et al.</i> , 2023)
	Design of open space	(Farag <i>et al.</i> , 2019; Jogdande & Bandyopadhyay, 2022; Malekinezhad <i>et al.</i> , 2020; Muqueeth, 2021; Peker & Ataöv, 2020)
	Walkability, Bikability	(Alexander Erath Rusterholtz, 2016; Capelli & Conserva, 2020, Iftikhar <i>et al.</i> , 2020; Kellstedt <i>et al.</i> , 2021; King <i>et al.</i> , 2020; Lee & Shepley, 2020; Middleton, 2010; Shang <i>et al.</i> , 2020a)

	Spatial organization	(Abdelaal, 2017; Alnusairat <i>et al.</i> , 2021; Farag <i>et al.</i> , 2019; Özkan <i>et al.</i> , 2017; Tao <i>et al.</i> , 2019)
<b>The student's needs, perception and behavior</b>	Meaningful place, Quality of open spaces	(Bahriny & Bell, 2021; Hanan, 2013; Jogdande & Bandyopadhyay, 2022; Mt Akhir <i>et al.</i> , 2017)
	Individual mood, gender	(Loder <i>et al.</i> , 2020; Taşkan <i>et al.</i> , 2005; Yin <i>et al.</i> , 2012)
	User's Preference: Informal social gathering, Friendship, usage during leisure time, character and spatial landscape	(Alhusban <i>et al.</i> , 2019; Alwah <i>et al.</i> , 2021; Hami & Abdi, 2021; Mt Akhir <i>et al.</i> , 2017)
	Users' needs: physiological, safety and security, safe and welcoming spaces belonging, esteem, self-actualization, intellectual	(Alhusban <i>et al.</i> , 2019; Alwah <i>et al.</i> , 2021; Özkan <i>et al.</i> , 2017)
	Users' needs: social, cultural and ideological dimensions	(Bahriny & Bell, 2021; Carmona, 2019)
	Perception of pedestrians of the presences and the steepness of space.	(Iftikhar <i>et al.</i> , 2020; Meeder <i>et al.</i> , 2017; Sabrin <i>et al.</i> , 2021; Shang <i>et al.</i> , 2020b; Sun <i>et al.</i> , 2015)
<b>Thermal conditions</b>	User's thermal preference and thermal comfort	(Chen & Ng, 2012; Iyer-Raniga <i>et al.</i> , 2015; S & Rajasekar, 2022; Sabrin <i>et al.</i> , 2021)
	effects of microclimate	(Iyer-Raniga <i>et al.</i> , 2015; Yin <i>et al.</i> , 2012; Zacharias <i>et al.</i> , 2004)
	Seasonal climate and conditions	(Aruninta, 2018; Canan <i>et al.</i> , 2020)
	Thermal perception of outdoor urban spaces	(S & Rajasekar, 2022)
	Thermal comfort of outdoor urban spaces	(Iyer-Raniga <i>et al.</i> , 2015; Nikolopoulou <i>et al.</i> , 2001; Peng <i>et al.</i> , 2021)
	Thermal conditions in outdoor public spaces	(Peng <i>et al.</i> , 2021; Soares <i>et al.</i> , 2021)
	Spatial settings (building orientation, solid-void ratio)	(Tao <i>et al.</i> , 2019)
	User-oriented elements (i.e., sitting and shading facilities)	(Göçer <i>et al.</i> , 2018)
	People adaptive activities, thermal experience and expectation	(Li <i>et al.</i> , 2019)

This study envisions to assist Architects, Urban designers and university planners in assessing design impact on student perceptions. As it will reveal principles for urban planning practices and identify design solutions that meet users' expectations, this study would lay a base for better planning of campuses in the future as well as redeveloping spaces in the existing campus. The study aims at understanding the relationship between open space layout, thermal sensation and student behavior and preferences as an essential tool for campus planning. The significance of this research lies in investigating the emerging requirement for the design of outdoor spaces in universities, which involves establishing a quality of meaningful space based on the perception of the quality of open spaces for students.

## 2. Materials and Methods

The goal of this study, as stated earlier, is to explore the factors that affect students' perception of the quality of the open spaces on campus. The three primary outdoor open areas at the Indian Institute of Technology Roorkee, which served as a model university campus, were the site of a quasi-experiment to record user behavior, preferences and

perceptions of the quality of open spaces. The three open areas were selected as a result of questionnaire survey in which about 90 students took part. To document the students' need, behaviors, routine of uses and comfort, another online questionnaire survey were conducted where 59 students took part with observations of the students' activities.

### 2.1. Study Area (Case Study)

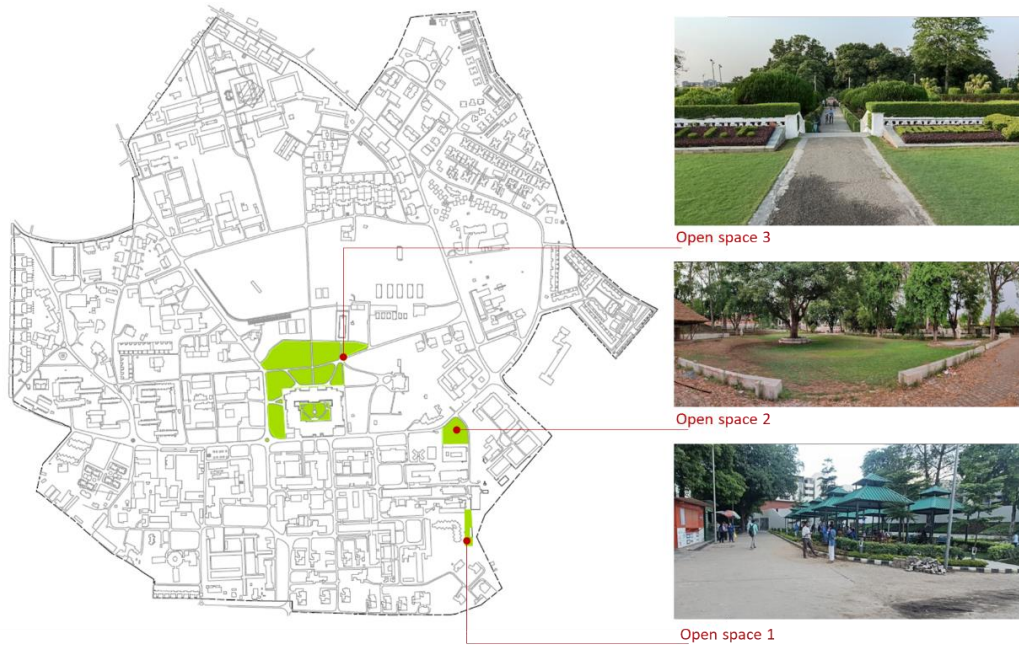
IIT Roorkee is the oldest engineering institution in India and the first engineering college in Asia, was founded as the College of Civil Engineering in British India in 1847. The campus encompasses a gated, urban environment, characterized by an “autonomous urban fabric”, spanning 365 acres (1,480,000 m<sup>2</sup>). The university has 21 academic departments, 1 academic center, 3 centers of excellence, 5 academic service centers and 3 supporting units. The building footprint of the main campus is 125.87 acres (5,09,295.67 m<sup>2</sup>) (IIT Roorkee, 2022). There is a hierarchy of open spaces for recreational and leisure activities, sports use, landscaping and student gatherings open spaces for car parking, which connects the campus buildings. The proportion of open space to the overall area is 81.83%. The area covered by natural forest vegetation is 2.9%, while the area with planted vegetation is 58.09%. The ratio of total open space area to the entire campus population is approximately 108 square feet per person. The university has a total enrollment of 8,020 students (NIRF, 2023).

Three outdoor student-gathering areas were selected for this study based on criteria such as students' questionnaire, location and usage frequency. These areas, situated between significant faculties, are frequently utilized by students. Table 2 summarizes their characteristics and the master plan for the academic area of the campus.

**Table 2.** Overview of the three open spaces

Site	O.S.1: Vigyan Kunj	O.S.2: Architecture Department Lawn	O.S.3: James Thomson Lawn
Area (m <sup>2</sup> )	155.76	3321.12	13687
Spatial configuration	Clustered gathering spaces along an axial path	Open area with low level of enclosure	Open area with low level of enclosure
Shaded area (m <sup>2</sup> )	78	-	-
Access	Vigyan kunj road, Khosla bhawan, Geomatics department	Architecture & planning department	James Thomson building, Mahatma Gandhi library, Department of management studies
Surrounding buildings and services	Khosla bhawan, Geomatics department, Civil engineering department	Architecture & planning department, Jawahar Bhawan	James Thomson building, Mahatma Gandhi library, Department of management studies, VC Lodge
Vegetation cover area (m <sup>2</sup> )	20	3200	12840
Seating length (m)	128	30	-





**Figure 1.** Campus layout and selected open spaces in IIT Roorkee, India

## 2.2. Questionnaire

Design based on student preferences may boost their satisfaction and enhance positive values for the open space. This could generate sustainable features for public spaces. This study took into account the perspectives of students, who are the most frequent users of open spaces in colleges. We could identify and assess the advantages and disadvantages of students' experiences, which may form the basis for university outdoor space planning, provided we had a better understanding of student conduct. Two questionnaires were shared with the students, first one was to identify students preferred open spaces in the campus, whereas the second questionnaire was to document the students' activities and behavior preferences. The study focused on problems that directly affect how open spaces in universities are planned. Based on the literature, a preliminary set of 20 questions was assembled and categorized into four groups: Student profile, regular usage, appealing features and comfort elements, listed in that sequence. The responses from the students were examined using descriptive statistics (SPSS) to determine the functions and purposes of the spaces, as well as user satisfaction with them.

A correlation study was carried out to ascertain the connection between the students' attitudes and their preferences for outdoor spaces. The responses were looked at regarding the three open spaces outdoors: 'O.S.1: Vigyan Kunj', 'O.S.2: Architecture Department Lawn', 'O.S.3: James Thomson Lawn'.

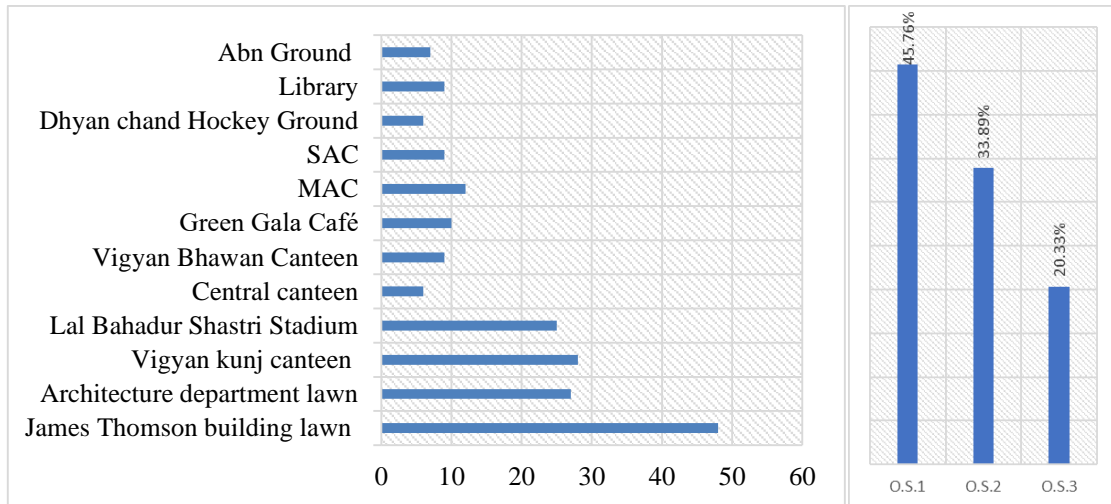


Figure 2. Students preferred open space in the IIT Roorkee campus, India

### 3. Result

#### 3.1. The Students' Observation and Behavior Analysis

The online questionnaire was sent out to faculty and students from various departments. A correlation analysis was carried out to assess the importance and strength of the correlations between the items in the questionnaire and the analysis findings are reported as numbers and percentages. Out of the 59 people who responded to the questionnaire 59% were males while 41% were females. Out of 59 people 35 were from Department of Architecture and planning, while 5 were from Centre of Excellence in Disaster Mitigation & Management, 3 each from Department of Humanities and Social Sciences, Civil and Mechanical Engineering, 2 were from Biosciences and Bioengineering Department and 1 each from Centre for Transportation Systems, Department of Hydro & Renewable Energy, Chemical Engineering, Physics, Earth Sciences, Management Studies, CSIR-CBRI. The outcomes of the questionnaire indicate that the variables such as duration of time spent in the university, duration of time spent in open space, frequency of time spent in open space, time preference for open space, preferred open space and location of open space exhibit significant positive correlations ( $p < 0.05$ ). Whereas, shade, thermal comfort and crowding all revealed significant unfavorable associations.

Regarding the preference of spaces, 25 (42.3%) out of the 59 people have rated 5 to James Thomson (Main Building) Lawn and is the most preferred open spaces by the students as well as faculty. The Vigyan Kunj Canteen is also rated at 4 by 16 (27.11%) people and is also one of the preferred locations by both students as well as faculty. 22 (37.28%) people have rated the architecture Department lawn as 3 and is preferred mostly by the students and faculty members from the same department. It appears that student preferences and the open space's location are closely associated; especially, the closer the faculty is to the open space, the more desirable it is deemed to be.

**Table 3.** Correlation matrix using the Chi-square test for the primary variables in the questionnaire

Variable	Questions	P
<b>The Routine uses of the open spaces</b>		
<b>Experiences in open spaces</b>	How much time do you spend in Campus daily?	0.00 (<0.05)
	How important is the use of open spaces for you?	0.00 (<0.05)
	Rate the open spaces in the campus as per your preference.	0.01 (<0.05)
	How easily are you able to find your way around the campus and locate the open spaces?	0.04 (<0.05)
	Are the open spaces well lit? (Artificial/ day light?)	0.01 (<0.05)
	Are the open spaces safe during off times?	0.00 (<0.05)
	How often do you visit or spend time in the open spaces on campus?	0.00 (<0.05)
<b>Frequency</b>	If you spend time in the campus open spaces, answer the following questions. When do you spend time in the open spaces on campus?	0.00 (<0.05)
	How long do you usually stay in this place?	0.00 (<0.05)
	Why do you spend time in this place?	0.00 (<0.05)
<b>The attractive features of the open spaces</b>		
<b>Student needs</b>	When you are in this place, how crowded do you find it to be?	0.06 (>0.05)
	What physical features in this place do you consider attractive?	0.00 (<0.05)
	How satisfied are you with the temperature, wind and humidity in the open space in which you spend the most time?	0.07 (>0.05)
<b>The comfort features of the open spaces</b>		
<b>Thermal satisfaction</b>	When do you feel most unsatisfied in the open space?	0.00 (<0.05)
	In warm/hot (All climatic zones) weather, how would you describe the temperatures in the open space?	0.06(>0.05)
	In cool/cold weather, how would you describe the temperatures in the open space?	0.03 (<0.05)
	In Rainy Days also how would you describe the temperature, wind, humidity in the open space?	0.06(>0.05)
	What would you describe as the source of this discomfort?	0.08(>0.05)
	How are the open spaces shaded during different seasons?	0.4 (>0.05)
	How are the green covers in the open areas?	0.07(>0.05)

**Table 4.** Descriptive statistics on the three dimensions of open space experience in student responses of the questionnaire

Dimension	Category	Questions	Answers	Response (%)
<b>The Student Profile</b>	Socio-demographic	Gender	Male	61.8%
			Female	38.2%
<b>The Routine uses of the open spaces</b>	Experiences in open spaces	How much time do you spend in Campus on a daily basis?	< 1 h	20.3%
			1-2 h	55.9%
			2-4 h	13.6%
			> 4 h	10.2%
		How important is the use of open spaces for you?	Very Important	81.4%
Important	15.3%			
Not Important	3.4%			
Rate the open spaces in the campus as per your preference.	O.S.1: Vigyan Kunj O.S.2: Architecture Department Lawn O.S.3: James Thomson Lawn		45.76%	
			33.89%	
How easily are you able to find your way around the campus and locate the open spaces?			20.33%	
			Very Easily	46.8%
			Easily	35.6%
		Moderately	16.9%	



			Difficult Very Difficult	0 1.7%
		Are the open spaces well lit? (Artificial/ day light?)	Well Lit Moderately lit Dark	89.8% 8.47% 1.69%
		Are the open spaces safe during off times?	Very Safe Safe Unsafe	61% 35% 4%
	Frequency	How often do you visit or spend time in the open spaces on campus?	Very Frequently Frequently Sometimes Rarely Never	22% 28% 26% 17% 7%
		If you spend time in the campus open spaces, answer the following questions. When do you spend time in the open spaces on campus?	Morning Afternoon Evening	13% 17% 70%
		How long do you usually stay in this place?	O.S.1: Vigyan Kunj < 2 H 2 - 4 H > 4 H O.S.2: Architecture Department Lawn < 2 H 2 - 4 H > 4 H O.S.3: James Thomson Lawn < 2 H 2 - 4 H > 4 H	69% 27% 4% 80% 10% 10% 90% 8% 2%
<b>The attractive features of the open spaces</b>	Student needs	Why do you spend time in this place?	O.S.1: Vigyan Kunj Play Leisure Socialize Work Others O.S.2: Architecture Department Lawn Play Leisure Socialize Work Others O.S.3: James Thomson Lawn Play Leisure Socialize Work Others	1.7% 67.7% 20.3% 0% 10.3% 1.7% 39% 50.8% 1.7% 6.8% 2% 22% 32% 29% 15%
		When you are in this place, how crowded do you find it to be?	O.S.1: Vigyan Kunj Very crowded Moderately Crowded Not Crowded O.S.2: Architecture Department Lawn Very crowded Moderately Crowded Not Crowded O.S.3: James Thomson Lawn Very crowded Moderately Crowded	59% 36% 5% 3.4% 42.4% 54.2%

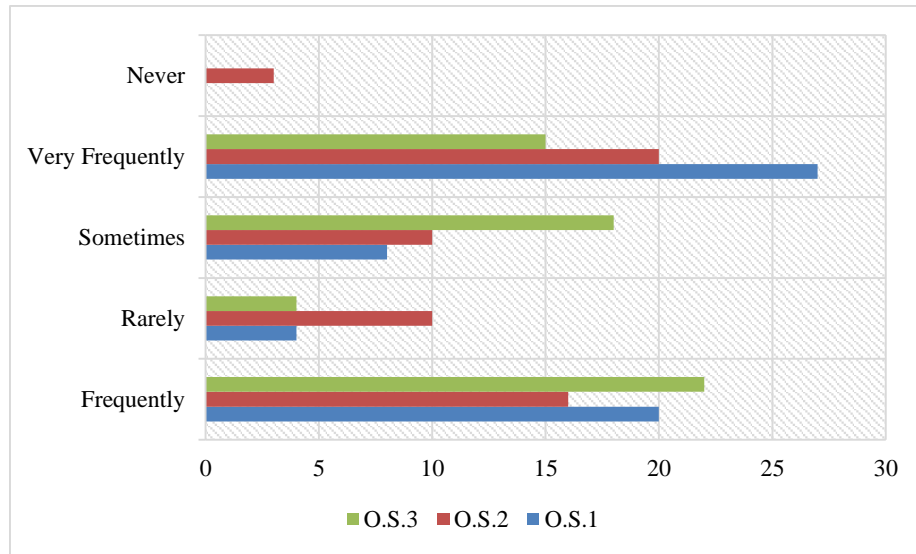
			Not Crowded	10%
				56%
				34%
	Physical Features	What physical features in this place do you consider attractive?	O.S.1: Vigyan Kunj Landscape Seating Covers Clear Ground Others (Specify) O.S.2: Architecture Department Lawn Landscape Seating Covers Clear Ground Others (Specify) O.S.3: James Thomson Lawn Landscape Seating Covers Clear Ground Others (Specify)	6.7% 71% 6.7% 5.6% 10%  30.5% 27% 22% 7% 13.5%  61% 0% 35.5% 3.5% 0%
<b>The comfort features of the open spaces</b>	Thermal satisfaction	How satisfied are you with the temperature, wind and humidity in the open space in which you spend the most time?	O.S.1: Vigyan Kunj Very Comfortable Moderately Comfortable Not Comfortable O.S.2: Architecture Department Lawn Very Comfortable Moderately Comfortable Not Comfortable O.S.3: James Thomson Lawn Very Comfortable Moderately Comfortable Not Comfortable	32% 61% 7%  28% 61% 10%  54% 37% 9%
		When do you feel most unsatisfied in the open space?	O.S.1: Vigyan Kunj Morning Afternoon Evening O.S.2: Architecture Department Lawn Morning Afternoon Evening O.S.3: James Thomson Lawn Morning Afternoon Evening	12% 73% 15%  7% 75% 18%  5% 86% 9%
		In warm/hot (All climatic zones) weather, how would you describe the temperatures in the open space?	O.S.1: Vigyan Kunj Very Comfortable Moderately Comfortable Not Comfortable O.S.2: Architecture Department Lawn Very Comfortable	13.5% 56% 30.5%

			Moderately Comfortable Not Comfortable O.S.3: James Thomson Lawn Very Comfortable Moderately Comfortable Not Comfortable	24% 53% 23%  24%  52% 24%
		In cool/cold weather, how would you describe the temperatures in the open space?	O.S.1: Vigyan Kunj Very Comfortable Moderately Comfortable Not Comfortable O.S.2: Architecture Department Lawn Very Comfortable Moderately Comfortable Not Comfortable O.S.3: James Thomson Lawn Very Comfortable Moderately Comfortable Not Comfortable	28%  54% 18%  20%  66% 14%  37%  53% 10%
		In Rainy Days also how would you describe the temperature, wind, humidity in the open space?	O.S.1: Vigyan Kunj Very Comfortable Moderately Comfortable Not Comfortable O.S.2: Architecture Department Lawn Very Comfortable Moderately Comfortable Not Comfortable O.S.3: James Thomson Lawn Very Comfortable Moderately Comfortable Not Comfortable	29%  58% 13%  15% 63%  22%  32% 46%  22%
		What would you describe as the source of this discomfort?	O.S.1: Vigyan Kunj Hot Temperature Cold Temperature Humidity Precipitation Wind Others (Specify) O.S.2: Architecture Department Lawn Hot Temperature Cold Temperature Humidity Precipitation Wind Others (Specify) O.S.3: James Thomson Lawn Hot Temperature Cold Temperature Humidity Precipitation Wind Others (Specify)	41% 5% 27% 7% 5% 15%  34% 8.5% 25.5% 17% 3.3% 11.7%  52.5% 5% 18.5%

				6.7% 6.7% 10.6%
		How are the open spaces shaded during different seasons?	O.S.1: Vigyan Kunj Well shaded Shaded Not Shaded O.S.2: Architecture Department Lawn Well shaded Shaded Not Shaded O.S.3: James Thomson Lawn Well shaded Shaded Not Shaded	47.6% 45.7% 6.7% 30.5% 54.3% 15.2% 17% 29% 54%
		How are the green covers in the open areas?	O.S.1: Vigyan Kunj Well covered Moderately covered. Not Covered O.S.2: Architecture Department Lawn Well covered Moderately covered. Not Covered O.S.3: James Thomson Lawn Well covered Moderately covered. Not Covered	17% 45.7% 37.3% 81.3% 15.2% 3.5% 49% 45.7% 5.3%

### 3.1.1. The Routine Uses of Open Spaces

Most of the people, 27 (45.7%) out of 59, very frequently visit the Vigyan Kunj Canteen, while 20 (33.8%) visit the Architecture Department Lawn very frequently and 12 (20.5%) visit the James Thomson (Main Building) Lawn very frequently. At the Vigyan Kunj Canteen 41(69.4%) people like to stay for <2 Hrs., while 16 (27.1%) stays between 2-4 Hrs. and 2 (3.5%) stays for >4 Hrs. At the Architecture Department Lawn 47 (79.6%) People stay for <2 Hrs., while 6 (10.2%) stay between 2-4 Hrs. and 6 (10.2%) stays longer than 4 Hrs. At the James Thomson (Main Building) Lawn 53 (89.8%) people stays for <2 Hrs., 5 (8.47%) stays between 2-4 Hrs. and 1(1.6%) like to stay for >4 Hrs. The usefulness of the open spaces for students during their breaks and free time is demonstrated by this usage-frequency pattern.



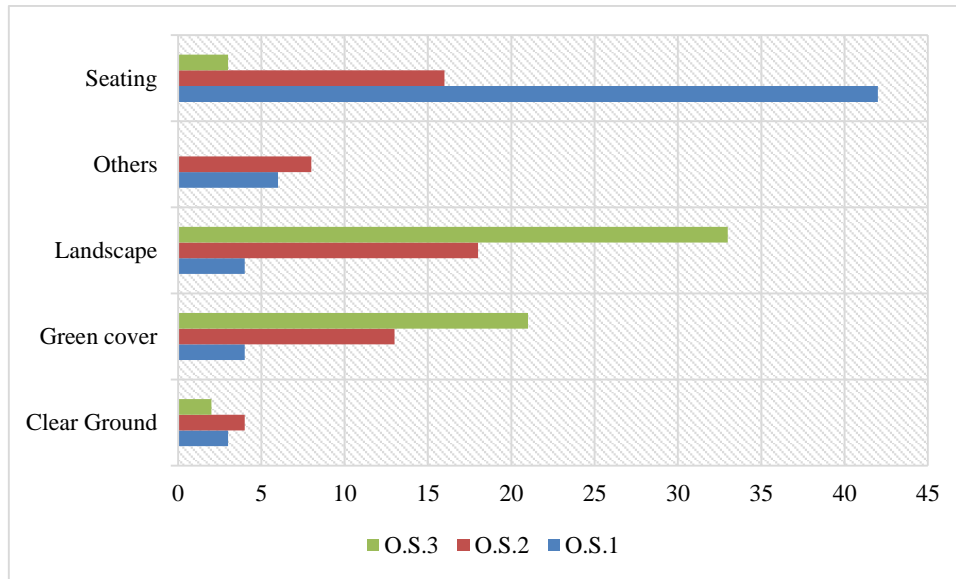
**Figure 3.** Respondents' opinion about routine use of open space in the IIT Roorkee campus

### 3.1.2. *The Attractive Features of the Open Spaces*

Prior research focused on the physical attributes of university open spaces, considering the appealing elements in terms of student needs. The primary functions of the open spaces during break times, in the eyes of the students, are social and interactive activities. For three main reasons, students spend time in the open areas: (1) Leisure (2) Socialize (3) Work 40 (67.7%) out the 59 people prefers the James Thomson (Main Building) Lawn for leisure, while 12 (20.3%) use for socializing, 6 (10.1%) use for other purposes while 1(1.6%) use for playing. Whereas 32 (54.2%) people like to socialize in the Vigyan Kunj Canteen, 23 (38.9%) use it for leisure and 4 (6.7%) people for other purposes. The Architecture Department Lawn is used by 19 (32.2%) people to socialize, 17 (28.8%) for work, 14 (23.7%) for leisure and 9 (15.2%) for other reasons. This is consistent with the observation that students predominantly utilize open spaces for socializing and interactive activities.

Most of the respondents have deemed the places very safe during their off times. Also, 53(89.9%) people think that all open spaces are well lit during the daytime, while 32(54.2%) think that these open spaces are moderately lit and 25(42.3%) thinks are well lit during night times. Seating was the most preferred physical feature in the Vigyan Kunj Canteen, with 42(71.1%) people preferring it. While in the James Thomson (Main building) Lawn Landscape was the most preferred physical feature with 36(61%) people and 21(35.6%) people liking the green cover. In the Architecture Department Lawn 18(30.5%) people like the landscape, while 16(27.1%) people like the seating and 13(22%) people like the green cover. Although there isn't much sitting in Vigyan Kunj Canteen, the pupils didn't mention this as a concern. This is in line with the findings of another study, which discovered that the quantity of seating had a negligible influence on the attendance and might possibly be regarded as irrelevant in terms of open space use. However, it was found that the quality and position of the sitting - which are influenced by climatic factors like temperature and sunlight - had a substantial impact on whether the seating was used. Additionally, neither a central performance space nor a place for group discussion are present.





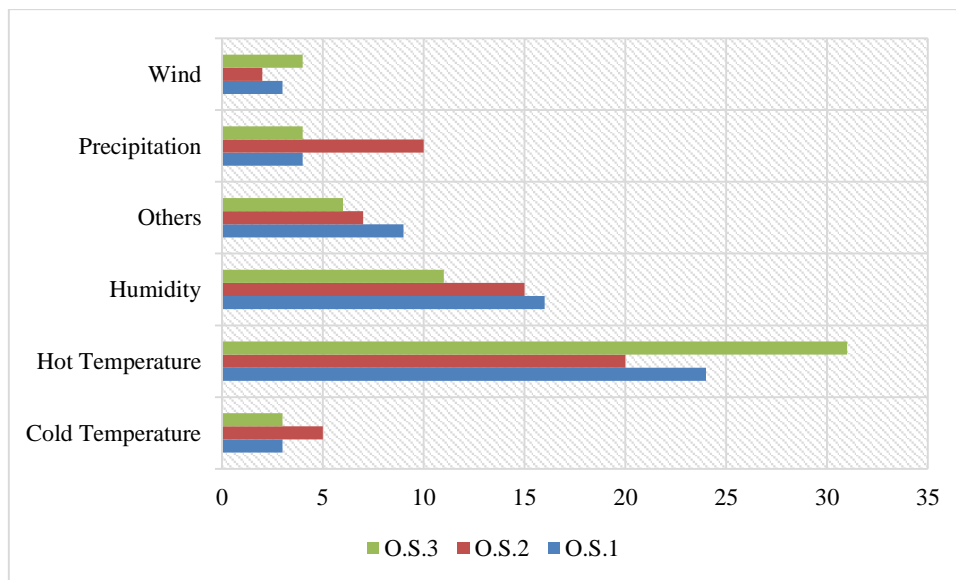
**Figure 4.** Respondents' opinion about physical features of the open space in the IIT Roorkee campus

### 3.1.3. The Thermal Environment of the Open Spaces

There is currently no universal paradigm for assessment in literature, even though the effect of thermal comfort on outdoor activities is multifaceted and affects both climate and behavior. The following elements must be taken into account when analyzing how people feel when they are outside: air temperature, solar radiation, humidity, air velocity and heat conduction. According to studies, a strong sun's rays make you feel hot, a strong wind makes you feel cool and a high humidity level makes you feel uncomfortably warm. Thus, it is demonstrated that temperature, solar radiation & wind speed are the most important variables. Of the respondents, most of the people like to use the open spaces during the evening hours and consider them to be most uncomfortable during the afternoon, with few using them during afternoon and morning hours. Of the respondents 32 (54.2%) people think that the James Thomson Lawn is very comfortable while 22 (37.2%) think it is moderately comfortable and 5 (8.4%) think it is not comfortable. The Vigyan Kunj Canteen is deemed by 36 (61%) people as moderately comfortable, 19(32.2%) people as very comfortable and 5 (8.5%) people as not comfortable. Whereas the Architecture Department Lawn is deemed very comfortable by 17 people, moderately comfortable by 36 (61%) people and not comfortable by 6 (10%) people. Although the open spaces don't have acceptable temperatures, it appears that the students are nevertheless happy to use them.

During the summers, the James Thomson Lawn is considered moderately comfortable by 23 (38.9%) people and not comfortable by 22 (37.2%) people. The Vigyan Kunj Canteen is deemed moderately comfortable by 28 (47.4%) people and not comfortable by 24 (40.6%) people. Similarly, the Architecture Department Lawn is considered moderately comfortable by 31 (52.5%) people and not comfortable by 14 (23.7%) people, rest feels the temperature to be comfortable. Similar data were collected for winters with 31 (52.5%) people considering the James Thomson Lawn as moderately comfortable, 32 (54.2%) people deemed Vigyan Kunj Canteen as moderately comfortable and 39 (66.1%) people considering Architecture Department Lawn as moderately comfortable. During Rainy Season 27 (45.7%) people consider the James Thomson Lawn

as moderately comfortable, 34 (57.6%) people deemed Vigyan Kunj Canteen as moderately comfortable and 37 (62.7%) people considering Architecture Department Lawn as moderately comfortable. 31 (52.5%) people for James Thomson Lawn, 24 (40.6%) people for Vigyan Kunj Canteen and 20 (33.8%) people for Architecture Department Lawn have considered hot temperatures as reason for their discomfort in these open areas. 32 (54.2%) people deemed James Thomson Lawn to not be properly shaded, while 48 (81.3%) people consider it to be well covered with green covers, 28 (47.4%) people consider Vigyan Kunj Canteen to be well shaded and 27 (45.7%) people considered it to be moderately covered with green covers and 32 (54.2%) people have considered Architecture Department Lawn as shaded and 29 (49.1%) people consider it to be well covered with green covers. Out of the respondents 33 (55.9%) people consider James Thomson Lawn to be moderately crowded, 35 (59.3%) people consider Vigyan Kunj Canteen to be very crowded while 32 (54.2%) people consider Architecture Department Lawn to be least crowded.



**Figure 5.** Respondents' opinion about discomfort features of the open space in the IIT Roorkee campus

In a prior study conducted by several researchers (Alnusairat *et al.*, 2021; Carmona, 2019; Deasy & Lasswell, 1998; Hanan, 2013; Mt Akhir *et al.*, 2017; Özkan *et al.*, 2017), It was observed that the relationship between student needs, open space satisfaction, outdoor thermal conditions and strategic location (the positioning of the open space) is interconnected. Specifically, a higher attractiveness is perceived when the faculty is in closer proximity to the open space. Similar results can be found in current study.

#### 4. Finding and Discussion

The outdoor open spaces on the campus offer insights into the environment in which university students reside. Open spaces attract and retain students by facilitating connections and communication among them. This study aims to explore the factors influencing students' perception of the quality of open spaces on campus. An online survey was implemented to document the activities and behavioral preferences of students, who are the most frequent users of these open spaces on campus.

Three open spaces were selected based on the data collected from the questionnaire. To ascertain the functions and goals of the spaces as well as the satisfaction of their users, the responses from the students were analyzed through descriptive statistical analysis using SPSS. The study involved an assessment of students' preferences regarding urban layout (accessibility, spatial organizations, views); physical features (seating, shading and rain shelter, surrounding buildings and facilities, landscape, greenery, areas for groups, design elements (color, texture, etc.); outdoor thermal perceptions (air temperature, solar radiation, relative humidity, air speed) and students' needs and behavior (socializing, eating and drinking). Notable findings are as below:

1. 'O.S.1: Vigyan Kunj', 'O.S.2: Architecture Department Lawn' and 'O.S.3: James Thomson Lawn' were the three open spaces outside that the responses were based on.

2. Positive significant associations exist between the variables time spent in university, time spent outdoors, frequency of time spent outdoors, while in outdoors, preferred outdoors and location of outdoors.

3. Strongly detrimental associations were discovered for shade, thermal enjoyment and crowding.

4. The placement of the open space and student preferences are closely related; in particular, the closer the faculty is to the open space, the more attractive it is thought to be.

5. The study also emphasizes that it is important to consider students' needs and preferences in order to ensure that they have a better sense of satisfaction as well as encourage alternate activities after regular academic hours. There were several studies which concurred with the conclusions (Alnusairat *et al.*, 2021; Carmona, 2019; Deasy & Lasswell, 1998; Hanan, 2013; Mt Akhir *et al.*, 2017; Özkan *et al.*, 2017).

Jacobs has stated that “it is critical to evaluate the urban context in which a POS is located and having more parks does not always suggest a higher quality of life. The activities that a site provides, including recreational features and the aesthetics of the place, can be used to quantify diversity. It is also notable in the case of the open spaces chosen for this study in IIT Roorkee”.

- James Thomson Lawn is strategically located at the center of the university and acts as a buffer between the academic and the hostel buildings. The students use it as a transition space. Though it has a manicured lawn, which is inaccessible for people and lacks seating spaces and shades, it is highly used by all the students of IIT Roorkee for transitioning between spaces, small gatherings and chit chats. People use the steps to sit and spend shorter durations.

- The Architecture Department Lawn is adjacent to the Department of Architecture and has a sense of exclusivity for the students of architecture, although it is accessible to all. This Open space is used by the students during lecture breaks, after classes for gathering, recreation, group work etc. As this space has good seating space and is well shaded, it is used for longer durations by the students.

- The Vigyan Kunj lawn sees the most footfall. It is well located and connected in the academic zone of the campus and is in close proximity with various departments. The place is well shaded, lit and has a good amount of seating space which is often used by the students for gatherings, recreation, leisure for a longer duration of period, during various time of the day.

All the three open spaces have different characters, usage, significances, preferences and the duration and time in which they are used. Although there are several other open

spaces adjacent to these spaces and maintained in a similar manner are not given much preferences when compared to these open spaces. These factors led to the development of the student's perception of the space as well as the campus and led to the integration of the built spaces with the unbuilt and the campus as a whole.

The outcomes of this study could help to create performance criteria for constructing new open spaces and renovating existing ones. As a result of the findings, appropriate planning and management techniques are urgently needed to maximize open spaces contributions on university campuses and raise stakeholder quality of life. To improve open space's performance, policymakers and planners must consider the importance of open spaces and include Open Space Management strategies into decision-making frameworks as indicated in figure below.

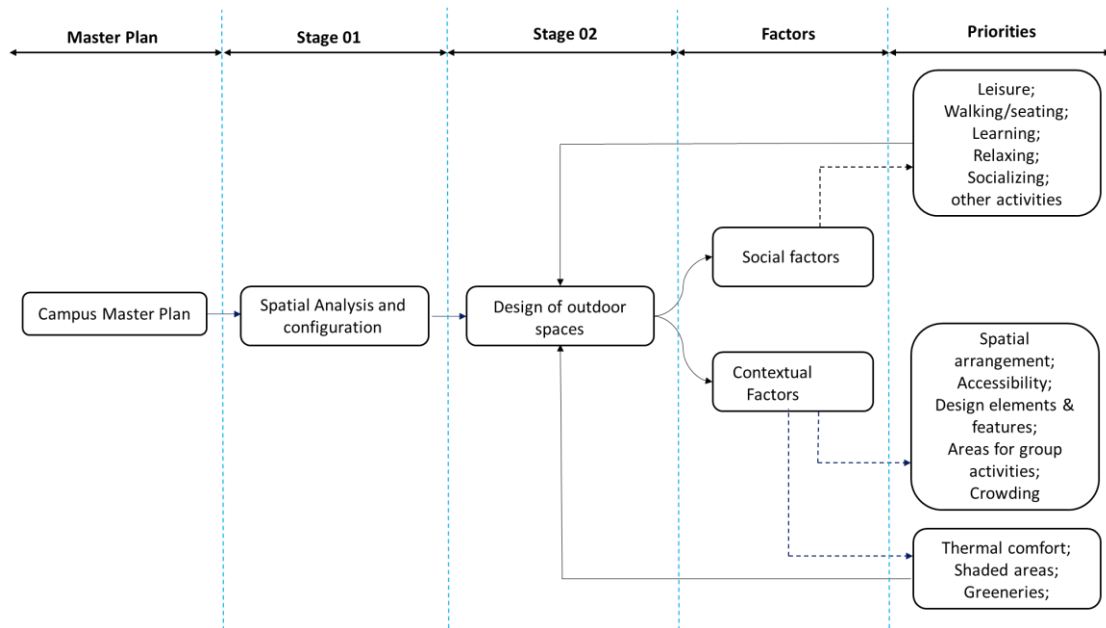


Figure 6. Proposed outdoor space framework for the university campus

## 5. Conclusion

The study acknowledges potential limitations due to the use of an online survey, citing concerns about the reliability of responses. It highlights the scarcity of research on outdoor spaces at the Indian university campus level, emphasizing the lack of understanding regarding user perceptions, preferences and the impact on well-being. Despite these challenges, the study is significant as the first of its kind in the context of Indian universities. It underscores the importance of the findings in establishing criteria for designing new open spaces and improving existing ones. The researcher recommends further investigation, proposing a comprehensive analysis of open spaces in 22 other IITs to gauge student preferences across different climatic zones and suggesting the development of a toolkit based on the findings.

The research concludes that the significance of the quality of open spaces, as well as their distribution and location within the campus are the important key aspects which must be taken into consideration along with student's preferences and perceptions, which will help in defining the character, significance and usage of the open spaces which further helps in integration of the landscape to its adjacent buildings and the campus as a

whole, as in case of the open spaces of IIT Roorkee. These parameters play a crucial role in facilitating social interaction and academic communication between students on every campus. While planning and designing outdoor open spaces in the university campus, contextual factors should be incorporated. Furthermore, priority should be given to the physical features that enhance thermal performance. Architects, urban designers and planners must keep in mind these factors while designing a new campus or redeveloping an old one.

## References

- Abdelaal, M., Doheim, R. & Abdelaal, D. (2017, April). A framework for assessing the efficiency of outdoor spaces within university Campus: A case study of Effat University, Jeddah. In *Conference of Meamaryat International Conference*, 18-20. Saudi Arabia.
- Ahirrao, P., Khan, S. (2021). Assessing public open spaces: A case of city Nagpur, India. *Sustainability*, 13(9), 4997. <https://doi.org/10.3390/su13094997>
- Akhir, N.M., Sakip, S.R.M., Abbas, M.Y. & Othman, N. (2017). A taste of spatial character: Quality outdoor space in campus landscape leisure setting. *Environment-Behaviour Proceedings Journal, Shah Alam*, 2(6), 65-70. <https://doi.org/10.21834/e-bpj.v2i6.987>
- Alhusban, A.A., Alhusban, S.A. & Al-Betawi, Y.N. (2019). The degree of the Hashemite university students' desires, needs and satisfaction with their campus urban design. *Journal of Place Management and Development*, 12(3), 408-448. <https://doi.org/10.1108/JPMD-08-2018-0062>
- Alnusairat, S., Ayyad, Y. & Al-Shatnawi, Z. (2021). Towards meaningful university space: Perceptions of the quality of open spaces for students. *Buildings*, 11(11), 556. <https://doi.org/10.3390/buildings11110556>
- Alwah, A.A., Li, W., Alwah, M.A. & Shahrah, S. (2021). Developing a quantitative tool to measure the extent to which public spaces meet user needs. *Urban Forestry & Urban Greening*, 62, 127152. <https://doi.org/10.1016/j.ufug.2021.127152>
- Aruninta, A., Kurazumi, Y., Fukagawa, K. & Ishii, J. (2018). The integration of human thermal comfort in an outdoor campus landscape in a tropical climate. *GEOMATE Journal*, 14(44), 26-32. <https://doi.org/10.21660/2018.44.7207>
- Bahriny, F., Bell, S. (2021). Traditional versus modern? Perceptions and preferences of urban park users in Iran. *Sustainability (Switzerland)*, 13(4), 1–27. <https://doi.org/10.3390/su13042036>
- Bekci, B., Taşkan, G., Rastilantie, M. & Bogenç, Ç. (2013). The effect of courtyard designs on young people, which have been made according to different functional preferences: Bartın university (Turkey). *Journal of Food, Agriculture & Environment*, 11(3&4), 1804-1813. <https://www.researchgate.net/publication/287622837>
- Beyer, K.M.M., Kaltenbach, A., Szabo, A., Bogar, S., Javier Nieto, F. & Malecki, K.M. (2014). Exposure to neighborhood green space and mental health: Evidence from the survey of the health of wisconsin. *International Journal of Environmental Research and Public Health*, 11(3), 3453–3472. <https://doi.org/10.3390/ijerph110303453>
- Bharath, H.A., Vinay, S., Chandan, M.C., Gouri, B.A. & Ramachandra, T.V. (2018). Green to gray: Silicon valley of India. *Journal of Environmental Management*, 206, 1287–1295. <https://doi.org/10.1016/j.jenvman.2017.06.072>
- Budruk, M., Thomas, H. & Tyrrell, T. (2009). Urban green spaces: A study of place attachment and environmental attitudes in India. *Society & Natural Resources*, 22(9), 824–839. <https://doi.org/10.1080/08941920802628515>
- Canan, F., Golasi, I., Falasca, S. & Salata, F. (2020). Outdoor thermal perception and comfort conditions in the Köppen-Geiger climate category BSk. One-year field survey and measurement campaign in Konya, Turkey. *Science of The Total Environment*, 738, 140295. <https://doi.org/10.1016/j.scitotenv.2020.140295>



- Capelli, M., Conserva, F. (2020). The environmental sustainability at the time of COVID-19 pandemic: An holistic approach through LEED® v4 BD+ C rating system. Preprint, <https://doi.org/10.13140/RG.2.2.24299.90407>
- Carmona, M. (2019). Principles for public space design, planning to do better. *Urban Design International*, 24(1), 47–59. <https://doi.org/10.1057/s41289-018-0070-3>
- Chen, L., Ng, E. (2012). Outdoor thermal comfort and outdoor activities: A review of research in the past decade. *Cities*, 29(2), 118–125. <https://doi.org/10.1016/j.cities.2011.08.006>
- Deasy, C.M., Lasswell, T.E. (1998). *Designing Places for People: A Handbook on Human Behavior for Architects, Designers and Facility Managers*. USA, Whitney Library of Design.
- Dong, W., Wu, J., Chen, Y. & Zhou, X. (2023). A bibliometric review of research on the perceptions of campus public spaces. In *Buildings*, 13(2), 501. <https://doi.org/10.3390/buildings13020501>
- Działek, J., Homiński, B., Miśkowiec, M., Świągost-Kapocsi, A. & Gwosdz, K. (2023). The assessment of the quality of campus public spaces as key parts of the learning landscape: Experience from a crowdsensing study on the Third Campus of Jagiellonian University, Krakow, Poland. *Urban Design International*, 1-16. <https://doi.org/10.1057/s41289-023-00224-1>
- Erath, A. (2016). Bike to the future: Experiencing alternative street design options. *Engaging Mobility*. <https://Blogs.Ethz.Ch/Engagingmobility/2016/09/12/Bike-to-the-Future/>
- Farag, A.A., Badawi, S.R. & Doheim, R.M. (2019). Assessment of user happiness in campus open spaces. *The Journal of Public Space*, 4(1), 45–64. <https://doi.org/10.32891/jps.v4i1.566>
- Gascon, M., Mas, M.T., Martínez, D., Dadvand, P., Forns, J., Plasència, A. & Nieuwenhuijsen, M.J. (2015). Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review. In *International Journal of Environmental Research and Public Health*, 12(4), 4354–4379. <https://doi.org/10.3390/ijerph120404354>
- Göçer, Ö., Göçer, K., Başol, A.M., Kırac, M.F., Özbil, A., Bakovic, M., Siddiqui, F.P. & Özcan, B. (2018). Introduction of a spatio-temporal mapping based POE method for outdoor spaces: Suburban university campus as a case study. *Building and Environment*, 145, 125–139. <https://doi.org/10.1016/j.buildenv.2018.09.012>
- Grahn, P., Stigsdotter, U. K. (2010). The relation between perceived sensory dimensions of urban green space and stress restoration. *Landscape and Urban Planning*, 94(3–4), 264–275. <https://doi.org/10.1016/j.landurbplan.2009.10.012>
- Hami, A., & Abdi, B. (2021). Students' landscaping preferences for open spaces for their campus environment. *Indoor and Built Environment*, 30(1), 87–98. <https://doi.org/10.1177/1420326X19887207>
- Hanan, H. (2013). Open space as meaningful place for students in ITB Campus. *Procedia - Social and Behavioral Sciences*, 85, 308–317. <https://doi.org/10.1016/j.sbspro.2013.08.361>
- Iftikhar, H., Shah, P. & Luximon, Y. (2020). Human wayfinding behaviour and metrics in complex environments: A systematic literature review. *Architectural Science Review*, 1–12. <https://doi.org/10.1080/00038628.2020.1777386>
- IIT Roorkee. (2022). Annual Sustainability Report 2021-2022. Indian Institute of Technology, Roorkee.
- Jogdande, A., Bandyopadhyay, A. (2022). Identifying and assessing uses of public parks: A systematic literature review. *Civil Engineering and Architecture*, 10(3), 1142–1151. <https://doi.org/10.13189/cea.2022.100330>
- Kellstedt, D.K., Spengler, J.O. & Maddock, J.E. (2021). Comparing perceived and objective measures of bikeability on a university campus: A case study. *SAGE Open*, 11(2), 2158244021101865. <https://doi.org/10.1177/21582440211018685>
- King, S.B., Kaczynski, A.T., Knight Wilt, J. & Stowe, E.W. (2020). Walkability 101: A multi-method assessment of the walkability at a University Campus. *SAGE Open*, 10(2), 215824402091795. <https://doi.org/10.1177/2158244020917954>

- Lee, J., Shepley, M.M. (2020). College campuses and student walkability: Assessing the impact of smartphone use on student perception and evaluation of urban campus routes. *Sustainability*, 12(23), 9986. <https://doi.org/10.3390/su12239986>
- Li, X., Ni, G. & Dewancker, B. (2019). Improving the attractiveness and accessibility of campus green space for developing a sustainable university environment. *Environmental Science and Pollution Research*, 26(32), 33399–33415. <https://doi.org/10.1007/s11356-019-06319-z>
- Loder, A.K.F., Schwerdtfeger, A.R. & Van Poppel, M.N.M. (2020). Perceived greenness at home and at university are independently associated with mental health. *BMC Public Health*, 20(1). <https://doi.org/10.1186/s12889-020-8412-7>
- Lu, M., Fu, J. (2019). Attention restoration space on a university campus: Exploring restorative campus design based on environmental preferences of students. *International Journal of Environmental Research and Public Health*, 16(14), 2629. <https://doi.org/10.3390/ijerph16142629>
- Malekinezhad, F., Courtney, P., bin Lamit, H. & Vigani, M. (2020). Investigating the mental health impacts of university campus green space through perceived sensory dimensions and the mediation effects of perceived restorativeness on restoration experience. *Frontiers in Public Health*, 8. <https://doi.org/10.3389/fpubh.2020.578241>
- Meeder, M., Aebi, T. & Weidmann, U. (2017). The influence of slope on walking activity and the pedestrian modal share. *Transportation Research Procedia*, 27, 141–147. <https://doi.org/10.1016/j.trpro.2017.12.095>
- Meenatchi Sundaram, A. (2011). Urban green-cover and the environmental performance of Chennai city. *Environment, Development and Sustainability*, 13(1), 107–119. <https://doi.org/10.1007/s10668-010-9251-y>
- Middleton, J. (2010). Sense and the city: Exploring the embodied geographies of urban walking. *Social & Cultural Geography*, 11(6), 575–596. <https://doi.org/10.1080/14649365.2010.497913>
- Mogra, S., Furlan, R. (2017). Public Realm at Qatar University Campus: Perception and sustainability of Open Green Spaces. *Saudi Journal of Humanities and Social Sciences*, 2(1), 80-94. <https://doi.org/10.21276/sjhss.2017.2.1.13>
- Muqueeth, S. (2021). Parks: A vital community condition. *Parks Stewardship Forum*, 37(1). <https://doi.org/10.5070/P537151742>
- Nagendra, H., Nagendran, S., Paul, S. & Pareeth, S. (2012). Graying, greening and fragmentation in the rapidly expanding Indian city of Bangalore. *Landscape and Urban Planning*, 105(4), 400–406. <https://doi.org/10.1016/j.landurbplan.2012.01.014>
- National Institutional Ranking Framework Ministry of Education, Government of India (2021). Welcome to data capturing system: OVERALL submitted institute data for NIRF'2023'.
- Nikolopoulou, M., Baker, N. & Steemers, K. (2001). Thermal comfort in outdoor urban spaces: Understanding the human parameter. *Solar Energy*, 70(3), 227–235. [https://doi.org/10.1016/S0038-092X\(00\)00093-1](https://doi.org/10.1016/S0038-092X(00)00093-1)
- Özkan, D.G., Alpak, E.M. & Var, M. (2017). Design and construction process in campus open spaces: A case study of Karadeniz Technical University. *Urban Design International*, 22(3), 236–252. <https://doi.org/10.1057/s41289-017-0041-0>
- Panjwani, T. (2017, July 1). Higher Education in India. <https://www.Ukibc.Com/Higher-Education-in-India/>
- Peker, E., Ataöv, A. (2020). Exploring the ways in which campus open space design influences students' learning experiences. *Landscape Research*, 45(3), 310–326. <https://doi.org/10.1080/01426397.2019.1622661>
- Peng, Y., Peng, Z., Feng, T., Zhong, C. & Wang, W. (2021). Assessing comfort in urban public spaces: A structural equation model involving environmental attitude and perception. *International Journal of Environmental Research and Public Health*, 18(3), 1–17. <https://doi.org/10.3390/ijerph18031287>

- Manavvi, S., Rajasekar, E. (2022). Evaluating outdoor thermal comfort in urban open spaces in a humid subtropical climate: Chandigarh, India. *Building and Environment*, 209, 108659. <https://doi.org/10.1016/j.buildenv.2021.108659>
- Sabrin, S., Karimi, M., Nazari, R., Pratt, J. & Bryk, J. (2021). Effects of different urban-vegetation morphology on the canopy-level thermal comfort and the cooling benefits of shade trees: Case-study in Philadelphia. *Sustainable Cities and Society*, 66, 102684. <https://doi.org/10.1016/j.scs.2020.102684>
- Scholl, K.G., Betrabet Gulwadi, G. (2015). Recognizing campus landscapes as learning spaces. In *Journal of Learning Spaces*, 4(1), 53-60.
- Schwander, C., Kohlert, C. & Aras, R. (2012, January). CAMPUSANALYST: Towards a spatial benchmarking system for university campuses. In *Proceedings of 8th International Space Syntax Symposium*, 3-6.
- Shang, H., Lin, M. & Zheng, Y. (2020a). The Perception reshaping strategy of campus public space. In *Advances in Human Factors in Architecture, Sustainable Urban Planning and Infrastructure: Proceedings of the AHFE 2019 International Conference on Human Factors in Architecture, Sustainable Urban Planning and Infrastructure, July 24-28, 2019*, 381-391. Springer International Publishing. [https://doi.org/10.1007/978-3-030-20151-7\\_36](https://doi.org/10.1007/978-3-030-20151-7_36)
- Shang, H., Lin, M. & Zheng, Y. (2020b). The perception reshaping strategy of campus public space. *Advances in Intelligent Systems and Computing*, 966, 381–391.
- Shooshtarian, S., Iyer-Raniga, U., Andamon, M. & Ridley, I. (2015, December). Thermal perceptions and microclimates of educational urban precincts in two different seasons in Melbourne. In *Proceedings of the 49th International Conference of the Architectural Science Association, Melbourne, Australia*, 2-4. <https://www.researchgate.net/publication/311946578>
- Soares, R., Corvacho, H. & Alves, F. (2021). Summer thermal conditions in outdoor public spaces: A case study in a mediterranean climate. *Sustainability*, 13(10), 5348. <https://doi.org/10.3390/su13105348>
- Sun, G., Haining, R., Lin, H., Oreskovic, N.M. & He, J. (2015). Comparing the perception with the reality of walking in a hilly environment: An accessibility method applied to a university campus in Hong Kong. *Geospatial Health*, 10(1). <https://doi.org/10.4081/gh.2015.340>
- Sung, H., Lee, S. (2015). Residential built environment and walking activity: Empirical evidence of Jane Jacobs' urban vitality. *Transportation Research Part D: Transport and Environment*, 41, 318–329. <https://doi.org/10.1016/j.trd.2015.09.009>
- Tao, Y., Lau, S.S.Y., Gou, Z., Zhang, J. & Tablada, A. (2019). An investigation of semi-outdoor learning spaces in the tropics: Spatial settings, thermal environments and user perceptions. *Indoor and Built Environment*, 28(10), 1368–1382. <https://doi.org/10.1177/1420326X19841115>
- Tudorie, C.A.M., Vallés-Planells, M., Gielen, E., Arroyo, R. & Galiana, F. (2020). Towards a greener university: Perceptions of landscape services in campus open space. *Sustainability (Switzerland)*, 12(15). <https://doi.org/10.3390/su12156047>
- Wang, R., Jiang, W. & Lu, T. (2021). Landscape characteristics of university campus in relation to aesthetic quality and recreational preference. *Urban Forestry & Urban Greening*, 66, 127389. <https://doi.org/10.1016/j.ufug.2021.127389>
- Xie, X., Li, Y., Wang, R. & Gou, Z. (2023). Park recreation intention and satisfaction of blue-collar workers based on the ACSI model: A case study of anning industrial park in Yunnan. *Land*, 12(4). <https://doi.org/10.3390/land12040798>
- Yin, J., Zheng, Y., Wu, R., Tan, J., Ye, D. & Wang, W. (2012). An analysis of influential factors on outdoor thermal comfort in summer. *International Journal of Biometeorology*, 56(5), 941–948. <https://doi.org/10.1007/s00484-011-0503-9>
- Zacharias, J., Stathopoulos, T. & Wu, H. (2004). Spatial behavior in San Francisco's plazas. *Environment and Behavior*, 36(5), 638–658. <https://doi.org/10.1177/0013916503262545>