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Citation: Torun, Ayse Ozbil, Gocer, Ozgur, Bakovic, Mujesira and Gocer, Kenan (2018) A Quantitative Investigation of the Factors Affecting Patterns of Occupation in a Suburban Campus: The Case of Ozyegin University in Istanbul. International Journal of Architectural Research: ArchNet-IJAR, 12 (2). pp. 98-125. ISSN 1938-7806

Published by: ArchNet-IJAR

URL: <https://doi.org/10.26687/archnet-ijar.v12i2.1611> <<https://doi.org/10.26687/archnet-ijar.v12i2.1611>>

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## A QUANTITATIVE INVESTIGATION OF THE FACTORS AFFECTING PATTERNS OF OCCUPATION IN A SUBURBAN CAMPUS: THE CASE OF OZYEĞİN UNIVERSITY IN ISTANBUL

DOI: <http://dx.doi.org/10.26687/archnet-ijar.v12i2.1611>

Ayşe Ozbil\*, Ozgur Gocer, Mujesira Bakovic, Kenan Gocer

### Keywords

Suburban university campus; outdoor space; behavioral mapping; space syntax analysis.

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### Abstract

*This study investigates the patterns of occupation of outdoor spaces on a suburban university campus and seeks to understand the factors that affect them. The comprehensive methodology applied in this research attempted to overcome some of the shortcomings of related studies by conducting a longitudinal study (behavioral mapping during a year, as opposed to a few days) and by objectively analyzing the associations of user behavior and physical attributes, and the configurational properties of the campus layout. The results show that campus users fail to capitalize on the potential offered by the spatial configuration of outdoor spaces because they are not supported by amenities for pedestrians such as seating, shading elements and catering facilities. Supporting campus outdoor spaces that have the configurational potential of bringing various types of users (students and staff) with amenities for pedestrians and service facilities would create a lively and sustainable campus for its users.*

Ayşe Ozbil\*

Senior Lecturer, Department of Architecture and Built Environment, Northumbria University, Newcastle upon Tyne, UK

Ozgur Gocer

Associate Professor, Department of Architecture, Ozyegin University, Istanbul, Turkey

Mujesira Bakovic

MSc Student, Institute of Science and Technology, Istanbul Technical University, Istanbul, Turkey

Kenan Gocer

Dr. Department of Architecture, Ozyegin University, Istanbul, Turkey

\*Corresponding Author's email address: [ayse.torun@northumbria.ac.uk](mailto:ayse.torun@northumbria.ac.uk)



## INTRODUCTION

Concomitant with the rapid increase in the number of universities in Turkey and in Istanbul in particular, design approaches that meet user needs on university campuses are becoming critical. Due to the limited space and high price of land in the urban centers of the city, the trend for new universities is to establish campuses outside the city center in suburban settings, with the intention of providing education in well-equipped and spatially adequate areas. Since suburban campuses must meet primary user needs such as accommodation, study, recreation and transportation, and house a relatively high population (10,000 inhabitants per mid-scale campuses), these settings need to be considered individual urban settlements (Erkman, 1990). University campuses are not only made up of various social and educational buildings, but they also create a unified place through their buildings, outdoor spaces, social features and an effective spatial configuration. Hence, urban planning needs to be applied strategically in their design to provide effective relationships between various outdoor spaces as well as between outdoor spaces and individual buildings so that they can function as a unified setting and maximize their ability to satisfy user needs.

Studies of university campuses mostly focus on the physical qualities (seating and shading elements, service features) of outdoor areas and the perception of these qualities by inhabitants (Çubukçu and Işıtan, 2011; Erçevik and Önal, 2011; Yıldız and Şener, 2010; Hanan, 2013; Hussein and Jamaludin, 2015; DeClercq, 2016). The relevant literature argues that campus outdoor spaces that house user-oriented features (green spaces, water elements, sculptures, seating, meeting points, etc.) enhance life quality and mental health (Lau and Feng Yang, 2009; Lau et al., 2014; Salama, 2009; Aydin and Ter, 2008).

The main conclusion of the relevant studies is that the physical qualities of outdoor spaces on university campuses affect the extent to which inhabitants occupy them. These qualities are generally identified through subjective evaluations based on users' perceptions as reported on questionnaires and in interviews. They fail to provide objective results regarding the causes of specific behavioral choices and patterns of use. Some studies attempt to assess the link between physical qualities and user behavior by objectively measuring and mapping user behaviors (behavioral mapping, tracing, counting). However, since these observations are cross-sectional in nature (conducted in a single season), their conclusions are limited in scope. Another shortcoming of these studies is that they tend to study individual spaces as isolated from the entire outdoor area. However, environmental quality is actually related to the character of an entire area: neighborhood, campus and city. Thus, to accurately evaluate the quality of outdoor areas on a campus, it is critical to consider them as a whole through both subjective and objective measurements.

Space syntax, a theory and set of techniques for analyzing spatial configurations at various scales, is a promising approach for objectively measuring the degree to which built spaces are associated with human activity (Hillier and Hanson, 1984). Configurational analysis refers to any kind of spatial analysis that characterizes the relation of each elementary spatial unit, here the individual outdoor space, to all others. Space syntax analyses have demonstrated that the spatial configuration of public outdoor areas is significantly associated with user behavior in these areas (Karimi, 2014; Seçkin and Türkoğlu, 2010; Read, 1999). These studies emphasize the significance of designing public open urban spaces as settings integrated with their surrounding context and as areas with relatively higher accessibility and visibility potentiality to enhance their spatial performance in terms of increased occupation rates and activity types (Yaylalı-Yıldız et al., 2014; Grajewski and Psarra, 2001; Rose, 2003). Research based on this approach has documented a significant relationship between the



accessibility and visibility patterns offered by the spatial configuration of urban environments and observed occupation (the locations and numbers of users) and movement patterns (Kooshari et al., 2016; Van der Hoeven, 2014). Even though space syntax analysis has identified the significance of spatial configuration of built environments, only a few studies have used space syntax methodology to study university campuses (Yaylalı-Yıldız et al., 2014; Heitor et al., 2013). Moreover, these studies either have disregarded user behavior in outdoor spaces or have analyzed it based on a small number of observations.

This study uses the term ‘outdoor space’ to refer to the concepts of open space, the built exterior environment and open areas. These are the spaces that lie between and are limited by the buildings on a university campus. Many researchers have focused on the concept of outdoor space since the 1960s. According to Payne (2009), outdoor spaces, which link the buildings with their surrounding natural environment, both provide directional guidance by organizing and complementing diverse areas and elements and provide a sense of aesthetics by creating visual surprises. According to Whyte (1980), successful outdoor space designs have the following key elements: (i) adequate seating and food, (ii) access to sunlight, (iii) shelter from the wind and (iv) water elements and vegetation. Similarly, Mehta (2007) argues that three aspects of open spaces—physical use, land use and social use—are critical for achieving a quality of public space that is conducive to stationary, lingering and social activities. Outdoor spaces play an important role in the achievement of sustainability goals and objectives, which can be formulated as three key issues according to Al-Hagla (2008): space management, space function and sustainable landscape. One of the most important functions of these spaces is to foster a sense of social fabric by facilitating chance encounters between users (Talen, 2000). The transformation of outdoor spaces into socializing arenas through not only necessary activities, such as traveling between origins and destinations, but also optional and social activities depend on the design of these spaces as well as the convenience of the user-oriented features in them (Gehl, 2006).

Thus, from an urban design and planning perspective, it is crucial to create open spaces that act as social condensers enabling the realization of such activities. The extent to which users utilize the outdoor spaces of a campus depends not only on the physical and social features they offer, but also on their spatial configuration because user behavior is significantly related to configurational properties (the extent which one can see and move directly without any visual or physical barriers) (Hillier and Hanson, 1984). The potential for unplanned interactions (spontaneous encounters) between users offered by the configuration of spatial layout is critical for fostering collective social structures and creating healthy and sustainable urban environments. Investigating and evaluating user behavior in campus outdoor spaces yields information regarding the link between their spatial configuration and user choices, which, in turn, contributes to campus design decisions.

This study aims to determine objectively the underlying reasons of use patterns in outdoor spaces during different seasons on a suburban university campus by integrating space syntax methodology and behavioral mapping, supported with user surveys. By offering a comprehensive methodological approach, it attempts to overcome the shortcomings of the literature on suburban campus design. The primary question that this study attempts to answer is: to what extent do outdoor spaces on a suburban campus shape individual behaviors and choices?



## RESEARCH APPROACH

### Case Study

Özyeğin University (OzU) is located within the boundaries of the city of Istanbul (Turkey) (Figure 1). The university welcomed its first students to its downtown Altunizade Campus in Istanbul in 2008 and then moved to the suburban Çekmeköy Campus in 2011. OzU Çekmeköy Campus is situated on 280,000 square meters of land. The campus offers all the amenities and facilities necessary to foster students' academic development and exposure to social, sports and cultural events.

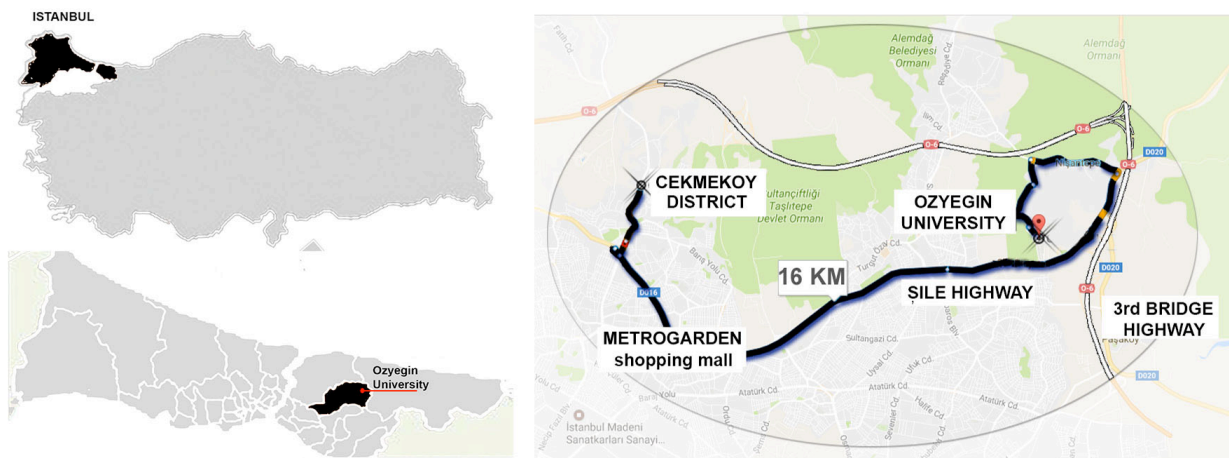


Figure 1: The location of the university campus (Source: Authors).

OzU campus has identifiable physical characteristics with its modern buildings on a sloping topography. The buildings are located on the main promenade, which starts from the drop off point on the northern edge and reaches the main courtyard (quad) in the center of the campus (Figure 2). The pedestrian walkways and car roads are separated from each other. The dormitories are located at a distance from the educational areas, creating a quieter area for housing.

### Methodology

A synthesis of three types of tools is used in this study: behavioral mapping, space syntax analysis and user surveys. Space syntax and behavioral mapping methodology can be integrated to evaluate the relationship between the individual characteristics of spaces as well as all the spaces that constitute the spatial organization of a building or an outdoor space (Karimi, 2012; Read, 1999). Overlapping the results of these two methods can identify the strengths and weaknesses of spatial designs and develop design strategies for potential improvements. In this methodology, user surveys are also integrated in order to understand user satisfaction, which affects occupancy patterns and frequencies as well as user behaviors as a result of their preferences of pedestrian-oriented design elements.

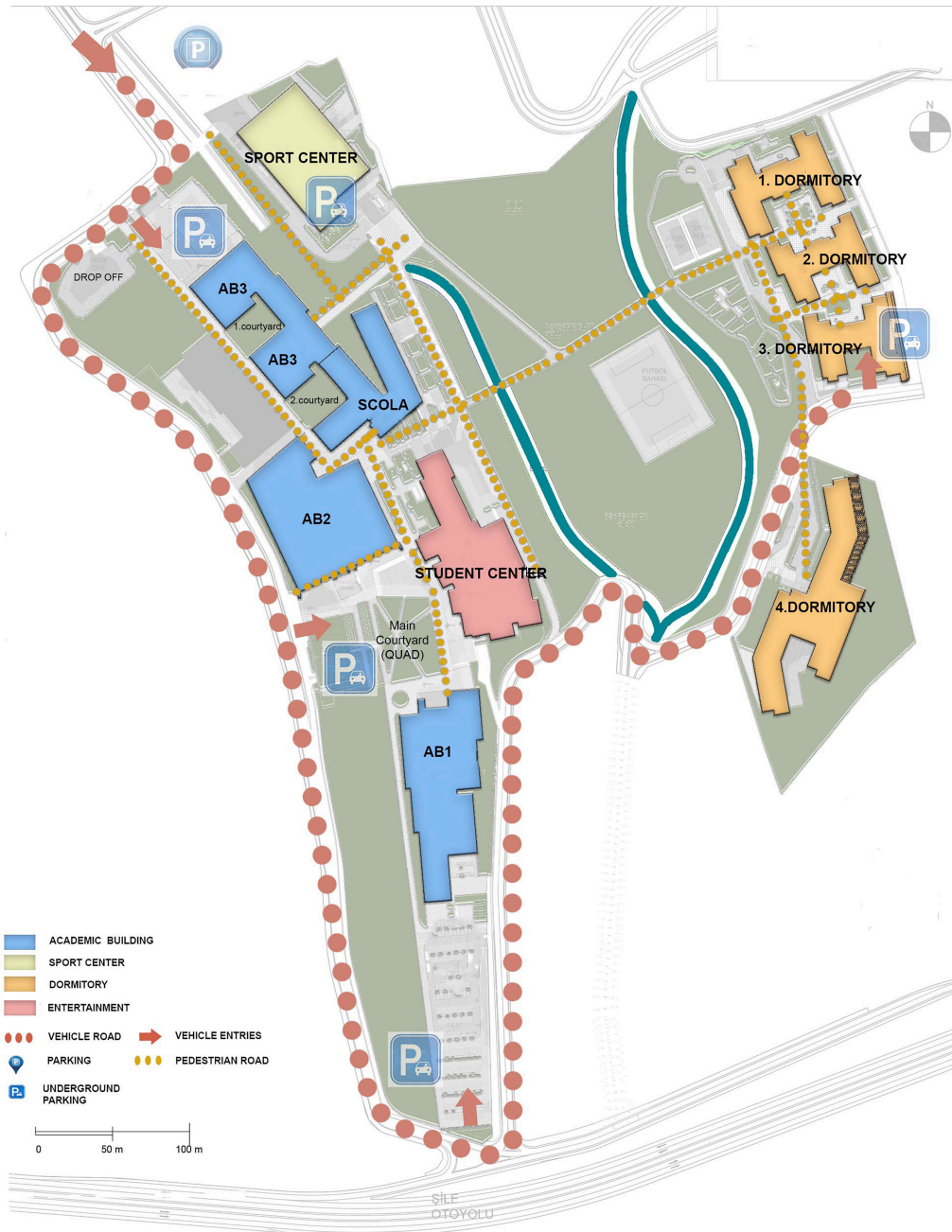


Figure 2: Land use map of OzU (Source: Authors).

### Behavioral Mapping

User behavior was observed and mapped in four sub-areas in the outdoor spaces of the campus. The sub-areas were determined based on preliminary behavioral observations (significant points of congregation and circulation), the physical characteristics of the pedestrian axis (where it diverts and/or meets small and large courtyards) as well as the



areas onto which main buildings open. It was also ensured that these areas were measurable spaces defined by buildings. One of the areas excluded from the study is the ceremonial ground, which is only used on a few specific days (graduation ceremonies, concerts and other activities). The outdoor spaces surrounding the dormitories were also excluded from the analysis since the patterns of their occupation vary significantly during the day, which prevents comparing them to the rest of the campus. Figure 3 shows the selected four sub-areas. The first sub-area includes the pedestrian axis lying between the shuttle drop-off area on the north edge of the campus and the School of Language building (SCoLA). The second sub-area lies between the SCoLA and the Faculty of Business (AB2). The third sub-area includes the large staircase connecting the SCoLA and the cafeteria in the student center, including the space to the east side of AB2. Finally, sub-area 4 includes the large courtyard (quad) enclosed by the student center and the Faculty of Engineering (AB1). These areas are described in more detail in Section 3.2.

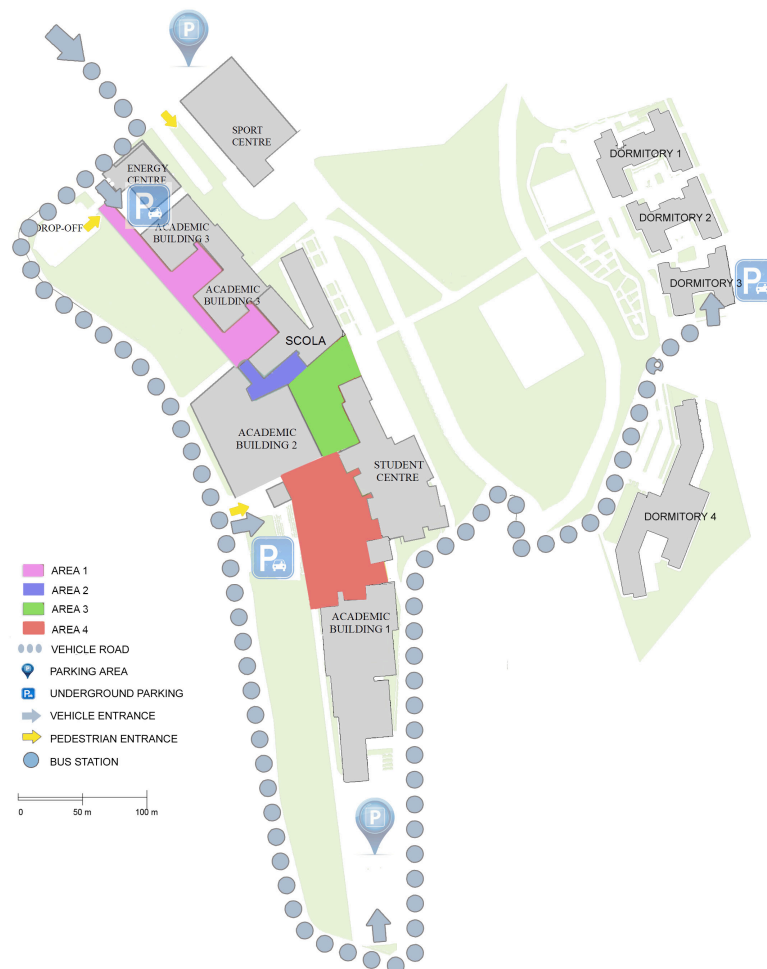


Figure 3: Sub-areas observed for behavioral mapping (Source: Authors).

User behavior in these sub-areas was measured by direct observation in 10-minute intervals using the methodology developed by Goličnik, Marušić and Marušić (2012). Spatial behavior

mapping was conducted for both passive (sitting, standing, lying down) and active (walking, running) occupancy on campus during a typical weekday, repeated over five time intervals (8:00-10:00, 10:00-12:00, 12:00-14:00, 14:00-16:00, 16:00-18:00). Since outdoor space use is affected by seasonal changes and time of day, behavioral mapping was repeated in four seasons to identify how the campus was occupied during an entire year. The duration and location of observed activities were also noted. Passive activities that lasted under a minute and were performed in circulation spaces and building entrances were regarded as unplanned activities (spontaneous encounters). The data, including the number of users as well as the type, duration and location of activities, were then transformed into a geographic information system (GIS) database.

### Space Syntax Analysis

Space syntax offers a rich set of analytical measurements to evaluate the cognitive scale of urban space. The most important is the axial map, which models urban space as a network representation of open public spaces based on graph theory. The axial map consists of the fewest longest straight lines (axial lines) covering all urban public spaces. Each axial line represents a line of sight and access offered by the environment to users. Thus, the axial map both defines the cognitive scale of the urban space and allows for the systematic quantification of this network. Studies using axial lines have found spatial integration to be the most significant predictor of potential use of space in built environments. Integration calculates the distance of any axial line from all the others in the system, measured in steps. Integration measures how accessible each space is from all the others using the least number of steps. The most integrated spaces—requiring least number of steps to access all other spaces—and the most segregated spaces—requiring highest number of steps to access all others—are encoded from red to dark blue, respectively, on a spatial integration map. This graphical representation enables researchers to visualize the usage potential of an urban space. Connectivity is another measure used in space syntax analysis to measure the accessibility of spaces (axial lines). It calculates the number of lines intersected by individual axial lines. Two types of analysis are conducted in axial lines analysis. Global level analysis ( $r: n$ ) calculates integration and connectivity starting from each individual axial line to all the others for all axial lines in the system, while local analysis ( $r: 3$ ) calculates these measurements for only three steps away from each axial line. The former identifies spaces where all users may encounter each other, and the latter describes local spaces where only those inhabiting these spaces interact.

To conceive an urban environment, the pedestrian needs to consolidate the sequences of views created during one's movement. Hence, researchers have developed various measurements to objectify the visual properties of the urban environment. In space syntax analysis, the concept of an isovist, first identified by Benedick (1979), was developed based on the idea of viewsheds as used in the fields of geography and landscape design. Isovists are the largest visibility polygons that can be drawn from an individual point in an environment. However, an urban fabric cannot be viewed and experienced entirely from a single point. Thus, Turner et al. (2001) developed visibility graph analysis to consider multiple points in a system. This analysis measures the visibility relations and polygon areas of various points distributed evenly in the environment. Studies using visibility graph analysis have shown that various attributes of isovists are associated with patterns of movement and spatial cognition of users in a system (Hölcher et al., 2012; Conroy-Dalton, 2003; Arruda Campos, 1997). Visual integration defines the potential for a space to be seen from any place in the system, that is, how central it is in the entire system (Kürkçüoğlu and Ocakçı,



2015). Visual connectivity is a measure of the number of places that can be seen directly from each location (Seçkin and Türkoğlu, 2010). In short, these criteria can be regarded as the spatial indicators of the possibilities of visitors to be in same place at the same time (Lau et al., 2014).

The entire OzU campus was analyzed using axial lines and visibility graph analysis. Both global and local measurements were used to describe the potentials of encounter and occupation offered by the spatial configuration of the campus layout. In this study, all the space syntax analyses were conducted using Depthmap software (Turner and Friedrich, 2011).

### User Surveys

In order to understand the extent to which users are satisfied with the functionality and capacity of outdoor areas on campus, a user survey was administered to the students and staff during the 2015-2016 academic year. The survey asked about the spatial choices and preferences of users using 5-point Likert-type questions and their socio-demographic characteristics using 16 open-ended questions. The survey enabled us to interpret the patterns of behavioral mapping not only in relation to spatial configuration of the campus, but also as shaped by the existing amenities for pedestrians such as the availability of seating, and quality and quantity of shade. A total of 1,041 students participated in the survey. When the total number of students is considered, the number of surveys is statistically acceptable to the error of 0.03 samples (19.6%). Table 1 shows the distribution of the students surveyed by faculty. Of the participants, 48.8% were female, and 47 respondents did not fully complete the survey.

Table 1: A comparison of the 2015-2016 student population and the number of students surveyed by faculty (Source: Authors).

FACULTIES	The number of students in under- graduate programs	The number of surveyed Students	Per cent
Faculty of Architecture and Design	522	198	37.9
FAS-Faculty of Social Science	324	127	39.2
FEAS-Faculty of Business	868	58	6.7
FE-Faculty of Engineering	1255	137	10.9
FLAW-Faculty of Law	847	124	14.6
SAS-School of Applied Science	311	49	15.8
School of Aviation and Aeronautical Science	258	91	35.3
School of Language (SCOLA)	930	251	27.0
<b>Total</b>	<b>5315</b>	<b>1041 (1035+6*)</b>	<b>19.6</b>

\*Six students did not specify their department

A total of 304 employees participated in the staff survey. When the total number of employees is taken into account, the number of surveys conducted is statistically acceptable to the error of 0.05 sample errors (43.6%). The distribution of employees surveyed by work status is shown in Table 2. Instructors working for hourly wages and the employees of





subcontracting firms were not included. Of the participants, 58.0% were academic staff, 68.4% were female, and 11 did not specify their status.

Table 2: A comparison of the 2015-2016 staff population and the number of staff surveyed (Source: Authors).

	The number of staff	The number of surveyed staff	Per cent
Academic staff	345	170	49.3
Administrative staff	353	123	3.5
<b>Total</b>	<b>698</b>	<b>304 (293+11*)</b>	<b>43.6</b>

\*11 participants did not specify their employment status.

## FINDINGS

### The results of the analysis for the entire campus

#### Syntactic Analysis

Figure 4 shows the axial lines and visibility graph analysis of the campus. The average global (r: n) integration of the entire campus is 0.71, and the average local (r: 3) integration is 2.61. Global integration analysis (Figure 4a) found that the spaces with the most integrated axial lines lie in sub-areas 2 and 3. The most integrated (0.98) axial line connects the entrance of the sports center and the rear entrance of the student center (sub-area 3). The second most integrated space (0.97), which is connected to the most integrated axial line, contains the stairs leading from SCoLA towards the dormitories (sub-area 3). On this axial line are the side entrances of the cafeteria and SCoLA. The third (0.93) most integrated axial line covers the area between SCoLA and AB2. This outdoor area, which lies between sub-areas 2 and 3, can be seen as a node. From this area, both the small square in front of SCoLA as well as the stairway leading to the dormitories are visually accessible, while the student center is partially visible. The areas with the most isolated axial lines are the mini-quads located on the main access route between the shuttle area and SCoLA on the western edge of AB3, segregated from the main courtyard (quad) and public areas. Except for AB3 and AB1, the main entrances of most buildings are not located on the most integrated axial lines. The main entrances of these two buildings open onto spaces with average integration values. However, when connectivity values are considered, the main access route connecting sub-areas 1 and 2 appears as the most integrated axial line (Figure 4b). This shows that the entrances of AB3 open onto a locally more connected, but globally less integrated axial line. The most isolated areas are the pedestrian paths surrounding the campus. This is to be expected for a suburban campus isolated from the urban fabric.

Figure 4c shows the visibility model of the campus using the measure of global integration. As in the axial analysis, the most visually integrated space is the nodal space in sub-areas 2 and 3. This area offers the opportunity to see both the small square in front of SCoLA and the main pathway connecting the faculties with dormitories as well as providing visual access to the student center and AB1. The main quad in front of the student center in sub-area 4 also has relatively high visual integration values since it lies in the intersection of multiple



isovists offered by buildings. The most segregated places are the mini-quads, which are visually secluded from the entire campus.

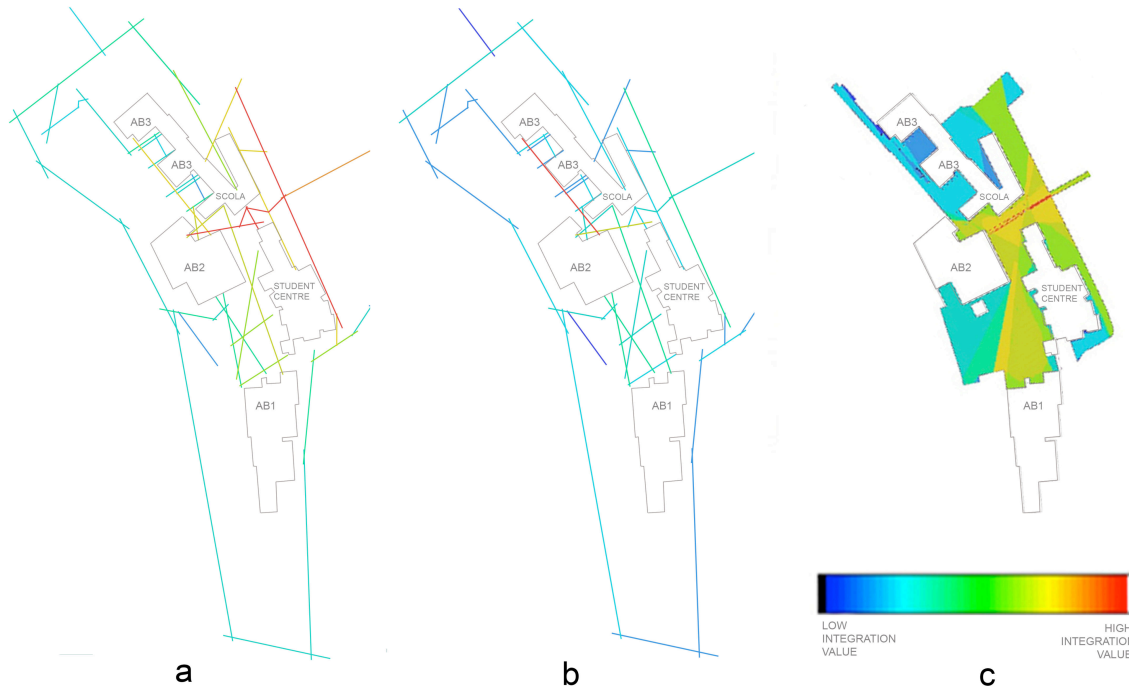


Figure 4: The entire campus: (a) global Integration, (b) connectivity, and (c) visual integration (Source: Authors).

### Behavioral Analysis

Figure 5 shows the behavioral mapping results of sub-areas 1-4 at different time intervals during a typical weekday in four seasons. These analyses show that the main quad (sub-area 4) and the nodal square (sub-area 2) as well as the terraces in front of SCoLA (sub-area 3) are the most intensely occupied outdoor spaces on campus in all seasons. While the main quad is preferred during autumn and spring, the courtyard is under-utilized during the cold and windy days of winter and the hot and humid days of summer. During those days, the immediate surroundings of buildings, which provide increased thermal comfort with their canopies, are preferred by users. Since educational activities are carried out in three semesters (fall, spring and summer), and extra-curricular activities, such as internships, seminars and workshops, are also conducted during the summer, the campus is occupied intensely during the summer season as well. When the intensity of occupancy is compared quantitatively across seasons (Table 3), it is found that outdoor spaces are preferred mostly in the fall. The occupancy rates decline significantly in spring and winter due to rain and cold. The number of active users is highest in fall and summer.

In general, the observed intensity of outdoor space use was relatively low when compared to user numbers in common interior spaces (cafeteria, cafes and restaurants). The insufficiency of shading and seating elements, and catering services in outdoor spaces results in their

under-utilization. For example, there are 114 individual (0.6 m) and 24 group (1.5 m) seating elements (total 104.4 m) in the most heavily occupied main quad (sub-area 4).

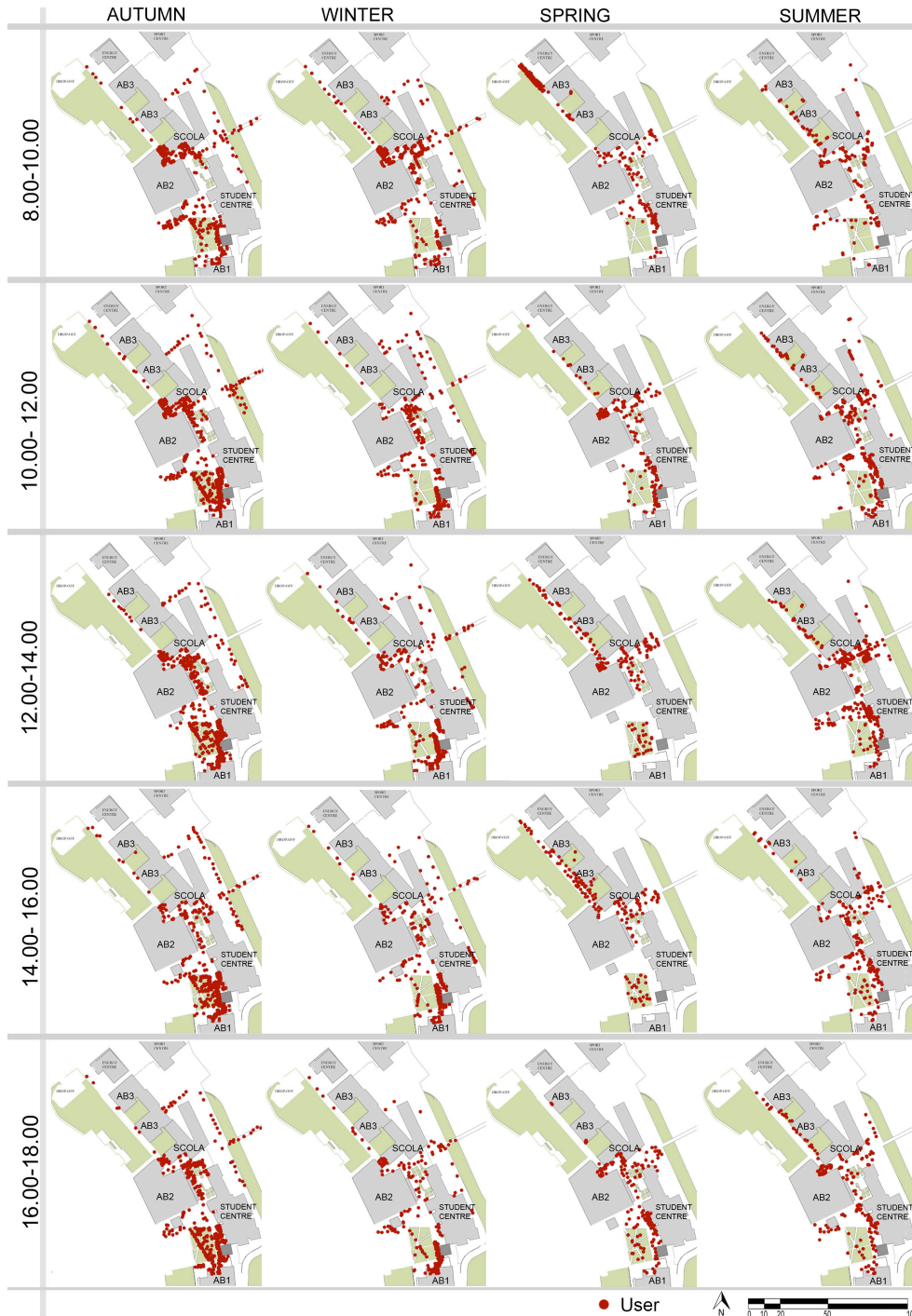


Figure 5: User occupancy at different time intervals during a typical weekday in four seasons (Source: Authors).



Even though there is not a defined standard in the urban design literature, Yücel (2006) argues that the minimum usable width of seating elements in public open spaces needs to be 60cm per person. Considering the fact that OzU campus accommodates 7,000 users, it is clear that the main recreational space of the campus lacks seating capacity. The lack of amenities for pedestrians in certain outdoor spaces causes a significant decline in user activities, particularly in hot weather, and a major increase in use intensity in shaded service facilities (café fronts), which have a limited usage capacity. The daily occupancy of the campus rises sharply after the start of classes at 9:00, and a sharp decline is observed after work hours are over and shuttles depart at 17:00.

Table 3: The number of users in outdoor spaces in four seasons (Source: Authors).

	avg. number of users	avg. number of active users	avg. number of passive users	avg. number of standing users	avg. number of sitting users	avg. number of walking users
Fall	438.4	252.8	181.6	71.4	114.2	252.8
Winter	267.2	171.4	95.8	43.6	52.2	171.4
Spring	201.6	121.8	79.8	21	57.8	120.8
Summer	321.2	235.4	85.8	27.4	56.8	235.4

## Survey Results

Figure 6 shows the mean values of the responses by staff and students to the 5-point Likert-type items on the survey. The users evaluated all the items moderately positively (every item has a mean value above 3.0), but the staff was less satisfied than the students with the extent to which the campus is well organized. The campus design includes a mixed-use layout. Spaces such as the library, the dining hall and the student center are designed to be close to each other, but the academic offices are far from these spaces. This may be why the staff feel less satisfied with the organization of the campus. The highest mean value belongs to the item regarding security (both in daytime and at night). While the staff feels safer during daytime than the students, it is the opposite for nights. There is a statistically significant difference between user profiles regarding the item of safety in daytime ( $p < .00$ ; 99% CI). This may be because academics choose to work late hours. The female users feel more unsafe than the male users ( $p < .05$ ; 95% CI). The lowest score on both the staff and student surveys was recorded for the item regarding the availability of shady places. The students are more adversely affected by the lack of shady places than the staff (Figure 6). The female users feel more unsatisfied than the male users in finding opportunities to make friends ( $p < .05$ ; 95% CI) (Table 4). With regard to privacy, the staff is more satisfied than the students with being able to find places to be alone when needed ( $p < .00$ ; 99% CI). This is because they have private offices.



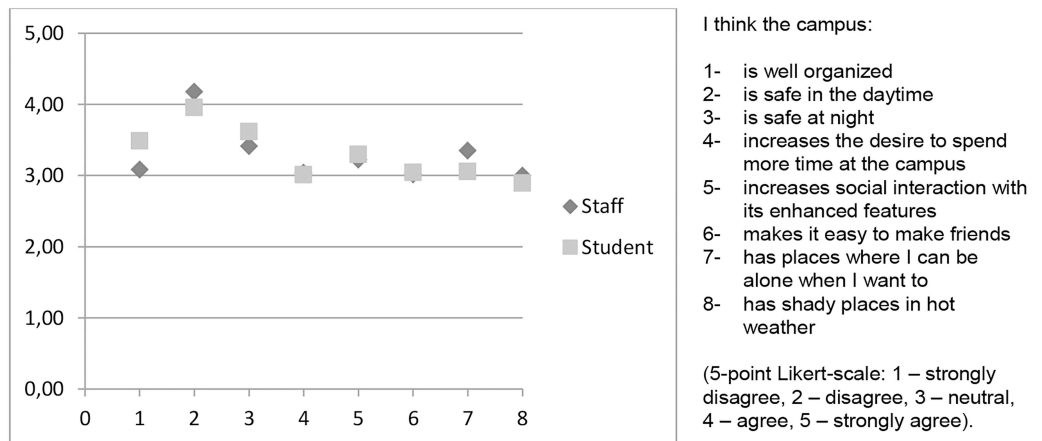
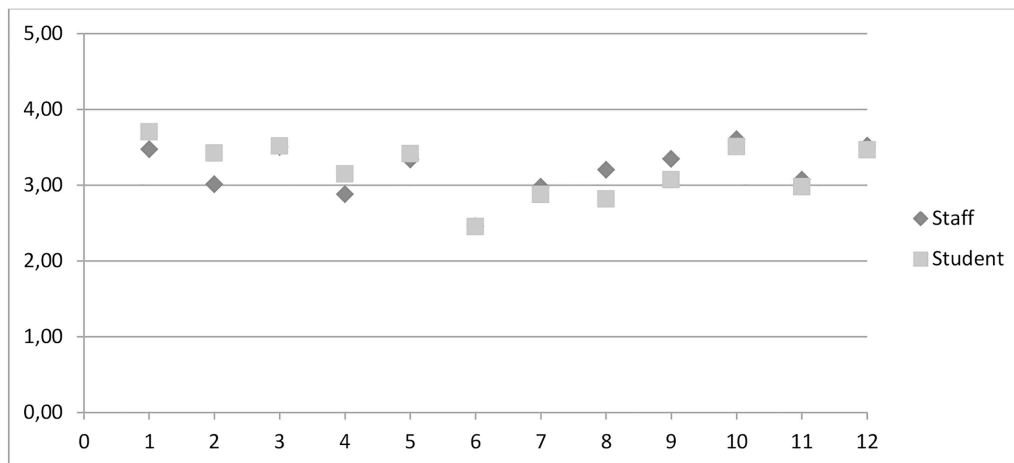


Figure 6: Results of the student and staff surveys -- plotted points denote mean values – (Source: Authors).

Table 4: T-test results for the questionnaire items by user profile and gender (Source: Authors).

I think campus		N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed) / (p)
is well-organized	staff	321	3.08	1.034	.058	.000
	student	1024	3.48	.939	.029	.000
is safe in the daytime	staff	321	4.17	.822	.046	.000
	student	1020	3.95	.980	.031	.000
is safe at night	staff	306	3.41	1.008	.058	.006
	student	1019	3.61	1.166	.037	.003
	female	705	3.49	1.128	.042	.006
	male	570	3.66	1.133	.047	.006
makes it easy to make friends	female	712	2.98	1.036	.039	.037
	male	578	3.11	1.087	.045	.037
has places where I can be alone when I want to	staff	318	3.35	1.054	.059	.000
	student	1026	3.05	1.222	.038	.000

The users were asked to evaluate the sufficiency of the items on campus that are assumed to affect their use of space. The mean values of the responses to the items on the survey ranged between 2.40 and 3.70 (Figure 7). The availability of water elements, such as fountains and pools, was considered the most insufficient (2.40) item by both the staff and students. While both staff and students are quite satisfied with the sufficiency of outdoor sports fields, the students are particularly dissatisfied with the availability of outdoor catering services on campus since the staff generally prefers to use the school cafeteria ( $p < .00$ , 99% CI) (Table 5).



- 1- Hygiene & Cleaning
- 2- Placement and proficiency of information signs
- 3- Landscape design
- 4- Grown trees
- 5- Green areas
- 6- Water elements, such as fountains, pools, etc.
- 7- Sculptures and other outdoor art works
- 8- Outdoor catering (eating/drinking) services
- 9- Gathering areas (picnic areas, amphitheater, etc.)
- 10- Outdoor sports fields (basketball, photo tennis, etc.)
- 11- Benches and other seating elements
- 12- Outdoor lighting design and fixtures

(5-point Likert-scale: 1 – strongly insufficient, 2 – insufficient, 3 – neutral, 4 – sufficient, 5 – strongly sufficient)

Figure 7. Results of the student and staff surveys -- plotted points denote mean values – (Source: Authors).

Table 5: T-test results for the survey items by user profile (Source: Authors).

Items	User profile	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed) / (p)
Hygiene & Cleaning	staff	316	3.47	1.061	.060	.000
	student	1007	3.70	.879	.028	.001
Information signs placement and proficiency	staff	314	3.01	1.089	.061	.000
	student	1010	3.42	.970	.031	.000
Grown trees	staff	319	2.88	1.108	.062	.000
	student	1018	3.15	1.125	.035	.000
Outdoor catering (eating/drinking) services	staff	318	3.20	1.025	.057	.000
	student	1017	2.81	1.177	.037	.000
Gathering areas (picnic areas, amphitheater etc.)	staff	315	3.35	.916	.052	.000
	student	1007	3.07	1.069	.034	.000



Gathering spaces, such as picnic areas, amphitheatres and forums, play an essential role in congregating users, which in turn, enables them to make new friends and socialize. Since these spaces are more important for students, their results were significantly lower than those of the staff ( $p < .05$ ; 95% CI). Although the students were more dissatisfied with the availability of shady areas than the staff (Figure 6), they consider the mature trees on campus to be more sufficient. This may be because students consider shady semi-open built areas with eating and drinking facilities more important than mature trees. There were no statistically significant differences between the male and female users.

### The results of the analysis for each sub-area

#### Descriptive Evaluation of sub-areas

Figures 8-13 show the sub-areas' physical, syntactic and behavioral characteristics.

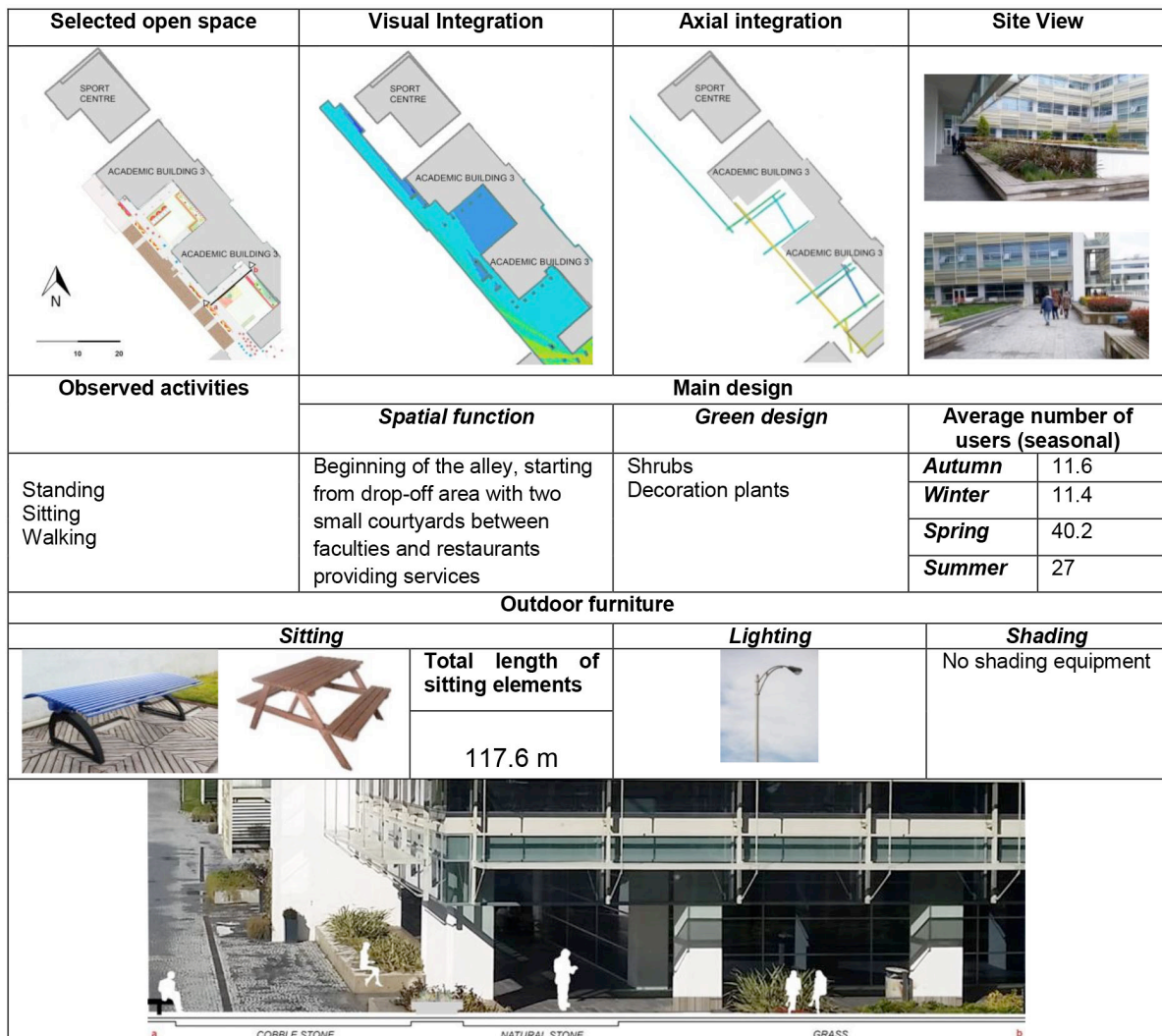


Figure 8: Guide to sub-area 1 (Source: Authors).



Comments on sub-area 1 (Figure 8):

- This pedestrian axis, which includes two mini-quads (courtyards), is supported by a café that provides users a catering facility and limited seating.
- Although this sub-area is designed as mainly a walkway, users often choose to walk or sit under the arcade because it provides shade.
- This sub-area has low visual integration (5.803) due to its isolated location on campus.
- The activities observed were mostly walking during shuttle hours with limited standing and sitting for short durations. Passive activity intensity is quite low in the mini-quads, which lack seating and shading elements (Figure 9).
- Although this sub-area is rich in terms of vegetation, such as shrubs and perennials, it lacks trees and large plants.
- There are 171 (per 0.6 m) concrete benches along the walkway and around the mini-quads as well as four wooden benches (1.65 m) and six iron benches (1.40 m) benches.
- This sub-area, which is mostly used as a circulation space, has the highest intensity of use in spring (Figure 5). Walking and other activities appear to occur inside the buildings in autumn and winter (AB3).

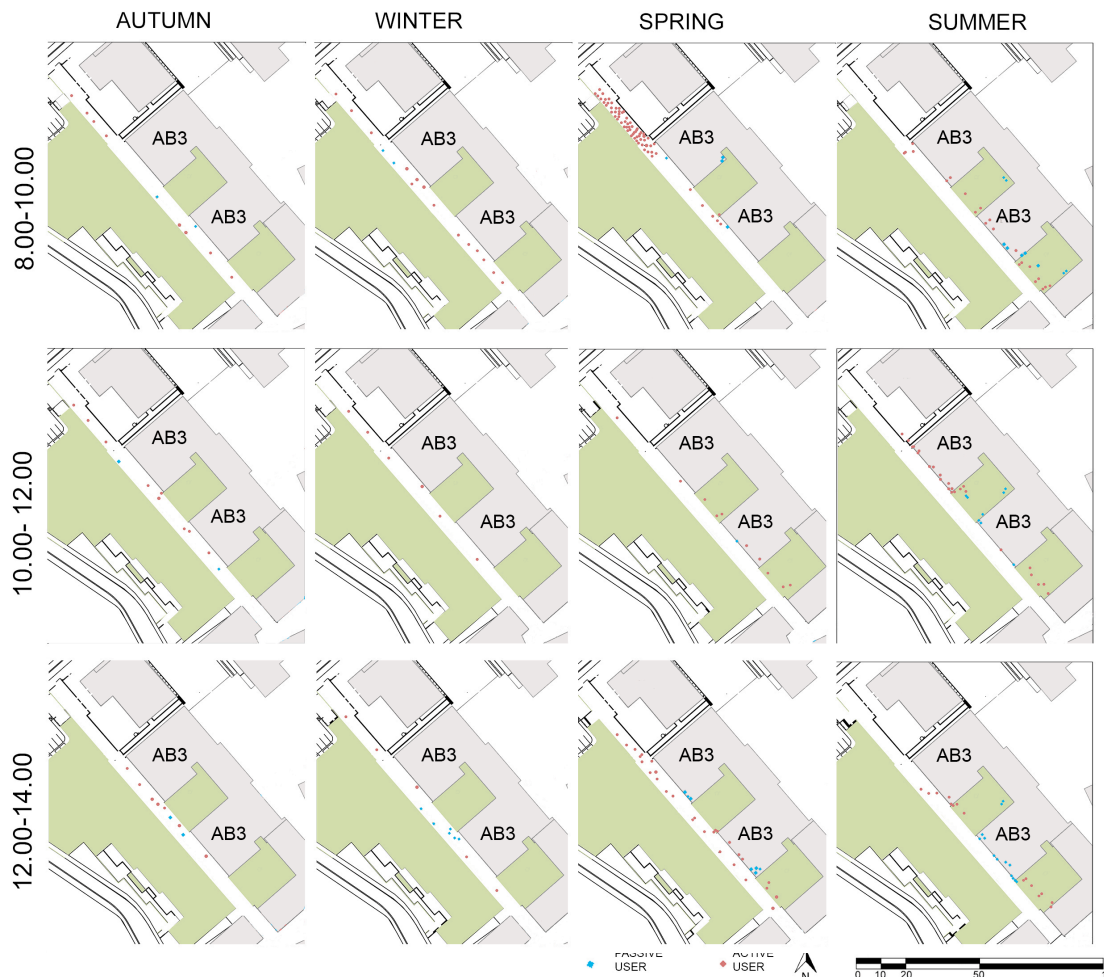


Figure 9: Seasonal behavioural mapping in sub-area 1 (Source: Authors).



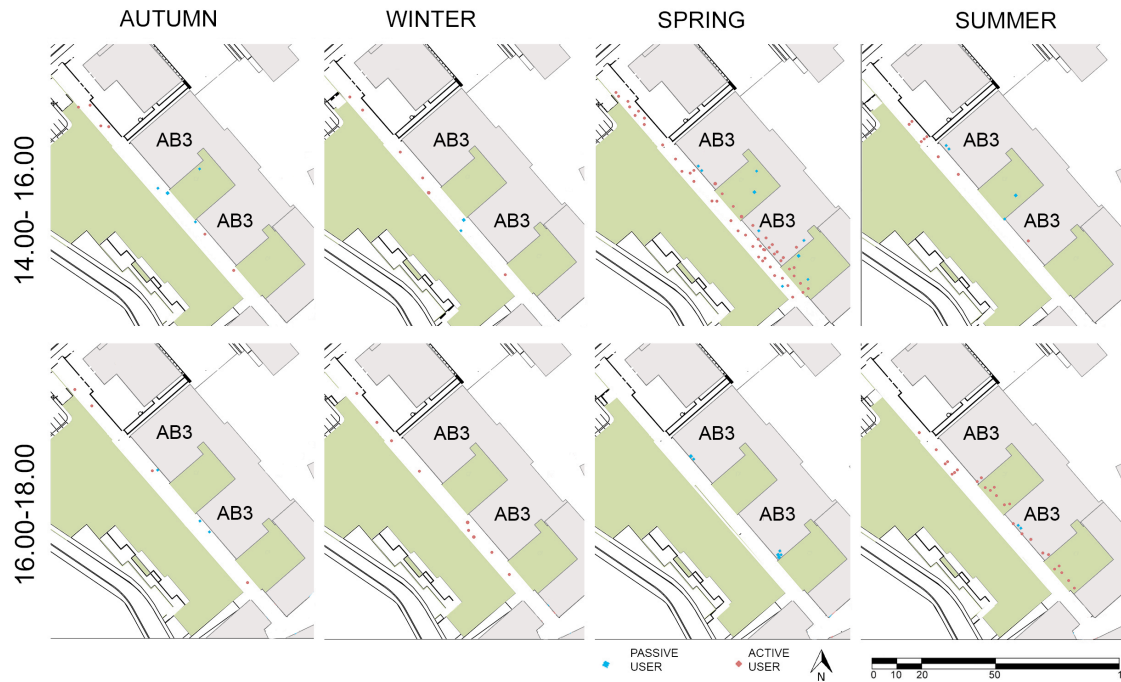


Figure 9: contd. Seasonal behavioural mapping in sub-area 1 (Source: Authors).

#### Comments on sub-area 2 (Figure 10):

- This area is enclosed by buildings and catering amenities (a café and a restaurant), which provide opportunities to spend time.
- Although the intensity of passive activity is quite high, users mostly occupy the corners of the buildings and the arcades, while the few benches in the central part are less used (Figure 12). This may be related to the lack of shading elements since the existing trees do not provide any shade. In addition, the catering facilities, which attract long-term passive activity, are located on the ground floors of buildings. Walking occurs mostly in the central parts of this area.
- In terms of spatial configuration, this area has moderate visual and axial integration values (8.981 and 0.684, respectively).
- Although there is no green space, this area has a limited number of trees (6) planted in concrete pots.
- Its seating elements are concrete and metal backless benches (35.4m). Lighting is also provided throughout the area.
- In the morning hours, pedestrians crossing the area were observed most, while passive group activities occur later in the day. User numbers increase towards the end of work hours since this area is used as a circulation space to access the shuttle point.

#### Comments on sub-area 3 (Figure 11):

- This area includes the landscaped terraces of the student center and the stairs that connect the educational section of the campus and the dormitories. It also includes the main walkway that connects the main quad with rest of the campus (Figure 3).
- The main walkway is used mostly for walking, while the stairs are used mostly for a limited number of passive activities of shorter duration, such as standing and sitting on terraces with views of the surrounding landscape (Figure 12).



- The lack of catering facilities and other amenities for pedestrians (seating and shading elements, and recreational facilities) is a major reason why this area fails to attract long-term passive activities.
- During summer, the users mostly prefer to smoke and chat standing in the shaded areas provided by the eaves of the buildings (Figure 12).
- During the day, the intensity of use (mostly walking) is highest at lunchtime (12:00-14:00) since this area connects the buildings with the cafeteria.
- This area is the most visually integrated area on campus (9.841) and acts as a node on the intersection of three routes, joining AB3, the main quad and the dormitories.
- This area is rich in vegetation with various types of trees and shrubs providing good aesthetics, but limited shading.
- This area has concrete benches with wooden decking on both sides of the walkway (87.4 m) and square concrete benches with wooden decking (14.4 m) on the terraces.

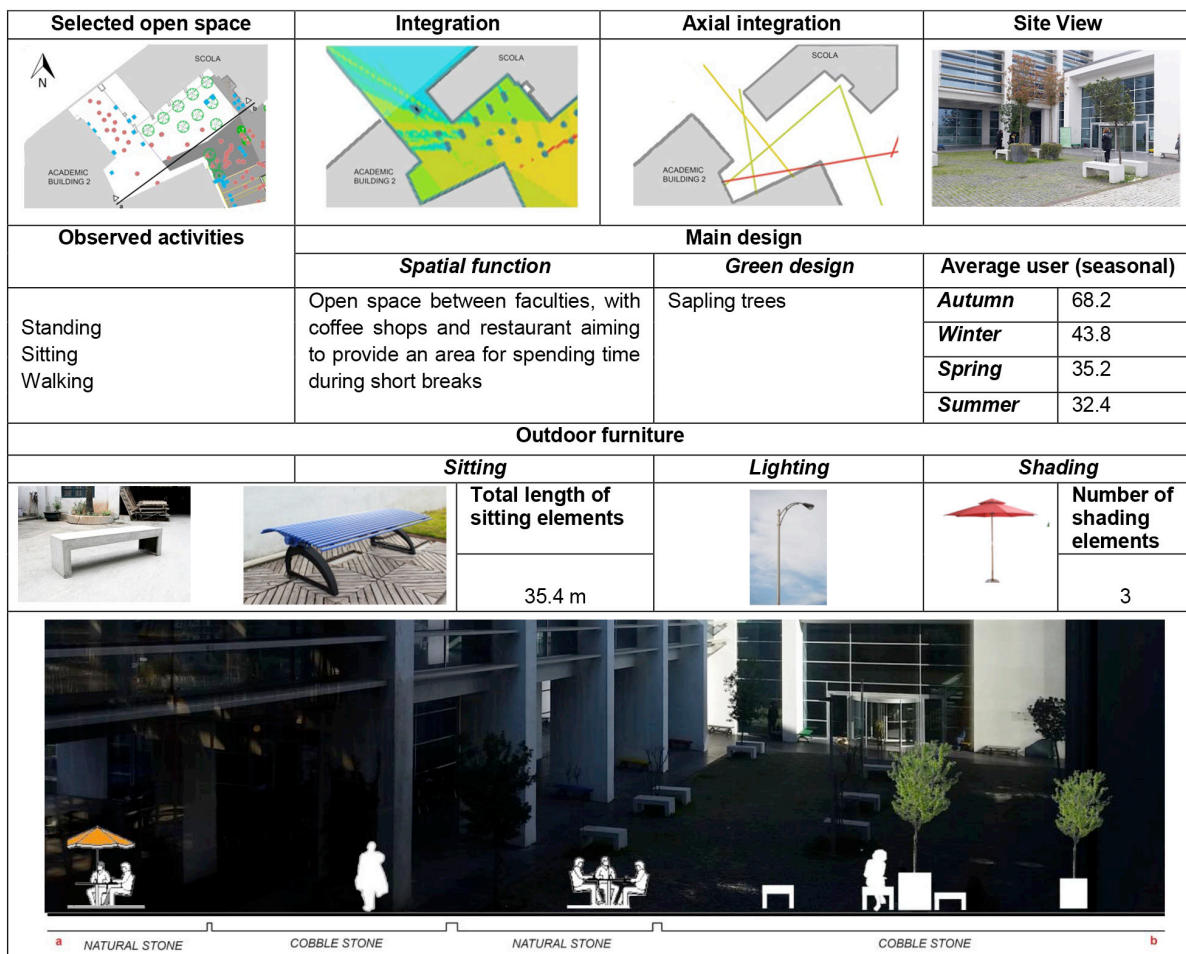


Figure 10: Guide to sub-area 2 (Source: Authors).



Figure 11: Guide to sub-area 3 (Source: Authors).





Figure 12: Seasonal behavioral mapping in sub-areas 2 and 3 (Source: Authors).

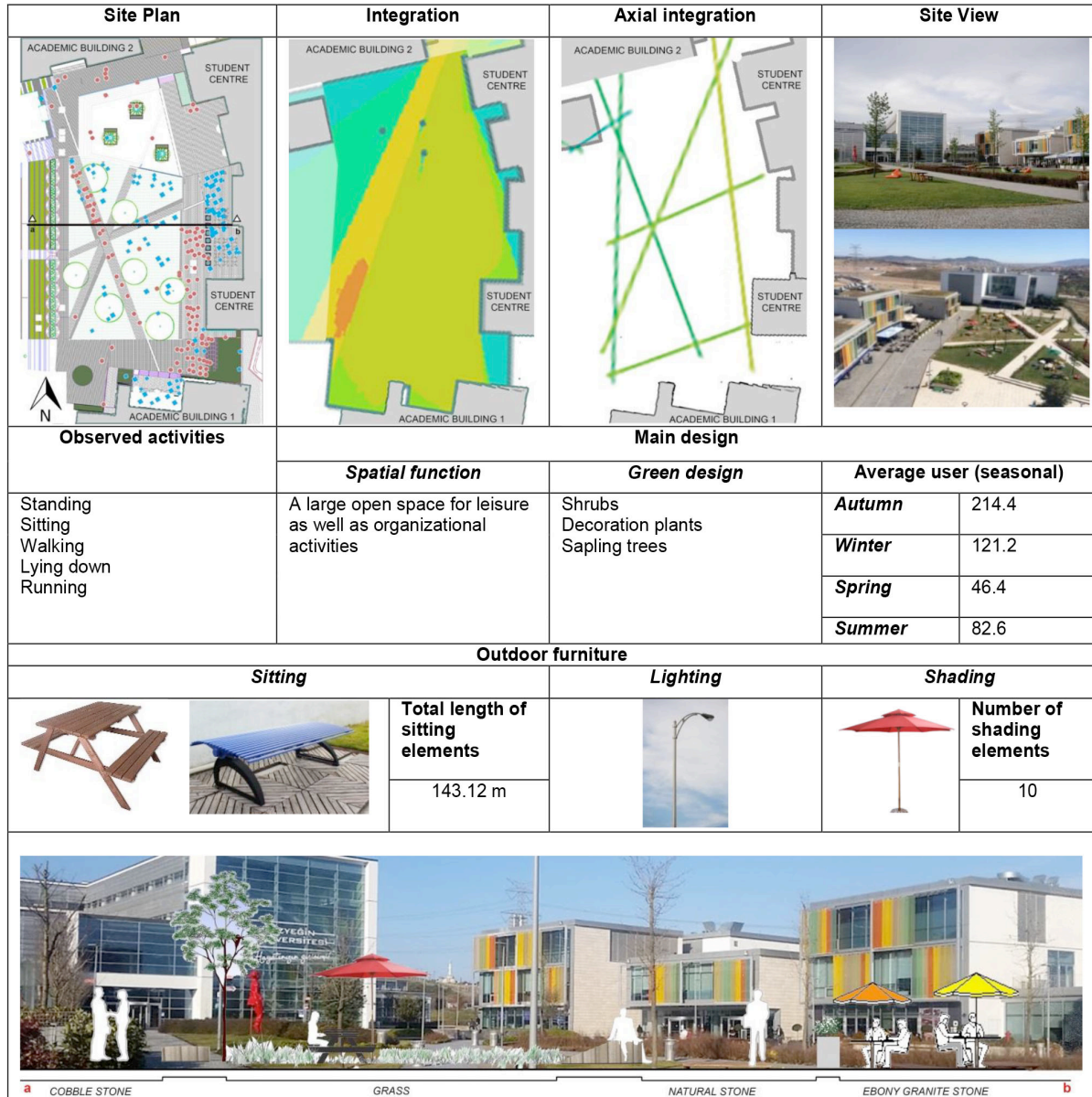


Figure 13: Guide to sub-area 4 (Source: Authors).

Comment on sub-area 4 (Figure 13):

- This is the largest outdoor area on the campus. It is located in front of the student center, AB1 and AB2. Due to the relatively higher number of amenities for pedestrians and services provided, it is the most intensely used outdoor space. This area is designed to accommodate a variety of types of activities, from academic to recreational.







Figure 14: Seasonal behavioural mapping in sub-area 4 (Source: Authors).



- Passive activities mainly occur beside the student center, which houses a café on the main ground opening onto the outdoor space and the main courtyard. This space has a few benches (81.2 m) and 10 shading elements. Thus, users generally do not prefer the courtyard for long-term passive activities. Unlike the rest of the outdoor spaces, lying down and running occur in the courtyard since it has ample grass. On the other hand, active users were observed along the pathways in the courtyard as well as on the paved walkway connecting AB1 with other areas on campus.
- During autumn and winter, high user numbers were observed in the sheltered areas under canopies and umbrellas around the café, whereas during summer and spring the number of users increases in the main courtyard (Figure 14). However, since the benches in the courtyard are fixed in place, the shading elements fail to provide them with appropriate shading throughout the day.
- This main recreational outdoor space is under-used in the early morning while both active and passive activity rates increase during lunchtime. In the afternoon, while fewer standing and sitting activities occur in the courtyard, more walking occurs on the walkway.
- Although this sub-area has the highest occupancy rate, its average visual integration value (8.951) is less than that of sub-areas 2 and 3.
- Despite the fact that trees and shrubs make it a pleasant environment, the plants fail to provide shade due their sizes and types.
- There are 53 benches (81.2 m) on the main courtyard as well as 114 metal chairs (61.92 m) in the café front by the student center, all of which are covered with umbrellas.
- In the evening, the area is well-lit.

### Quantitative evaluation of the sub-areas

The results of behavioral mapping and syntactic analysis of sub-areas indicate that the users of the OzU campus fail to capitalize on the potential offered by the spatial configuration of outdoor spaces. The main reasons are that these areas were not strategically designed as public spaces and that they are not supported by appropriate pedestrian amenities, such as seating and shading elements, and catering facilities. For example, sub-area 3, which is the most integrated space on campus, is mainly used as a circulation space and accommodates the lowest rates of long-term passive activities (Table 10).

Table 6: A comparison of the sub-areas in terms of average syntactic and behavioral values (Source: Authors).

	Average Syntactic Values		Average Seasonal Values	
	avg. Visual Integration	avg. Axial Integration	avg. Active users	avg. Passive users
CAMPUS	7.962	0.731	193.35	110.75
Sub-area 1	5.803	0.684	16.1	7.8
Sub-area 2	8.981	0.839	21.75	19.35
Sub-area 3	9.841	0.916	47.35	7
Sub-area 4	8.951	0.731	67.8	48.35

The insufficient number of seating and shading elements coupled with the lack of service amenities (café booths, services for social activities) fail to encourage users to spend time in



this area. On the other hand, the highest rates of passive activities were observed in sub-area 4, which has medium values of visual and axial integration. The existence of relatively higher number of amenities for pedestrians in this area, such as shaded seating elements and the main café, makes this space preferable for long-term passive activity. This finding conforms with the results of an earlier study on campus design in Jordan, which concluded that users chose to occupy outdoor areas furnished with benches and shading elements (Abu-Ghazze, 1999). Thus, it can be argued that the effects of spatial organization on user behavior cannot be considered independently from the amenities for pedestrians that support occupancy. Both spatial configuration and user-oriented amenities work mutually to encourage or discourage occupancy of outdoor spaces on a suburban campus. It can be concluded that there exists a lack of synergy between the patterns of occupancy and patterns of spatial configuration of outdoor spaces on the OzU campus. This finding is congruent with the results of another study of a suburban campus in Turkey (Yaylalı-Yıldız et al., 2014).

Another significant finding is the shortcoming of the design of campus in terms of the relationship between the buildings and outdoor spaces. Most of the building entrances are designed to open onto spaces with low and medium integration values rather than onto integrated areas. Similarly, instead of opening onto the main square with a high visibility level, the main entrance of SCoLA is attached to a secondary space with relatively lower visibility. The spaces adjacent to these entrances are preferred for short-term stationary conversations and gatherings, implying that users prefer outdoor spaces with relatively lower visibility and accessibility for unplanned activities. This supports the findings indicating that users avoid relatively open areas and opt for relatively private spaces for spontaneous passive activities (Campos, 1999; Campos and Golka, 2005).

Although the student and staff surveys indicate that users have moderately positive feelings about the campus outdoor spaces, there are some statistically significant differences when the users are categorized by profile (staff or student) and gender. User profile is a significant factor that determines the use of spaces and their requirements. The statistically significant differences shown in Tables 4 and 5 support this claim and indicate the reliability of the study. The deficiency of shady areas is indicated both by the surveys and by behavioral mapping. The requirement of new gathering areas and catering services linked with these areas, which enable socialization, is a clear result of some over-crowded areas in the campus. These findings conform with the results of an earlier study on the occupancy of an outdoor space on a university campus in Turkey, which suggests that areas offering a variety of activities are associated with higher user satisfaction and user preference (Ozkan et al., 2017).

## CONCLUSION

Suburban university campuses, which accommodate spaces for education (classrooms, studios, offices, laboratories and libraries) and for transportation, housing, recreation and catering, are planned as self-sufficient urban settings. Thus, it is of the utmost importance that they be designed strategically to enable outdoor spaces to perform efficiently. As Zengel and Kaya (2011) indicated, the quality of education and students' occupancy are directly related to satisfaction with spatial design.

This study intended to identify the patterns of occupancy of outdoor spaces on a suburban university campus and their causes through the systematic use of two quantitative tools,



behavioral mapping and space syntax analysis, with the support of user surveys. This comprehensive methodology attempted to overcome some of the shortcomings of the relevant studies by conducting a longitudinal study (behavioral mapping during a year, as opposed to a few days) and by objectively analyzing the associations of user behavior with the physical attributes and configurational properties of the campus layout. The findings show that the effects of spatial organization on user behavior cannot be considered independently from the amenities for pedestrians that support occupancy, particularly long-term passive activities, since configurational and physical qualities have interrelated influences on user choices.

The findings of this study are not just theoretical. They also have practical implications. They demonstrate the significance of designing the outdoor spaces of suburban university campuses, which serve as the main social and cultural arenas for their users, in a way that satisfies user needs. The analyses of OzU campus indicate that the architects' consideration of the main courtyard in front of the student center as the only public open area for long-term passive activities is a weakness of the design because this area will fail to satisfy the needs of users in the future, when the university's population is bound to grow considerably. The results outlined here can guide both architects and landscape planners in the design of prospective suburban university campuses. For example, locating the service facilities, which are related with the outdoor spaces, in areas with higher configurational potential of bringing students, academics and administrative staff together will support the creation of a lively campus by shaping user behavior. Moreover, designing sufficient number of amenities for pedestrians (seating and shading elements, and recreational facilities) in outdoor spaces with high visibility and accessibility levels will encourage increased rates and types of activities. This, in turn, will create a sustainable and healthy environment by supporting both unplanned and planned activities. It is essential to provide a collective life in the outdoor spaces of a suburban campus since it is already disconnected from the city's urban areas and social features. From a design point of view, it is critical to plan integrated outdoor spaces together with the buildings on the entire campus and support these areas with user-oriented features that encourage long-term occupancy.

## RECOMMENDATIONS, LIMITATIONS, FUTURE WORK

In the design and planning of university campuses, it is essential that outdoor spaces should not be treated as leftover areas. Careful consideration needs to be given to the overall spatial configuration of the buildings and the outdoor spaces they define, the location of building entrances and the details of outdoor spaces. During campus planning, as in any other site planning, it is critical to conduct a participatory process by including prospective users in the decision-making process from the start. Similarly, it is important to do some sort of evaluation—evaluating occupancy patterns and investigating their causes—once the design is implemented so that changes or additions to an existing campus can be planned strategically. A recent study has documented the significance of both aspects (participatory design and occupancy evaluation) in the design of an outdoor space on a university campus (Ozkan et al., 2017).

This study's scope is limited because it was conducted on a suburban university campus, which is isolated from its surroundings, and the integration levels of outdoor spaces in the overall urban fabric was not measured. In addition, behavioral mapping was conducted only for one day during each season. Future studies can conduct observations on a higher number of days to strengthen the reliability of their data. The user surveys could also be



expanded to include questions about users' specific reasons for preferring certain outdoor spaces. More research concerning the factors that affect the patterns of use of outdoor spaces in a variety of campus designs (both urban and suburban) with a larger number of participants is needed before definitive design and planning guidelines for the development of university campuses can be offered to urban designers, landscape designers and planners.

## ACKNOWLEDGEMENT

The presented work has been carried out with research project 1115Y225 "Post-occupancy evaluation of outdoor spaces in campus buildings with spatio-temporal mapping method" funded by TUBITAK (The Scientific and Technical Research Council of Turkey).

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