International Journal of Sustainable Development and Planning
Vol. 19, No. 7, July, 2024, pp. 2479-2487
Journal homepage: http://iieta.org/journals/ijsdp

Employing 360° Video Panorama Technology to Determine the Impact of Details on the Collective Memory of the Urban Scene

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https://doi.org/10.18280/ijsdp.190705

Received: 6 May 2024
Revised:4 June 2024
Accepted: 10 June 2024
Available online: 30 July 2024

Keywords:
urban scene, mental image, 360-degree video techniques, architectural elements, architectural identity,university of Mosul

ABSTRACT

The urban scene on the campus is formed by a diverse array of elements. Organizing these elements and understanding their relationships contribute to creating an urban structure that meets individuals' needs. This study aims to present a practical methodology for identifying and revealing influential architectural details, focusing on the case of Mosul University. An interactive virtual environment was tested through a 360-degree video presentation of the case study, employing the Gazerecorder computer program with a group of students and professors from Mosul University, thus conducting in-depth interviews to identify the multiple architectural elements that contribute to shaping the architectural identity of the campus. These elements include built features such as details in facades, floors, and ceilings, as well as non-built elements such as furniture, activities, and green spaces. These elements interact with various characteristics and relationships that contribute to creating a comprehensive image of the urban environment, with variations in impact and influence depending on the architectural context and geographical location of each element.

1. INTRODUCTION

The concept of urban scenery emerged in the early twentieth century. During the Middle Ages, the church was considered the visual and dominant focal point, while the Renaissance introduced classical forms and artistic concepts, including wall paintings, sculptures, fountains, squares, and greenery, as essential parts of shaping the urban scene. In the modern era, new materials (such as glass, iron, and concrete) were embraced, with sequential vision playing a significant role in shaping the urban scene in the post-modern era. Attention was given to all aspects like size, texture, and materials. The changing image of the city is evident in contemporary architecture, where information technology has played a significant role in shaping and enhancing its aesthetics, uniqueness, and breaking the monotony and repetitiveness in similar forms [1]. The urban scene organically forms during development processes or grows unintentionally, resulting in the city's unique nature varying from place to place [2]. Several attributes influence individuals' perceptions of a place, which can be categorized into three categories. The first includes emotional qualities such as clarity, human scale, safety, vitality, and cleanliness. The second category encompasses detailed morphological elements like street furniture, signs, blocks, vegetation cover, road patterns, edges, barriers, architectural quality, and containment. The third category includes dominant elements in the urban environment, meaning predominant buildings in terms of function, height, scale, historical buildings, and preservation areas [3]. The buildings on the university campus have undergone various and cumulative construction periods, resulting in a diversity and variation of architectural elements, details, and building materials. Previously, they relied on traditional building and finishing materials such as stone and plaster, while newer buildings have been influenced by modern building materials and details, relying on glass and steel columns in their facades. The research aims to present a practical methodology for identifying and uncovering influential architectural details. A purposive sample of 30 individuals, including architecture professors and students, was interviewed and tested. The pathway was presented using a 360-degree video presentation, selected using Depthmap software. Expert opinions emphasized the pathway's importance as the focal point of the university campus. Each person was then interviewed for half an hour and asked to mention distinctive architectural elements, whether positive or negative. Finally, a test was conducted using Gazerecorder software to track focus points to ensure accurate results.

2. THE URBAN SCENE AND THE MENTAL IMAGE

The urban scene represents the overall image perceived by people of the fundamental components of the city, including its buildings, spaces, experiences, smells, and memories, which are imprinted in their minds and affect individuals to varying degrees according to their inclinations [4]. The urban scene is considered a product of the interaction between social activities and ideological concepts, as well as economic, material, artistic, and other variable factors [5]. The clarity of

the urban scene is related to variable factors such as the observer's distance, lighting conditions, and weather conditions [6]. Organizing the urban scene relies on organizing all parts and elements, not limited to architectural elements alone but extending to the relationships between elements and blocks to achieve a harmonious urban scene [7]. The acoustic scene also influences the urban scene, as natural sounds such as the sound of water movement improve the quality of life, the user experience, and comfort [8]. Additionally, the visual scene consists of natural landscapes that depend on lighting sources or changes in light and shadow [9]. Lynch [10] defined clarity as the range that facilitates people in forming mental images of the city. The mental image represents the idea that individuals have about the surrounding environment and the resulting behaviors, whether negative or positive. It is defined as "a set of knowledge, ideas, and beliefs that individuals form in the past, present, and future, retaining their most important characteristics and prominent features to evoke them when needed." It helps them navigate it. People must be able to recognize urban elements and organize them into a cohesive pattern when moving in the urban environment. According to Lynch [10], the mental image consists of five basic and pivotal elements, which are paths, districts, landmarks, nodes, and edges.

3. 360° VIDEO TECHNOLOGY

360-degree video technology has become a form of immersive experience, especially with VR headsets, where head movement allows users to choose the direction and field of view. 360-degree videos can be captured during static or slow walking movements [11]. The use of 360-degree video technology ensures that participants are exposed to the same weather, visual, and auditory conditions, providing similar results to the real world with a larger participant sample [12]. Through this technology, information and data can be presented to all individuals, enabling them to find information, build a comprehensive image of the city, and view the world from a 360-degree angle [13]. Real environments composed of places and things fade over time, meaning that people do not rely on their personal memory to retain those environments. Instead, virtual reality technologies allow the reconstruction of those real environments in virtual settings, enabling individuals to preserve memories and emotions associated with those places and things collectively [14].

4. PREVIOUS LITERATURE

Studies have diverged between a group of studies focusing on urban scenes and those specializing in mental images. Studies on urban scenes addressed the elements that constitute them and the impact of characteristics and features on distinguishing these elements. Abbasi and Pourjafar [15] addressed the interconnected elements of the urban scene, such as buildings, vegetation cover, and signs, in achieving artistic display. The research aimed to identify suitable and effective criteria for designing pedestrian pathways, focusing on basic elements such as edge, line, surface, volume, shape, texture, color, and lighting. On the other hand, Lazim and Said [16] clarified that the urban scene is part of the city, giving it a distinct character, identity, and sense of place. They used photographic analysis to understand and identify changes in the physical elements of the urban environment, such as historical elements, building styles, urban furniture, and people's activities between the past and present. Any physical changes in these elements affect urban morphology. Phetsuriya and Heath [17] adopted the local perception of the street scene, emphasizing that physical elements unify the urban environment and give it a sense of identity. These elements include seating areas, urban furniture decoration, artistic elements, electrical wires, signs, visual pollution, green spaces, open urban spaces, and bike paths. Tahalea et al. [18] elucidated that analyzing the morphology of the urban area based on its elements helps in its improvement, increasing tourism activities, and uncovering and emphasizing its visual appeal. They stated that the urban scene is formed through four elements, including sequential vision, place, content, and functional tradition, and based on these elements, the cityscape focuses on identity and meaning [1]. Fairuza and Ekomadyo [1] mentioned that the shape of the city depends on the relationship of blocks with spaces, and the urban environment is understood through the urban scene from a human perspective as they sequentially navigate it. They identified three aspects that make the urban scene emotional: sequential vision, place, and content. Details such as color, texture, scale, style, uniqueness, and personality add pleasure to the place [19]. Elabd [19] addressed architectural chaos in the urban environment, resulting from the juxtaposition of different architectural patterns, the use of dazzling colors and lights, disparities in shape and proportion, and a and a lack of safety and cleanliness. The research analyzed facade elements consisting of openings, windows, doors, and decorations with symbolic and religious beliefs and aesthetic and functional functions [2]. Setiawan and Pangarso [2] stated that the urban scene is a visual impression of organizing blocks, streets, and spaces to form urban areas. The culture of the place can be expressed through the constituent elements of space, such as roads, buildings, road signs, and ground patterns [20]. Additionally, Park and Garcia [20] emphasized the importance of understanding pedestrians' perceptions and psychological and emotional actions toward public places to create safe living areas. The quality of the urban environment was evaluated based on measures of urban form quality, including imageability, human scale, transparency, complexity, and cleanliness. Sites containing pedestrian pathways, stop signs, lighting, and activity density aid in walking. Social concepts should be generalized in street design through diversified uses, increased sidewalk widening, added slopes, and increased nighttime lighting [21].

The following studies relied on the image of the city. Latypova et al. [21] attempted to understand how individuals perceive the city's image. They used the methodology of mind mapping for the study area and conducted in-depth interviews and surveys via social media. The study concluded that the city's image consists of environmental symbols, distinctive urban elements, iconic buildings, signs, and urban spaces [22]. Homolja et al. [22] conducted experimental studies to measure subjective and objective data to understand the spatial characteristics' impact on residents' emotions. The study utilized virtual reality technology and body and brain sensors. The research revealed that three factors affect emotions: visual complexity, size, and light [23]. Metelkova et al. [23] focused on the impact of the architectural shapes of urban space buildings on individual psychological comfort. Color preferences depend on the individual's psychological state, and building aggressiveness is revealed through color evaluation.

Decorative frames of windows, balconies, arches, columns on building facades, and decorative motifs add a special expression to the buildings. Green spaces also play an important role in giving color to the city [24]. Su et al. [24] mentioned that the mental image is the image of the place in a person's mind, embodying feelings, sensations, and opinions expressed in visual and textual ways. This study explores a method for classifying types of images and reaching a comprehensive image of the city. Urban images can be integrated with tourism to create an interactive urban system [25]. Studies have emphasized the importance of paying attention to the urban landscape in city design and planning. These studies have examined various fabric types (modern, traditional, and campus), leading to diversity in the elements and methods used. They have analyzed the urban landscape in terms of its elements and the relationships between them, highlighting the significance of certain elements in designing an urban environment preferred by residents. These studies have also explored the impact of these elements in terms of climatic, economic, and social considerations, as well as how the formal characteristics of elements influence the urban landscape. Some studies have relied on larger sample sizes through digital surveys, diversifying ages and nationalities, yielding diverse results. Conversely, some studies have failed due to their limited sample size and failure to incorporate the perceptions of local residents towards their urban landscape and its impact on their emotions. Previous studies have not covered all the details of the urban landscape, focusing instead on specific details and characteristics. However, this study focuses on all detailed elements of the urban landscape, including urban facades, urban roofs, urban floors, urban furniture, and vegetation cover, and how all these elements' characteristics impact their distinction and revelation.

5. ELEMENT OF URBAN SCENERY

The components of urban scenery can be divided into built elements, including urban facades, ground surfaces, and roofs, and non-built elements, which encompass urban furniture and activities within urban spaces.

5.1 Built elements

Built elements include urban facades, which play a crucial role in urban scenery, serving as a link between the interior and exterior spaces [25]. Urban facades consist of various components such as columns, blocks, balconies, awnings, signage, a canopy above entrances, doors, windows, stairs, and elevators [26]. Urban roofs, on the other hand, comprise various formations, including canopies, which are essential means of enhancing the urban environment and integrating aesthetically with other elements in urban spaces [27]. Walkways and gateways are erected over streets and pathways at the entrances of parks and buildings, as well as pergolas, which are used to provide shaded areas in gardens and at pathway intersections. Climbing plants can be planted to cover pergolas, providing privacy within them [28]. Flooring elements encompass roads, which serve as the means of access from one place to another, facilitating the movement of people and goods for specific purposes [29]. They include various types depending on their usage nature, such as streets, which are vital in defining the character of cities and stimulating social activities [30]. Pathways are essential elements in the urban environment, requiring attention to shading, furnishing, and providing security and comfort [31]. Sidewalks, located alongside roads, use comfortable building materials for pedestrian movement, with the addition of seating and plants to enhance their attractiveness. Stairs, ramps, and escalators are used to connect roads, pathways, and parks with different levels [28].

5.2 Non-built elements

Urban furniture comprises all elements that facilitate the lives of residents and make the urban environment useful and functional. They are located in different places according to their nature of usage and include lighting fixtures, telephone booths, mailboxes, fences, transportation stations, garbage bins, benches, bike lanes, park boundaries, and other distinctive features [32]. Urban furniture elements are used to make the street more attractive aesthetically and include fountains, barriers, sculptures, and artworks [33]. Meanwhile, activities in urban spaces rely on open areas and activities within urban spaces and are divided into three categories: social, optional, and necessary activities [34]. For effective design and management of public spaces, it is essential to understand the role these places play in people's lives. There are five types of activities: relaxation, recreation, indirect participation, direct participation, and exploration [35].

5.3 Common characteristics and components of urban scenery

Urban scenery elements possess numerous features and characteristics that distinguish them, including color, which enhances urban quality, comfort, and identity for residents [36]. Texture is another characteristic through which we explore the urban environment, as changes in building materials result in diverse textures that help us explore the city [37]. Vegetative cover also plays a crucial role, positively and significantly related to perceptions of diversity, cohesion, and beauty [38]. The openness of the street represents the distance that setbacks from building boundaries extend backward to shape suitable urban spaces. Additionally, the size of buildings, meaning the dimensions of their form (length, width, and height), and spatial containment, represented by the ratio of building height to street edge distances between buildings, are significant. Material finish and its distinction and nature are essential due to their abundance and diversity [39]. Decoration is considered a part of the architecture of all people and a reflection of their identity, placed in various locations and forms such as facades, entrances, and interior spaces [40]. Writing on walls is called urban graffiti, which is a method of conveying a message to everyone in a spontaneous manner that does not affect the engineering of the place [41]. Relationships like repetition, symmetry, containment, rhythm, continuity, diversity, contrast, and harmony are important in shaping urban scenery [42]. Visual pollution in urban environments has a negative impact on users, particularly when dark colors and deteriorating materials are used [43]. The use of heterogeneous buildings, increased size of external advertisements, and neglect of consistent decorative style have also contributed to this effect [44]. Additionally, poorly planned environments with disorderly and dense structures lacking green elements, as well as neglected buildings with disproportionate numbers of floors and poorly planned transportation systems, create visual

pollution. Columns, electrical wires, and air conditioners attached to the exterior walls of buildings also contribute to visual pollution [45]. There are numerous elements considered destructive and disfiguring to the urban landscape, giving a negative impression, such as wandering vendors (temporary visual elements that may appear from time to time and disappear) [46]. See Table 1.

Table 1. Elements affecting the formation of the mental image

Elements Affecting the Formation of the Mental Image			Common Elements, Properties, and Relationships
Structural elements	Urban facades	walls, openings include windows, doors and other openings, prominent elements include columns, curtains, frames, and cornices, signs and banners on facades, balconies, canopies, and a shed above the entrance	color, texture, vegetation, degree of openness of the street, space containment, decoration, measure, technical elements, finishing materials,
	Urban roofs	sunshade, gallery, pergola	repetition, symmetry, rhythm,
	Floor elements	streets, pathways, sidewalks, stairs, slop, and escalators	continuity, diversity, variance,
Non-structural element	Urban furniture	fountains, lighting installations, seating, public restrooms, garbage containers, pergolas, sculptures, booths, signboards, flower beds, taps	singularity, form simplicity, continuity, clarity of joins, directional differentiation, visual scope, motion awareness,
	Activities in urban space	comfort, relaxation, passive engagement, active engagement, discovery	time series, names and meanings, harmony

6. METHODOLOGY

The methodology employed in this study involves the utilization of 360-degree video technology and interviews to assess the impact of architectural elements and details on forming and enhancing the mental image of the urban landscape in Mosul City. Influential elements were identified based on presenting the route to 30 individuals, comprising professors and students from the Faculty of Engineering, Architecture Department. Professors contribute practical experiences and specialized insights, while students offer fresh perspectives, facilitating answering research questions, guiding the study in the right direction, and accessing students and professors to collect data easily. The sample represents the study population, making the results applicable at a general level and more susceptible to generalization and transformation into measurable responses. Larger sample tests could be conducted due to the available time; however, a sample size of 30 individuals was determined. The route was filmed using a 360-degree video captured with a Ricoh camera, mounted on a head-level stand, and recorded through steady, slow walking. Six videos of the route were obtained, each lasting five minutes. Subsequently, the videos were processed using the Ricoh Theta camera's software, and then adjustments were made using the VSDC Free Video Editor. The videos were presented using the projector available in the Architecture Department, and participants were asked to identify the most influential elements positively or negatively and describe their key features to determine and understand their impact on shaping the urban landscape of the university campus. Afterward, in-depth interviews were conducted with each individual for half an hour, and the results were tested using Gazerecorder eye-tracking software, which determines focus locations using each participant's webcam to ensure the elements selected by the participants and obtain accurate results. Figure 1 illustrates the type of camera used and the testing procedure.

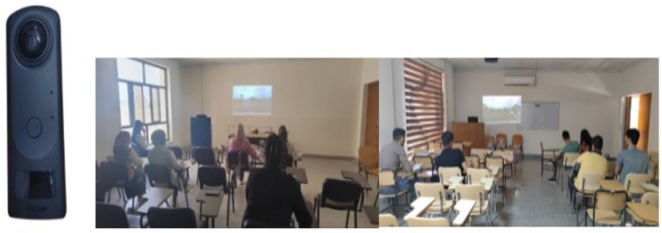

Figure 1. Relies on a Ricoh camera and conducting the test

7. CASE STUDY: UNIVERSITY OF MOSUL

The University of Mosul was chosen as a case study, consisting of a collection of buildings and spaces designed cumulatively rather than all at once. The Depthmap software was used to access several pathways, which is one of the most important programs that work to reveal the accessibility and connectivity in the urban fabric [47] among the most important within the campus. Expert responses were also utilized, affirming the significance of these pathways. The selected pathway runs between the Dentistry Gate (A) and the Science Gate (B). Along this pathway, various buildings serve different functions, including educational, administrative, and recreational purposes. Due to the diversity of these functions, the detailed elements in the urban landscape varied, as illustrated in Figure 2.

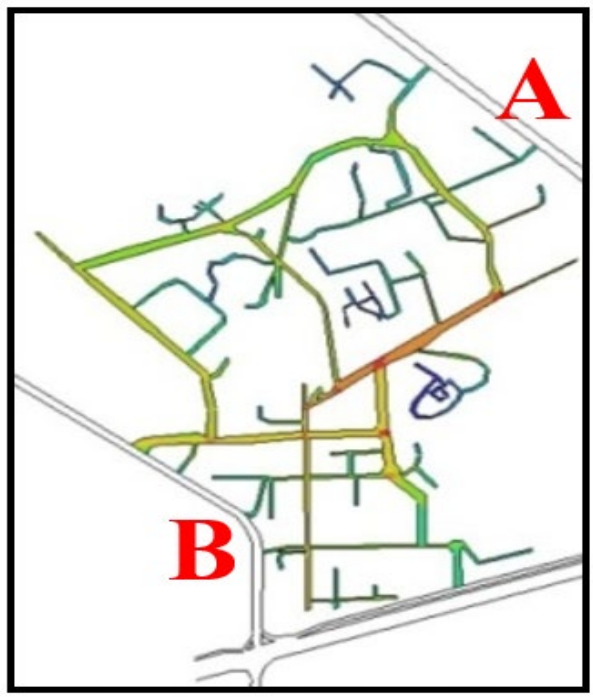

Figure 2. The main pathways of the University of Mosul

8. RESULTS AND DISCUSSION

Previous studies have relied on specific elements and characteristics in shaping the urban landscape, while the current study presents all influential elements and their characteristics in shaping the urban landscape of the university campus. The 360-degree video technology provides a semi-immersive virtual environment where all details can be perceived in moving and multiple images, unlike ordinary images that do not capture all details. It is a powerful and effective tool for urban memory research and documenting environments and spaces. It offers an interactive and comprehensive experience with scenes, allowing exploration of the urban environment and viewing from all directions. The 360-degree video technology documents urban environments comprehensively and accurately, aiding in preserving changes occurring in urban structures and understanding the impact of elements and their characteristics on individuals.

After completing the pathway presentation, the study results were collected in specific tables, statistically analyzed, and ratios extracted using Excel. The analysis revealed that 77% of the participants interviewed indicated elements of the Assyrian Library, such as openings, crenellations, sloping walls, and the gate. This interest can be attributed to the distinctive details of the Assyrian Library and its differences from the design of neighboring buildings, as well as its strip openings, repetition of elements, and comparison to castles. Similar results were obtained in the Gazerecorder program. Figure 3 illustrates the elements of the Assyrian Library.

It was found that 15% of the participants were able to distinguish the elements of the Central Library, primarily due to its deviation from the chosen path in addition to its black color, which participants described as not harmonizing with the building. Figure 4 illustrates the Central Library building.

38% of the participants reported elements of the Faculty of Arts building, including the columns on the façade, the arch in the center, and the elevator. These elements stand out due to finishing materials that differ from the overall context, as well as the blue color and glass cladding. The results obtained showed similarity with the Gazerecorder program. Figure 5 illustrates the Faculty of Arts building.

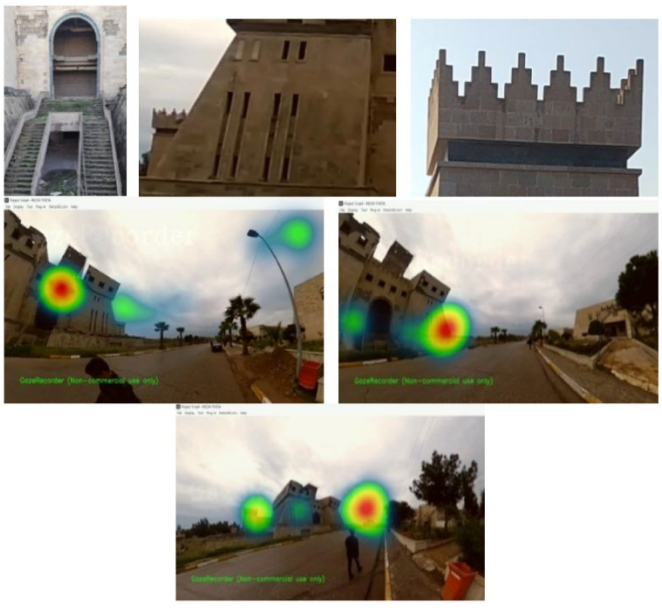

Figure 3. Elements of the Assyrian Library

Figure 4. The Central Library building

92% of the participants mentioned elements of openings and drawings of the kindergarten building. These elements are characterized by attractive colors and wall art that reflects the function of the building. Participants noted that color is the most distinguishing feature in this regard. The results obtained showed similarity with the Gazerecorder program. Figure 6 illustrates the elements of the kindergarten building.

77% of the participants mentioned the arch element of the facade of the Department of Quranic Sciences and Islamic Education building, describing it as not harmonizing with the other elements on the façade. Additionally, inappropriate finishing materials were used. The results obtained showed similarity with the Gazerecorder program. Figure 7 illustrates the elements of the Department of Quranic Sciences and Islamic Education building.

Figure 5. Faculty of Arts building

Figure 6. Elements of the kindergarten building

Figure 7. Elements of the Department of Quranic Sciences and Islamic Education building

38% of the participants mentioned the terraces in front of the Pharmacy College building, attributing them to their monumental scale, distinctive design, visibility from distant places, and construction materials. Additionally, 7% mentioned the terraces of the Faculty of Humanities, which are characterized by their size, height, and visibility from distant places. Figure 8 illustrates the terraces.

62% of the participants mentioned the elements of the dividing wall between the University of Mosul and the Technical Institute due to the size and shape of the elements, their repetition along the wall, and the inappropriate materials used. Similar results were obtained through the Gazerecorder program. Figure 9 illustrates the elements of the wall.

According to the data, 76% of individuals prefer a row of palm trees along the path as they add beauty and spirituality to the place, provide shade, help in reducing the feeling of time passing, and aid in defining the path's direction. On the other hand, some individuals noted that these palm trees might obstruct visibility, hinder visual communication, and lead to boredom and monotony. Additionally, 62% of the participants pointed out the significance of the three palm trees near the Civil Engineering building as a prominent landmark due to their uniqueness and location at the end of the axis. Meanwhile, 15% mentioned the single palm tree near the Student Center due to its singularity and angular inclination, and 7% referred to the two palm trees defining the entrance of the Mosul Heritage Center building. The results showed variation in the Gazerecorder program, where plant elements appeared that were not mentioned during the interviews by the participants. Figure 10 illustrates the plant elements.

Figure 8. The terraces

Figure 9. Elements of the wall

Figure 10. Plant elements

Figure 11. University campus gardens

While 23% of participants highlighted the landscaping and design of the dental college gardens and their gathering and seating areas, which aid in social interaction, 38% pointed out elements of the arts college gardens, seating areas, and entrance arches, which serve as gathering spots that encourage social interaction. Some participants noted the lack of shelters and the need for more attention. Meanwhile, 46% of participants mentioned interaction areas in the student center

gardens, which are considered the most popular gathering spots for students due to their central location on campus and proximity to public buildings frequented by students. Figure 11 illustrates the university campus gardens.

85% of participants mentioned the arts college courtyard due to its location, visually appealing scenery, diverse plant life, and arrangement. However, some participants noted that it requires more attention. Figure 12 illustrates the arts college courtyard.

69% of respondents mentioned the open-air theater in the arts college gardens due to its location and distinctive white color contrasting with the surroundings. It is considered a place for social interaction and student gatherings. The results obtained were consistent with those from the Gazerecorder program. Figure 13 illustrates the open-air theater.

62% of respondents pointed out the elements of the fountains along the pathway opposite the arts college due to their location, design, and the sound of water, which gives the impression of a natural environment. Figure 14 illustrates the fountains.

85% of participants mentioned the dome of the student center due to its large size, vibrant colors, and its location within the most heavily used building by students, distinct from its context. The results obtained were consistent with those from the Gazerecorder program. Figure 15 illustrates the dome of the student center.

Figure 12. Arts college courtyard

Figure 13. Open-air theater

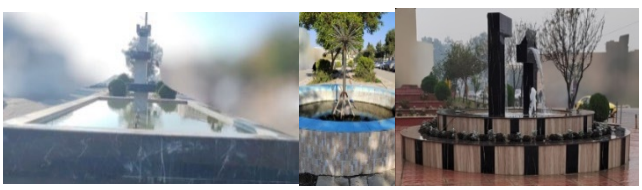

Figure 14. Fountains

Figure 15. Student center dome

Figure 16. Elements of the kiosk group

Figure 17. Flooring elements

Figure 18. Student center facade

As mentioned, 38% of individuals noted the kiosks belonging to the telecommunication company near the student center, as well as the kiosk adjacent to the kindergarten building. The telecommunication kiosks are characterized by eye-catching colors that can be seen from a distance, while the distinguishing feature of the kiosk adjacent to the kindergarten is its age, distinctive design, and location along the most heavily trafficked pathway by students. Figure 16 illustrates the elements of the kiosk group.

Regarding the design of the outdoor flooring near the student center gardens, it was mentioned by 54% of individuals, which has recently been changed. Figure 17 illustrates the elements of the flooring.

While 23% of individuals mentioned the drawings on the facade of the student center, describing them as not fitting with the context and nature of the campus. The results obtained were consistent with those from the Gazerecorder program. Figure 18 illustrates the facade of the student center.

Although 360-degree video technology provides visual and auditory immersion, it doesn't encompass all senses, like smell and touch. Regardless of how it's captured, it fails to replicate a fully realistic environment and can cause fatigue when used for extended periods. Additionally, its widespread adoption and usage are hindered by the need for advanced equipment and techniques in filming. Editing and manipulating 360-degree video footage are complex tasks requiring specialized skills compared to traditional video editing. Furthermore, privacy issues may arise when capturing locations and individuals without their consent.

9. CONCLUSIONS

The urban scene consists of elements interconnected through relationships, distinguished by various characteristics such as color, size, texture, and ornamentation. These elements can be either structural or non-structural. Structural elements include details of facades, exterior floors, and urban roofs, while non-structural elements encompass urban furniture and

activities in urban spaces. This research achieved promising results regarding architectural details and their impact on the urban scene using 360-degree video technology, which was not previously utilized in studies on urban memory. The use of 360-degree video technology facilitated the involvement of a larger sample size and obtaining more precise results through the use of eye-tracking software like Gazerecorder, which highlighted elements not mentioned by participants during interviews. The research results are significant in enhancing the urban environment of the campus by emphasizing both structural and non-structural details and their impact, such as color, size, texture, materials, uniqueness, and continuity. Future research could utilize panoramic viewers and advanced computer programs in the eye-tracking process.

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