P-ISSN 2708-6453	Pakistan Languages and Humanities Review	Apr-June 2024, Vol. 8, No. 2
O-ISSN 2708-6461	https://doi.org/10.47205/plhr.2024(8-II)48	[555-563]

Pakistan Languages and Humanities Review
www.plhr.org.pk

RESEARCH PAPER

Development of Predictive Model for the Number of Public Park Visitors: A Case of Rawalpindi, Punjab Pakistan

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ABSTRACT

This study aims to determine the impact of spatial attributes on the number of users of public parks and to propose baseline data for future park locations. Public green areas are essential for promoting social interaction and physical activity within communities. Beyond their recreational benefits, these spaces are crucial for maintaining ecological balance, acting as vital green lungs in urban environments. This study utilized spatial indices from space syntax and the gate count method, triangulated with primary data. A regression analysis was conducted for spatial indices and the number of visitors. The results indicate a linear correlation between spatial integration and the number of visitors, $R^2 = 0.91$ and $p = 0.04$. This means, parks with higher integration values tend to attract more visitors and vice versa. The findings of this research may be adopted by planners and policymakers for the strategic location of future parks and optimal resource utilization.

KEYWORDS Accessibility, Integration, Public Parks, Spatial attributes, Sustainability

Introduction

Sustainable development has been analyzed from economic, environmental, and social perspectives. Various studies have highlighted the importance of these three aspects. Additionally, this research suggests ways to balance these aspects effectively. Numerous development and action procedures have been established for economic protection and environmental development. However, demonstrating the scope of social justice remains challenging. Compared to research on economic and environmental aspects, there has been no significant progress in research on social aspects (Pitarch-Garrido, 2018).

These characteristics include accessibility, strategic location, and opportunities on the site. In contemporary society, urbanization trends indicate that the majority of the global population resides in metropolitan areas (Eizenberg & Jabareen, 2017). This demographic shift underscores the importance of fostering social sustainability within these urban environments. The inherent diversity within city communities, encompassing a wide range of cultural, socioeconomic, and ethnic backgrounds, plays a crucial role in shaping the dynamics and overall relevance of social sustainability initiatives. These traits include accessibility, strategic placement, and on-site opportunities (Huang et al., 2020).

Urban public spaces shall be designed to attract a wide range of users, rather than being located in obscure corners where they are neither noticeable nor utilized. These spaces play a crucial role in social sustainability and user health, functioning like the lungs of the city by absorbing pollution and providing fresh air. Additionally, they help maintain

the balance of the water table and benefit the ecosystem. If these green areas are not placed in the right locations, they often become crime scenes rather than vibrant activity zones within the urban fabric (Din et al., 2023; Ceccato & Nalla, 2020).

City green parts are ideal places where people can enhance their physical activities (McCormack et al., 2010) and social interaction (Matsuoka & Kaplan, 2008). Such places have innumerable psychological and physical health advantages for people (Ullah et al., 2022; Bedimo-Rung et al., 2005). Currently, different parks attract different numbers of visitors due to their strategic location, integration into the environment, proximity, activities within the park, and security (Goma et al., 2024).

The green areas in cities are planned by the state to maintain a balance for better living conditions (Huang et al., 2020). Implementing various strategies to maintain public green spaces is essential for the social sustainability of urban areas. The layout of these green spaces within the urban environment is crucial for their usability. The goals of this study are to better understand the influence of park integration on the number of users and to provide baseline data and guidelines for future planning and placement of parks within the urban fabric.

Literature review

Several studies have examined street networks in urban regions from a global perspective (Ahmad et al., 2014). Additionally, research on planning urban facility types is being conducted to enhance social sustainability. Sustainable public spaces emphasize environmental awareness and appeal to individuals from all walks of life (Tumlin, 2011).

Paying close attention to spatial layout, accessibility, and the strategic placement of green areas is essential for creating public spaces that enhance the overall community experience. Urban public spaces that adhere to these principles can promote social sustainability and the well-being of both the city and its residents (Matsuoka & Kaplan, 2008). Inclusion in urban public areas is a vital component of social sustainability (Littke, 2016).

The spatial arrangement of urban public places influences how people perceive their surroundings (Goma et al., 2024). Varied parks frequently attract different numbers of visitors, which can be attributed to factors such as strategic location, integration with the surrounding environment, available activities, safety measures, and the general ambiance of the place (Goma et al., 2024). The positioning of public areas within the urban landscape is critical. Proximity to residential neighborhoods, public transportation, and commercial hubs enhances accessibility and usage. Planned city layouts promote effective connections between public spaces and the neighborhood (Adinolfi et al., 2014).

Integrating public spaces seamlessly with their surroundings and maintaining a welcoming atmosphere is crucial for increasing functionality and attractiveness. The design should complement the existing urban context and create an inviting environment that encourages people to visit and spend time there. Providing a variety of activities and implementing safety measures within the space can also enhance its attractiveness and usability. These elements foster community participation and social interaction (Adinolfi et al., 2014).

Studies have also found that a park's internal layout and accessibility influence its usefulness and attractiveness (Zhai & Baran, 2013). For example, the placement of seating areas, paths, and recreational facilities can affect how visitors explore and interact with the

park environment (Zhai & Baran, 2013). Space syntax tool explains how spatial arrangement and path connections influence park use and user experience (Huang et al., 2020). Green areas of cities are planned by the state to maintain a balance for good living. However, using diverse measures to preserve public green spaces is ideal for the social sustainability of cities.

Space Syntax approaches provide a comprehensive arsenal for examining spatial configurations and their effects on human activity (Ullah et al., 2023). Space Syntax, a series of methodologies (Tarabieh et al., 2019), makes it easier to represent and analyze spatial layouts in a variety of contexts (Ullah & Park, 2016). Axial map analysis, which entails constructing axial lines by intersecting lines to map circulation patterns within urban grids, with the goal of fully covering the grid and understanding spatial connections (Hillier et al., 1987).

Material and Methods

In this study, four parks of Rawalpindi were analyzed based on accessibility and strategic location. This study demonstrates how access affects the number of users. All of the parks were adequately maintained by Rawalpindi's Parks and Horticulture Authority. These parks were evaluated within a two-kilometer radius. To begin the procedure, data was collected using gate count, a popular method for determining number of visitors. To ensure accuracy, the data from gate count was cross-verified with data collected from Rawalpindi Parks and Horticulture Authority. Observations were made during peak hours (8 a.m. to 11 a.m., 6 p.m. to 9 p.m.) on weekdays and weekends from Mid-July to Mid-August of 2023. The spatial plan of each park and its immediate 2-kilometer radius was then meticulously drafted in AutoCAD. The final plans were then imported into Depth-MapX, for axial and line graph analysis. The values of integration, choice, connectivity, Nach, and controllability were determined for each park in the study along the urban fabric. Regression analysis was applied to the resultant spatial data sets for each park. This statistical approach revealed the underlying correlations, patterns, or changes in the data set, shedding light on the park's spatial integration and user dynamics. Finally, the results were summarized to draw conclusions on the urban significance and effectiveness of selected parks of Rawalpindi.

Results and Discussion

Liaquat Bagh was once known as Company Bagh, located at the junction of the Murree Road, the road to the main city center developed by the British to bypass the local area (near the Purana Qilla or present-day Raja bazar area) and headed towards Murree. The park is now named after Pakistan's first Prime Minister, Liaquat Ali Khan.

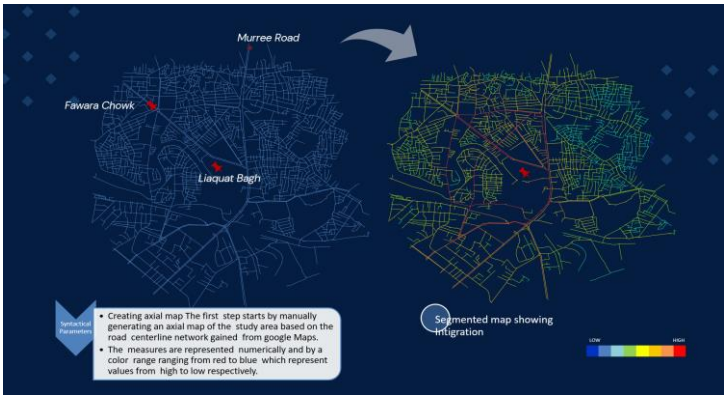

Figure 1 Liaquat Bagh's line plan & Segment map

Figure 1, Showing Liaquat Bagh's line plan & showing integration Auto-Cad was used to track the region around Liaquat Bagh, which is over 2 kilometers in radius. This region was then studied using depthmap. The left side of the above image depicts the basic plan, while the right side depicts the syntactic analysis. The plan has a maximum integration value of 0.660, a minimum value of 0.210, and an average value of 0.63 for the road entering the park. The Nach analysis is a normalized selection based on the average depth of each road segment, with a maximum of 1.574 and a minimum of 0 (value 1.32) for roads leading to the park. Controllability refers to the extent to which each place has the ability to move in reference to its immediate neighbors. The park above has a maximum adjustable value of one, a minimum of 0.01, and a value of 0.16 for the road that enters it.

Rawal Park is located on Rawal Road, near Chah Sultan / Sultan ka Khuu. The park is triangular in design and provides ample gated parking. This park was once known as Shahbaz Sharif Park before being renamed Rawal Park. The park is an open public green space that attracts many visitors from Chah Sultan and Kurri Road.

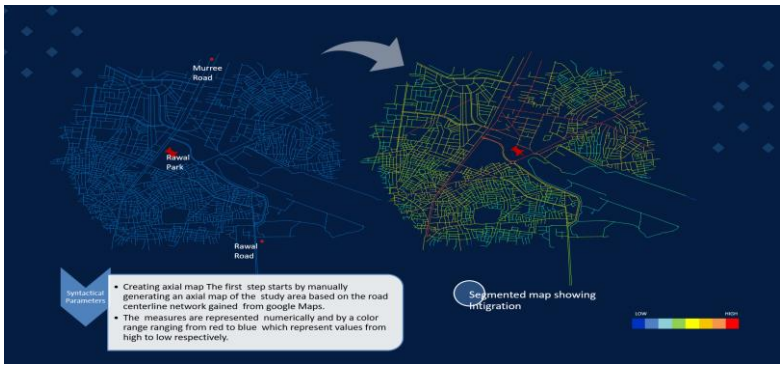

Figure 2 Rawal Park's line plan & Segment map

The left side of the Figure 2 depicts the basic plan, while the right side depicts the syntactic analysis of Rawal Park. The basic plan was initially changed to an axial plan. The highest integration value produced from this integrated map is 1.055, the lowest is 0.178, and the integration value of the road approaching the park is 0.766.

The Nach analysis shows a maximum value of 1.73 and a minimum value of 0, while the road entering the Rawal Park has a value of 1.51. A maximum controllability value of 1, a minimum of 0.076, and a value of 0.217 for the road that entering the Rawal park was observed.

Pothohar Park, located in the Dhok Munshi and Gharibaba areas, acts as a recreational and social gathering place for the area's low-income residents. The park is not located on the main road, but rather within a residential zone.

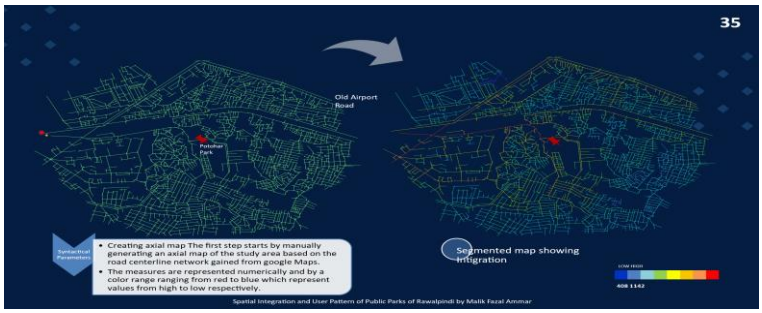

Figure 3 Pothohar Park's line plan & Segment map

A maximum integration value of 0.651 and a minimum of 0.307 was observed for Pothohar Park, while the road entering the park have an integration value of 0.586. A maximum of 1.560 and a minimum value of 0 Nach was observed, while the road entering the park has a value of 1.3559. The park above has a maximum controllability value of 1, a minimum of 0.04, and a value of 0.33 for the road that enters the park.

Allama Iqbal Park is located on Murree's Main Road. This is the only park accessible immediately from Murree Road. The park's strategic position places it immediately near to the Rawalpindi Arts Council, Rawalpindi Cricket Stadium, and Rawalpindi Food Street.

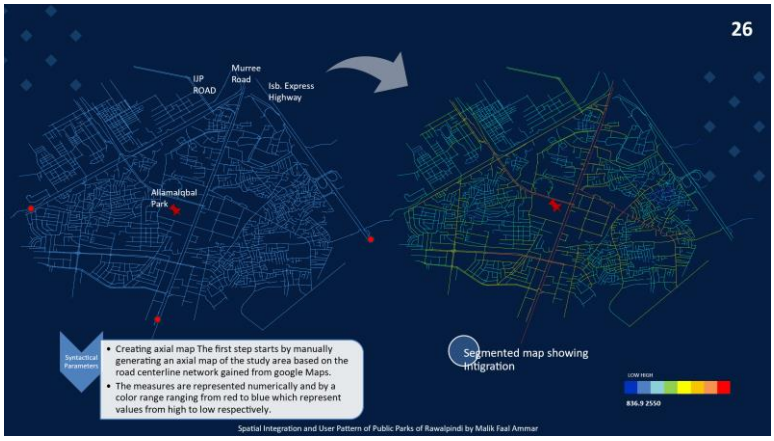

Figure 4 Allama Iqbal Park's Line plan & Segment map

A maximum integration value of 0.922, minimum 0.267, and the road that leads to the park has an integration value of 836.8 in the case of Allama Iqbal Park. A maximum connectivity value of 33 and a minimum of 0 was observed, while the road that leads to the park has a connectivity value of 26. The maximum Nach value of 1.560 and minimum of 0 was observed, while the road entering the park has a Nach value of 1.3559. The park above has a maximum controllability value of 1, a minimum of 0.04, and a value of 0.33 for the road that enters the Allama Iqbal Park.

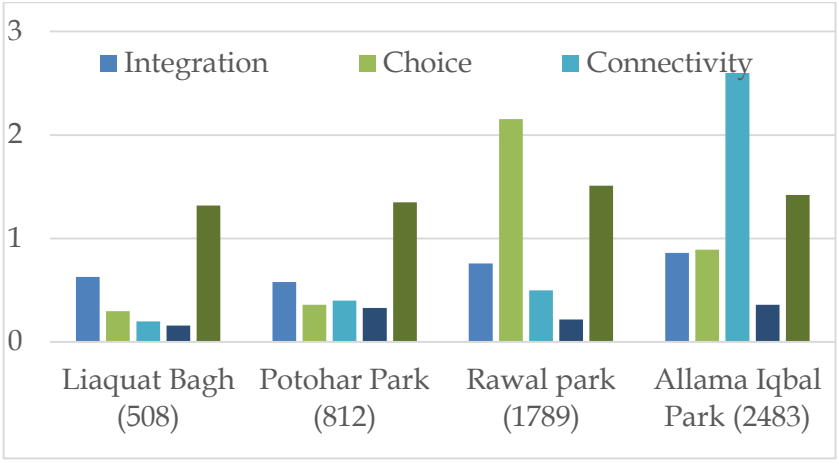

Figure 5 Integration, Choice, Connectivity, Controllability and R value of all four parks

Figure 5 shows a summary of all four parks are being compared on the basis of Integration, Choice, Connectivity, Controllability and Nach Analysis (R value). Data obtained from the above analysis was statistically analyzed and compared for correlation with the number of users. Figure 6 below shows the regression analysis with p value of

0.04 and R^2 of 0.91. Based on this correlation, the number of visitors of urban parks of Rawalpindi could be predicted using the formula below:

Y (Number of visitors) = 6785.5(integration value) – 3412.9

This model could predict the number of visitor/ users of urban parks, if the value of integration is above 0.

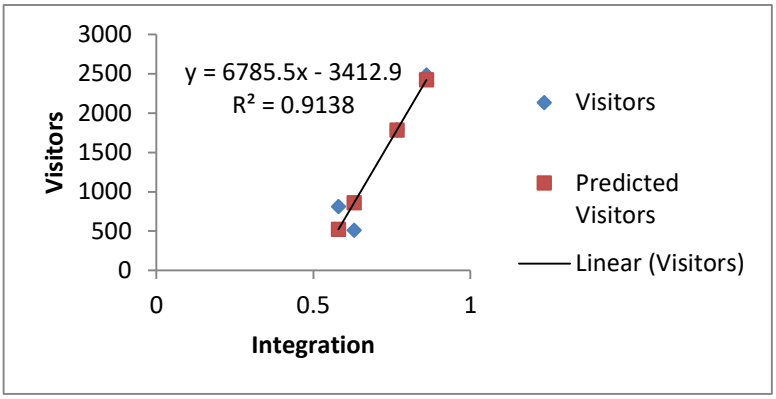

Figure 6 Integration line fit plot

The coefficient 6785.5 estimates the impact of the integration value on the number of visitors/users. A higher integration score is expected to correlate positively with more users. The constant (-3412.9) represents the regression line's intercept. It takes into account the baseline level of users when the integration value is 0 or negligible. This prediction method is a useful tool for evaluating the utilization of a spatial facility based on its integration values. Higher integration values indicate improved connectedness and accessibility, which are linked to enhanced number of user or activity in the investigated spatial environment.

Conclusion

The above analysis of four urban parks of Rawalpindi were analyzed through space syntax. The syntactic values of integration, connectivity, controllability and Nach were determined of all four. The data obtained from spatial analysis was correlated with the number of visitors through statistical analysis. A significant linear correlation was found between integration values and number of visitors through regression analysis, the statistical model emphasizes the significant link between park location (integration) and the number of visitors. Spatial analysis reveals that parks with better integration attract more visitors. These findings have substantial implications for urban planning and design, indicating that strategically locating parks within urban spatial structure may increase the use of parks in the community.

Recommendations

Based on the analysis of four urban parks in Rawalpindi, several recommendations can be made to enhance urban park usage through strategic planning and design. The analysis considered various spatial indices, including Integration, Choice, Connectivity, Controllability, and Nach Analysis (R value). The results indicate a strong correlation between integration values and the number of visitors, providing a valuable model for predicting park usage.

- It is recommended to Enhance Park Integration by locating new parks in areas with high integrated areas to maximize accessibility and usage.
- Improvements of connectivity between parks and surrounding neighborhoods through better pedestrian pathways, cycling routes, and public transportation links.
- Ensure that parks are designed to be accessible to people with mobility issues. This includes providing ramps, smooth pathways, and accessible entry points.
- The predictive model (Number of visitors)=6785.5(integration value)−3412.9 given that the integration value is greater than 0, to estimate potential park usage. This can help in planning and resource allocation.
- A Regular assessment of park usage data and adjustment of integration strategies as necessary to ensure optimal visitor numbers is recommended.
- Community participation and engagement to understand their needs and preferences can inform the design and features of the parks, making them more attractive and user-friendly.

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