

A GIS-Based Assessment of Attributes Affecting Publicness of Urban Open Spaces

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Abstract

Urbanisation is rapidly reducing open spaces, while the remaining urban open areas often need better qualities to transform them into inclusive public places. This study examines the effect of key factors such as accessibility, ownership, management, control, facility provision, and naturalness on publicness perception. Socio-political and physical attributes of the open spaces were recorded during field surveys and structured as geospatial data in GIS for geostatistical analysis. The findings reveal that accessibility and management significantly enhance publicness. On the other hand, natural features and government ownership negatively correlate with publicness due to the underutilisation of natural elements and strict access controls at government-owned open spaces. To address these gaps, this study recommends improving accessibility, adopting better management practices, reducing restrictions, and integrating natural features into open-space design. By combining empirical evaluations with GIS-based spatial analysis, this research presents actionable strategies to enhance the publicness of urban open spaces.

Keywords

Urban open space; GIS; Accessibility; Publicness; Natural landscape; Inclusiveness

1. Introduction

The concept of publicness considers the degree to which an open space is accessible, inclusive, and welcoming to all. Analysing publicness involves detailed site observation and questionnaire surveys (Karaçor, 2016). How a person perceives the publicness of any open space often is influenced by the appearance, usability, and overall ambience of that space, and these perceptions vary in different situations and among various persons (Broek, 2015). Urban open spaces, such as parks, streets, or other loose-fit spaces, serve as essential breathing spaces for the city population, providing venues for relaxation, social interaction, and cultural exchange (Thompson, 2002; Stanley et al., 2012). However, rapid urbanisation, particularly in developing countries, is shrinking these spaces at an alarming rate despite increasing demand. Encroachment and unplanned developments further reduce the practical volume of open spaces to be less than the physically existing open

spaces (Nilufar, 1999). In developing countries like Bangladesh, where the need for open spaces is critical, creating new spaces in core city areas often is challenging. Converting small green patches into public spaces and promoting multipurpose land use can serve as a viable solution. In this context, understanding the factors influencing publicness and how they shape people's perceptions is essential for enhancing the usability and inclusivity of existing open spaces.

There are four general qualities of having publicness: universal access, neutrality, inclusivity and representativeness of collective, and sociability. Publicness can be measured through five major dimensions - ownership, control, civility, physical configuration, and animation; ranging from "less public" to "more public" (Varna & Tiesdell, 2010). A highly public space encourages activities, sociability, and comfort, fostering healthy interaction between the space and the residents (Pan et al., 2022). Factors like accessibility, management, ownership pattern, available facilities, social and environmental benefits, and surrounding land use types influence the degree of publicness of the open spaces. Additionally, environmental conditions like climate, temperature, humidity level, and sound acoustics play a vital role in shaping user experience and perceptions (Yang & Kang, 2005; Yu & Kang, 2010; Cohen et al., 2012; Bandara et al., 2013).

1.1 Research Objectives

While urban open spaces increasingly are recognised as essential to urban well-being, limited empirical research exists on the interplay between their physical and administrative attributes and the public's perception of their publicness, particularly in developing countries like Bangladesh. Also, limited research has applied an integrative framework that combines these aspects with GIS-based geostatistical analysis to visualise and understand their spatial implications. This study aims to bridge this gap by exploring these factors in Sylhet City, Bangladesh. The primary objective of our study is to identify and quantify the relationship between the physical (e.g., accessibility, facilities) and administrative (e.g., ownership, management) attributes and public perception to better inform urban planning and design practices.

Specifically, this research seeks to:

- Examine the spatial and non-spatial attributes of selected urban open spaces, such as accessibility, facility provision, ownership, and management.
- Analyse how these attributes influence perceptions of publicness.
- Identify the attributes most strongly affecting publicness based on user experiences and geo-statistical analysis.

2. Literature Review

Urban open spaces are critical elements of city landscapes, providing recreational, environmental, and social benefits to urban populations. However, their publicness depends on several factors. Studies show that the concept of publicness in urban spaces is influenced by a combination of access and control (Dovey & Pafka, 2020). Control factors like different ownership patterns offer varying degrees of openness in a space, while management indicates how open spaces are maintained and regulated (Gawlak et al., 2021). Additionally, accessibility is not only a matter of physical proximity but also of design features that enhance both visual and physical accessibility. Research further suggests that the quality and availability of facilities and the naturalness of open spaces also impact publicness (Gómez-Baggethun et al., 2013; Manta et al., 2018). This

section explores the definition and typologies of urban open spaces, followed by an in-depth review of existing literature on the attributes affecting publicness, including ownership, management, accessibility, naturalness, and facilities, and examines how these factors influence the usability and inclusiveness of urban open spaces. It also examines the impact of land use diversity and entropy on the quality and utilisation of these spaces.

2.1 Urban Open Spaces

Urban open spaces can be defined as open spaces that are publicly accessible or later can be transformed into places available to the city population. These include parks, plazas, urban voids, green patches, and even unused industrial or housing spaces. Such spaces provide environmental, recreational, and economic benefits by reducing congestion, improving air quality, and enhancing social interactions (Thompson, 2002; Stanley et al., 2012;). However, the effective use of such spaces depends on their accessibility, management, gender-sensitive design, and functionality (Jim & Chen, 2003; Cohen & Meesters, 2012; Ponizy et al., 2017; La Rosa et al., 2018). While developed nations have extensive research and guidelines for the planning and management of public open spaces, studies in developing countries remain limited (Paul et al., 2020). In developing countries, poor planning, fragmentation, mismanagement, and lack of coordination among authorities often undermine the potential of these spaces (Broek, 2015; Khan, 2019). For instance, the megacity of Dhaka has been facing continuous destruction of open spaces since the 1960s (Begum, 2020), where many large and medium-scale open spaces are scattered but are not used to their full potential (Khan, 2014).

2.2 Typology of Open Spaces

Open spaces can be categorised into different typologies according to the following criteria: scale, ownership, naturalness, accessibility, and facility.

- Scale: Open spaces range from residential-scale spaces, closely tied to everyday life, to intermediate and city-scale spaces, which emphasise public accessibility.
- Ownership: Open spaces may be owned by governments, private entities, communities, or institutions. Ownership influences the degree of public access and control.
- Naturalness: Open spaces can be either natural (e.g., green spaces supporting ecosystems) or manmade (e.g., plazas facilitating human activities) (Stanley et al., 2012). Sustainable urban development requires a balance between these grey and green spaces.
- Accessibility and Active Use: Open spaces can be classified as active or unused, such as urban voids (Hall, 2010). Open spaces, as part of public spaces, include areas intended for interaction, contact, and proximity beyond home or work zones. The focus here is on fostering community interaction and public engagement rather than just public stewardship or ownership (Francis et al., 2012).
- Facilities and Functionality: The provision of facilities and functional use are other indicators of open space typology. Facilities like fencing, construction of sheds, walkways, sittings, roads, parking areas and security enhance the usability of these spaces (Wandl et al., 2017; Pokharel & Khanal, 2018).

2.3 Ownership Pattern

Ownership patterns of urban open spaces determine their accessibility and inclusiveness. Based on user accessibility, the ownership pattern of urban open spaces can be categorised as:

- i. **Public Spaces:** These spaces are owned and managed by government authorities. Except for ecological reserved areas, these spaces are designed for general or specific public use, such as parks or plazas that improve the overall city image (Peña-Salmón et al., 2014). They foster recreational, social, and political activities and contribute to urban well-being (Rahman & Zhang, 2018). They typically are perceived as more open, resulting in a higher degree of publicness.
- ii. **Private Spaces:** These spaces, owned by individuals or groups, include courtyards, gardens, and private vacant spaces. As access often is restricted, they generally possess lower publicness. These spaces can compensate for the absence of public spaces by offering localised benefits, such as recreation for children or fostering a connection to nature.

Another type of urban open space, termed **Informal Green Spaces**, refers to areas covered at least partly with non-remnant and spontaneous vegetation. Though, often overlooked, private and informal urban green spaces are crucial in maintaining urban biodiversity and providing ecosystem services in urban areas (Coolen & Meesters, 2012). The distinction between public and private spaces can blur, especially in green spaces with restricted access that provide aesthetic and ecological benefits to surrounding areas (Le Texier et al., 2018). Community-owned open spaces represent another hybrid type, where access is managed collectively through agreements or contracts, offering a controlled form of publicness (Chiodelli & Moroni, 2014). In high-density urban areas, land scarcity and economic pressures frequently threaten open spaces (Fatemi, 2014). Public-private partnerships can enhance the quality and sustainability of these spaces without fully privatising them, ensuring they remain accessible and functional while enhancing publicness (Stephenson et al., 1951).

2.4 Management and Control

The management and control of urban open spaces influence their accessibility, inclusiveness, and overall functionality. Management is the authority the urban open space holds and how that place is regulated and managed (Gawlak et al., 2021). Urban open spaces typically are managed by an institution, community welfare society, or government. Government-run open spaces usually are maintained by a group of personnel assigned to specific tasks.

Privatisation of open spaces involves transferring management rights from public developers to the private sector (Stephenson et al., 1951). In some cases, the space is neither privately managed nor government-run but instead managed by the community. In such instances, the community holds the authority to control access and regulate the inclusivity of the space, including factors such as entrance policies and accommodations for different ages, social classes, and genders (Jim & Chen, 2003). Control defines how spaces are utilised, often influenced by age, gender, or social distinctions. For instance, some events or areas may cater exclusively to specific age groups or genders, raising questions about inclusivity and equality (McDowell, 1983; Yang & Kang, 2005; Yu & Kang, 2010). Inclusive management practices can ensure urban open spaces remain universal and equitable, fostering publicness.

2.5 Accessibility

Accessibility is a spatial feature that refers to the ease of access to a particular place within a city. This type of physical attribute is particularly suited for GIS analysis, which allows for detailed spatial mapping and assessment of access patterns (La Rosa et al., 2018). Factors like distance, location, road condition and

distribution, population density, and attraction level can influence the accessibility of urban open spaces (Liang et al., 2016; Shi et al., 2020). For instance, high population density and long distances can reduce accessibility, while poor infrastructure, such as inadequate road conditions or lack of pedestrian paths, further limits access. Accessibility can be of two types: visually accessible and physically accessible. Visual accessibility is important for enhancing the city's image. Accessibility is crucial for encouraging the use of open spaces, particularly for different genders and age groups (Rahman & Zhang, 2018). Enhancing physical accessibility may involve adding pedestrian routes, bike lanes or connections to public transport, whereas visual accessibility can be enhanced by using low-height trees or fences instead of solid boundaries (Jim & Chen, 2003). This study examines how these parameters impact the publicness of urban open spaces.

2.6 Naturalness

Natural features such as trees, grass, and water bodies enhance the environmental quality and public perception of urban open spaces. Rapid urbanisation often replaces natural surfaces with asphalt and concrete, which increases the city temperature and produces urban heat island effects (Rakhshandehroo et al., 2017). Vegetation mitigates these effects by cooling urban open spaces, particularly during summer, by providing shade and reducing heat absorption (Cohen et al., 2012; Lehmann, 2023). For example, research indicates that an urban green park would be 1 °C cooler than spaces without vegetation (Bowler et al., 2010).

The benefit of urban greens is not limited to the on-site users; the neighbouring areas also receive environmental services (Gómez-Baggethun et al., 2013). These include clean air and reduced noise pollution. Trees absorb the toxic air and generate a cleaner air, providing a serene environment for the occupants by giving them mental peace. Vegetation cover also reduces the noise and creates a buffer (De Ridder et al., 2004). Additionally, green spaces facilitate rainwater infiltration, reduce surface runoff, and help mitigate urban flooding by supporting natural drainage systems. However, green spaces must be integrated thoughtfully to ensure they are actively used by the public rather than merely serving as aesthetic or ecological buffers. Well-designed green spaces not only enhance environmental sustainability but also promote inclusivity and engagement.

2.7 Facilities

The presence of essential facilities influences the usability and publicness of urban open spaces, fostering social interaction and cultural diversity (Manta et al., 2018). These spaces provide platforms for people from various racial, social, and religious backgrounds to connect and engage. Facilities such as shading, street furniture, walkways, food stalls, and restrooms enhance user comfort and encourage prolonged use of these spaces. Different age groups interact with these facilities in unique ways, often forming clusters within similar demographic groups (Yang & Kang, 2005; Yu & Kang, 2010). Moreover, specific features like proper lighting, railings, and seating areas are crucial for the comfort and safety of women, children, and the elderly. Open spaces that support sports and exercise activities contribute to physical and social well-being (Stanley et al., 2012). Providing adequate facilities ensures that urban open spaces remain inclusive and functional, catering to diverse user needs and promoting active engagement.

2.8 Land use Diversity

Land use diversity plays a critical role in shaping public perception of open spaces. It can contribute to the residents' life satisfaction and enhance greenness (Wu et al., 2022). Mixed-use developments that integrate

residential, commercial, and recreational spaces near urban open spaces enhance accessibility and usability, making these areas more appealing to the public. Diverse land uses promote social interaction and encourage non-motorised travel, such as walking or cycling, improving connections between people and open spaces (Bordoloi et al., 2013). Additionally, it enhances the perception of safety and convenience, as people are more likely to use open spaces when they are integrated into active, mixed-use environments. This mix of functions also ensures that open spaces are utilised throughout the day, preventing them from becoming isolated or underused. By supporting varied activities and offering a balance of amenities, land use diversity strengthens the public perception of open spaces as vibrant, accessible, and inclusive hubs of urban life. It also aligns with sustainable development goals by encouraging efficient land use and reducing dependence on motorised transportation.

2.9 Geo-Statistical Analysis

The geo-statistical analysis focuses on the spatial distribution of variables and their interactions with underlying attributes relevant to a specific issue. Ordinary Least Squares (OLS) is a statistical technique widely used in urban analysis to examine the relationship between a dependent variable and one or more independent variables, assuming these relationships remain consistent across the study area (Scott & Janikas, 2010). Traditional OLS generates a single equation representing these relationships, providing a global perspective. Whereas, when location-specific data are available, GIS-based OLS offers a more nuanced approach by incorporating spatial representation. This allows for visualising variable relationships across geographic locations, which is particularly valuable in urban studies where relationships may vary locally.

GIS-based OLS has proven effective in analysing urban phenomena, such as predicting perceived urban stress based on built environment properties like visibility and building density (Knöll et al., 2018). However, limited studies have investigated the impact of various attributes of open spaces on people's perception of publicness. Our study addresses this gap, leveraging GIS-based OLS to analyse how independent attributes such as ownership patterns, management, accessibility, facilities, and naturalness influence the publicness of urban open spaces.

3. Methodology

The research methodology consisted of several stages to analyse how various factors influence public perception of open spaces. First, a questionnaire survey was conducted to select open spaces in Sylhet City. A systematic survey was conducted to identify the prominent urban open spaces in Sylhet City. During this survey, public opinions were gathered to understand which areas residents consider as open spaces. The study only included open spaces that at least 10 respondents recognised as places they actively use for leisure or recreation. Additionally, any land smaller than 4047m² (one acre) was excluded from the assessment, as it was deemed insufficient in size to serve as a meaningful public open space. Based on the responses, a total of 38 prominent urban open spaces were selected for further analysis.

The perceived publicness score, the dependent variable in this research, also was recorded during this survey. The users graded the publicness of places from 1 to 10, with higher values indicating a greater sense of inclusiveness. The questionnaire was designed on a single legal-sized sheet, with the names of all 38 open spaces in the left and scores in the right columns. Participants chose the open spaces they wanted to evaluate and marked their scores for each selected space. 238 participants participated in the survey. The age, gender,

and address of the participants were recorded at the top of the sheet. Participants' names were not collected to ensure anonymous data collection and protect privacy. This was followed by a detailed survey to assess the impact of independent variables such as accessibility, management, land use diversity, ownership pattern, number of natural features, and facilities at selected sites. Additional data were obtained from Sylhet City Corporation.

Accessibility was measured through the 'calculate geometry' tool in GIS using software ArcMap version 10.4.1. Physically accessible, street-facing, and visually accessible perimeters of each open space were calculated to define the accessibility attributes. Simple regression was used to examine the correlation of the perceived publicness score with these individual attributes of the open spaces. Land use types within 500 m buffer areas of each study site were calculated in GIS. Entropy value, a measure of land use diversity, was calculated using the following mathematical formula:

$$H = \frac{\sum_k P_k \ln P_k}{\ln N}$$

k , is the category of land use

P , is the proportion of the land area dedicated to specific land use.

N , is the number of land use categories

Here, the value of H ranges between 0 and 1, where the higher value represents better land use diversity.

A simple correlation between land use diversity entropy and publicness score was examined through simple regression. Other non-spatial attributes like ownership pattern, management and control, and spatial attributes like types of natural features and facilities available on the sites were identified through physical survey. Simple regression was employed to examine how individual attributes like accessibility and land use diversity correlated with the perceived publicness score, while OLS analysis was used to identify statistically significant relationships between multiple independent variables and publicness. The underlying reasons behind the results were discussed with support from an empirical study. Based on the results of the analyses and the identification of statistically significant factors through OLS, recommendations were made for urban planning strategies that support the positive attributes of open spaces to enhance their publicness. Figure 1 illustrates the outline of the research methodology, detailing the sequential steps taken.

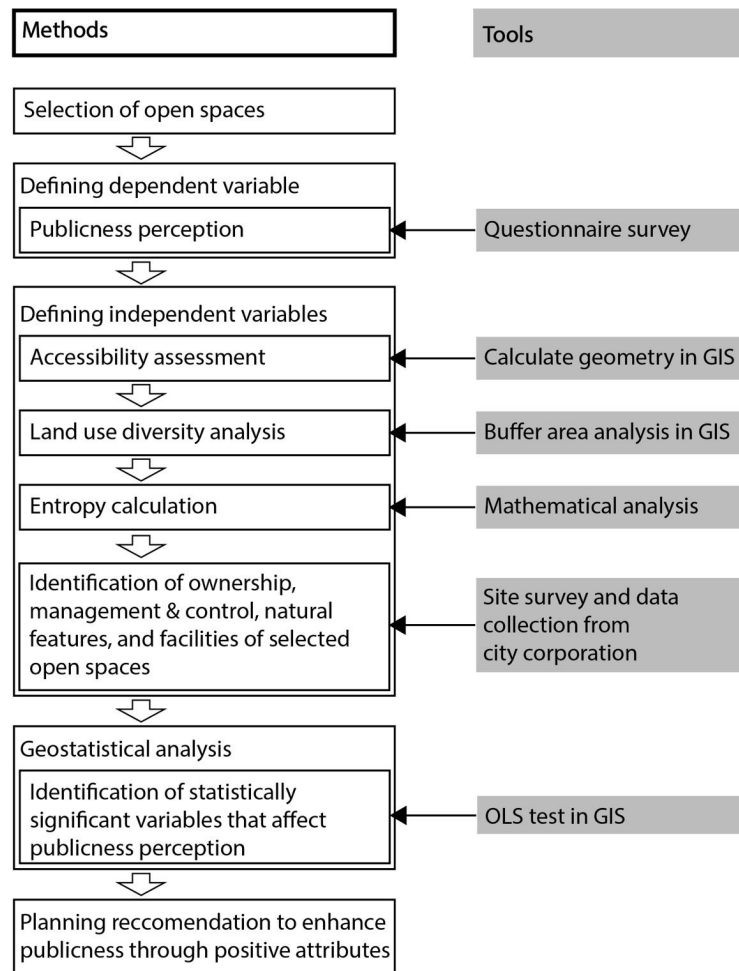


Figure 1. Research methods, tools, and workflow.

4. Analysis and Results

4.1 Selection of Open Spaces in Study Area

The study area, Sylhet City (Figure 2), is known for its immense natural beauty that attracts many tourists, inhabitants, and investors to travel and settle. According to the Sylhet City Corporation, the city is a home to 10 lakh inhabitants. Due to the rapidly growing population, the city has lost 50% of its valuable green coverage, and 70% of 300 natural hillocks have been dismantled in the last two decades. Despite the green city branding, most green areas are not accessible as public open spaces. Large tea gardens and green hills have many environmental benefits but cannot be considered public open spaces due to restricted access and lack of facilities.



Figure 2. Location map of Sylhet City.

The city has very few intermediate-scale urban open spaces and the existing ones lack accessibility and publicness. Many of the existing open spaces are prohibited and inaccessible to public activity due to government safety regulations, while some remain hidden by high boundary walls, which results in visual impermeability (Shangi et al., 2020). Additionally, the provision of open spaces hardly followed any planning standard, with some administrative zones having no open space to serve on a local scale. As illustrated in Figure 3, studies reveal a concerning trend, where the proposed master plan for Sylhet City allocates a smaller amount of green and open spaces compared to the existing number of such spaces in all the Strategic Planning Zone (SPZ). This disparity raises critical concerns about the needs of the city’s residents.

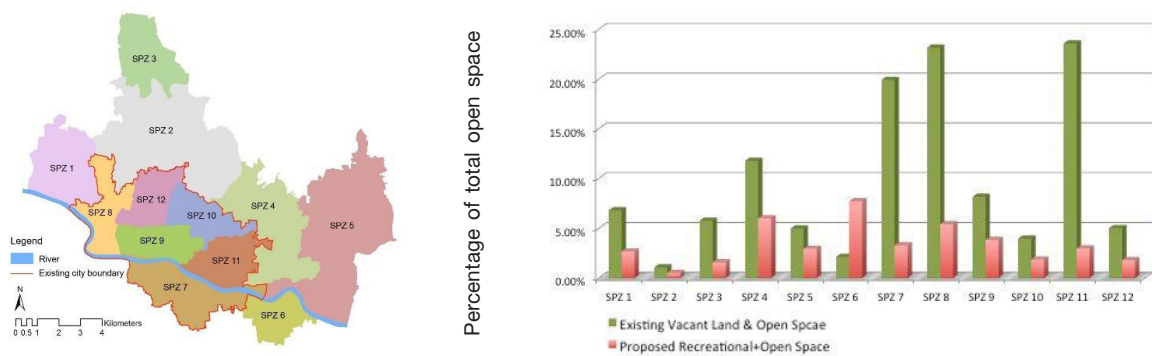


Figure 3. Comparative view of existing and proposed designed open spaces in 20-year urban area plan. Source: Prepared by author according to data from Urban Development Directorate.

To address these issues, the research analysed planning features, physical attributes, and public preferences to identify the significant factors that enhance publicness. 38 prominent urban open spaces were selected based on a questionnaire survey to conduct further research (Figure 4). These selected spaces represented a cross-section of the most commonly used and recognised open spaces within the city, offering a variety of ownership types, management practices, and physical characteristics.

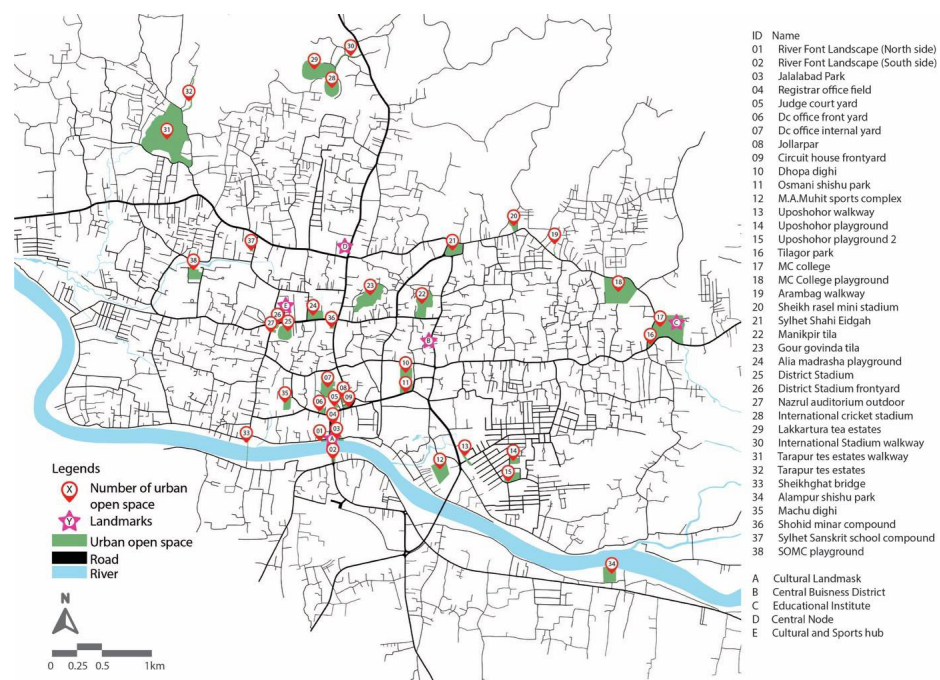


Figure 4. Location of 38 selected urban open spaces in Sylhet City.

Data on these 38 selected open spaces were collected through physical surveys, which involved documenting the type of open spaces, their land ownership category, and by whom they are managed and controlled. Moreover, the types of natural features that are available near the open spaces, the types of facilities they provide, and the activities that occur in the spaces also were noted. These independent variables—ownership, management, accessibility, naturalness, and facility provision— were derived from the literature review as critical factors influencing publicness.

The 38 selected open spaces were traced using GIS and Google Earth in the city map, forming the base map for conducting further research. Each space was identified on the GIS map with a unique ID (Figure 4), and a corresponding list of names is provided in Table 1. Photographs of prominent urban open spaces are showcased in Figure 5.

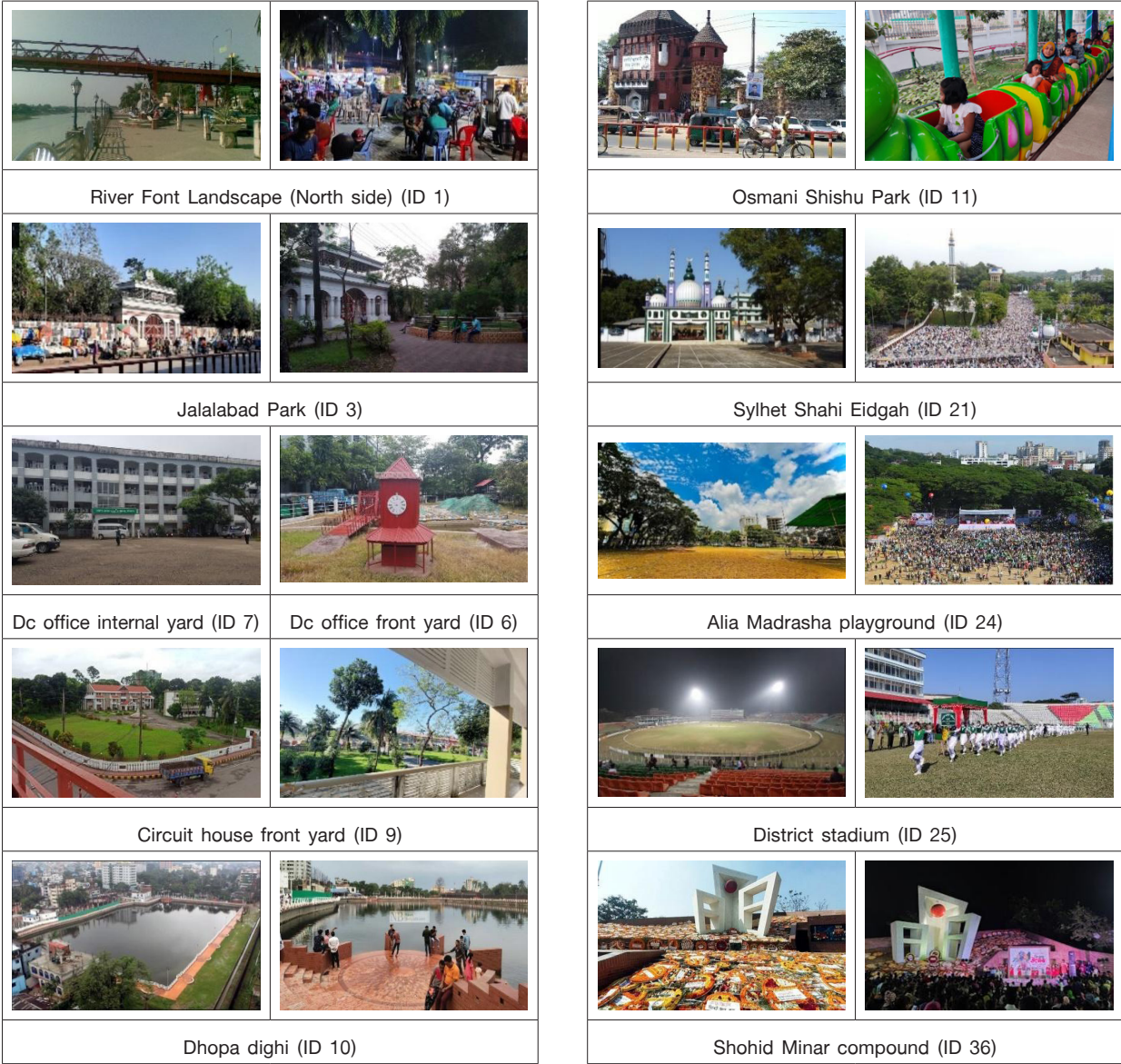


Figure 5. Photographs of some selected urban open space.

Source: Author, open internet sources, and google map.

4.2 User Response and Perceived Publicness

To understand user perceptions of publicness in Sylhet's urban open spaces, a questionnaire survey was conducted among visitors across the selected sites. During the survey, we found that some urban open spaces are visited by people with their family members of diverse age groups. On the other hand, some places mostly are occupied by young adult males. Special facilities for children and elderly people were not enough in most places. There were some places where female visitors were not permitted. The security and accessibility of spaces also influenced the publicness of the place.

In general, then, it was observed that the open spaces are not very women-friendly and there are a limited number of spaces that facilitate activities for children and elderly people (Figure 6).

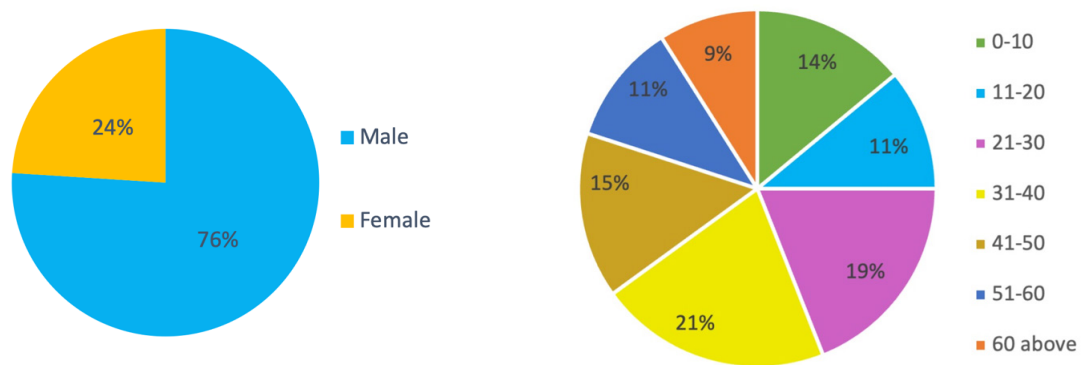


Figure 6. Gender and age group distribution of the survey participants.

A total of 1,770 responses were collected from 238 participants. Each participant evaluated multiple urban open spaces, including the space where we interviewed them and they also were encouraged to evaluate all other open spaces they knew well. The average score for each site is presented in Figure 7. During the survey, some locations, such as Gour Govinda Tila, known for its historical significance, received very few responses, as they are completely restricted to the general public. During the survey, we also could not find general visitors inside the circuit house compound due to strict restrictions to ensure high-security standards for the VVIP government officials staying at the circuit house. However, the circuit house is clearly visible from the riverfront landscape on the north side of the Surma River. Some people were taking photos keeping the circuit house in their background and they were very interested in visiting the place. So, this place is well-known, but it is not open to the public. Most participants were interviewed in the Surma riverfront landscape area, Alia Madrasah playground, and Osmani Shishu Park (children's park). Among these, the riverfront and playground are open to all and require no permission or admission fee. These are among the very few and most popular open spaces in the city. The perceived publicness value also is quite high for these places. The children's park is very popular and most of the participants under the age of ten have responded here. However, due to the ticketing system and being operated for a limited time daily, the guardians gave comparatively low scores to this place.

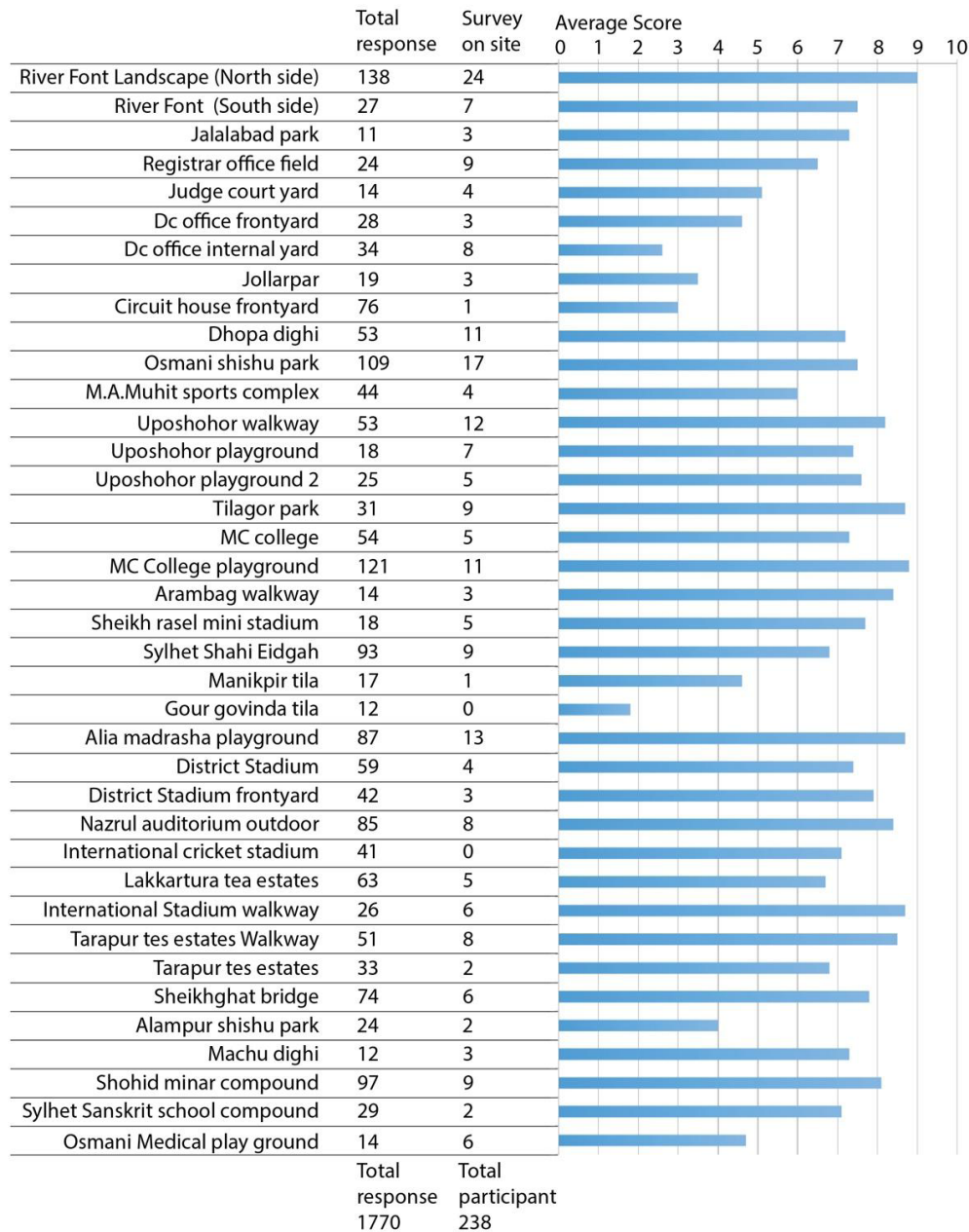


Figure 7. Publicness score of the urban open spaces according to the survey.

4.3 Accessibility Assessment

In this study, accessibility is measured in three dimensions: visual accessibility, physical accessibility, and street-facing periphery (Figure 8). The initial phase of the study was to assess the accessibility of each site. The accessibility of the sites was calculated using the ‘calculate geometry’ tool in ArcGIS. The maps were obtained from the detailed master plan GIS data from Sylhet City Corporation, while the accessibility-related boundaries were documented during physical surveys.

The physically accessible, street-facing, and visually accessible boundaries of the open spaces recorded through physical surveys were converted into structured GIS data in three polyline shapefiles representing the types of accessible boundaries. The length of each type of accessible perimeter was then calculated using the calculate geometry tool in GIS. Later, their percentage value was calculated to obtain the physically accessible, visually accessible, and street-facing periphery of the urban open spaces.

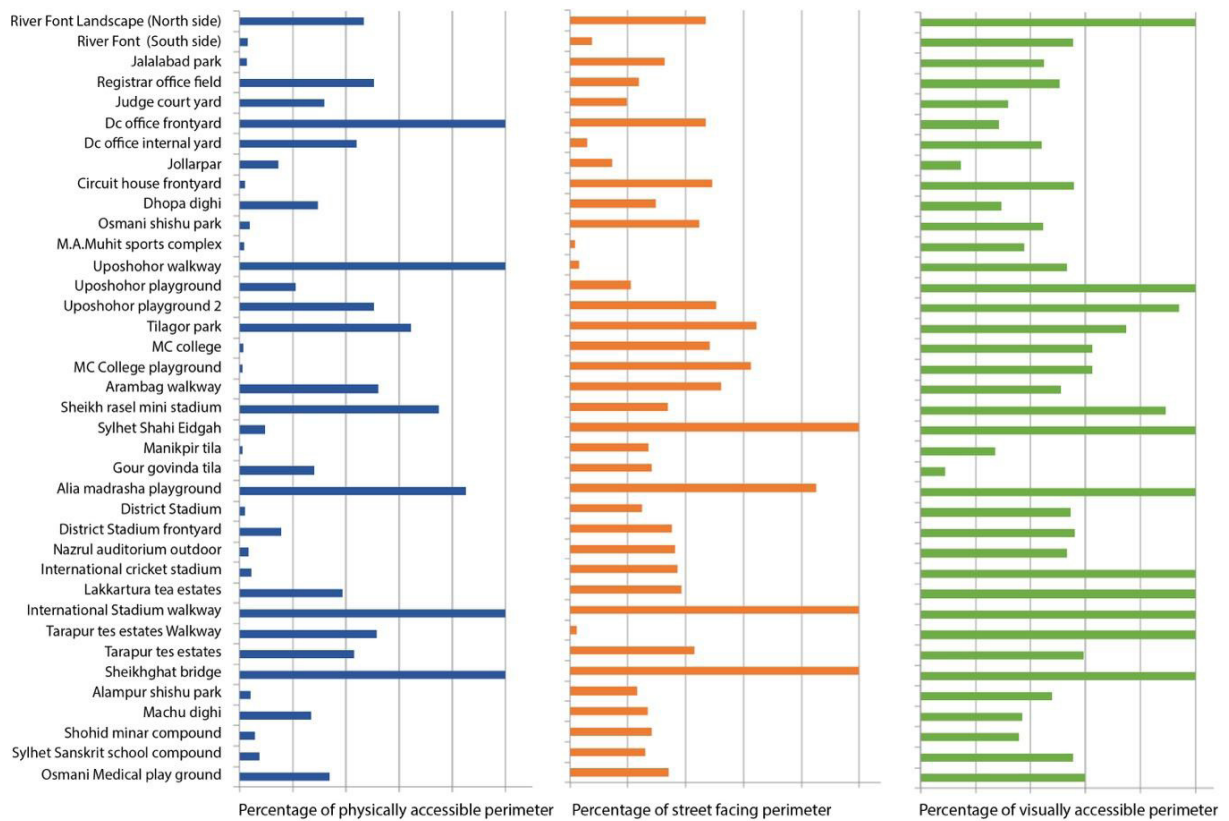


Figure 8. Proportion of accessible perimeters of selected urban open spaces.

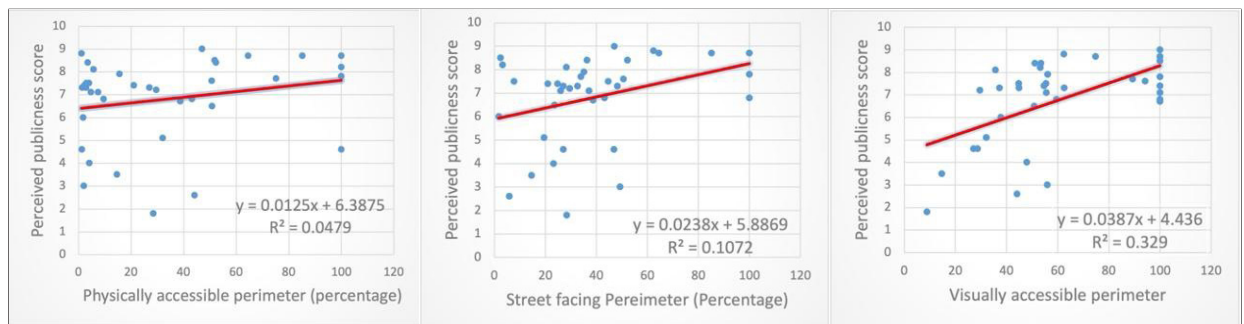


Figure 9. Correlations between perceived publicness score and measured accessibility attributes.

As displayed in Figure 9, perceived publicness increases with increased accessibility. Correlation coefficient (Pearson product moment) for percentage of physically accessible, street facing and visually accessible perimeter of the open spaces are 0.218768, 0.327447, and 0.573598 respectively. It indicates that the visual accessibility creates highest impact on publicness. However, correlation of physical accessibility is not statistically significant with p-value of 0.193306. Street facing and visual accessibility of open spaces are statistically significant with p-value of 0.04789 and 0.000206 respectively.

A detailed survey of Sylhet's urban open spaces revealed diverse characteristics based on ownership, management, natural features, and available facilities. Table 1 summarises these attributes, providing a foundation for the statistical analysis, which evaluates how these factors influence public perceptions of publicness.

Table 1. Urban open spaces and summary of ownership, management, natural features, and facilities for the visitors.

ID	Name	Land ownership	Management and control	Natural features*	Facilities**
1	River Font Landscape (North side)	Government	Open	W, T	F, Sf, Li
2	River Font Landscape (South side)	Government	Open	W	Sf
3	Jalalabad Park	Government	Controlled	T, G	Wl, Sf
4	Registrar office field	Government	Controlled	T, G	Li
5	Judge court yard	Government	Controlled	T, G	Sf, Li
6	Dc office front yard	Government	Controlled	T, G	Sf, Li
7	Dc office internal yard	Government	Controlled	T, G	Li
8	Jollarpar	Government	Abandoned	W, T, G	
9	Circuit house frontyard	Government	Restricted	T, G	Sf, Li
10	Dhopa dighi	Government	Open	W, T, G	Wl
11	Osmani shishu park	Private	Controlled	T, G	Tl, S, F, Sf, Li
12	M.A.Muhit sports complex	Government	Controlled	T, G	Tl, S, Sf, Li
13	Uposhohor walkway	Government	Open	W, G	Wl, Sf, Li
14	Uposhohor playground	Community	Open	T, G	
15	Uposhohor playground 2	Community	Open	T, G	
16	Tilagor park	Government	Open	T, G	Li
17	MC college	Institute	Controlled	W, T, G, H	S, Wl, Sf, Li
18	MC College playground	Institute	Open	T, G	
19	Arambag walkway	Government	Open	W, T, G	Tl, S, Wl, F, Sf, Li
20	Sheikh rasel mini stadium	Government	Open	T, G	
21	Sylhet Shahi Eidgah	Government	Open	W, T, G	Wl, Sf, Li
22	Manikpir tila	Government	Controlled	T, G, H	Wl, Li
23	Gour govinda tila	Government	Restricted	T, G, H	
24	Alia madrasha playground	Institute	Open	T, G	
25	District Stadium	Government	Controlled	T, G	Tl, S, Sf, Li
26	District Stadium frontyard	Government	Open		S, F, Li
27	Nazrul auditorium outdoor	Government	Open		S, F, Li
28	International cricket stadium	Government	Controlled	G	Tl, S, F, Sf, Li
29	Lakkartura tea estates	Private	Controlled	T, G, H	
30	International Stadium walkway	Government	Open	T, G	Wl, Li
31	Tarapur tes estates walkway	Government	Open	W, G, H	Wl
32	Tarapur tes estates	Private	Controlled	T, G, H	
33	Sheikhghat bridge	Government	Open	W	Wl, F, Li
34	Alampur shishu park	Government	Controlled	W, T, G	Tl, S, F, Sf, Li
35	Machu dighi	Community	Open	W, G	
36	Shohid minar compound	Government	Open	T, G	Tl, Wl, F, Sf
37	Sylhet Sanskrit school compound	Institute	Open	W, T, G	Li
38	SOMC playground	Institute	Controlled	T, G	

* W = waterbody, T = tree, G= green/grass lawn, H= hills

**Tl= toilet, S=shade, Wl= walkway, F= food stall, Sf= street furniture, Li= light

As illustrated in Table 1, the selected urban open spaces are categorised into four typologies based on land ownership:

- i. Government-Owned Spaces: These are government-owned public spaces. Although many of them remain underdeveloped or poorly maintained, these spaces offer the highest potential for public access and serve as critical resources for urban communities.
- ii. Community-Owned Spaces: Community lands are collectively owned by local communities and development is supported by the government. These spaces provide public value, catering to broader community needs while fostering inclusivity.
- iii. Institutional Open Spaces: Owned and maintained by various institutions, these semi-public spaces primarily serve specific groups, with limited access for the broader public.
- iv. Private Lands: Privately owned or leased lands, such as tea gardens, often are celebrated for their natural features but are not dedicated to public use. These lands have the lowest potential for open public access.

Open spaces were further classified into four types based on their management system:

- i. Abandoned: Completely unusable for public activities.
- ii. Restricted: Accessible only to a small group.
- iii. Controlled: Requires ticketed entry.
- iv. Open: Fully accessible to the public, representing the highest level of public character.

The degree of impact on public perception of publicness for each type was represented by assigning a corresponding numeric value to perform statistical analysis. The numeric values were assigned according to level of public access. For instance, for land ownership, the sequence is private, institute, community, and government lands with corresponding values of 0,1,2 and 3. Similar numbers were followed for management types as abandoned (0), restricted (1), controlled (2), and open (3).

Naturalness was assessed by documenting water bodies, trees, green lawns, and hills. Facilities provision included toilets, shading, walkways, food stalls, street furniture, and lighting. The presence of these features in each space was counted to generate corresponding values for statistical analysis. Presence of any natural feature or facility was assigned as a score of 1 and for absence its 0. Spaces were sorted based on the availability of these elements, reflecting their usability and public value.

4.5 Land use Diversity and Entropy Calculation

The analysis of land use diversity within a 500 m buffer zone around each urban open space revealed variations across different land use categories (Figure 10). The choice of a 500 m service radius is based on the average walking distance, which generally is considered a reasonable distance for pedestrian access to urban open spaces. This distance allows residents to reach these spaces comfortably within a short period.

The total area for each land use category within the buffer zones was calculated using the 'Calculate Geometry' tool in GIS. The centroid buffering technique addressed instances where open spaces lacked well-defined boundaries. By drawing circular buffers from the centre of each park, this approach effectively captured the surrounding context. Due to data limitations, alternative methods like perimeter buffering or service area analysis were deemed unsuitable.

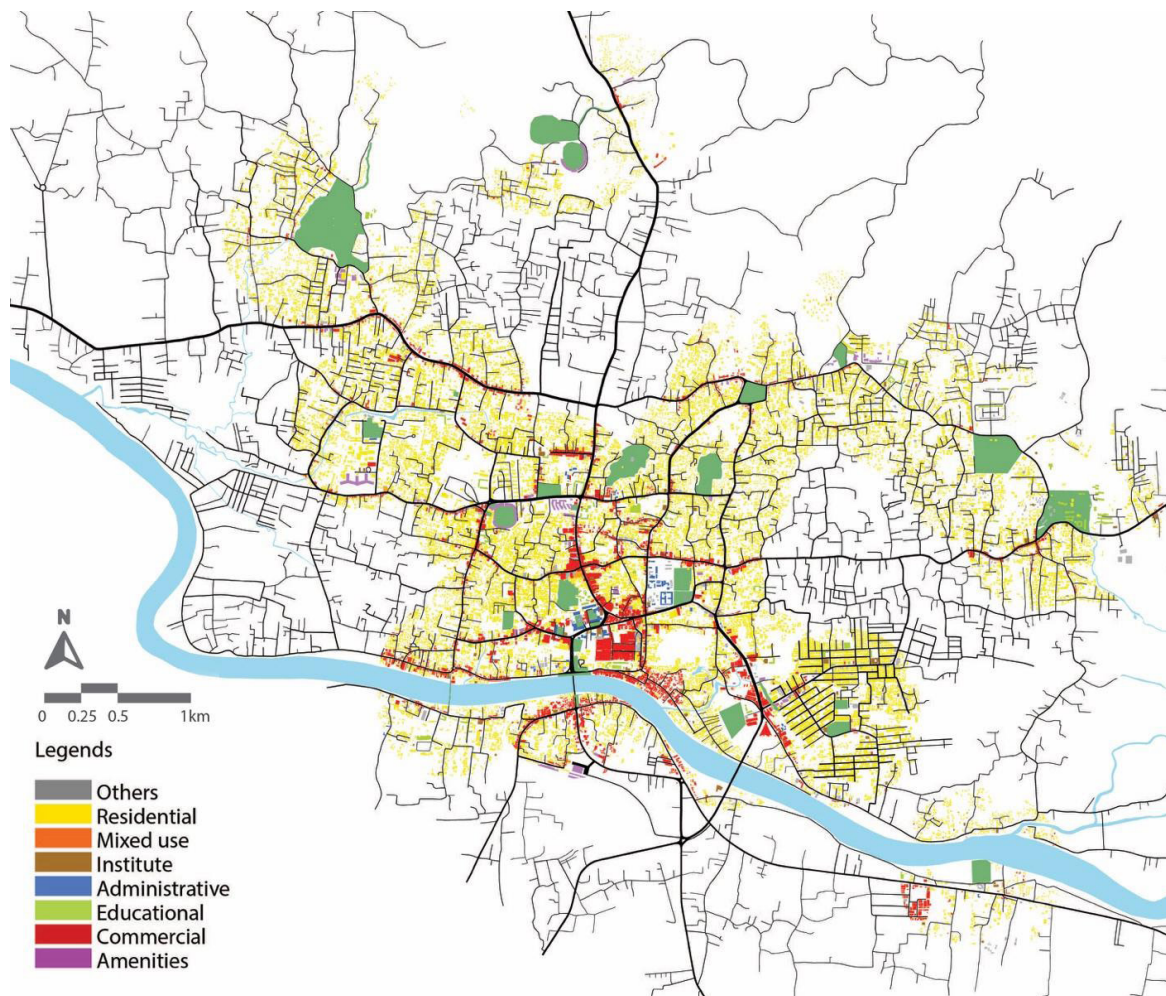


Figure 10, Land use map of 500 m buffer zone for urban open spaces.

Land use diversity was quantified using land use entropy. In addition to land use entropy, building density around each urban open space was examined to understand the land use pattern. Building density was obtained by dividing the total building footprint by the total buffer area calculated by the field calculator tool in GIS. Later, all the structures within the 500 m buffer zone were categorised under the eight fields to identify the land use diversity. The fields were named Residential, Commercial, Administrative, Amenities, Educational, Institutional, and Religious, and the rest of the types were considered under the ‘Others’ category. Land use diversity and corresponding entropy values are compared to understand the impact of urban fabric in (Figure 11).

A statistical analysis explored the correlation between the perceived publicness scores and land use diversity entropy values. Previous studies showed that land use diversity positively impacts urban open space. Interestingly, the results indicate that increased entropy value correlated with decreased perceived publicness of open spaces in Sylhet City (Figure 12). This trend is attributed to privacy concerns in areas with high land use diversity, where residents often restrict outsiders from accessing available open spaces. These limitations highlight the complex interplay between land use diversity and the inclusivity of urban open spaces.

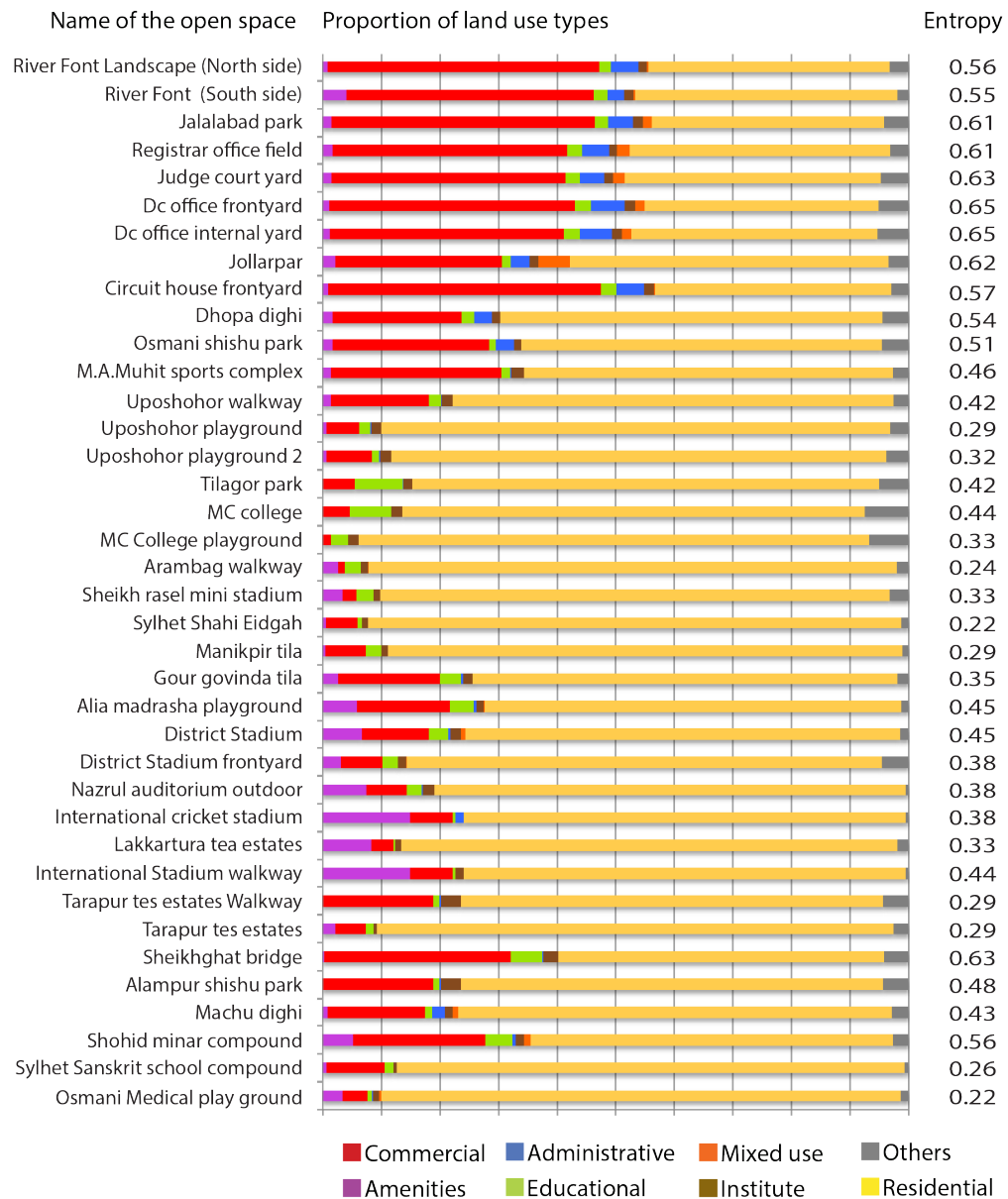


Figure 11. Summary of land use within a 500 m buffer zone of urban open spaces and calculated entropy value.

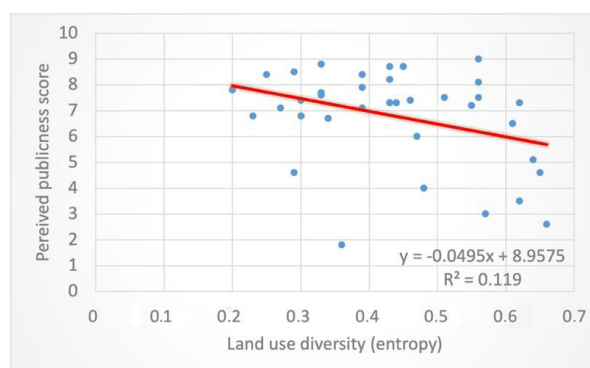


Figure 12. Correlation between perceived publicness score and land use diversity entropy value.

Correlation coefficient (Pearson product moment) for land use diversity is -0.35 that indicates negative correlation with publicness. p-value is 0.033705 which is statistically significant.

4.6 Geo-Statistical Analysis

The geo-statistical analysis was undertaken with nine numeric variables representing the following features: publicness perception score from the user survey, land ownership type, management and control status, the naturalness of the study areas, availability of facilities for different user groups, provision and size of physical access points, a portion of peripheral lengths directly adjacent to the street, ratio of visually accessible perimeters of the open spaces, and entropy of land use diversity (Table 2). Using the linear regression technique, the OLS (Ordinary Least Squares) method estimates the unknown parameters in a mathematical model. Linear measurements of physically accessible, visually accessible, and street-facing periphery line values are numeric by default. The other attributes affecting publicness were assigned numeric values as outlined in section 4.4.

After converting the aspects considered influential in defining the publicness of open space, the numeric independent variables were compared to the dependent variable of perceived publicness. The first OLS test presented non-linear scatter plots for the linear measured variables. So, the log value of these variables was used for the next OLS test, which presented a better model performance. This process minimises the sum of squared residuals between the predicted and actual values, with the least variance being compared among all linear and unbiased estimators. The dependent variable 'inclusive' refers to the perceived publicness score to analyse correlations with all other independent variables to run the OLS test in GIS. This analysis examines the impact of individual variables on the dependent variable at a time and connects the overall correlations to identify the most significant factors that influence the pattern. Changes in the selection of independent variable sets can change the result. The inclusion or exclusion of one variable can affect the correlation of other variables with the dependent variable. So, it is crucial to start the test with all possible variables and exclude the least significant variable step by step until the model achieves a satisfactory performance level.

Table 2. Description of variables used in the geo-statistical test.

Feature	Variable name	Content
Publicness perception	PUB	Average score collected from user survey opinion on publicness of different open spaces.
Land ownership	LO	Type of landownership which exists in any particular site. The ownership pattern is judged under four fields: government, institute, community and privately owned lands.
Land ownership (Number type)	LO_NUM_TYP	Numeric expression of the type of landownership pattern. Values: Private=0, institute=1, community=2, government=3
Management	MA	Type of management system which exists in any particular site. Defines whether the site is open to all, has controlled or restricted access, or is abandoned.
Management (Number type)	MA_NUM_TYP	Numeric expression of the type of management system. Values: abandoned =0, restricted =1, controlled=2, Open=3
Natural features	NF	Types of natural features that exist in any particular site. It marks if there are any hills (H), trees (T), green area (G) or waterbody (W) in the site.
Natural features (Number type)	NF_NUM_TYP	Numeric expression of the type of natural features. Total number of existing natural feature types on the site is represented with this variable.

Table 2. Description of variables used in the geo-statistical test. (continued)

Feature	Variable name	Content
Facilities	FA	Facilities include the availability of toilets, shade, walkways, food stalls, street furniture, and light.
Facilities (Number type)	FA_NUM_TYP	Numeric expression of available facilities. The total number of existing facility types on the site is represented with this variable.
Visual accessibility	VISACC_RAT	The proportion of the visually accessible periphery of the urban open spaces.
Visual accessibility (Log value)	VISACC_LOG	Log value of the proportion of the visually accessible periphery of the urban open spaces.
Street facing	STRFAC_RAT	The proportion of street-facing periphery of the urban open spaces.
Street facing (Log value)	STRFAC_LOG	Log value of the proportion of street-facing periphery of the urban open spaces.
Physical accessibility	PHYACC_RAT	Proportion of physically accessible periphery of the urban open spaces
Physical accessibility (Log value)	PHYACC_LOG	Log value of the proportion of the physically accessible periphery of the urban open spaces.

From the first OLS result in GIS, the statistically less significant variables were identified and removed from the model for better accuracy. The probability value for land use diversity entropy was high, indicates this variable is very much unlikely to be statistically significant and might have been affecting the model performance, so it was excluded in the second OLS test. This test result also revealed that the variable related to accessibility has a nonlinear correlation or heteroscedasticity. To resolve this issue, the log values of these variables were considered for the third OLS test and the model performance was better with multiple R-squared value of 0.76 and an adjusted R-squared value of 0.71. The third OLS test model performance was satisfactory and considered as the final test to identify statistically significant independent variables influencing publicness perception. The t-statistic value indicates the influence of the particular independent variable on the dependent variable (Table 3). A positive value refers to a high positive correlation between the variables, and a negative value indicates the opposite. However, the high t-statistic value may not be statistically significant, represented by probability and robust probability score (Table 3).

Table 3. Summary of OLS test result - model variables.

Variable	Coefficient [a]	StdError	t-Statistic	Probability [b]	Robust_SE	Robust_t	Robust_Pr [b]	VIF [c]
Intercept	38.766055	11.569171	3.350807	0.002251*	7.918303	4.895753	0.000033*	-----
LO_NUM_TYP	-1.8937 36	1.969132	-0.9617 11	0.344147	1.184268	-1.599077	0.120641	1.257728
MA_NUM_TYP	16.375624	2.738949	5.978798	0.000002*	1.488377	11.002338	0.000000*	1.677628
NF_NUM_TYP	-1.0063 54	2.219099	-0.4534 97	0.653565	2.000595	-0.503027	0.618743	1.202530
FA_NUM_TYP	0.780863	1.087147	0.718268	0.478339	0.921317	0.847551	0.403630	1.378870
VISACC_LOG	7.167174	3.974209	1.803422	0.081720	2.429948	2.949518	0.006236*	1.727886
STRFAC_LOG	1.836060	1.843714	0.995848	0.327562	2.056310	0.892891	0.379267	1.104855
PHYACC_LOG	-0.9782 27	1.290825	-0.7578 31	0.454667	1.040291	-0.940340	0.354812	1.294641

(* $p < 0.05$, significantly different from zero at 99% confidence.)

Table 4. OLS diagnostics.

Input features:	SUDS_OLS	Dependent Variable:	Inclusive
Number of Observations:	38	Akaike's Information Criterion (AICc) [d]:	291.954136
Multiple R-Squared:	0.765791	Adjusted R-Squared [d]:	0.709258
Joint F-Statistic:	13.545891	Prob(>F), (7,29) degrees of freedom:	0.000000*
Joint Wald Statistic:	258.451712	Prob(>chi-squared), (7) degrees of freedom:	0.000000*
Koenker (BP) Statistic:	5.176173	Prob(>chi-squared), (7) degrees of freedom:	0.638474
Jarque-Bera Statistic:	12.697935	Prob(>chi-squared), (2) degrees of freedom:	0.001749*

The multiple R-squared value of 0.76 and adjusted R-squared value of 0.71 indicate the model performance is satisfactory, with 70% of the variability in the independent variable being explained (see also, Table 4). Above 70% accuracy is a well-acceptable performance for analysing social issues. The value of the Jarque-Bera Statistic indicates that there is no spatial biasness in the result of the OLS model, so the explanatory variables set to the dependent variable are acceptable.

The summary of the OLS test indicates that management type (MA_NUM_TYP) is statistically significant and has a strong positive relationship with publicness perception. Also, visual accessibility (VISACC_LOG) has a positive relationship with publicness. Though the relationship between the other independent variables and publicness is not statistically significant, the variable distribution and relations charts (Figure 13) visualize the association between the variables. A higher proportion of street-facing boundaries and physically accessible perimeters are positively related with publicness. The provision of public facilities like a walkway, seating, toilet, shade, and street furniture also supports the publicness of the urban open spaces. Interestingly, the open spaces with better natural settings are considered less public in the present situation. Open spaces owned by the government also have a slightly negative relationship. This study revealed that the most popular open spaces are informal public spaces. In terms of scale, the most active public open spaces are smaller than the abandoned urban voids.

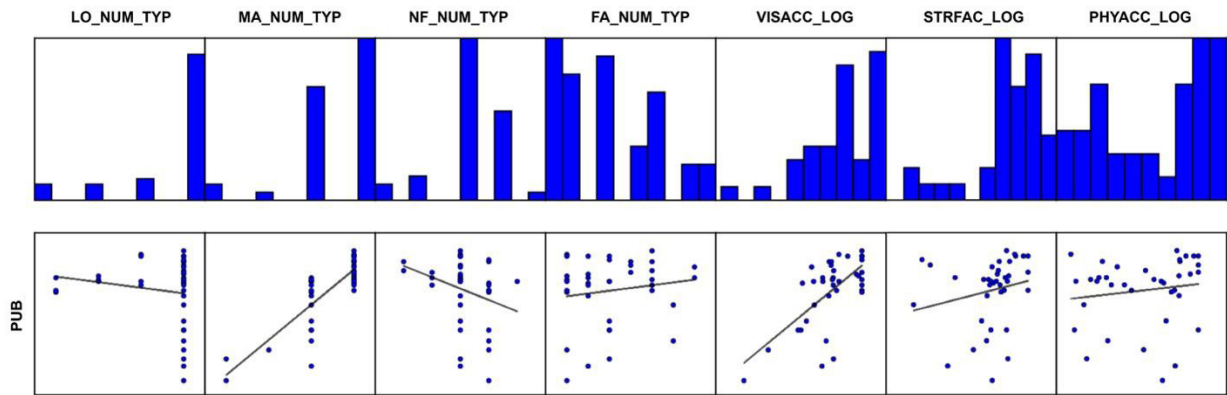


Figure 13. Variable distribution and relations.

5. Discussion and Recommendation

The discussion aims to synthesise the findings from the study analysis and questionnaire survey with existing literature, identifying key factors that contribute to the publicness of urban open spaces in Sylhet City. While previous research highlights the importance of accessibility, management, land ownership, naturalness, and facilities in shaping the quality of public spaces, this study reveals how these factors interact in the local context. The findings are analysed to provide insights into the unique challenges and opportunities that can inform future urban design and planning strategies.

5.1 Accessibility

Accessibility, particularly visual and physical accessibility, was the second most influential factor in defining the publicness of urban open spaces. Previous studies have identified user accessibility as the most important parameter defining urban open spaces' quality (Maruani & Amit-Cohen, 2007). This study extends these findings by showing that street adjacency and unrestricted physical entry enhance the usability of urban spaces. For example, the riverfront landscape and Alia Madrasa playground received excellent responses from the users. Both sites have at least 50% of their periphery directly adjacent to the street and allow entry from any point. This physical setting improved the publicness of the space.

However, unlike earlier studies that emphasise uniform accessibility patterns in public spaces, this study reveals the vital role of boundary designs, which can either enhance or hinder public engagement, depending on their permeability. For example, enclosed playgrounds and parks like Jalalabad Park failed to fully utilise their street-facing potential due to high, opaque boundary walls. This inconsistency highlights the need for more sensible streetscape design and responsive urban placemaking, which can enhance the publicness of all street-facing open spaces. For instance, cities like Nanjing, China, have implemented "green corridors" with low fences and layered landscaping to balance visibility and security (Jim & Chen, 2003). Such approaches could be adapted in Sylhet City to preserve visual connectivity while ensuring safety. To improve publicness, urban planners should integrate multiple physical access points, prioritise visibility in design, and preserve view corridors from key streets and nodes. Designing urban spaces with these principles can increase their inclusiveness and usability.

5.2 Management

The management of urban open spaces emerged as the most crucial issue in enhancing the publicness of the spaces. This study underscores the role of inclusivity in management practices to ensure equitable access, comfort, and functionality for diverse user groups. Control over movement and restriction on permitted activities reduces the perceived publicness of the space. Management levels vary greatly, from restricted and controlled spaces, to fully open ones. Spaces with open management policies, such as the Surma riverfront and playgrounds, displayed higher levels of inclusiveness and were more popular with a diverse range of users. Conversely, spaces with restrictive management—whether due to physical barriers, activity regulations, or perceived security concerns—scored lower in publicness. For instance, the study revealed that some open spaces, like the circuit house front yard, strictly restrict entry of general people, MC college playground is not welcoming to elderly people, and in Shahi Eidgah, entry of women is not encouraged. This echoes McDowell's (1983) and Yang & Kang's (2005) observations on the impact of gender- and age-based controls in diminishing inclusivity.

Privately managed spaces, while often better maintained and equipped, sometimes impose financial barriers restricting access to a narrower demographic, limiting their publicness. By contrast, government-managed spaces, though accessible to all, often lack the security and comfort seen in community-managed or privately owned spaces. This points to the need for an integrated management approach where government, private entities, and communities collaborate to create inclusive, equitable, and well-regulated urban open spaces. Enhancing the publicness of urban open spaces requires balancing control and accessibility, addressing security concerns, and ensuring inclusivity for all age groups, genders, and social classes. Such measures can transform these spaces into vibrant, universally welcoming environments.

5.3 Land Ownership

The spatial analysis performed in GIS indicates the differences in publicness perception based on ownership patterns, reflecting distinctions between public, private, and community-owned spaces. Government-owned spaces, although theoretically accessible to all, lack openness in design, have control over public movement, and are failing to become active public open spaces. Privately owned spaces, by contrast, received better user feedback in terms of maintenance and activity facilitation. However, their restricted access and financial barriers often limit inclusivity and reduce their publicness.

The open spaces owned by institutes serve the people's need for active recreational activities and get many visitors spending their leisure time. In fact, the largest playgrounds are owned by academic institutes, where the local children get the opportunity to have active recreation after their regular academic activities. Nevertheless, these spaces also can serve local user groups, especially children, women, and older adults, to interact with each other and serve as open spaces on a neighbourhood scale. Community-owned spaces, though limited in number, were found to be highly active in terms of use. Though they do not allow visitors from other areas to use the space, they improve neighborhood living standards and social cohesion. This finding reinforces Chiodelli & Moroni's (2014) assertion that community-managed spaces balance inclusivity and control, making them valuable in high-density urban areas.

The study also identified opportunities within government-owned lands with rich vegetation and attractive topography, which are currently underutilised. As suggested by the literature, blending aesthetic and ecological benefits with improved accessibility can enhance the utility of these green spaces (Le Texier et al., 2018).

Thus, developing these areas into active public spaces could bridge the gap in accessibility and inclusiveness. To address the limitations of both public and private ownership models, a public-private partnership approach, as suggested by Stephenson et al. (1951), could ensure equitable access and quality maintenance. Such collaborations could further safeguard open spaces from economic pressures and land scarcity while balancing accessibility, functionality, and long-term viability.

5.4 Naturalness

The study revealed a surprising negative relationship between the naturalness of a site and its perceived publicness. While literature emphasises the positive role of natural features such as trees, green areas, and water bodies in enhancing urban space quality (Bowler et al., 2010), our results showed that natural spaces in Sylhet City are underutilised. Our GIS-based analysis showed that these natural sites often are not integrated well into the urban fabric; the questionnaires further confirmed this, with users frequently citing the lack of facilities and accessibility in natural spaces rich in greenery or water bodies as barriers to their use.

However, spaces that effectively combined natural elements with functional designs—like the Surma riverfront and the Arambag walkway—exhibited higher levels of publicness. This supports the idea that natural features must be complemented by well-planned accessibility and amenities to transform them into active public spaces. The results indicate that preserving natural features while simultaneously introducing pathways, seating, and visual permeability can bridge the gap between ecological richness and public utility. Urban planners must ensure that natural spaces are not isolated but instead are integrated into accessible networks to enhance their usability and public engagement.

5.5 Facilities

The provision of public facilities was found to have a strong positive relationship with perceived publicness. Spaces equipped with basic amenities—such as public toilets, shaded areas, walkways, and street furniture—were more inclusive and attracted diverse user groups, including children and the elderly, resulting in higher publicness scores. This aligns with the literature, which identifies facilities as essential for increasing the appeal and usability of public spaces (Manta et al., 2018).

Spatial analysis and questionnaire results highlighted that sites with more facilities, such as the Surma River Front (north), were frequented by a broader demographic, while the Surma River Front (south) scored lower in publicness. Although both sites are two fronts of the same river, the contrast in their publicness scores can be attributed to the varying levels of facility provision, emphasising the role that facilities play in enhancing the accessibility and functionality of these spaces. Moreover, the absence of child-friendly amenities and gender-sensitive designs, such as safe lighting and accessible pathways, was a recurring issue at many sites. Addressing these gaps could improve the inclusiveness of urban spaces, making them more inviting and functional for diverse user groups. Overall, the findings suggest that prioritising the development of public amenities in future projects can enhance public engagement, inclusivity, and the overall functionality of urban open spaces, contributing to a more equitable urban environment.

5.6 Recommendations

Develop Accessibility

Connect open spaces to main roads, key nodes, and neighbourhoods through pedestrian-friendly pathways.

Enhance accessibility to green spaces by linking them with public transportation hubs for greater publicness

Enhance Visibility and Invite Participation

Avoid high, solid boundaries around public spaces. Implement permeable or low fences and incorporate greenery to maintain visual openness while ensuring safety and security. Design spaces that foster an open, welcoming atmosphere to encourage community engagement.

Utilise the Potential of the Natural Landscape

In areas with high natural value, provide the necessary amenities to improve usability, such as shaded seating, waste bins, and water stations, making them more inviting and functional for all users.

Prioritise Inclusiveness

When providing facilities, ensure that the design accommodates the diverse needs of all users. This includes providing comfortable seating and good lighting for elderly individuals, gender-specific restrooms, and child-friendly spaces with play equipment and safe zones. In addition, adopting the principles of universal design ensures that spaces are accessible to individuals with disabilities.

6. Conclusions

This study showed that open spaces may not attract people despite having multiple positive attributes that are supposed to enhance publicness. Lack of planned development and missed opportunities to utilise the site-specific strengths result in less active open spaces. The geo-statistical analysis confirmed that enhanced visibility and better management play crucial roles in enhancing the public perception of open space users. Some places with limited opportunities became very active gathering spaces for the city people, whereas many other open spaces having better natural settings and development potential still remain inaccessible or unattractive to the city people. Identifying these missed opportunities and including public perceptions to evaluate the quality of public space is the most significant contribution of this research. Future research may employ qualitative or alternative quantitative approaches to dive deeper into management-related attributes and investigate reasons behind the perceived lack of public accessibility on government-owned lands. The crucial factor here is to transform the open spaces into effectively utilised public spaces. Sustainable management of urban open spaces, particularly in densely populated areas, can enhance environmental quality and social cohesion and thus transform them into public spaces.

Human Subject Declaration:

All research procedures involving human participants were done in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. An ethical approval certificate was obtained from Shahjalal University of Science and Technology, Sylhet, Bangladesh (Ref. no: SAST/ 342/ 77) to conduct the questionnaire survey. The survey among the children was conducted with the presence of the parents/ legal guardians with their permission, and a comfortable environment for all the participants was ensured during the process. Participation in the study was voluntary, and verbal consent was obtained for all research components that involved human participants, in accordance with standard ethical practice. No written consent or signature was collected to make it anonymous.

Author Contributions

Conceptualisation, S. Das; methodology, S. Das, F. Moon; validation, R. Paul, S. Das; formal analysis, S. Das, F. Moon, R. Paul; investigation, G. Dey, M. Das; resources, S. Das; data curation, S. Das, R. Paul, F. Moon; writing – original draft, S. Das, G. Dey, F. Moon, M. Das, R. Paul; writing – review & editing, S. Das, F. Moon, R. Paul; visualisation, F. Moon, S. Das; supervision, S. Das, G. Dey; project administration, S. Das.

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Data Availability Statement

Data may be obtained from the corresponding author upon written request.

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