ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun1511

Comparative Analysis of Daylight Performance in Atrium Spaces: A Study of Jamuna Future Park and Bashundhara City Shopping Complex, Dhaka

Tanjina Rahman[1]; Rumana Rashid[2]; D. M. A. Sufian Reza[3]; Sharmila Sutradhar[4]

[1]Postgraduate Scholar, Department of Architecture Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh
[2]Professor, Department of Architecture Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh
[3]Instructor, Department of Architecture AITVET, Dhaka, Bangladesh
[4]Lecturer, Department of Architecture Daffodil Polytechnic Institute, Dhaka, Bangladesh

Publication Date: 2026/07/13

Abstract: Natural daylight is an essential factor in creating comfortable, energy-efficient, and sustainable indoor environments in contemporary commercial buildings. Atriums serve as important architectural features that facilitate the penetration and distribution of daylight within large shopping malls, enhancing both visual quality and spatial experience. The design characteristics of an atrium, such as its size, shape, height, and skylight configuration, have a significant influence on the amount and quality of daylight reaching interior spaces.This study aims to comparatively evaluate the daylight performance of the atrium spaces in Jamuna Future Park and Bashundhara City Shopping Complex, two of the largest shopping malls in Dhaka, Bangladesh. The research investigates how different atrium configurations affect daylight penetration, illuminance distribution, and overall visual comfort within the surrounding circulation and retail areas. A combination of field observations, architectural analysis, and daylight assessment techniques is employed to examine the effectiveness of each atrium design. The comparative analysis focuses on key parameters including atrium geometry, skylight coverage, daylight availability, and spatial quality. The study seeks to identify the strengths and limitations of each atrium system and to determine which design performs more effectively in providing natural illumination within a large-scale commercial environment. The findings are expected to contribute to the understanding of daylight-responsive atrium design and provide practical recommendations for improving environmental performance in future shopping mall developments. Furthermore, the research highlights the importance of integrating daylight-oriented design strategies to enhance user comfort while reducing dependence on artificial lighting in commercial buildings.

Keywords: *Atrium, Daylighting, Shopping Mall, Natural Light, Visual Comfort, Skylight, Sustainable Design, Jamuna Future Park, Bashundhara City, Dhaka.*

How to Cite: Tanjina Rahman; Rumana Rashid; D. M. A. Sufian Reza; Sharmila Sutradhar (2026) Comparative Analysis of Daylight Performance in Atrium Spaces: A Study of Jamuna Future Park and Bashundhara City Shopping Complex, Dhaka. *International Journal of Innovative Science and Research Technology*, 11(6), 3292-3297. https://doi.org/10.38124/ijisrt/26jun1511

I. INTRODUCTION

Daylight is a fundamental component of sustainable building design and plays a vital role in enhancing indoor environmental quality, visual comfort, occupant well-being, and energy efficiency. Effective daylight utilization can significantly reduce dependence on artificial lighting, thereby lowering energy consumption and operational costs while creating healthier and more pleasant indoor environments [1,2]. As a result, daylighting has become an essential consideration in contemporary architectural design, particularly in large commercial and public buildings. In shopping malls and other large-scale commercial complexes, achieving adequate daylight penetration is often challenging because of extensive floor areas, deep building plans, and enclosed interior spaces. To overcome these limitations, atriums have been widely incorporated into modern commercial architecture as effective daylighting elements. Atriums facilitate the distribution of natural light into interior zones that would otherwise rely heavily on artificial illumination, while simultaneously enhancing spatial quality, visual connectivity, and user experience [3,4]. An atrium is generally defined as a vertically open central space enclosed within a building and often covered by a glazed roof or skylight. Besides serving as a circulation and orientation hub, an atrium functions as a major daylight collector and distributor, allowing sunlight to penetrate deep into the building interior [1]. Previous studies have demonstrated that

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atrium geometry, height-to-width ratio, skylight configuration, roof form, surface reflectance, and spatial proportions significantly influence daylight availability and illuminance distribution within atrium spaces and adjoining areas [3,5]. Well-designed atriums can improve daylight penetration, reduce glare, enhance visual comfort, and contribute positively to overall building energy performance [4,6]. Over the past few decades, shopping malls have evolved from purely retail facilities into multifunctional environments that integrate shopping, entertainment, recreation, dining, and social interaction. Consequently, the quality of indoor environmental conditions has become increasingly important in ensuring visitor satisfaction and comfort. Daylighting strategies are particularly valuable in shopping malls because they create visually attractive environments, improve the perception of space, and reduce daytime energy consumption associated with artificial lighting [5,7]. However, the effectiveness of daylighting strategies largely depends on the design characteristics of the atrium and skylight systems. Dhaka, one of the fastest-growing metropolitan cities in South Asia, has experienced rapid commercial development during the last two decades. Among the city's major commercial landmarks, Jamuna Future Park and Bashundhara City Shopping Complex are recognized as two of the largest and most prominent shopping malls in Bangladesh. Both buildings incorporate atrium spaces as key architectural features; however, their atrium configurations differ considerably in terms of scale, geometry, skylight coverage, roof design, and spatial organization. These variations provide a valuable opportunity to investigate how different atrium design approaches affect daylight performance within similar commercial contexts. Although daylight-responsive design has gained increasing attention worldwide, limited research has been conducted on the comparative daylight performance of atrium spaces in shopping malls within Bangladesh. Existing studies primarily focus on general atrium daylighting principles or individual case studies conducted in different climatic regions, leaving a gap in understanding the relative effectiveness of different atrium configurations in large retail environments under local climatic conditions [8,9]. Therefore, this study aims to conduct a comparative analysis of the daylight performance of atrium spaces in Jamuna Future Park and Bashundhara City Shopping Complex. The research evaluates key daylighting parameters, including atrium geometry, skylight characteristics, daylight penetration, illuminance distribution, and visual comfort. The findings are expected to provide valuable insights for architects, planners, and researchers in developing more effective daylight-oriented design strategies for future commercial buildings in Bangladesh.

➢ *Aim and Objectives:*

This study aims to conduct a comparative analysis of the daylight performance of atrium spaces in Jamuna Future Park and Bashundhara City Shopping Complex, Dhaka, with particular emphasis on how different atrium configurations influence the indoor daylight environment and visual comfort within large commercial shopping environments through field-based lux meter measurements. The objective of the research is to examine the existing daylight conditions of the selected atrium spaces and to identify how architectural elements such as atrium geometry, spatial configuration, and skylight design affect the availability and distribution of natural light.

II. METHODOLOGY

This study employs a mixed-method research approach through a field-based comparative analysis of the atrium spaces in Jamuna Future Park and Bashundhara City Shopping Complex, Dhaka. The research focuses on evaluating indoor daylight performance at the ground floor level beneath the atrium spaces using lux meter measurements, along with observational analysis of spatial daylight conditions. Quantitative data were collected through field-based lux meter readings taken only at the ground floor level directly under the atrium spaces of both case study buildings. Multiple measurement points were selected within each atrium zone to represent different spatial positions under the skylight influence. The readings were recorded during daytime under similar environmental conditions in order to ensure consistency and comparability between the two sites. In addition to quantitative measurements, qualitative data were collected through on-site observational surveys to understand daylight quality, spatial brightness, and visual comfort at the ground floor atrium areas. Observations focused on daylight penetration, shadow patterns, and overall spatial experience created by natural light within the atrium space. A comparative analytical approach was used to evaluate the performance of the two atrium spaces based on ground floor illuminance levels. The analysis includes comparison of average lux values, variation in daylight distribution, and overall visual comfort conditions between Jamuna Future Park and Bashundhara City Shopping Complex. The collected lux data were analyzed using descriptive statistical methods, including average values and comparative interpretation. Graphical representation was used to highlight differences in daylight intensity between the two case study locations. By combining field-based measurements and observational analysis, this study provides a comparative understanding of how atrium design influences daylight performance at the ground floor level in large commercial buildings.

III. RESULTS AND DISCUSSIONS

This section presents the results obtained from field-based lux meter measurements and observational analysis of atrium daylight performance at the ground floor level in Jamuna Future Park and Bashundhara City Shopping Complex. The findings are discussed in terms of illuminance levels, daylight distribution patterns, and visual comfort conditions.

➢ *Comparative Analysis of Luminous Environment:*

The lux meter measurements indicate that the atrium of Bashundhara City Shopping Complex effectively introduces natural daylight into the interior environment. The large central dome skylight allows daylight to penetrate the atrium, creating a bright, visually appealing, and comfortable indoor atmosphere. This daylighting strategy not only enhances the architectural character of the space

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun1511

but also helps reduce dependence on artificial lighting during daytime hours. Although some variation in illuminance levels was observed across different measurement points, the overall daylight experience within the atrium remains positive and contributes significantly to user comfort and visual quality. In contrast, the atrium of Jamuna Future Park demonstrates comparatively lower daylight penetration in certain areas. The large scale of the building, deep interior spaces, and greater distance from the skylight to the lower floors limit the effective distribution of natural light throughout the atrium. As a result, lower illuminance values were recorded at several measurement points, increasing the reliance on artificial lighting. Furthermore, the extensive interior volume causes daylight intensity to diminish before reaching the ground level, reducing the overall effectiveness of the daylighting system. Therefore, in terms of daylight quality, visual comfort, and architectural ambiance, the atrium of Bashundhara City can be considered more successful than that of Jamuna Future Park.

Table 1 Comparison of Ground Floor Illuminance (Lux Level)

Measurement Point	Bashundhara City (Lux)	Jamuna Future Park (Lux)
Point 1 (Center under atrium)	420 lux	260 lux
Point 2	380 lux	240 lux
Point 3	460 lux	310 lux
Point 4	390 lux	220 lux
Point 5	440 lux	280 lux

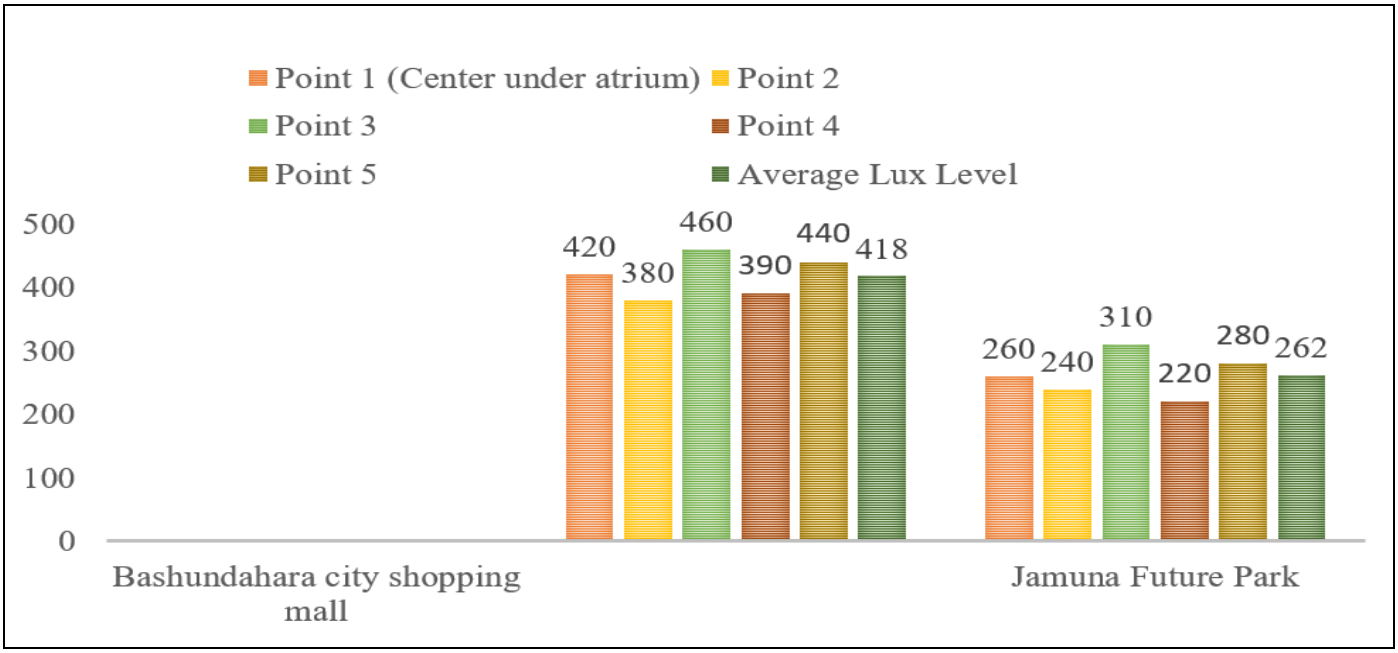

Table 1 presents a comparative analysis of ground floor illuminance levels under the atrium spaces of Bashundhara City Shopping Complex and Jamuna Future Park. The measured daylight values are evaluated against the recommended illuminance range for retail and shopping environments specified in the Bangladesh National Building Code (BNBC), which recommends approximately 300–500 lux for indoor commercial circulation and shopping areas.

The recorded data indicate that Bashundhara City Shopping Complex achieves an average illuminance level of 418 lux, which falls within the recommended BNBC range. This demonstrates that the atrium provides adequate natural daylight to support visual comfort and everyday shopping activities. The central atrium and skylight system contribute significantly to daylight penetration, creating a bright and visually pleasant indoor environment. The measured illuminance levels confirm that the building successfully meets daylighting requirements for commercial facilities while enhancing the spatial quality and architectural character of the atrium. The relatively high illuminance values indicate efficient daylight distribution and reduced dependence on artificial lighting during daytime hours.

In contrast, Jamuna Future Park records an average illuminance level of 262 lux. Although this value remains within an acceptable daylight range for certain circulation spaces, it is comparatively lower than that of Bashundhara City Shopping Complex. The large scale and extensive interior volume of the building can reduce the effectiveness of daylight penetration at the ground floor level, particularly in deeper areas where natural light must travel greater distances. As a result, portions of the interior may rely more heavily on artificial lighting to maintain adequate illumination and visual comfort. Furthermore, the vast spatial depth may limit the overall perception of daylight quality within some commercial zones. Overall, both buildings demonstrate the contribution of atrium spaces to indoor daylight availability. However, Bashundhara City

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jun1511

Shopping Complex exhibits superior daylight performance, achieving higher illuminance levels and a more effective integration of daylight with architectural design. The atrium daylighting strategy enhances visual comfort, improves the shopping environment, and contributes positively to the overall indoor atmosphere, making Bashundhara City a notable example of effective atrium-based daylight design.

➢ *Visual Comfort Observation:*

Based on field observations, Bashundhara City Shopping Complex provided a comfortable and visually balanced environment at the ground floor level, contributing to a pleasant user experience. The controlled penetration of natural daylight through the central atrium created a well-lit atmosphere while minimizing glare issues. This balanced lighting condition enhanced visual comfort and supported shopping and circulation activities throughout the day. In contrast, some areas of Jamuna Future Park experienced higher daylight intensity due to direct skylight exposure, which occasionally resulted in mild glare conditions. Additionally, the large interior volume and extensive open spaces led to variations in lighting quality across different zones, affecting the consistency of visual comfort within the atrium space.

Fig 1 Central Atrium of Jamuna Future Park.


Fig 2 Central Atrium of Bashundhara City Shopping Mall.

Fig 3 Central Gathering Space Beneath the Atrium of Bashundhara City Shopping Mall.

➢ *Comparative Discussion:*

The comparative analysis reveals that atrium design plays a crucial role in shaping indoor daylight performance within large commercial environments. The results show that Bashundhara City Shopping Complex, with its centrally located atrium and iconic dome skylight, provides an effective and visually comfortable daylighting environment. The atrium allows natural light to penetrate the interior spaces while maintaining a balanced lighting condition that enhances visual comfort and architectural quality. This contributes to a pleasant indoor atmosphere and an improved shopping experience for users. In contrast, Jamuna Future Park, despite its larger and more expansive atrium system, demonstrates certain limitations in daylight effectiveness at the user level. The extensive spatial volume and large interior depth can reduce the perceived quality of daylight in some areas, while variations in skylight exposure may create inconsistencies in lighting conditions across different zones. As a result, daylight distribution is not always experienced as uniformly comfortable throughout the atrium space. The overall findings suggest that atrium design quality, skylight configuration, and spatial organization have a direct influence on indoor daylight performance. A well-designed central atrium can effectively distribute natural light while maintaining visual comfort and minimizing glare-related issues. The study also indicates that successful daylighting depends not only on the size of the atrium but also on how efficiently daylight is controlled and integrated into the building's overall design. In summary, the study highlights that atrium configuration is a key design factor in determining indoor daylight quality and visual comfort in shopping malls. Bashundhara City Shopping Complex demonstrates a more successful integration of daylighting and architectural design, creating a comfortable, visually appealing, and user-friendly indoor environment. Properly designed atrium spaces can significantly enhance natural lighting conditions and contribute to a more comfortable and energy-efficient interior environment in large-scale commercial buildings.

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IV. FINDINGS

The findings of this study are based on field-based lux meter measurements and observational analysis of atrium daylight performance at the ground floor level in Bashundhara City Shopping Complex and Jamuna Future Park. The results highlight notable differences in daylight quality, distribution patterns, and visual comfort conditions between the two case studies. Firstly, the study found that Bashundhara City Shopping Complex provides a comfortable and visually balanced daylight environment within its atrium space. The measured illuminance levels fall within the acceptable range recommended for commercial environments, ensuring adequate natural lighting for shopping and circulation activities. The central dome skylight effectively introduces daylight into the interior while maintaining a pleasant visual atmosphere. Secondly, the findings reveal that the atrium design of Bashundhara City supports a controlled distribution of natural light, which contributes to reduced glare and improved visual comfort for users. Although daylight intensity varies across different locations, the overall lighting environment remains comfortable and suitable for indoor commercial activities. The atrium also enhances the architectural character of the building and creates an attractive spatial experience. In contrast, Jamuna Future Park demonstrates certain limitations in daylight performance despite its larger atrium volume. The extensive interior spaces and greater spatial depth can make daylight management more challenging, resulting in variations in lighting conditions across different zones. In some areas, direct skylight exposure may create mild glare, which can affect visual comfort. The large-scale atrium configuration also reduces the consistency of daylight perception at the ground floor level.

The study further finds that visual comfort conditions are generally more favorable in Bashundhara City Shopping Complex due to its balanced daylight environment and reduced glare potential. The integration of daylight with the building's architectural design contributes positively to user experience and indoor environmental quality.

Overall, the findings confirm that atrium configuration has a direct impact on daylight performance. The centrally organized atrium system of Bashundhara City Shopping Complex demonstrates a more effective integration of natural lighting and visual comfort, while the larger and more expansive atrium system of Jamuna Future Park presents challenges in maintaining consistent daylight quality throughout the interior environment.

V. CONCLUSION

This study examined and compared the daylight performance of atrium spaces in Bashundhara City Shopping Complex and Jamuna Future Park, focusing on ground floor illuminance levels and spatial daylight distribution. The comparative analysis demonstrates that atrium configuration plays a significant role in determining the quality and effectiveness of natural daylight within large commercial environments. The results indicate that Bashundhara City Shopping Complex provides a more comfortable and visually balanced daylight environment through its centrally organized atrium and iconic dome skylight. The atrium effectively introduces natural daylight into the interior spaces while maintaining a pleasant visual atmosphere and minimizing glare-related issues. The integration of daylight with the architectural design enhances the overall shopping experience and contributes to a comfortable indoor environment. In contrast, Jamuna Future Park experiences challenges in maintaining consistent daylight quality across its extensive interior spaces. The large atrium volume and expansive spatial arrangement can result in variations in lighting conditions and visual comfort throughout different zones of the building. The study confirms that atrium geometry, skylight design, and spatial organization directly influence indoor daylight conditions in shopping malls. A well-designed central atrium can create a balanced daylight environment, improve visual comfort, and enhance the architectural character of the space. The findings suggest that the effectiveness of daylighting depends not only on the size of the atrium but also on how efficiently natural light is controlled and distributed within the building. Overall, the research highlights the importance of integrating effective atrium design strategies in commercial architecture to improve daylight performance, user comfort, and environmental quality. Bashundhara City Shopping Complex demonstrates a successful relationship between daylighting and architectural design, offering a comfortable, visually appealing, and user-friendly indoor environment. The findings can serve as a useful reference for architects and planners in developing more daylight-responsive shopping mall designs in tropical urban contexts such as Dhaka. Further studies may include seasonal daylight variation, simulation-based analysis, and energy performance evaluation to provide a more comprehensive understanding of atrium daylight behavior.

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