

Spatial Accessibility for Campus Public Spaces: A Space Syntax Study of Universitas Nusa Cendana

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ABSTRACT

Public open spaces (POSS) within the campus environment play a crucial role in supporting the psychological well-being, social interaction, and quality of life of the academic community. This study aims to evaluate the spatial accessibility of POSS within the Universitas Nusa Cendana (Undana) campus using a space syntax approach. By combining Axial Map analysis and user perception surveys, this study assesses the spatial connectivity, integration (HH), and intelligibility of three vacant plots of land with the potential to be developed as POPs. The analysis results indicate that plot B has the highest integration value (0.48) and a gentle contour, making it the most feasible location spatially and topographically. The regression test results indicate that perceived accessibility has a positive and significant effect on the assessment of public space feasibility ($r = 0.582$, $p < 0.01$), in line with the theories of Lynch (1960) and Jacobs (1961) regarding the role of accessibility and visibility in shaping functional public spaces. This study confirms that the space syntax approach combined with user perception can be an evidence-based evaluation instrument in planning more inclusive and adaptive campus public spaces.

Keywords: Accessibility, Campus Public Space, Space Syntax, User Perception, Universitas Nusa Cendana

1. INTRODUCTION

The academic life of students in a university environment is significantly influenced by the quality of the spatial environment in which they operate. Amidst high academic demands, students need spaces to relieve stress, engage in informal activities, and build social connections outside the classroom [1]. In this context, public open spaces (POSS) on campus are a crucial element in supporting the balance between academic life and student psychological well-being [2].

Ideally, a campus public space should be easily accessible to the entire academic community, both spatially and visually, thus supporting mobility, social interaction, and ownership of space. Spatial accessibility plays a crucial role in ensuring that public spaces are accessible without physical or structural barriers and are integrated with the campus's main circulation system [3], [4]. Within the higher education sector, POS serves as a supporting infrastructure that supports the overall sustainability of the campus environment. Public spaces on campus serve as areas for students to relax, engage in recreational activities, and foster social connections [5], so that every academic community member who has access to this space and interacts has a high quality of life and low stress levels [6]. Furthermore, the presence of public spaces on campus can create a relaxed atmosphere, provide fresh air, reduce stress and improve mental health, psychological well-being and the quality of life of students [7], [8].

In reality, not all campuses in Indonesia have the spatial structures to support these needs. For example, at the University of Riau, although the Science Park public space has been built, its presence remains unpopular due to the physical quality and minimal and poorly maintained

facilities [9]. Meanwhile, what happened at the Kalimantan Institute of Technology (ITK) was that the use of outdoor space was not optimal and planned, and still required landscape design, so it was suggested that the site, which was initially barren and dry, could be managed into a green open space with a multifunctional space concept [10]. A similar thing was also experienced by Campus A of Trisakti University, Grogol, West Jakarta, which stated that even though it is an active area, the public open space area is minimal, causing high temperatures to occur during the day, and is prone to pollution [11]. In the library area of the University of Indonesia, there is an empty (undeveloped) plot of land, which would be a shame if this open space were not properly designed and optimized. These studies show that public open spaces on campus are generally not optimally designed or managed [12]. This condition is in accordance with what was stated by Hanan [13] which states that in reality many campuses are designed to only express the architecture of the building rather than the comfort needs of the users within it.

The phenomenon of limited campus public space can also be observed at Universitas Nusa Cendana (Undana), Kupang, East Nusa Tenggara. To date, architectural studies related to public space on this campus are still relatively minimal. Previous research by Jerobisonif, et al [14] focused more on identifying forms of outdoor space such as open courtyards, parking lots, gardens, sports fields, and field laboratories, but did not examine the extent to which these elements support connectivity and ease of access between campus activity zones. Another study by Dahoklory [15] highlighted the role of signage systems in supporting visitor orientation, but did not address the aspect of integrated spatial systems as a whole. These two studies demonstrate that although the presence of open spaces has been physically identified, the approaches used have not addressed how these spaces function structurally in supporting the mobility and accessibility of campus users. In this context, understanding spatial configuration is not sufficient by simply recording spatial elements or their distribution, but must also include how these spaces are interconnected and form networks that enable or hinder daily movement [5]. Therefore, a spatial structure-based analysis that considers the spatial relationships between campus elements is crucial for evaluating the potential of open spaces to support the social and daily activities of the academic community.

Based on the above phenomenon, this research uses an approach. Space syntax to quantitatively evaluate the spatial structure of campuses, focusing on the dimensions of accessibility and physical visibility as key indicators. Although this method has been widely applied in settlement and urban studies, its application in the context of evaluating campus public spaces in Indonesia remains limited. Therefore, this study not only provides a spatial mapping of undeveloped areas with the potential to be developed into public spaces, but also seeks to fill the methodological gap in campus spatial studies.

Description of Study Location

Universitas Nusa Cendana (University of Nusa Cendana) or Undana is the first state university in East Nusa Tenggara Province, located on Jalan Adisucipto, Penfui Village, Maulafa District, Kupang City. Established in 1962, Undana's main campus comprises academic buildings, public facilities, open spaces, and undeveloped areas with potential for development.

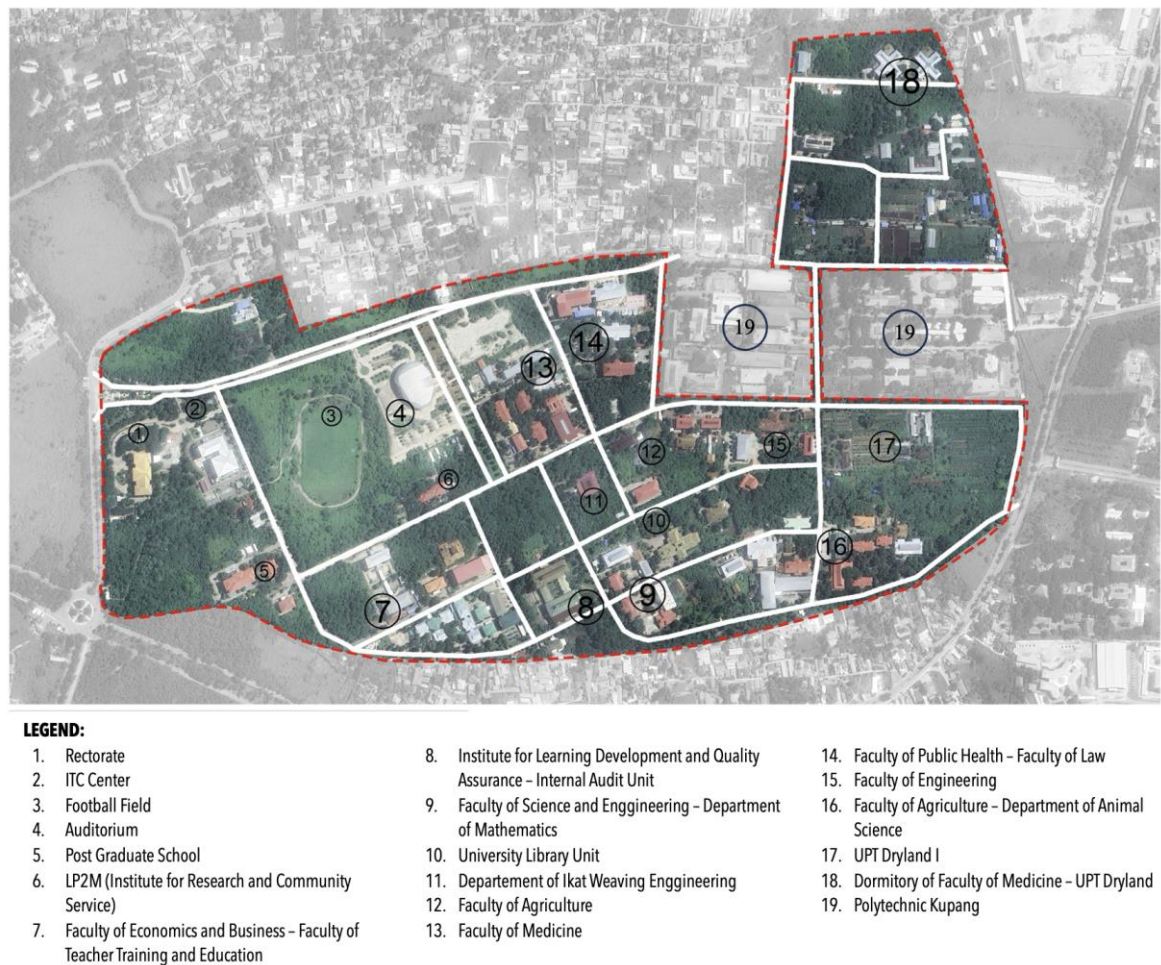


Figure 1. Existing Development Map of Nusa Cendana University (Undana)

Figure 1 shows the current physical development of the Undana Campus, including key locations such as faculty buildings, public facilities, and non-built-up areas. Each element is numbered according to the legend, which covers 18 key campus functions. This map differs from the master plan because it reflects the land use and distribution of existing built and used spaces as they appear on the ground.

Spatially, the Undana campus has a master plan for area development that includes functional zones (academic, administrative, laboratory, and supporting facilities), primary and secondary circulation networks, and green open spaces. The master plan illustrates the layout structure. A relatively organized campus space with main axes connecting buildings, as well as a distribution of open spaces spread across several points. Based on the master plan, location number 3 is designated as an area for student activities, sports, and parks. However, based on field observations, several undeveloped areas with high potential for social and recreational functions have not been optimally utilized. This location selection also aligns with the utilization in the Undana master plan and the remaining space that can be utilized as POS. Furthermore, currently, the spatial connection between the main activity zone and the open area does not always show strong integration, especially in terms of pedestrian accessibility and visibility.

In this context, the Undana campus is an appropriate study location to test the space syntax approach in analyzing the spatial structure of public open spaces. The existence of a master plan provides a formal planning framework, while this study seeks to provide a spatial data-based

evaluation of the existing structure. By assessing the connectivity and visibility of non-built-up areas within the campus spatial system, this study aims to provide an objective basis for determining strategic locations for the development of public open spaces that are connected and accessible to all campus users.

2. METHODS

This study uses a quantitative-descriptive approach based on spatial analysis to evaluate the level of accessibility and spatial intelligibility of potential open spaces within the Universitas Nusa Cendana (Undana) Campus. The main objective is to identify and assess the spatial performance of undeveloped land that has the potential to be developed as public open spaces, by considering the actual spatial connectivity structure formed by the campus circulation network. The primary data were obtained from existing maps of the area, including active buildings, road networks, and undeveloped open spaces. These maps have been verified through field observations, then converted into digital format using AutoCAD and analyzed with DepthmapX software.

The main method used is Axial Map Analysis, in accordance with the theoretical framework of space syntax [16]. Through this technique, two main spatial indicators are calculated, namely connectivity (the local connectedness of a segment to the surrounding space) and integration [HH] (the degree of integration of the segment within the overall network). This analysis is expanded by calculating intelligibility, namely the correlation between connectivity and integration [HH] values, which describes the extent to which the spatial structure can be intuitively understood by users [16], [17].

As a first step in the analysis, each plot was assessed based on the average connectivity and integration values of directly intersecting axial segments. To strengthen the validity of the findings and anticipate interpretation bias, all vacant plots were selected to reflect different spatial characteristics: two high-performing plots (plots A and B), and one plot with low spatial and physical performance (plot C) served as a control site. This strategy allows for a comparative analysis of user perceptions of spaces with contrasting spatial conditions.

Theoretically, this approach relies not only on spatial measurements but also adopts the concepts of spatial legibility by Lynch [18], visibility and user comfort by Ghel [19], and the principle of natural surveillance by Jacobs [20]. Thus, this study combines quantitative evaluation of spatial networks with the basic principles of public space design that support accessibility, ease of orientation, and overall user comfort. This approach provides a methodological contribution to campus spatial studies in Indonesia, particularly in filling the gap in accessibility evaluation based on spatial configuration, which has not been widely implemented.

3. RESULTS AND DISCUSSION

3.1 Results of Spatial Accessibility Analysis

Spatial analysis using the approach space syntax was conducted to evaluate the pedestrian movement system in the Universitas Nusa Cendana (Undana) Campus environment. The two main techniques used were traffic analysis. Axial map to measure two main indicators: connectivity and integration [HH]. Connectivity reflects the extent to which a space or road segment is directly connected to other spaces around it, whereas integration [HH] measures the level of integration of a space within the overall campus spatial system [16].

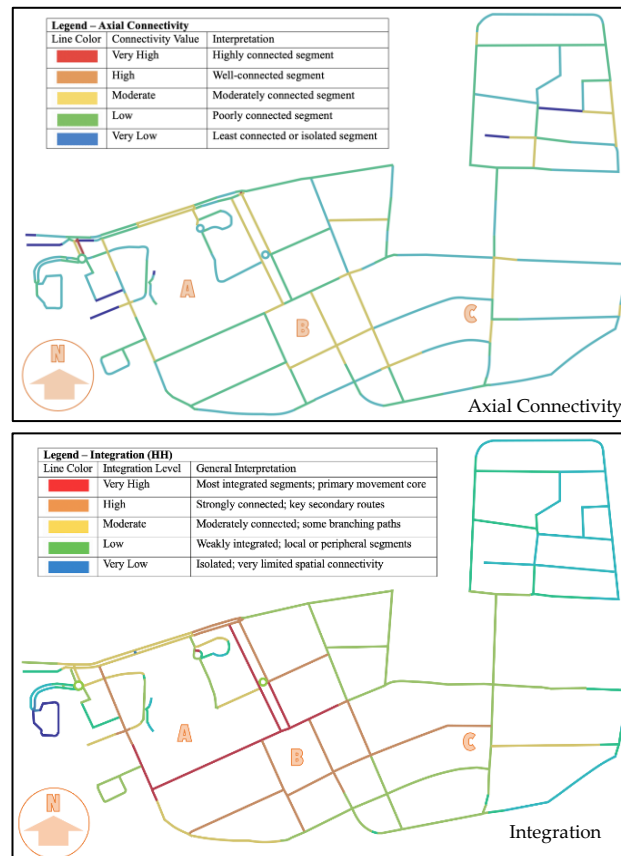


Figure 2. Spatial Distribution of Axial Connectivity and Integration (HH) in Undana

The axial connectivity map shows that the main campus network, especially in the central and southwest corridor areas, has higher connectivity than the eastern and northern areas. This is shown by the dominant red-orange color on the paths passing through land A and B. Conversely, the eastern area of the campus (around land C) is dominated by bluish green, which indicates a lower level of connectivity. Meanwhile, the results of the integration [HH] analysis show that land B is the location with the highest spatial integration value (0.48), followed by land A (0.45), and land C (0.35). This value indicates that land B has the most integrated position in the global campus movement network, while land C is in a relatively more isolated position.

As for The highest average connectivity value was found in land A (3.75), indicating strong local connectivity. Land B followed with a value of 3.50, while land C recorded the lowest average connectivity value (2.67). A summary of the results can be seen in the following table:

Table 1. Average Connectivity and Integration (HH) Values for Each Vacant Plot

| Land | Connectivity (Mean) | Integration [HH] (Mean) |
|------|---------------------|-------------------------|
| A | 3,75 | 0,45 |
| B | 3,50 | 0,48 |
| C | 2,67 | 0.35 |

However, in assessing the suitability of public spaces, spatial aspects cannot stand alone. Therefore, this study continues the analysis by measuring intelligibility, namely the extent to which the local spatial system can represent global integration. Scatter plot between connectivity and integration [HH] indicates coefficient of determination (R^2) of 0.198736, which indicates the level of intelligibility currently on the campus spatial system (see the following figure).

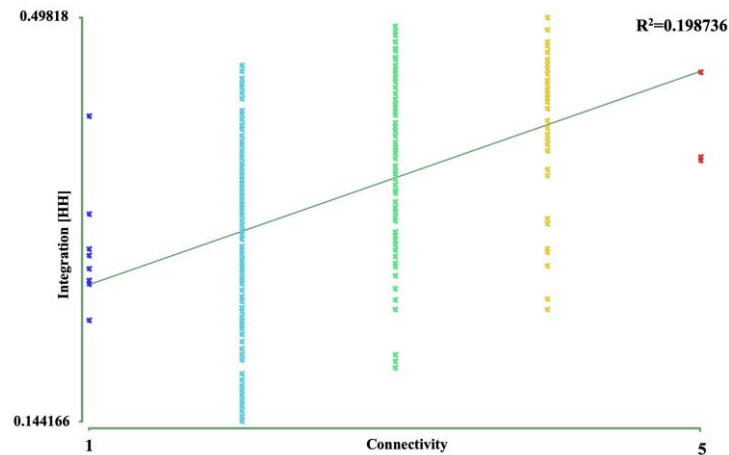


Figure 3. Intelligibility Value Graph on Undana Campus Spatial System

In the context of Hillier's theory, a moderate intelligibility score indicates that users can understand most of the relationships between spaces on campus through their local experience, although there may still be certain areas that are difficult to recognize spatially. This finding is important because higher intelligibility tends to support natural navigation abilities and improve user orientation to the spatial system as a whole. Netto [21] adds that intelligibility is not only a morphological aspect, but is the foundation of the social logic of space, where easily read spatial relationships encourage more fluid and collaborative social activities. In this context, a fairly good intelligibility still provides a strong foundation for the development of public open spaces on campus, especially in areas A and B.

Thus, although site C has relatively lower spatial performance, these intelligibility results strengthen the position of sites A and B as potential prime locations for campus public space because the local connectivity of these two locations can reflect global functional integration. This analysis forms the basis for the next stage, namely spatial design implications and user survey-based validation of the quality and potential of public space in these three locations.

3.2 Implications for the Potential of Undana Campus Public Space

Analysis results space syntax shows variations in spatial performance at vacant land locations in the Universitas Nusa Cendana (Undana) Campus area. Two main parameters are used, connectivity and integration [HH], serves to assess the level of local connectivity and global integration within the campus pedestrian movement network. However, as Hillier and Hanson [16] noted, interpreting spatial performance cannot be separated from the physical and social context. Therefore, this analysis is accompanied by topographic mapping as a basis for interpreting the area's physical landscape.

LEGEND:

- | | |
|---|---|
| 1. Rectorate | 10. University Library Unit |
| 2. ITC Center | 11. Departement of Ikat Weaving Enggineering |
| 3. Football Field | 12. Faculty of Agriculture |
| 4. Auditorium | 13. Faculty of Medicine |
| 5. Post Graduate School | 14. Faculty of Public Health – Faculty of Law |
| 6. LP2M (Institute for Research and Community Service) | 15. Faculty of Engineering |
| 7. Faculty of Economics and Business – Faculty of Teacher Training and Education | 16. Faculty of Agriculture – Department of Animal Science |
| 8. Institute for Learning Development and Quality Assurance – Internal Audit Unit | 17. UPT Dryland I |
| 9. Faculty of Science and Engineering – Department of | 18. Dormitory of Faculty of Medicine – UPT Dryland |

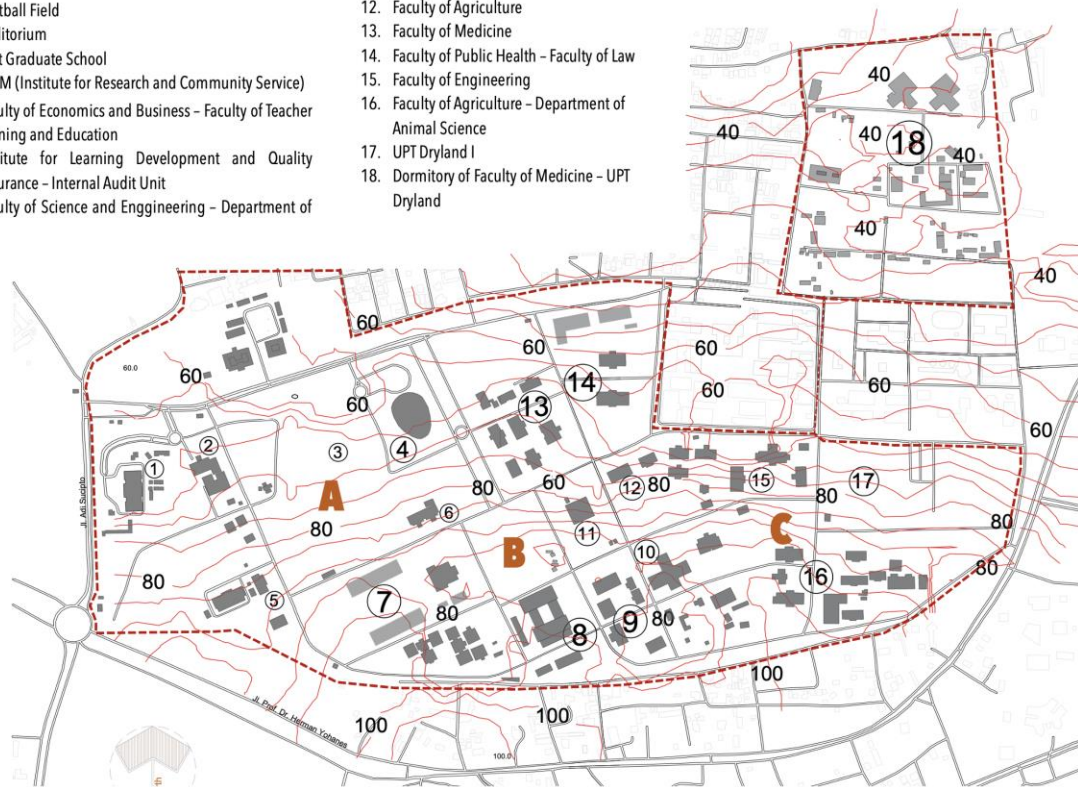


Figure 3. Undana Campus Contour Map

Land B exhibits the most balanced spatial performance, with the highest integration [HH] value (0.48) and relatively high connectivity (3.50), and is located on a flat contour. In the context of Jacobs' (1961) theory of natural surveillance, this land has ideal characteristics for the development of a public space that is safe, active, and easily accessible to the entire academic community, including vulnerable groups. The combination of spatial connectivity, visual openness, and physical accessibility make this location a prime potential location for campus public open space.

Land A has the highest connectivity score (3.75), demonstrating the strength of local connectivity. However, its integration [HH] score is slightly lower than that of Land B (0.45). Topographically, this land also lies on a flat contour, making it highly suitable for supporting pedestrian activities. However, the main problem with Land A lies in its lack of global integration within the campus spatial system, so it does not automatically attract large traffic flows. Therefore, spatial design approaches such as strengthening orienting elements, landmarks, or visual signage systems can increase the social potential of this space.

In contrast, site C recorded the lowest spatial performance, both in terms of connectivity (2.67) and integration [HH] (0.35), and is located on a steeper slope. The combination of low spatial value and topographical constraints indicates structural and physical limitations to support active public space. However, adaptive landscape design approaches, such as the provision of ramps, terraced seating, or open view paths, still allow this space to be optimized, especially if it is directed as a thematic or complementary public space.

As a complement to spatial analysis, this study also examines intelligibility, or the user's ability to understand the spatial system as a whole based on local experience. The scatterplot between connectivity and integration [HH] yields a coefficient of determination R^2 of 0.19837, which is categorized as moderate intelligibility. Within Hillier's theoretical framework, this condition indicates that users need more orientational cues to understand the inter-spatial relationships

comprehensively. Furthermore, Netto [21] emphasizes that intelligibility is not only a morphological attribute, but also a prerequisite for the social logic of space, namely how spatial structure can encourage or limit the potential for social interaction. In this context, even though the intelligibility value is not high, social potential can still be strengthened through the design of clear, open, and visually recognizable spaces.

Considering the moderate intelligibility value of the Undana Campus, it needs to be carefully interpreted in a topographical context. Sloping contours, such as those on site C, can reduce the effectiveness of spatial legibility due to limited visibility and physical obstacles. As emphasized by Lynch [18], good spatial perception must consider not only spatial structure but also visual and physical accessibility. Therefore, good spatial legibility needs to be reinforced with a landscape design that adapts to the land morphology.

Based on the spatial analysis above, the conclusions of the spatial and topographical synthesis are as follows:

1. Land B is the most suitable location for the development of active public spaces, because it combines high spatial performance, sufficient intelligibility, and easy physical access.
2. Land A shows strong potential in terms of local connectivity and ease of access, but requires strengthening of the orientative design to be more socially integrated.
3. Land C serves as a relevant control location for user perception surveys, while demonstrating the importance of adaptive design in areas with low topographic barriers and spatial connectivity.

This finding confirms that a quantitative approach based on space syntax, when combined with the reading of physical conditions and the theory of spatial perception from Lynch and Jacobs, and expanded through the intelligibility framework Hillier & Netto [22] and morphology-based design policies by Palaiologou, G., & Griffiths [23] is able to provide an analytical and practical basis for the development of public open spaces in higher education environments that experience similar problems such as the Undana Campus.

3.3 Results of Accessibility Perception Analysis

To complement the space syntax-based spatial evaluation, this study also conducted a perception survey to assess the extent to which the spatial and topographic structures identified in the previous analysis align with user experiences. Questionnaires were distributed to 100 respondents, consisting of students (80%) and academic staff (20%), with this proportion reflecting each group's level of engagement with the use of public spaces on campus.

Respondents were asked to rate three main variables: accessibility, perception of topography, and the suitability of public spaces. The survey was conducted on three different vacant lots (A, B, and C) that had previously been spatially analyzed. Table 2 shows descriptive data on perceptions of accessibility and suitability of the Undana Campus public space.

Table 2. Descriptive Perception of Accessibility and Suitability of Public Spaces

| Location | Accessibility (Mean±(SD)) | RTP (Mean) Eligibility±Elementary School |
|----------|---------------------------|--|
| A | 3.93±1.08 | 3.73±1.15 |
| B | 3.90±1.16 | 3.66±1.11 |
| C | 3.50±1.25 | 3.60±1.18 |

Location A demonstrated the highest level of perceptual accessibility, with 81% of respondents stating "agree" or "strongly agree" that this location is easily accessible from various points on campus. Similarly, for the public space suitability variable, this location received a positive assessment from 73% of respondents. The mean score of 3.93 with a standard deviation of 1.08 indicates a strong but still fairly widespread perception.

Location B, which has the highest spatial integration value, received a consistently positive response from respondents, with 66% agreeing or strongly agreeing with the accessibility and suitability of this location. A mean of 3.90 and a mode of 5.00 indicate that user perceptions are very positive and uniform. This strengthens the validity of the space syntax results, indicating that land with high spatial performance is also subjectively appreciated by users.

Location C, which has the lowest spatial value and is located on an uphill slope, still showed relatively positive perceptions, albeit more mixed. Approximately 50% of respondents considered the location fairly accessible, but 21% disagreed. This indicates that while the land isn't completely rejected, spatial and topographical limitations impact the user experience.

3.4 Statistical Tests and Implications for Public Space Assessment

To test the relationship between perceived accessibility and the suitability of public spaces, Pearson correlation analysis and simple linear regression were conducted. Details of this relationship can be seen in Table 3, which shows the Pearson correlation between the variables.

Table 3. Pearson correlation between variables

| Variables | r | Sig. (2-tailed) |
|---------------------------------|-------|-----------------|
| Accessibility – RTP Eligibility | 0.582 | 0.000** |
| Topography – RTP Eligibility | 0.758 | 0.000** |

Based on table 3 above, the results show that:

1. Accessibility has a strong and significant relationship with the suitability of public space ($r = 0.582$, $p < 0.01$).
2. The regression results show that accessibility significantly influences the suitability of public spaces with a regression coefficient of 0.438 ($p < 0.000$). The R value = 0.504 and $F = 99.485$ indicate that the regression model adequately explains variations in perceived suitability.

These results reinforce the theoretical framework of Jacobs (1961) and Lynch (1960), stating that ease of access, both physical and perceptual, is an important basis for the creation of functional and appropriate public spaces. Furthermore, perceptions of topography also showed a stronger correlation ($r = 0.758$, $p < 0.01$), confirming that accessibility cannot be separated from land morphology conditions as described in the adaptive landscape design literature.

The independent sample t-test between students and lecturers showed that there was no significant difference in the assessment of the suitability of public spaces ($p = 0.243$), so it can be concluded that perceptions of accessibility are relatively uniform among campus user groups. Furthermore, the results of the ANOVA test on three locations show perceptions between groups and locations with results.

1. Student vs. Lecturer and academic staff t-test: $p = 0.243$ - not significant
2. ANOVA test between locations: $p = 0.9925$ - not significant

This concludes that there was no significant difference in perceived feasibility ($p = 0.925$). This means that despite variations in spatial and topographical values, user perceptions of the feasibility of the three locations remained positive.

3.5 Synthesis between Spatial Performance and User Perception

The results of statistical analysis using simple linear regression indicate that user perceptions of ease of spatial access (X) have a positive and significant effect on the assessment of the feasibility of campus public spaces (Y). A significance value of $0.000 < 0.05$ and a correlation coefficient of 0.497 indicate a moderate and unidirectional relationship: the easier a site is to access from various points

on campus, the higher the user perception of the feasibility of that space as a public space. The results of simple linear regression can be seen in Table 4 below.

Table 4. Simple Linear Regression Results

| Model | R | R | F | Sig | Beta Coefficient | Sig Beta |
|-----------------------------|-------|-------|--------|---------|------------------|----------|
| Accessibility - suitability | 0.504 | 0.254 | 99,485 | 0.000** | 0.438 | 0.000** |

This finding reinforces the results of the previous space syntax analysis, which showed that land areas B and A have relatively high connectivity and integration [HH] values compared to land area C. Land area B, with the highest integration value and flat contour, is the most ideal candidate for development as a public space because it has global spatial integration as well as ease of access locally. This is in line with the theory of Hillier and Hanson [16] that the level of integration and connectivity of a space determines the intensity of movement and social potential within it.

Furthermore, positive perceptions of accessibility also align with Lynch's (1960) principle of imageability, which states that ideal public spaces should be easily accessible and recognizable from multiple directions. Furthermore, these perceptions support Jacobs's [20] principle of natural surveillance, where visual openness and ease of physical access enhance users' sense of security and comfort.

Overall, the questionnaire data reinforces the validity of the spatial findings, suggesting that locations with favorable spatial configurations tend to receive positive user ratings. In other words, quantitative spatial data and user perception data support each other and can provide a strong basis for evidence-based design decisions for campus public spaces.

CONCLUSION

This study concludes that the integration of space syntax-based spatial analysis and user perceptions can provide a comprehensive picture of the feasibility of public spaces within the campus environment. Lands B and A are proven to have high spatial performance and positive accessibility perceptions, making them strategic locations for the development of POS. User perceptions reinforce these findings, with regression results indicating that accessibility has a significant influence on the assessment of the feasibility of public spaces. This suggests that spatial structures that support mobility and visibility contribute to the perception of comfort and social function of spaces. This study recommends that the development of campus POSs consider the actual spatial configuration, user perceptions, and design adaptations to the morphological conditions of the site to create inclusive, feasible, and highly supportive spaces for the well-being of the academic community.

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