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Improving Spatial Connectivity in Multi-Faculty Academic Buildings through Minimal Design Interventions

A Space Syntax Approach to The Megawati Soekarno Putri Building

Muhammad Imam Faqihuddin[1], Rizqi Maulana[2], Muhammad Rafi Musaddad[3], Muhammad Izzuddin Jasim[4)]

[1, 2, 3, 4)] Department of Architecture, Universitas Islam Negeri Maulana Malik Ibrahim, Malang, Indonesia

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Corresponding author:
Muhammad Imam Faqihuddin
imamfaqihuddin@arch.uin-malang.ac.id

Abstract – The spatial configuration of a building plays a crucial role in facilitating daily activities. Previous research has demonstrated that the layout of spaces within a building significantly affects the level of connectivity between rooms. Moreover, existing studies tend to provide recommendations in the form of entirely new spatial designs that differ significantly from existing conditions, thereby reducing the likelihood of successful implementation. The Megawati Soekarnoputri Building at UIN Maulana Malik Ibrahim Malang serves as an intriguing case study for this research due to the varying complexity and spatial characteristics across its different floors. In this study, the Space Syntax method is employed to analyze the connectivity between spaces within the building to demonstrate that the proposed recommendations can optimally preserve existing conditions while effectively enhancing spatial connectivity, thereby making them more feasible for practical implementation. The findings reveal that floors with more rooms and clearly defined physical barriers tend to exhibit lower levels of connectivity. Conversely, floors with fewer rooms generally display higher connectivity. This indicates that to enhance connectivity between spaces, barriers do not necessarily have to be solid physical dividers (such as walls), but could be represented by unique visual cues such as colors or distinctive signs.

Keywords: *Connectivity, space configuration, space syntax, spatial design.*

I. INTRODUCTION

In architecture, space represents a highly essential element within a building (Lee, 2022; Olanusi & Oluwadepo, 2023; Akşehir, 2003). Spaces are arranged in terms of layout and dimensions to achieve optimal, effective, and efficient configurations within the building—whether in the context of energy consumption, comfort levels, or spatial perception (Du et al., 2020; Zhao, 2016; Dehnadfar, 2016). The arrangement of these spaces is typically based on function and circulation between spaces. Users are expected to easily reach and access these spaces as optimally as possible, ensuring that no space becomes difficult to access and subsequently transforms into a negative space (Safizadeh, 2024; Natapov et al., 2020).

Similarly, in campus buildings, the arrangement of spaces that support the learning process (classrooms, libraries, laboratories, etc.) significantly determines learning outcomes. Additionally, the organization of spatial arrangements or spatial configurations also influences the level of connectivity between spaces (Kustiani et al., 2024; Higgins, 2015; Shahbazi et al., 2018). High connectivity between spaces indicates that these spaces are easily accessible and comprehensible to users (Ahmed et al., 2022; Krasheninnikov, 2019). Spatial connectivity also directly influences communication and interaction between lecturers and students (De Borba et al., 2020). Spaces with high connectivity can enhance communication and interaction between them. (Permata et al., 2022; Benkechkache & Kaghouche, 2023). More specifically, if the spaces are difficult for students and faculty to access, or in other words, they require extra effort to reach them, the learning process becomes ineffective as users may already be fatigued before teaching and learning activities begin. (Pham & Ngô, 2023; Zurainan et al., 2021; Jamieson, 2003).

Furthermore, recent studies on academic buildings also highlight that each faculty typically has distinct intra-space requirements shaped by their curricula, learning methods, and functional needs (Cleveland & Fisher, 2014; Jamieson, 2003). Faculties often require specialized room configurations—ranging from laboratories, microteaching rooms, and discussion areas to consultation spaces—which influence their internal spatial organization (Temple, 2008). Meanwhile, the need for inter-space connectivity between faculties tends to be lower, as these academic units operate with differing activity patterns and user flows (Beckers et al., 2016). Previous researches further note that spatial configuration in multi-faculty buildings is often constrained by safety regulations, evacuation standards, and building codes, particularly in multi-storey structures with multiple exits shaping spatial configurations in ways that may not fully support efficient circulation (Cui et al., 2023; Shrahily & Albeera, 2025; Wang et al., 2025; Zhou et al., 2023).

In addition, numerous previous studies have analyzed spatial configurations in buildings with specific functions by measuring the level of connectivity between spaces. The results typically present recommendations for entirely new spatial arrangements that demonstrate high levels of inter-spatial connectivity (Arora & Vidya, 2024; Novalić & Zejnilović, 2019; Sari et al., 2024). Conversely, due to these conditions, implementing such changes requires a significant amount of effort and cost. Consequently, the feasibility of implementation becomes very low, ultimately contributing only to theoretical aspects of the discipline.

In response to those issues, this research aims to demonstrate that spatial connectivity in academic buildings can be improved without requiring a complete reorganization of the existing layout. Instead of proposing extensive structural changes, this study seeks to identify design adjustments that maintain the functional requirements of each faculty while remaining compliant with curriculum needs and safety standards. By showing that meaningful connectivity improvements can be achieved through minimally invasive interventions, this research offers more realistic and feasible recommendations for enhancing circulation and interaction within multi-faculty educational buildings.

In line with this objective, an appropriate case study is required to examine connectivity issues in a complex academic environment. The Megawati Soekarno Putri Building serves as one of the academic buildings at Universitas Islam Negeri Maulana Malik Ibrahim Malang. This building was selected as the case study for this research due to its exceptionally high spatial complexity, consisting of 3 floors and housing 4 faculties: the Faculty of Economics (with 3 study programs), the Faculty of Education and Teacher Training (with 10 study programs), the Faculty of Psychology (with 2 study programs), and the Faculty of Sharia (with 5 study programs). Additionally, this building exhibits unique characteristics on each floor (which will be explained in detail in the results and discussion section). Given these conditions, the Megawati Soekarno Putri Building presents spatial arrangement issues that require reevaluation of connectivity levels using the space syntax method to facilitate more effective and successful teaching-learning processes. From a social perspective, the results of this research are also expected to enhance the quality of social interactions among academic community members within the building.

II. METHODOLOGY

In the initial stage, spatial data for the Megawati Soekarno Putri Building were collected through direct field measurements. These measurements served as the basis for developing a digital model using Revit Architecture 2023. The resulting solid–void floor plans for levels 1, 2, and 3 were subsequently analyzed using the space syntax method with DepthmapX v.0.8.0, which functions as the primary analytical tool for assessing connectivity within the building.

Two forms of analysis were conducted. First, connectivity between faculty zones was evaluated using integrity values, which indicate the degree of accessibility and intelligibility formed by both direct and indirect spatial connections. Second, connectivity for each individual space on every floor was examined using Real Relative Asymmetry (RRA). Higher RRA values represent deeper, less accessible spaces with lower connectivity, while lower RRA values correspond to more integrated and easily reachable spaces (Yamu et al., 2021).

Fig. 1. Space Syntax Color Index
(Source: Author, 2025)

The results of both analyses were visualized through axial maps with color gradations, where red indicates high connectivity and blue denotes low connectivity (Figure 1). These two analytical stages were used comparatively to identify spatial configurations with the highest potential for improved connectivity. Based on these findings, several design recommendations were formulated for campus management and the faculties occupying the building. A summary of the methodological workflow is presented in Figure 2.

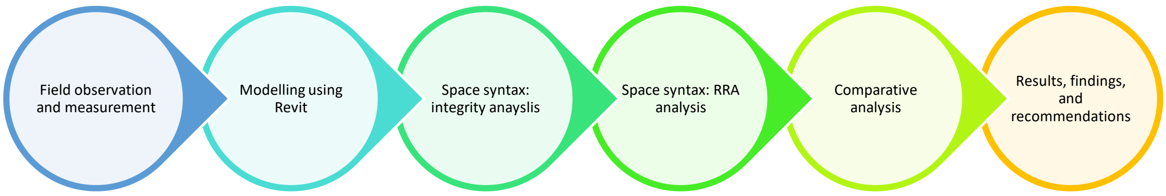


Fig. 2. Research Stages
(Source: Author, 2025)

In this study, the analysis is based on a quantitative, configuration-driven mode of space syntax, focusing on the spatial relationships and movement potentials generated by the existing layout rather than on recorded movement frequencies. Although no formal interviews or behavioural surveys were conducted, the existing room arrangements—including partitions and faculty zoning—reflect adaptations that have occurred over time to meet academic and administrative needs.

III. RESULTS AND DISCUSSION

A. *Case Study Overview*

The Megawati Soekarno Putri Building is located at Universitas Islam Negeri Maulana Malik Ibrahim Malang (Campus 1). This building consists of 3 floors and has a rectangular shape with four sides, each side serving as the main entrance for each faculty: the Faculty of Economics on the west side (with 3 study programs), the Faculty of Education and Teacher Training on the east side (with 10 study programs), the Faculty of Psychology on the north side (with 2 study programs), and the Faculty of Sharia on the south side (with 5 study programs). Consequently, a total of 20 study programs are housed within a single building, indicating an extremely complex spatial configuration. All four sides of the building feature relatively similar facade designs, with only minor differences in the entrance areas (figure 3). In the central area of the building, there is a courtyard that functions as a shared cafeteria surrounded by the four faculties.

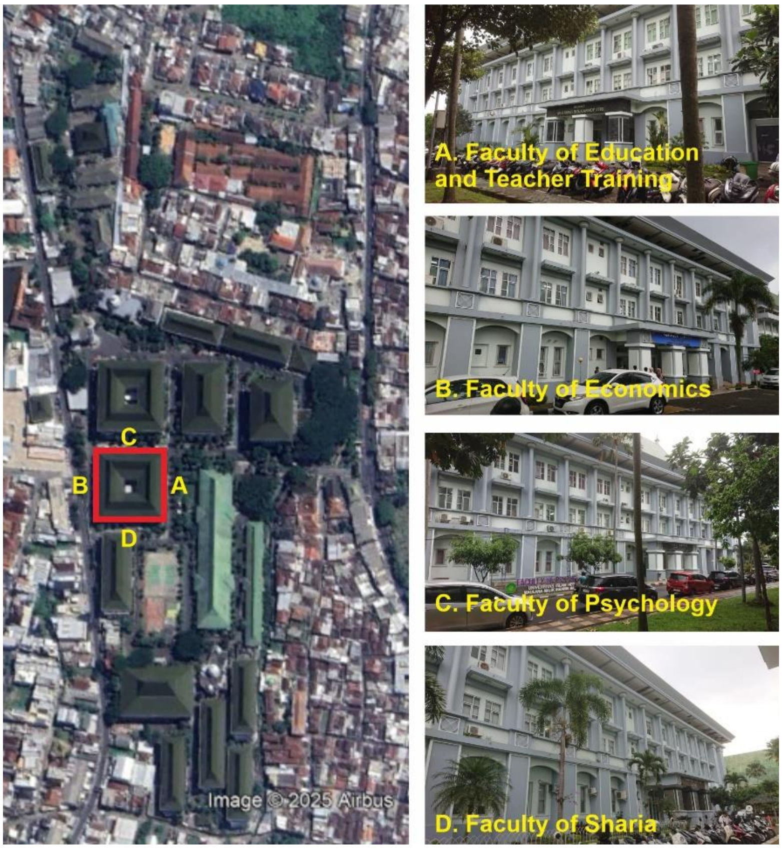
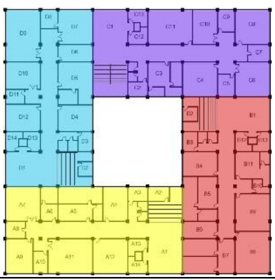
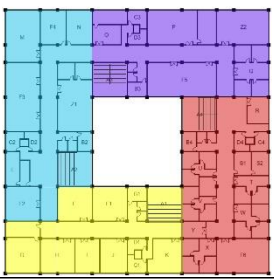
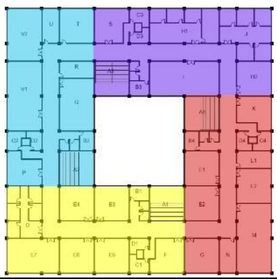


Fig. 3. The Building's Location and Its Façade
(Source: Auhtor, 2025)

Based on table 1, it can be observed that each faculty zone occupies a specific side of the building from the first floor to the third floor. The main entrances to each faculty can only be accessed through their respective sides of the building. To reach the second and third floors, users can utilize the staircases located directly in front of the building entrance in each faculty.

Table 1. The Building's Floor Plans

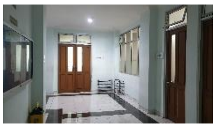
Floor Plan		
		
1st Floor	2nd Floor	3rd Floor

	Faculty of ychology (FP)		Faculty of ducation and Teacher raining (FETT)		Faculty of Sharia 'S)		Faculty of conomics (FE)

(Source: Author, 2025)

Table 2 indicates that on the first floor, physical barriers in the form of walls separate the faculty zones, restricting access to each faculty solely through the main entrance on each side of the building. On the second floor, physical barriers in the form of walls separating corridors exist between the Faculty of Education and Teacher Training and the Faculty of Sharia, as well as between the Faculty of Sharia and the Faculty of Economics. Meanwhile, the Faculty of Psychology and the Faculty of Education and Teacher Training are only separated by non-permanent dividers such as bookshelves, posters, and perforated partitions, allowing visibility beyond these barriers. Additionally, between the Faculty of Psychology and the Faculty of Economics, no physical wall barriers separate the corridors, enabling direct connection between these two faculties. In contrast, on the third floor, no physical barriers separate the corridors, allowing continued access as they directly interconnect between faculties. This is due to the presence of several spaces that can be shared among faculties. From these existing conditions on each floor, it can be concluded that each level possesses varied spatial configuration characteristics.

Table 2. Physical Barriers Identification in The Building

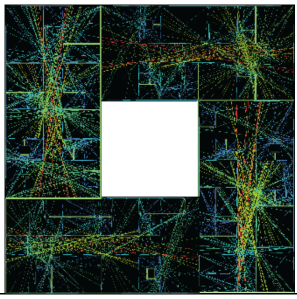
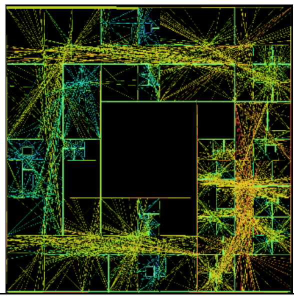
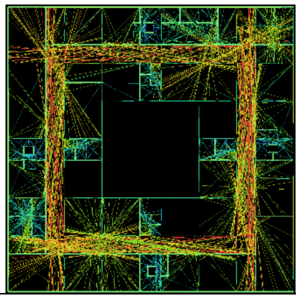
	Barriers between FP-FE	Barriers bertween FP-FETT	Barriers between FETT-FS	Barriers between FS-FE
1st Floor				
2nd oor				
3rd Floor				

(Source: Author, 2025)

B. Results and Findings

The integrity analysis using DepthmapX software on the spatial configuration of the Megawati Soekarno Putri Building reveals significant differences in connectivity levels between faculty zones on each floor (Table 3). On the first floor, the axial lines that appear tend to be blue, indicating low connectivity levels between spaces. This aligns with the existing conditions on the first floor, where physical boundaries in the form of walls separate faculty zones, preventing users from flexibly accessing spaces between faculties on the first floor. In contrast, the integrity analysis results for the second floor show that the axial lines tend to be yellowish-green, depicting moderate connectivity levels between spaces on the second floor. This is due to the condition where zones between faculties are not entirely separated by physical barriers such as walls, particularly between the Faculty of Psychology and the Faculty of Economics, which are directly connected. Consequently, users maintain reasonable flexibility in accessing spaces on the second floor. Differences reappear in the integrity analysis results for the third floor, where the dominant axial line color is reddish-orange, indicating relatively high connectivity values between spaces. This is supported by the existing conditions of faculty zones that are not separated by physical barriers such as walls, allowing users to very flexibly access spaces between faculties on the third floor as they are interconnected with one another.

Table 3. Integrity Analysis Result

		
1st Floor	2nd Floor	3rd Floor

(Source: Author, 2025)

Therefore, from the integrity analysis of inter-faculty zones on floors 1-3, it is evident that physical boundaries in the form of walls separating faculty zones result in very low connectivity values between zones. With physical wall barriers in place, users cannot easily access inter-faculty zones and must exit the building to reach other faculties. This condition significantly complicates user movement by extending access distances, requiring additional time, and demanding extra energy. However, if these physical wall barriers were removed, the management and operational systems between faculties would become faster, easier, more effective, and more efficient. Additionally, students could more easily access shared facilities from various closest directions. Consequently, it can be concluded that the more primary circulation paths connecting spaces are interconnected (without physical barriers separating them), the higher the connectivity level of these spaces within a spatial configuration. Thus, the presence of physical barriers in the form of walls separating corridors between faculties becomes the primary factor causing low connectivity values between zones, or it can be said that inter-faculty access is inflexible and relatively difficult.

After analyzing the connectivity levels between faculties, the next step is to analyze connectivity levels between rooms on each floor. At this stage, the objective is to identify the spatial configuration model with the highest connectivity value from each floor, each possessing different spatial configuration characteristics. The rooms on each floor are coded according to their current functional use, which was verified through field observation during data collection. Their RRA values calculated and then presented in tabular form. Previously, the range of RRA values was categorized into high, medium, and low connectivity, which was then also translated using a color scheme of red (high), yellow (medium), and blue (low). This reveals the number of rooms in each category on each floor. Subsequently, a comparative analysis is conducted to compare spatial connectivity levels between floors to determine the spatial configuration model with the highest connectivity value.

Table 4. RRA Analysis Result of Each Room on The 1st Floor

1st Floor Plan and The Room Codes

RRA Value Parameters in 1st Floor	
0,21-0,37	High Connectivity
0,38-0,53	Medium Connectivity
0,54-0,69	Low Connectivity

RRA Value for Each Room in 1st Floor

Room Code	RRA Values	Indicator	Room Code	RRA Values	Indicator
A1	0,48		C1	0,60	
A2	0,47		C2	0,63	
A3	0,39		C3	0,69	
A4	0,41		C4	0,58	
A5	0,67		C5	0,37	
A6	0,42		C6	0,58	
A7	0,39		C7	0,40	
A8	0,41		C8	0,37	
A9	0,32		C9	0,40	
A10	0,40		C10	0,40	
A11	0,39		C11	0,35	
A12	0,34		C12	0,60	
A13	0,54		C13	0,39	
A14	0,50		D1	0,63	
B1	0,47		D2	0,40	
B2	0,43		D3	0,63	
B3	0,50		D4	0,32	
B4	0,30		D5	0,61	
B5	0,49		D6	0,23	
B6	0,50		D7	0,54	

B7	0,42		D8	0,54	
B8	0,24		D9	0,50	
B9	0,22		D10	0,26	
B10	0,21		D11	0,40	
B11	0,50		D12	0,33	
B12	0,47		D13	0,63	
B13	0,29		D14	0,53	

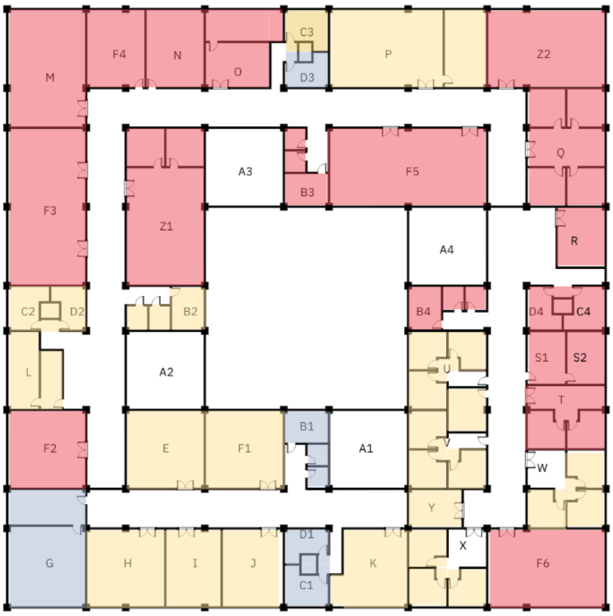
(Source: Author, 2025)

Based on the coding results, the total number of rooms on the first floor is 54. The RRA value calculations presented in table 4 indicate that there are 14 rooms categorized as having low connectivity values, 26 rooms with medium connectivity levels, and 14 rooms with high connectivity values.

The low connectivity values found on the first floor indicate a highly fragmented spatial structure, where movement between rooms depends on long and indirect circulation paths. This condition suggests that users—particularly students moving between classes or services—experience limited spatial choice and reduced visibility of alternative routes. As a result, wayfinding becomes less intuitive, and spontaneous social interactions are less likely to occur. The compartmentalized layout formed by faculty-based zoning and multiple enclosed room clusters creates deeper circulation structures, reinforcing the separation between activity areas. This spatial segregation aligns with the low integration values observed and highlights how the current configuration may hinder cross-faculty accessibility and reduce the overall efficiency of user movement on this level.

Tabel 5. RRA Analysis Result of Each Room on The 2nd Floor

2nd Floor Plan and The Room Codes



RRA Value Parameters in 2nd Floor	
0,61-0,84	High Connectivity
0,85-1,07	Medium Connectivity
1,08-1,32	Low Connectivity

RRA Value for Each Room in 2nd Floor

Room Code	RRA Values	Indicator	Room Code	RRA Values	Indicator
B1	1,1		I	1,02	
B2	0,91		J	1,03	

B3	0,81		K	0,93	
B4	0,77		L	0,86	
C1	1,32		M	0,66	
C2	0,85		N	0,63	
C3	1,01		O	0,83	
C4	0,61		P	0,91	
D1	1,32		Q	0,84	
D2	1,02		R	0,72	
D3	1,1		S1	0,80	
D4	0,79		S2	0,83	
E	1,02		T	0,83	
F1	0,88		U	1,01	
F2	0,77		V	1,04	
F3	0,74		W	1,02	
F4	0,71		X	0,85	
F5	0,81		Y	0,85	
F6	0,85		Z1	1,23	
G	1,13		Z2	0,66	
H	0,99				

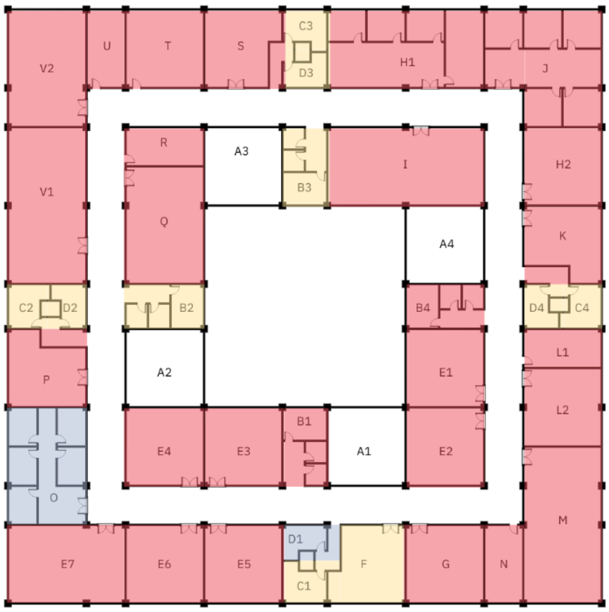
(Source: Author, 2025)

Based on table 5, it can be observed that the second floor contains a total of 41 rooms. Additionally, 6 rooms are categorized as having low connectivity, 18 rooms with medium connectivity, and 17 rooms with high connectivity levels.

The second floor displays moderate connectivity, indicating a transitional condition between the highly segregated first floor and the more accessible layout found on the third floor. Although some circulation paths are interconnected, the presence of internal rooms and semi-isolated faculty zones still generates local depth, which restricts movement choice. This suggests that users may navigate the level with slightly greater ease than the first floor, yet interaction between different clusters of rooms remains limited. The configuration reflects a spatial hierarchy where certain corridors act as local connectors, but do not successfully establish a coherent overall circulation system. Consequently, the spatial experience on this floor remains functionally adequate but less supportive of broader interaction and spatial legibility across faculty areas.

Table 6. RRA Analysis Result of Each Room on The 3rd Floor

3rd Floor Plan and The Room Codes



RRA Value Parameters in 3rd Floor	
0,28-0,48	High Connectivity
0,49-0,68	Medium Connectivity
0,69-0,88	Low Connectivity

RRA Value for Each Room in 3rd Floor

Room Code	RRA Values	Indicator	Room Code	RRA Values	Indicator
B1	0,45		G	0,38	
B2	0,65		H1	0,42	
B3	0,61		H2	0,46	
B4	0,43		I	0,42	
C1	0,66		J	0,45	
C2	0,64		K	0,47	
C3	0,63		L1	0,47	
C4	0,67		L2	0,32	
D1	0,88		M	0,38	
D2	0,64		N	0,38	
D3	0,63		O	0,69	
D4	0,67		P	0,43	
E1	0,38		Q	0,35	
E2	0,43		R	0,45	
E3	0,37		S	0,44	
E4	0,36		T	0,35	
E5	0,37		U	0,28	
E6	0,35		V1	0,45	
E7	0,36		V2	0,35	
F	0,49				

(Source: Author, 2025)

Table 6 demonstrates significant differences in RRA values for rooms on the third floor when compared to RRA values for rooms on the first and second floors. The total number of rooms on the third floor amounts to 39. There are only 2 rooms with low connectivity and 10 rooms with medium connectivity levels. Meanwhile, the number of rooms with high connectivity levels reaches 27 rooms.

The third floor demonstrates the highest connectivity among all levels, reflecting a more open and integrated spatial structure. The dominance of shared or less compartmentalized functions on this floor reduces spatial depth and increases the number of movement options available to users. This configuration not only supports efficient circulation but also encourages visual connection and spontaneous interaction, consistent with the high integration and intelligibility values found in the analysis. The openness of this level suggests that when programmatic functions are less strictly divided and physical barriers are minimized, spatial connectivity increases naturally. This finding reinforces the argument that improving circulation does not necessarily require major structural alterations, but can emerge from targeted adjustments to internal partitions and movement networks.

Tabel 7. Comparative Analysis of RRA Values, Number of Rooms, and Spatial Connectivity Levels

1st Floor		2nd Floor		3rd Floor	
Spatial onnectivity Levels RA Values)	Number of oms	Spatial onnectivity Levels RA Values)	Number of oms	Spatial onnectivity Levels RA Values)	Number of oms
High onnectivity (0,21-37)	14 rooms	High onnectivity (0,61-84)	17 rooms	High onnectivity (0,28-48)	27 rooms
Medium onnectivity (0,38-53)	26 rooms	Medium onnectivity (0,85-07)	18 rooms	Medium onnectivity (0,49-68)	10 rooms
Low onnectivity (0,54-69)	14 rooms	Low onnectivity (1,08-32)	6 rooms	Low onnectivity (0,69-88)	2 rooms
Total	54 rooms	Total	41 rooms	Total	39 rooms

(Source: Author, 2025)

From the comparative analysis presented in table 7, it can be observed that the fewer rooms within a spatial configuration, the higher the connectivity level between rooms. This is also influenced by primary circulation paths that interconnect with one another; thus, the better these rooms connect with the main circulation routes, the higher their connectivity levels. This statement is evidenced in the spatial configuration of the third floor, which has the fewest number of rooms and corridors that are well-connected to each other (without being separated by walls).

Conversely, the greater the number of rooms within a spatial configuration, the lower the connectivity level between rooms. Primary circulation paths that do not interconnect also contribute to decreased connectivity levels between rooms. This condition is apparent in the spatial configurations of the first and second floors, which have more rooms compared to the third floor. Many rooms have high depth levels and cannot be accessed directly from corridors but require entering other rooms first (rooms within rooms). Additionally, the segregated corridors between faculties on the first and second floors further reduce connectivity levels between rooms.

Therefore, based on the findings of this research, several recommendations can be considered by campus management to enhance connectivity between rooms in the Megawati Soekarno Putri Building: (1) removing/demolishing walls that separate corridors between faculties, (2) implementing an open plan concept in the interior to minimize rooms within rooms, (3) utilizing color elements or special markers (signage) as boundaries between faculty zones while simultaneously serving as distinctive identities differentiating between faculties. These recommendations significantly contribute to improving the quality of social interactions and further facilitating access for all academic community members to the facilities needed to support academic development.

These proposed strategies emerge directly from the connectivity patterns identified in the analysis, which indicate that spatial barriers and fragmented circulation paths are the primary factors contributing to low accessibility on several floors. Because the connectivity issues are largely caused by non-structural partitions rather than core building elements, the required improvements can be achieved through targeted and minimally invasive modifications. This ensures that the interventions are low-cost strategies compared to full spatial reconfiguration or structural remodeling commonly proposed in previous studies. Therefore, the proposed solutions offer a more feasible and economically realistic alternative for campus management, particularly in the context of resource-limited educational institutions.

In addition to improving spatial connectivity, the recommended interventions do not interfere with the functional requirements of each faculty nor with the curriculum-related activities conducted within their respective zones. The proposed adjustments maintain the existing academic room configurations and do not require relocating core teaching or administrative spaces. Furthermore, because the recommendations focus on selective wall removal and improving corridor continuity—without altering emergency exits or obstructing evacuation paths—they remain compliant with safety and building regulations. This indicates that the proposed connectivity improvements can be implemented while still preserving the operational integrity, curricular needs, and safety standards of the building.

IV. CONCLUSION

Space constitutes a fundamental dimension of everyday human experience, yet numerous studies have demonstrated that many built environments, upon systematic evaluation, fail to meet accessibility and usability standards. Conventional recommendations from such studies frequently necessitate extensive demolition or major structural modifications, resulting in prohibitively expensive interventions that remain unrealized—ultimately serving only as theoretical references rather than actionable solutions. This research addresses this persistent gap by proposing recommendations that minimize physical alterations to existing conditions while maximizing functional improvements in spatial connectivity.

The Megawati Soekarno Putri Building at Universitas Islam Negeri Maulana Malik Ibrahim Malang was purposively selected as a case study due to its complex spatial characteristics that vary distinctly across floors. This rectangular structure comprises three floors accommodating four faculties, each occupying one side of the building. The spatial organization demonstrates a notable gradation: the first floor features complete separation between faculties through solid walls; the second floor exhibits partial interconnection between certain faculties; and the third floor presents fully connected corridors without dividing partitions.

Space syntax analysis revealed that these varying configurations directly correspond to measurable differences in connectivity levels across floors. The third floor, characterized by the fewest number of rooms and unobstructed inter-faculty corridors, demonstrated the highest connectivity values—empirically validating that enhanced spatial accessibility can be achieved through selective wall removal along corridors, adoption of open-plan interior configurations, and implementation of visual differentiation systems such as color coding or distinctive signage to maintain faculty identities without physical barriers.

The significance of these findings lies in their practical applicability. Unlike recommendations from previous studies that often prove economically unfeasible, the proposed interventions target non-structural elements and can be implemented through minimally invasive modifications. This approach ensures that connectivity improvements remain achievable within the resource constraints typical of educational institutions, while simultaneously preserving functional requirements, curricular activities, and compliance with safety regulations. Ultimately, these evidence-based recommendations are expected to enhance social interaction quality and facilitate equitable access to educational spaces that support the academic development of the entire university community.

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