The Analysis of Spatial Configuration During the Pandemic
(Case Study: Student Dormitory)

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ABSTRACT
In the pandemic era, social distancing has an effect on the social interactions of occupants of student dormitory. Dormitory housing is one way of improving learning services in pandemic-affected universities. Typically, this study will examine a sample of ITERA student dormitories3 in Bandar Lampung. The spatial configuration relationship of buildings affects the movement of users' social activities through the circulation path (entrance halls, stairways, and hallways). The purpose of this research is to determine the optimal design plan for two distinct types of circulation (atrium corridors and double-loaded corridors) as well as to propose the optimal spatial design for use as a location capable of implementing social distancing procedures in the two cases studied. This study used the spatial configuration approach to assess the connectivity, integration, and visibility attributes in order to achieve the best possible results in terms of spatial accessibility. The aims of this study are to analyze spatial configurations inside the accessibility area in order to determine the ideal design type for applying social distancing. Analyzing the spatial configuration provided quantitative data for space syntax analysis. Projecting movement and view areas onto selected building plans showed users' interaction potential. Connectivity, integration, visibility, and isovist are all numerical values analyzed by the DepthmapX software. The findings of this study suggest that the best type of circulation between the two is the double-loaded corridor, which provides the highest integration and visibility values. This research is hoped to assist building users in implementing social distancing procedures in the case of a pandemic and architects in developing pandemic-friendly design solutions for optimal circulation areas in student dormitory buildings.

Keywords: *Spatial configuration, Social interaction, Dormitory, Pandemic.*

1. INTRODUCTION

The COVID-19 epidemic has impacted all aspects of civilization. By limiting the number of people in universities and ensuring a safe distance between students and staff, several countries have reduced the risk of virus transmission [1]. This surely impacts many elements of university education. However, there were no established parameters for universities to take into account during national situations, resulting in heterogeneity [2]. The virus is rapidly spreading in Indonesia, where it first appeared in March 2020 [3]. The COVID-19 pandemic causes students to physically withdraw. Activities such as social gatherings, sports, and group study [4] must be tightly regulated in the new normal era. Individuals sharing a dormitory have trouble maintaining physical separation. They routinely mingle, exercise, socialize, and share equipment [5]. Social distancing procedures that apply to large populations, such as entrance halls, stairways, and hallways. They will soon implement social distancing in accessibility areas and compare the best typology plans of dormitory for social distancing.

Building circulation connects exterior and interior spaces and represents the building's general spatial organization [6]. The movement illustrates how spatial and configuration patterns affect users [7]. To produce a complete picture of education building spatial arrangements that enable specific educational techniques, space syntactic analysis is performed [8]. The corridor layout allows for room circulation [9].

Hillier defines configuration as a collection of mutually exclusive interactions, each of which is specified by its relationship to the others. Space can be described in three distinct ways. People can move in a straight line (convex), or space can be viewed as a shifting form from any point [10]. Space syntax is an attempt to build a configurational theory in architecture by identifying how spatial configurations express social or cultural meaning and generate social interactions in constructed spaces [11].

Dormitory is one way to support education in pandemic-affected universities. Various restrictions demand restricting the number of dorm inhabitants to control the spread of the infection. This study typically uses a sample of ITERA student dormitories in Bandar Lampung as a case study.

The ITERA student dormitories have two typologies of different spatial forms based on the circulation type: the atrium corridor type and the double-loaded corridor type. Sampling in this study focuses on finding the value of spatial configuration analysis in the main entrances, corridors, and stairways as areas of accessibility and circulation for building users. See figure 1 bellow.

(a)

(b)

Figure 1 (a) Student dormitory 2; (b) Student dormitory 3.

The purpose of this study is to analyze the areas in which users interact socially, specifically in accessibility areas. The object areas evaluated are meeting points, entrances, and corridors, which are often visited by users as they enter the building. Additionally, this paper presents the spatial design that is optimum for usage as a place capable of implementing social distancing procedures in the two cases analyzed.

2. RESEARCH METHODOLOGY

The points of this research method are taken from areas considered to be fictionalized and used for social interaction, from spaces that are essential parts of the spatial configuration (entrances and circulation: nodal points, corridors, endpoints of the circulation). The parameters under investigation were chosen based on previous research on social interaction in a variety of different buildings with a variety of different circulation types. See figure 2 bellow.

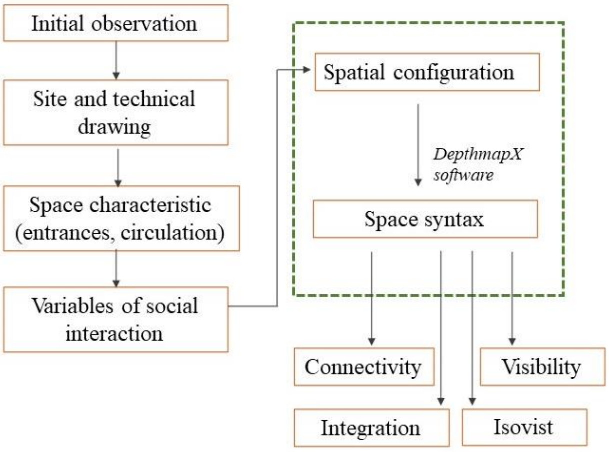


Figure 2 Research workflow.

By analytically evaluating the spatial configuration using space syntax analysis, quantitative data was obtained for space syntax analysis. The potential for users to interact has been determined by projecting movement and view areas on selected building plans. The use of the DepthmapX software to evaluate the spatial configuration values [12] such as connectivity, integration, visibility and isovist are all numerical values [9].

A types of visibility analysis may be built from a path to show human experiences as they walk across space. The Visibility Graph Analysis is suitable for evaluating path or movement visibility, and it can be used to increase safety because both natural and man-made factors can alter sight line. Isovist is used to analyze architectural space and urban morphology. In this case, Isovist and Visibility Graph Analysis are ideal tools. Some studies have combined approaches to the indoor environment [13].

The current study examines integration, an often-referenced visibility graph measure. Units are ranked "from the most integrated to the most segregated" based on their average depth from their surrounding units [14].

3. RESULTS

3.1. The Student Dormitory 2 Building

The Student Dormitory 2 building, with a floor area of 1152 m^2, has an atrium corridor type which is limited by a void in the middle of the building. Each corridor connects spaces with vertical access to circulation in the form of a main staircase located in the middle as the main access in the building, as well as the left corner of the building and the right corner as emergency circulation access.

The accessibility of points in student dormitories is illustrated in Figure 3. The main entrance faces south, while the side entrance faces north. Each floor's corridor accessibility is constrained by a circulation area comprised of stairs in the building's center and on its left and right sides. See figure 3 bellow.

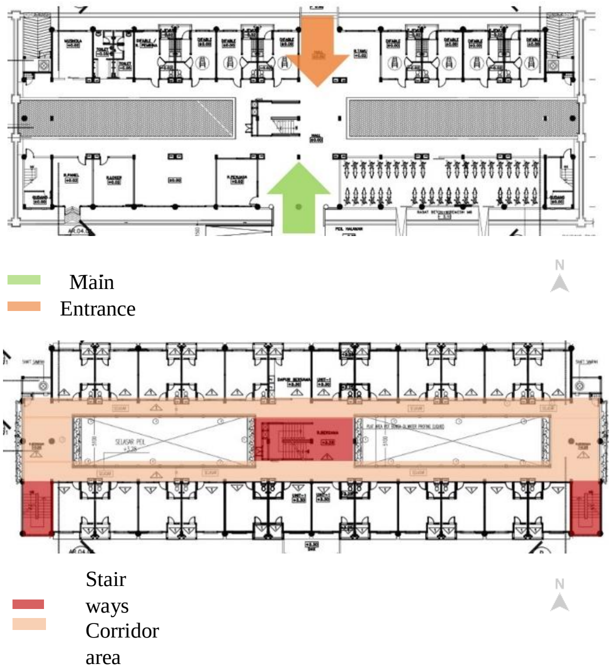


Figure 3 Accesibility point of student dormitory 2.

The visibility map and isovist map provided by the DepthmapX software program were used to analyze the floor plan for the selected area.

The visibility map depicts the relationship between connectivity to the first and second point moments. The first and second moments are used to define an object's area distribution with respect to its axis.

The representation of the results of the analysis is expressed in terms of spectral color gradations in the image. The higher the value of the visibility graph, the more it is marked in red. Conversely, the lower the value of the visibility graph is marked in blue. See figure 4 bellow.

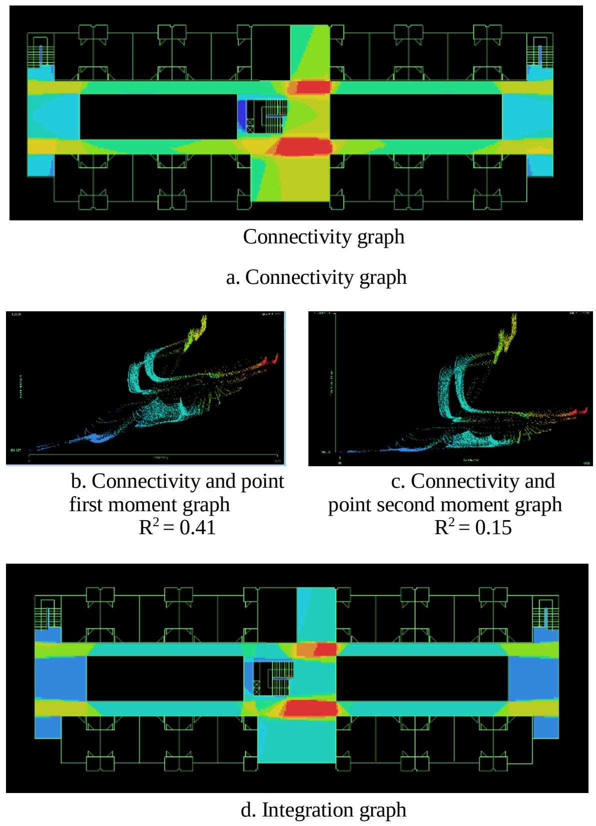


Figure 4 Student dormitory 2 visibility map analysis.

The visibility graph in Figure 4 presents the most visible areas of the student dormitory 2 building's floor plans. The parts that are most visible are emphasized in red and orange, while the areas that are least visible are emphasized in dark blue and blue. In this building, the correlation (R2) between connectivity and point first moment is 0.41, while the correlation (R2) between connectivity and point second moment is 0.15.

Table 1 presents the attribute summary of the visibility map analysis of the student dormitory 2 building floor plan. This concludes value as a result of connectivity, integration, and mean depth. The value of the attribute summary obtained includes the following: the average connectivity value is 3391.83, the integration value is 12.99, and the mean depth value is 0.47.

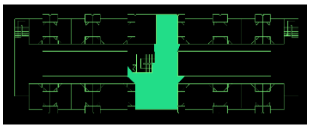
The field of view and control of the main entrances, side entrances, and vertical circulation in this building, including the covered field of view, were established using the Isovist map analysis.

Table 1. Attributes summary of spatial layout based on visibility map analysis

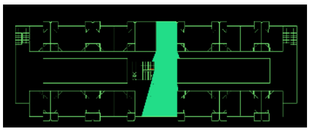
Attributes	Min	Avg.	Max
Connectivity	98	3391.83	6629
Integration	5.97334	12.9914	24.8127
Mean depth	0.252967	0.475687	1.19511

Figure 5 presents an isovist map analysis of the student dormitory 2 floor plans. The results of the isovist analysis show the user's perspective on a 360-degree scale, as seen from the main entrances, side entrances, and vertical circulation (stairways).

Main entrances field of view



Side entrances field of view



Vertical circulation (stairways) field of view

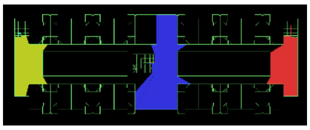


Figure 5 Student dormitory 2 isovist map analysis.

Table 2 presents the attribute summary of the isovist map analysis on the student dormitory 2 building floor plan. The value of the attribute summary obtained includes the following: the value of the main entrance field of view is 162.03, the value of the side entrance field of view is 132.74, and the vertical circulation (stairways) is 75.3.

Table 2. Attributes summary of spatial layout based on isovist map analysis

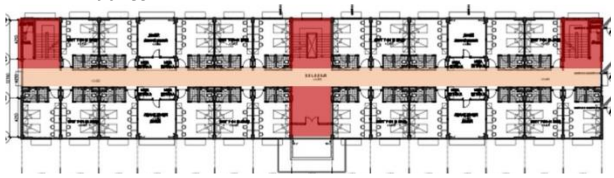
Attributes	Min	Avg.	Max
Main entrances	162.03	162.03	162.03
Side entrances	132.74	132.74	132.74
Vertical circulation	0.24	75.3	152.77

3.2. The Student Dormitory 3 Building

The Student Dormitory 3 building has a floor area of 816 m^2 with a double-loaded corridor type circulation that connects each room in the building. The main circulation access is in the form of a main staircase in the middle of the building, while emergency circulation access is located in every corner of the building.

From Figure 6, it can be seen that there are two entrances to the building, namely the main entrance, which faces the north of the building. The side entrance area is on the right and left sides of the building, facing the west and east of the building.

Main Entrance

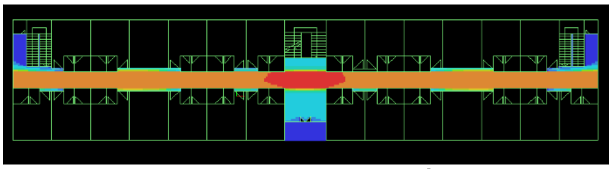


Stair ways

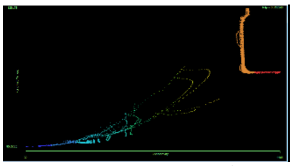
Corridor area

Figure 6 Accessibility point of student dormitory 3.

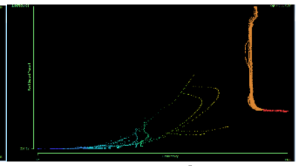
The visibility graph is composed of images from connectivity and integration analysis. The analysis results are represented in the image as spectral color gradations. The higher the value of the visibility graph, the more it is marked in red. Conversely, the lower the value of the visibility graph is marked in blue.



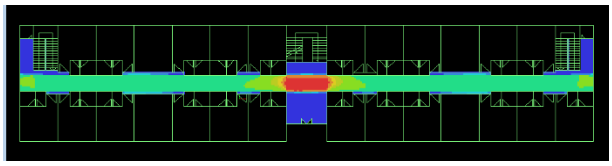
a. Connectivity Graph



b. Connectivity and Point first moment graph $R^2 = 0.81$



c. Connectivity and Point Second moment graph $R^2 = 0.55$



d.Integration Graph

Figure 7 Student dormitory 3 visibility map analysis.

The visibility graph in figure 7 depicts the most visible areas of the floor plans of the student dormitory

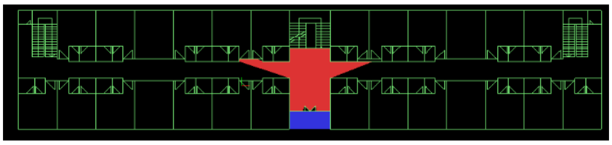
3 building. The parts that are most visible are emphasized in red and orange, while the sections that are least visible are emphasized in dark blue and blue. In this building, the correlation (R^2) between connectivity and point first moment is 0.81, while the correlation (R^2) between connectivity and point second moment is 0.55.

Table 3 presents the attribute summary of the visibility map analysis of the student dormitory 3 building floor plan. This concludes value as a result of connectivity, integration, and mean depth. The value of the attribute summary obtained includes the following: The average connectivity value is 2896.43, the integration value is 29.78, and the mean depth value is 0.17.

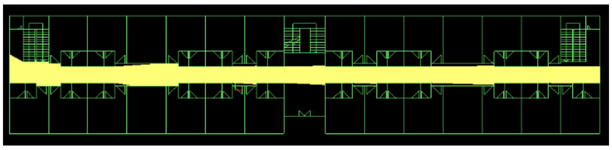
Table 3. Attributes summary of spatial layout based on visibility map analysis

Attributes	Min	Avg.	Max
Connectivity	32	2896.43	4465
Integration	7.97	29.78	71.61
Mean depth	0	0.17	1.03

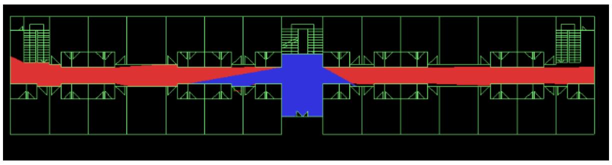
Figure 8 presents an isovist map analysis of the student dormitory 3 floor plans. The results of the isovist analysis show the user's perspective on a 360-degree scale, as seen from the main entrances, side entrances, and vertical circulation (stairways).



a. Main entrances field of view



b. Side entrances field of view



c. Vertical circulation (stairways) field of view

Figure 8 Student dormitory 3 isovist map analysis.

Table 4 presents the attribute summary of the isovist map analysis on the student dormitory 3 building floor plan. The value of the attribute summary obtained includes the following: the value of the main entrance field of view is 29.69, the value of the side entrance field of view is 151.25, and the vertical circulation (stairways) is 83.87.

Table 4 Attributes summary of spatial layout based on isovist map analysis

Attributes	Min	Avg.	Max
Main entrances	10.53	29.69	48.85
Side entrances	151.25	151.25	151.25
Vertical circulation	47.91	83.87	151.05

4. DISCUSSION

Connectivity, integration, and visibility were found to be the most important factors in both analyses (Visibility map analysis and Isovist map analysis).

According to the analysis of the visibility map, the highest visibility correlation was found in the student dormitory 3 building with a double-loaded corridor type circulation for the first moment point (R^2 = 0.81), and the second moment point (R^2 = 0.55). The lowest was in the student dormitory 2 building, with an atrium corridor type for the first moment point (R^2 = 0.41), and the second moment point (R^2 = 0.15).

The highest connectivity values were recorded in the atrium corridor type (3391.83), while the highest integration was recorded in the double-loaded corridor type (29.78). The lowest mean depth value (less isolated, more integrated) was scored in the double-loaded corridor type (0.17). This means that the optimal correlation between visibility and connectivity was determined using the type of atrium corridor with the highest connectivity value.

According to the analysis of the isovist map, the values for atrium corridor type and double-loaded corridor plan indicate the highest covered area of views (high visibility) in the selected areas (main entrance, side entrance, vertical circulations). The atrium corridor type has the main entrance with the highest field of view (162.03). The atrium corridor type has the lowest field of view areas from side entrances (132.74). Vertical circulations with the highest field of view areas are seen in double-loaded circulation types (83.87). This meant the best field of view from the main entrance area was found in the atrium corridor type. The double -loaded corridor type has the best field of view from the side entrance and vertical circulation.

The most integrated area has the highest integration value, indicating that it is more accessible or most accessible. According to the results of the visibility map analysis, the type with the highest integration value (29.78) is the double-loaded corridor because, based on the layout of the floor plan, the space is an open plan with affordable and close relationships between spaces. access points (entrances, stairways) that are not blocked by voids.

As shown in the findings of this study, the best type of circulation for achieving the highest values is the double-loaded type, as it has the highest visibility and integration values in terms of spatial characteristics and functional integration of space. In terms of social distancing in the area, it refers to the highest integration value obtained from that type due to the open plan layout and affordable and close relationships. Access points (entrances, stairways, corridors) that are not blocked by voids are suitable for implementing social distancing amongst space users.

5. CONCLUSION

Circulation design is necessary to determine the effectiveness of mobility, accessibility, and visibility on social interactions within a building. The student dormitory is one of the buildings that requires social distancing procedures in the current pandemic era, as the level of social interaction between users is quite high, with various joint activities occurring within the building. As a result, building design must be regulated in order to maximize the social interactions that occur. One of the initiatives is to examine the internal character of the spatial configuration and functionality of the accessibility spaces (entrances, stairways, and corridors), which serve as the focal point for building user interactions.

This relationship between spatial configuration and accessibility area is examined in this study, using two distinct types of circulation (atrium type corridor and double-loaded type corridor). The study's findings imply that the best type of circulation between the two is the double-loaded corridor type, which achieves the highest integration and visibility values. This type, on the other hand, has a lower degree of connectivity. It can be influenced in this case by the smaller correlation between areas (mean depth).

However, the spatial configuration relationship for the circulation type case requires additional investigation. One method is to compare it to a variety of other circulation types in order to determine the most optimal design for the dormitory building.

This study is the first step toward analyzing the spatial configuration relationship, which has the potential to be studied with additional types of circulation. It is hoped that this research will assist building users in implementing social distancing procedures during a pandemic and also architects in developing pandemic-friendly design solutions for optimal circulation areas in student dormitory buildings.

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