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Study of Pedestrian Path Connectivity Using Urban Network Analysis in the Bojong Gede Station Area, Bogor

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ARTICLE INFO

Keywords:
Bojong Gede Station; connectivity; Urban Network Analysis (UNA); spatial characteristics.

ABSTRACT

The Bojong Gede area, which is the current research location, is a mixed area consisting of stations, terminals, markets, shopping centers, education, offices, and housing. The urban layout occurs naturally without an overall urban layout concept. This study aims to identify spatial characteristics and factors that affect connectivity on pedestrian paths in the area around Bojong Gede station. To determine the level of connectivity, the Urban Network Analysis (UNA) tool is used, which is a quantitative analysis that includes three main elements in an urban area, namely roads, intersections, and buildings that represent the built environment. UNA is used to assess environmental quality quantitatively. This includes unplanned areas such as Bojong Gede. The results of the analysis are in the form of potential and problems that will be followed up with design proposals. The UNA study is then compared with the criteria of urban design elements, because the indicators resulting from UNA cannot stand alone to interpret the results of the analysis. The results show that UNA is very effective in assessing the quality of organically growing urban environments.

INTRODUCTION

In the Transit Connectivity Plan, connectivity refers to the elements that make up a transportation network. It refers to the extent to which a road network or road system is connected and its continuity within the network. When connectivity is increased, travel distances become shorter, and route choices increase, making travel more convenient, and moving between destinations more efficient. In addition, it creates a transportation system that is easily accessible.

The Bojong Gede area which is the current research location is a mixed area consisting of stations, terminals, markets, shopping centers, education, offices and settlements that develop organically so that the city's spatial planning occurs naturally. The area around Bojong Station with a fairly high number of rail-based transportation users is the main factor in the movement of people who should be friendly to pedestrians, however, the main transportation for the Bojong Gede community is private motorized vehicles. Therefore, connectivity and accessibility on pedestrian paths need to be improved immediately, because access for pedestrians to Bojong Gede station is inadequate, causing people to prefer private motorized vehicles or online motorcycle taxis rather than walking, there is still a lack of alternative routes for pedestrians for the surrounding community to reach the station. the length of the distance and time that must be taken when walking and connectivity and accessibility in the area which is also influenced by the Jakarta - Bogor railway which separates the area on the West side and on the East side of the Station.

Several studies have explored pedestrian path connectivity and urban network analysis, with a focus on enhancing walkability and transportation systems in urban environments. Research by (Srikanth et al., 2022) on urban network analysis (UNA) highlighted the effectiveness of UNA in evaluating connectivity, accessibility, and pedestrian mobility in dense urban areas. Studies by (Ardani & Imanullah, 2021) and (Iksanti, 2021) also used UNA to assess the placement of public transportation shelters and walkability design, providing insights into improving pedestrian infrastructure in station areas. However, few studies have focused specifically on the Bojong Gede area, an unplanned urban environment with mixed land uses, where connectivity for pedestrian paths remains a challenge despite its high commuter traffic.

Urban areas across the world are continuously evolving, and transportation networks play a vital role in shaping their development. The integration of efficient transport systems is essential for achieving sustainable urban mobility and improving accessibility for residents. Urban network analysis (UNA) is a tool that has gained recognition for assessing the spatial structure and connectivity of cities, enabling planners to identify areas that need improvement. The effectiveness of UNA in analyzing urban areas is supported by research conducted by

(Della Porta & Tarrow, 2005), who highlight the utility of UNA in evaluating connectivity and network centrality, which are key to improving pedestrian mobility. By studying connectivity in urban areas, cities can create pedestrian-friendly environments that foster inclusivity and ease of movement.

Connectivity is not just about ensuring that roads and paths are connected; it also involves understanding the relationships between these networks and how they facilitate or hinder pedestrian movement. According to (Gehl, 2013), pedestrian connectivity depends on the network's design, which includes the availability of alternative routes, the accessibility of key destinations, and the proximity of pedestrian paths to transportation hubs. In the case of Bojong Gede, the area's organic growth and lack of comprehensive urban planning have contributed to issues of connectivity, as many residents prefer using private vehicles instead of walking due to inadequate pedestrian facilities. Urban network analysis can help address these issues by evaluating pedestrian path accessibility and proposing design interventions that enhance walkability.

The concept of walkability is central to discussions about sustainable cities, where pedestrians are encouraged to use active transportation modes instead of relying solely on motorized vehicles. (Ewing & Cervero, 2010) define walkability as a combination of factors that make walking a more attractive and convenient mode of transportation. In urban areas like Bojong Gede, where the development has occurred without proper planning, walkability can be compromised. The use of UNA, as highlighted by (Iksanti, 2021), allows urban planners to evaluate how well pedestrian paths are integrated into the urban landscape and identify where improvements can be made to encourage walking.

In the context of urban planning, pedestrian connectivity is a critical factor influencing the livability and sustainability of cities. Effective pedestrian infrastructure design considers factors such as connectivity, safety, and comfort to enhance walkability and encourage healthier lifestyles (Raina & Mandal, 2024)). However, in many urban areas, especially those that have developed organically without structured planning, pedestrian pathways often lack coherence and accessibility. This disjointedness not only hampers walkability but also affects the overall urban experience, leading to increased reliance on motorized transportation and a subsequent rise in traffic congestion and pollution (Jabbari et al., 2023).

The challenges of implementing pedestrian-oriented development in such unplanned urban environments are multifaceted. Inadequate infrastructure, financial constraints, and cultural barriers often impede the development of cohesive pedestrian networks (Ribeiro et al., 2024). Moreover, the existing urban fabric in these areas may not support the integration of new pedestrian pathways without significant modifications. This necessitates innovative approaches that can adapt to the unique characteristics of organically developed urban spaces, ensuring that pedestrian needs are addressed alongside vehicular demands (Santos et al., 2024).

Urban Network Analysis (UNA) emerges as a valuable tool in addressing these challenges. By analyzing the connectivity, efficiency, and accessibility of urban networks, UNA provides insights that inform the design and enhancement of pedestrian infrastructure (Gao et al., n.d.)). This analytical approach enables planners to identify critical nodes and pathways that can improve overall walkability, even in complex urban terrains. The adaptability of UNA makes it particularly suitable for evaluating unplanned urban environments, where traditional planning methods may fall short.

The application of UNA in unplanned urban areas involves several key steps. Initially, a comprehensive mapping of existing pedestrian routes is conducted to understand current connectivity levels. Subsequently, UNA metrics are applied to assess aspects such as reach, betweenness, and straightness, which highlight areas requiring intervention (Ma et al., 2023). These insights guide the development of targeted strategies to enhance pedestrian movement and accessibility, ensuring that urban spaces become more inclusive and user-friendly for all residents.

Implementing UNA-driven strategies in organically developed urban areas has demonstrated promising outcomes. For instance, studies have shown that improving street network connectivity can significantly increase pedestrian volumes and reduce dependency on private vehicles (Wang et al., 2023)By focusing on strategic enhancements informed by UNA, cities can transform their pedestrian infrastructure, fostering environments that are both walkable and resilient. This holistic approach not only benefits pedestrians but also contributes to broader urban sustainability goals, including reduced carbon emissions and improved public health (Huang et al., 2024).

Studies have shown that improving connectivity in urban areas can significantly enhance the quality of life for residents. For instance, (Ewing & Cervero, 2010) found that well-connected pedestrian networks reduce travel times, enhance access to essential services, and foster healthier lifestyles. These benefits are especially important in rapidly developing areas like Bojong Gede, where urban sprawl has led to fragmented transport networks. By using UNA, this study aims to provide a detailed analysis of how the area's pedestrian network can be improved, ensuring that it meets the needs of its growing population.

Furthermore, the integration of spatial characteristics such as roads, intersections, and buildings into the analysis provides a more comprehensive understanding of how these elements interact within the urban environment. As noted by (Nua et al., 2019), the spatial configuration of cities greatly influences movement patterns and accessibility. By incorporating building mass and land use impact into UNA, this research offers valuable insights into how different factors contribute to pedestrian movement and connectivity. This methodology provides a clear picture of how the area can be redesigned to create a more pedestrian-friendly environment.

Previous research on UNA applications has focused on various urban settings, but few studies have applied this tool to organically developed areas like Bojong Gede. Most studies have concentrated on planned urban environments, where the road network and pedestrian infrastructure are already established. The work of (Srikanth et al., 2022) and (Ardani & Imanullah, 2021) has demonstrated the effectiveness of UNA in assessing connectivity in more structured environments. However, these studies do not account for the complexities involved in unplanned areas, which often present unique challenges for pedestrian mobility.

To fill this gap, this study applies UNA to Bojong Gede, an area characterized by its unplanned development and mixed land use. The research aims to explore the spatial characteristics of the area, including road networks, building placements, and intersections, and assess their influence on pedestrian path connectivity. As noted by (Gehl, 2022), spatial planning plays a critical role in improving the walkability of urban environments, and understanding the local dynamics of an area is crucial to designing effective interventions.

This research also highlights the importance of considering both built and natural environments in urban planning. The presence of rivers, parks, and open spaces significantly affects pedestrian movement and accessibility. As emphasized by (Talen, 2012)the integration of green spaces into urban design not only enhances the aesthetic appeal of cities but also encourages walking by providing safe, attractive routes. In the case of Bojong Gede, the Kalibaru River presents both a challenge and an opportunity for improving pedestrian connectivity, with potential for developing pedestrian paths along its banks.

Additionally, the study aims to contribute to the broader discourse on urban sustainability and transportation planning. Research by Newman and (Kenworthy, 1999)has shown that cities with better pedestrian connectivity tend to have lower levels of pollution, less traffic congestion, and improved public health outcomes. By improving pedestrian paths and making cities more walkable, urban areas can reduce their environmental impact and enhance the quality of life for their residents. This research, therefore, not only addresses the specific challenges faced by Bojong Gede but also provides insights that could be applied to other similar urban contexts.

Although the application of UNA has been widely used in various urban contexts to assess connectivity and walkability, there is a lack of studies that specifically address the spatial characteristics and pedestrian path connectivity in rapidly developing and unplanned areas like Bojong Gede. Previous studies have primarily focused on planned urban spaces or transport-centric networks, while few have explored how organic urban growth, such as in the Bojong Gede area, influences pedestrian connectivity. This study seeks to fill this gap by applying UNA to the specific case of Bojong Gede, aiming to provide detailed insights into how spatial characteristics, land use, and building activity impact pedestrian movement and connectivity in this organically developed urban space.

The novelty of this study lies in its application of Urban Network Analysis (UNA) to an unplanned, organically developed area like Bojong Gede. While UNA has been used extensively in planned urban environments, this research brings a new perspective by incorporating building mass intensity, land use impact, and pedestrian accessibility into the analysis of connectivity. Additionally, the study offers a unique approach by integrating the UNA results with urban design elements such as open spaces, pedestrian circulation, and parking, providing a comprehensive understanding of how various factors interact to influence pedestrian mobility in a real-world, mixed-use environment.

The purpose of this study is to determine connectivity pedestrian path in the Bojong Gede area using Urban Network Analysis. Elaboration of the results of the UNA analysis with the urban design elements used in this study is expected to identify spatial characteristics (roads, intersections and buildings) on pedestrian paths, identify factors that influence connectivity on pedestrian paths and the possibility of development in improving connectivity on pedestrian paths.

This research on connectivity was conducted to see the relationship between regional characteristics and pedestrian mobility using the Urban Network Analysis (UNA) tool, which is a plug-in tool in ArcGIS software. Urban Network Analysis (UNA) is a quantitative analysis that includes three main elements in an urban area, namely road lines, intersections, and buildings that represent the built environment. The difference between UNA and previous network analysis is the addition of building objects in the part that is analyzed. Most existing spatial network studies only represent networks using two types of network elements, namely nodes and edges. In the case of urban road networks, edges usually represent road segments, and nodes are intersections where two or more edges intersect (Della Porta & Tarrow, 2005)

METHOD

This study uses two methods of data analysis, namely analysis with a descriptive method to explain the description of the condition of the area, the stages of information collection and explanation of the simulation results. While quantitative analysis is used during simulation using UNA (Urban Network Analysis) using the ArcGIS application. UNA simulation will calculate the influence of spatial conditions by buildings and networks in the area by weighting the impact on the building. The Urban Network Analysis toolbox can be used to calculate five types of centrality metrics on the spatial network (Reach, Gravity Index, Betweenness, Closeness, and Straightness). Each result of the analysis scenario contains spatial conditions of the area that affect the simulation results but can be engineered as a form of design intervention.

RESULTS AND DISCUSSION

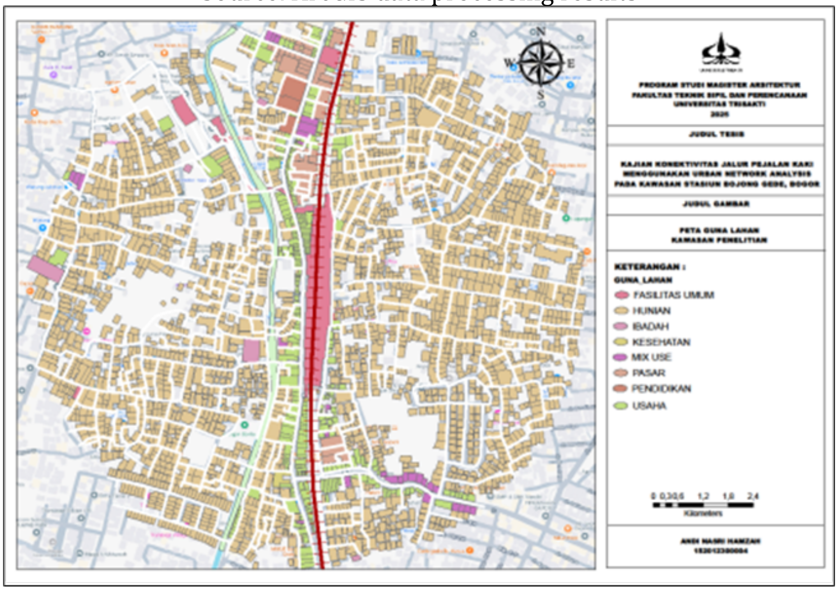
The initial analysis in this stage is an analysis using ArcGIS as a regional analysis.

Building Data Analysis

The results of inputting building data for the research area are as shown in the map below:

Figure 1Land Use Map of Research Area

Source: ArcGIS data processing results

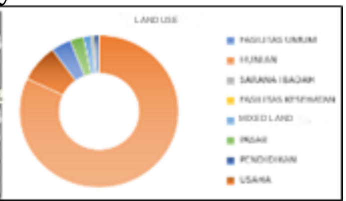


Meanwhile, for land use, the input data is obtained from building data as in the following table.

Figure 1Land Use in the Research Area

Source: 2024 Analysis Results

LAND USE	UNIT	AREA (M²)	%
PUBLIC FACILITIES	5.0	14,437	4.1%
RESIDENCE	2,617.0	291,469	82.1%
FACILITIES OF WORSHIP	4.0	2,694	0.8%
HEALTH FACILITIES	1.0	516	0.1%
MIXED LAND	32.0	5,419	1.5%
MARKET	45.0	9,768	2.7%
EDUCATION	3.0	2,638	0.7%
USAHA	321.0	[illegible]	[illegible]
TOTAL	3.028,0	355,228	100%



Road Data Analysis

Figure 2Results of road data input

Source: ArcGis data processing

Based on the data input in ArcGis, 396 road segment entities were obtained with a total length of 24,946 meters as shown in the following data:

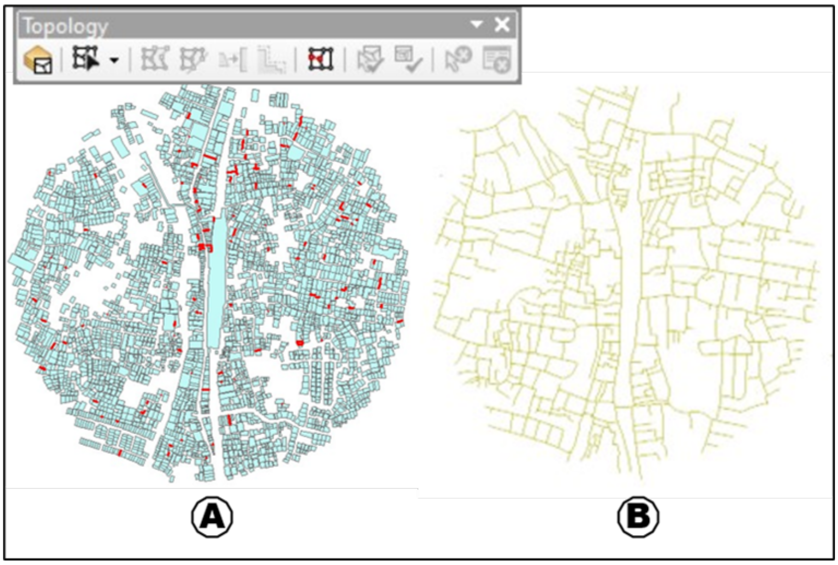
Table 1Road network data in the research area
Source: 2024 Analysis Results

ROAD TYPE	LENGTH	NUMBER OF SECTIONS	%
ARTERIAL	932,1	1	3,7%
COLLECTOR	422,5	3	1,7%
LOCAL	6.828,5	49	27,4%
ENVIRONMENT 1	2.191,1	30	8,8%
ENVIRONMENT 2	14.571,9	313	58,4%
TOTAL	**24.946,0**	**396,0**	**100%**

Topology Analysis

Topology analysis is done to ensure that there is no overlapping building data, while on the road network, to prevent gaps in the road network. The results of the topology analysis in the image on the left are building data, the red color is an error notification indicating overlapping data that must be fixed. The image on the right is a road network that is already in accordance because there are no error notifications.

Figure 3Building Topology Analysis (B) Road Network Topology Analysis
Source: ArcGis Data Processing

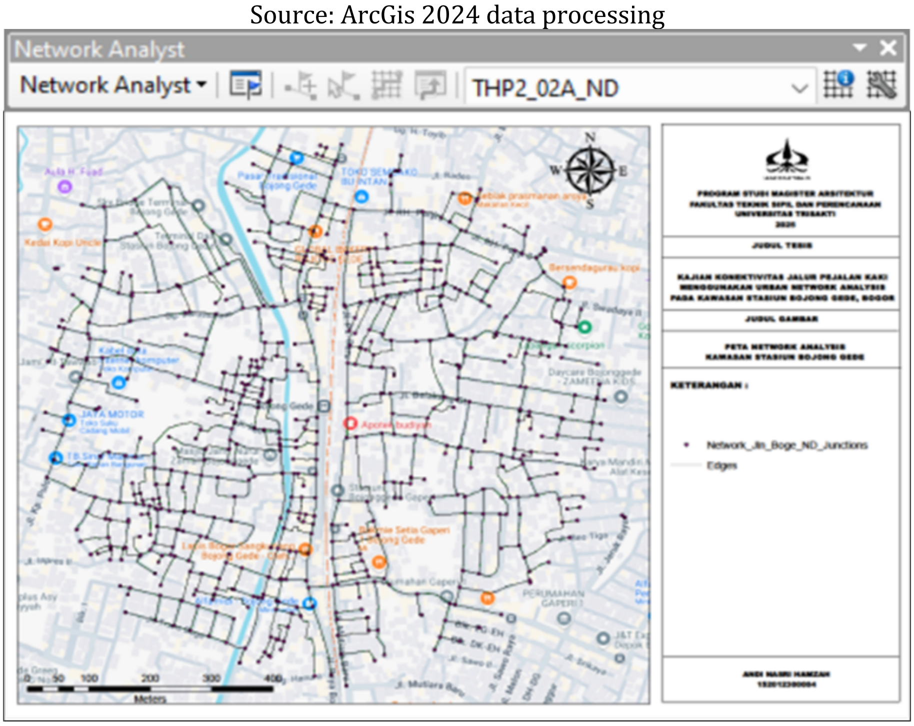


Road Network Analysis

Road network analysis is carried out to create *a Network Datasheet* which is the main data of the road network that will be used in simulations with UNA. The road data used is only the center line of the road.

Figure 4Results of road network analysis in the Bojong Gede Station area

Source: ArcGis 2024 data processing



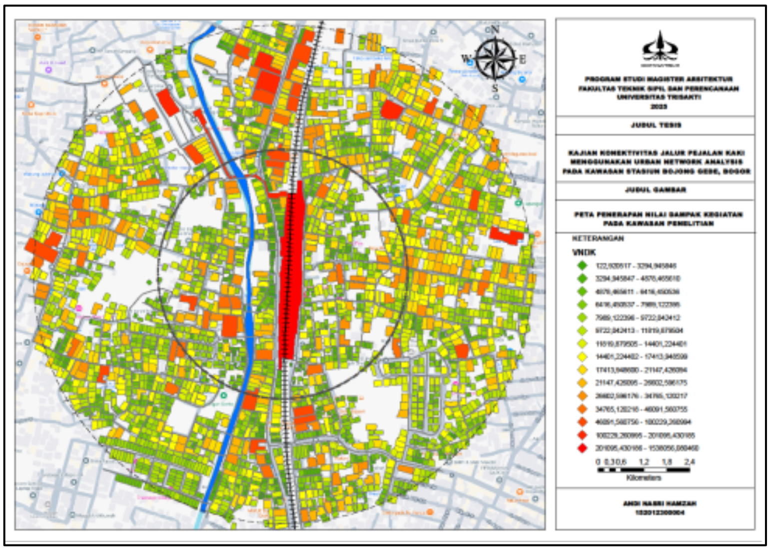
Other data such as length, width and type of road remain in the road attribute data in the database. In the transportation system, this analysis is used to find alternative routes or the fastest routes on the road network.

Activity Weight Value in Research Area

This value is the value obtained from calculating the building area with the value of the impact of activities on the function or category of the building obtained from the results of previous research.

Figure 5Application of the volume value of the impact of activities on buildings

Source: ArcGis 2024 data processing



As shown in the image above, the red color indicates a high value for buildings located in the station area, and yellow towards red for shops and the traditional market area of Bojong Gede. Including the terminal area and skybridge which are facilities that cause people to gather for activities. The activity weight value is obtained from the impact and function values in the field. In this study, the activity impact value data was obtained from the impact literature study data. The building value weight is estimated from the calculation of the building function impact value.

UNA (Urban Network Analysis) Analysis

The simulation area is the Bojong Gede station area with a radius of 450 m from the station. To obtain more accurate data, the location depiction is made up to a radius of 900 meters. Three simulations were carried out with UNA. The first is a simulation without taking into account the impact value of the activities of each building, this simulation is only based on the geographical position of the building with the surrounding buildings and the road network in the research area.

The second is a simulation with the impact value of building activities included as a weight calculation (*building weight*), in addition to the geographical position of the building and the road network in the research area to be analyzed with UNA. The addition of building weight to the centrality network size, the analysis results are expected to be close to the original environmental conditions. The simulation results in the form of index values will be applied to buildings with a gradient color from green to red. The lowest index value is green and the highest index is red. This setting is set in the symbology menu on the *ArcGis* device *layer property*

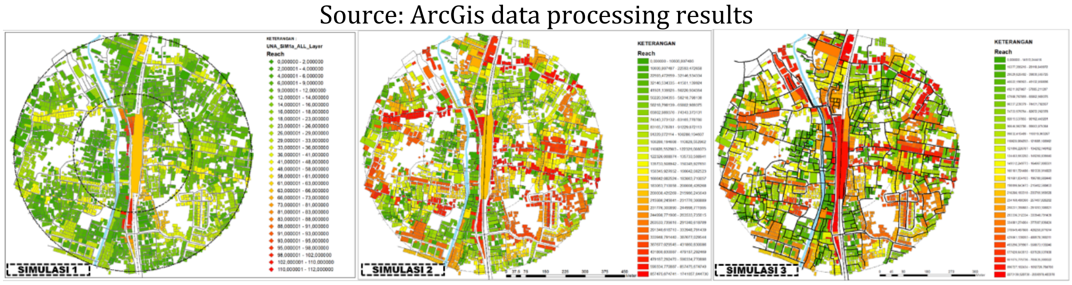
The third is a simulation that starts from the results of the second simulation, where in this simulation the potential for changes in the area to meet the connectivity criteria on the pedestrian path is also considered. Of the five centrality metrics, four metrics are used, namely reach *index*, *betweenness index*, *closeness* and *straightness index*.

1) *Reach* Index

Reach Index is a value that shows the reach that can be reached by each building in an area with the closest distance based on the radius that has been set in the simulation. The results of the reach index are influenced by three factors, namely the larger a building, denser space and denser road network.

Figure 6Results of Reach Index Simulation in the area

Source: ArcGis data processing results

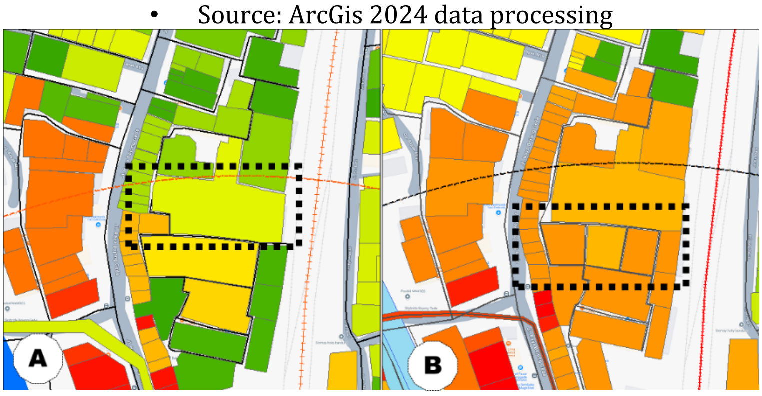


The first simulation was conducted without the impact value of the activity, the second simulation by entering the weight value of the activity and the third simulation was the addition of a proposal for area improvement to increase the index value to create an ideal area. The results of the first simulation showed that buildings that had a higher impact value had a significant impact on the surrounding environment, with colors ranging from orange to red around the building. From the second simulation of the area, it can be explained that the area around the Bojong Gede traditional market has a higher index because the area's activities are in the form of markets, shops, education and the government center of Bojong Gede Village. There is a green area around Kalibaru Bojong Gede because road access is not available along Kalibaru Bojong Gede, as well as the area across the river which must be detoured because access to cross the river is far from the location. The Bojong Gede station area as the center of the area has a higher index value. Across the station is a shop area with various kinds of businesses ranging from motorbike storage, stalls, cellphone services, grocery sellers and others. In the area to the east or the area behind the station is Kp. Kelapa has an area with a relatively high index, yellow to red because it is a dense settlement with road network access connected to the city center of Cibinong. The area of the Bojong Gede highway intersection and Abd. Halim road is a meeting point from the direction of Cilebut and Karadenan, Cibinong. This area also has a high index because of the many business activities in the area. The third simulation was carried out with several proposed changes such as:

- The construction of Bojong Gede Modern Market is intended to gather traders who sell a lot around the traditional market area. This modern market building has an impact on the surrounding area.
- Addition of parking area at the terminal, both for motorcycle and car parking. This parking is public and managed by the Bogor Regency Transportation Agency. The Bogor Regency Government plans to build a parking building on the terminal land so that the terminal and station are more integrated. The influence of the parking area on the reach index in the area is very large and makes activities in the area more diverse.
- Addition of circulation path in the traditional market area which in the simulation stage 1, this area was considered a large area without circulation. After the circulation path was added in the analysis stage 2, the area became more open with a higher reach index. There was an increase in the reach index from green to yellow to orange.

Figure 7(A) Area before adding circulation paths (B) Area after adding circulation

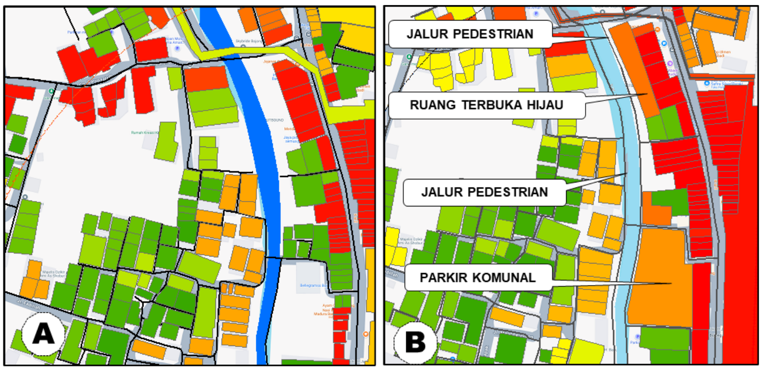
- Source: ArcGis 2024 data processing



- The addition of pedestrian paths in the riverbank area on both sides of the Kalibaru River for pedestrians from the station to the terminal. The addition of this pedestrian path is expected to restore the function of the riverbank and make the area around Bojong Gede Station more walkable. In addition to the pedestrian path, a communal parking space is also added.

Figure 8(A) Existing river boundary area (B) Addition of pedestrian paths, green open spaces and communal parking on the river boundary.

Source: ArcGis 2024 data processing

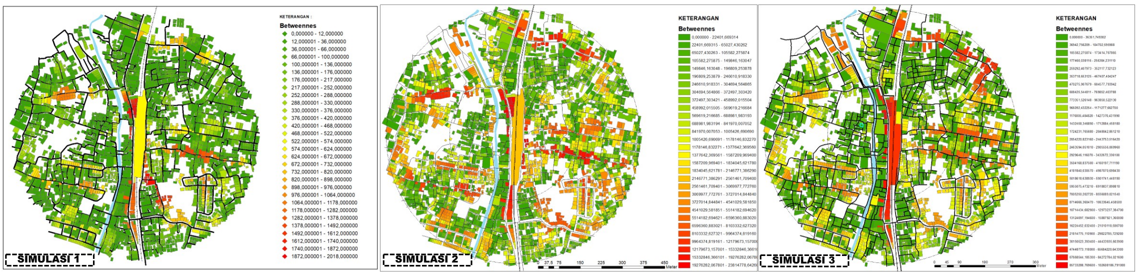


2) Betweenness (*Betweenness Index)*

To measure the Betweenness Index metric, three simulations were also carried out as shown in the simulation results below:

Figure 9Betweenness Index Simulation Results

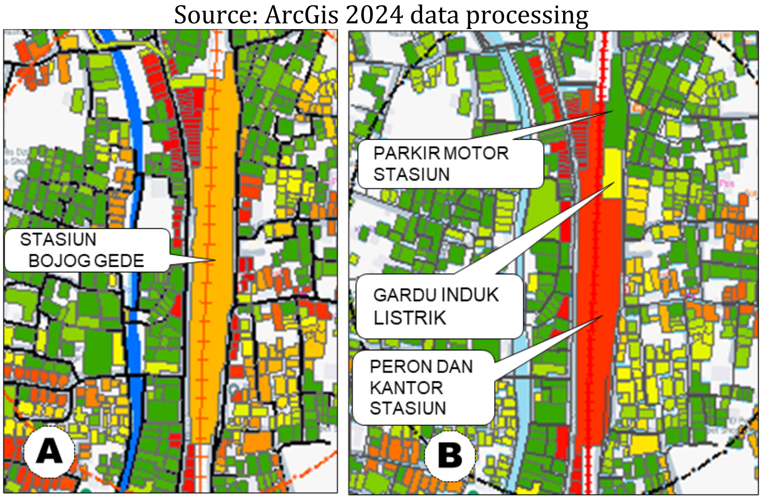
Source: ArcGis data processing results



The number of intersections indicates that it is easier to access and buildings in the area have a higher index value. In addition, the betweenness value is also given to the condition of buildings that are easily accessible between two high-weight building destinations. The results of the first simulation showed a low value in the area. The results of the second simulation on existing conditions after adding building weights and activity impact values resulted in an increase in the index value in the simulation results. There are many intersections, on Jalan Raya Bojong Gede, indicating easy access so that buildings in the area have a higher index value. Buildings around the station have a high value due to the existence of the station as a building with a high building weight. The area behind the station which has more access and intersections has a higher index value. Lack of bridges to cross the Kalibaru river connecting the western area with the center of the area. The long distance between intersections causes poor permeability of the area. The third simulation was carried out with changes to the station index value to be higher.

Figure 10(A) Stations that are one entity in the simulation. (B) Division of stations based on their function.

Source: ArcGis 2024 data processing



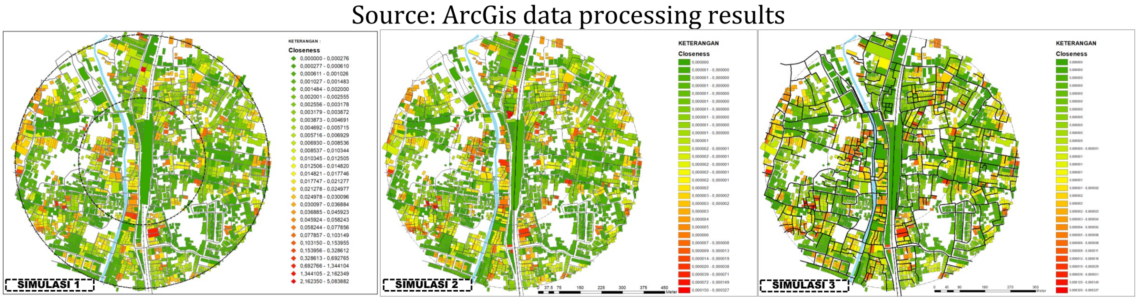
The Bojong Gede station building experienced a color change from orange to red in the second stage analysis due to the addition of pedestrian access to the skybridge building that is directly connected to the station which was previously not considered a pedestrian network but only as a building. The division of the station area which was previously considered a complete building was then divided into three parts, namely the platform and station office, the PLN substation and motorbike parking.

3) Closeness *(Closenes Index)*

The simulation was carried out three times, but in principle this simulation did not use the weight of the existing building but purely only how far the distance of the building was from the surrounding buildings so that the index values in the first and second simulations were not much different.

Figure 11Closeness Index simulation results in the area

Source: ArcGis data processing results

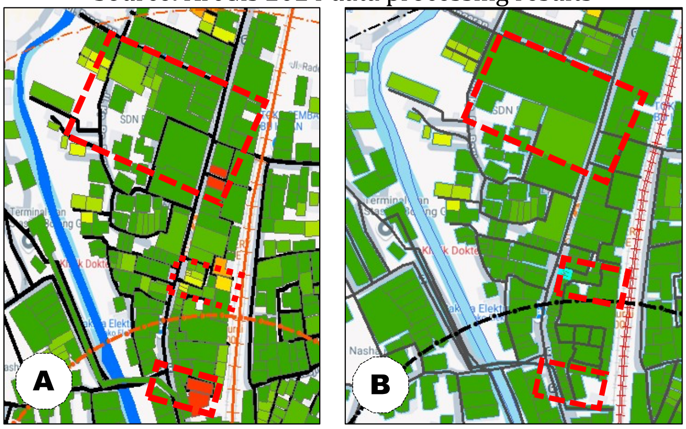


High index values indicate that the building is more closed than other buildings, while green to yellow buildings with low index values are considered more open and more accessible than other buildings. There is no significant change from the results of the first and second simulations. Some buildings have high index values because of their closed locations compared to other buildings. The Bojong Gede station area has a low index value because it is located on the Bojong Gede highway which is easily accessible and open. Overall, the 450-meter radius area that is the research area has a low index. There are buildings that have a high index because of the closed position of the building and poor circulation in the area. The building area is in an overly dense area. Many dead ends cause green to yellow results in the area between Jl. Raya Bojong Gede and the Kalibaru River. Lack of access to the western area due to being separated by the Kalibaru River. The structure of the western area is more closed and irregular.

After the third simulation, several buildings that initially had high isolation became low or no longer isolated due to the influence of surrounding buildings. The construction of a modern market in a traditional market location that was originally a collection of stalls or buildings that were later replaced into one large permanent building resulted in changes in the function of activities and activities in the area which also had a positive impact on the development of the area. The construction of the Bojong Gede Modern Market and the improvement of circulation routes in the traditional market area resulted in several buildings in the area that initially had a high closeness index value becoming low.

Figure 12(A) Location of the area before the construction of the market and the addition of pedestrian paths (B) After the construction of the modern market and the tidying up of the circulation paths

Source: ArcGis 2024 data processing results



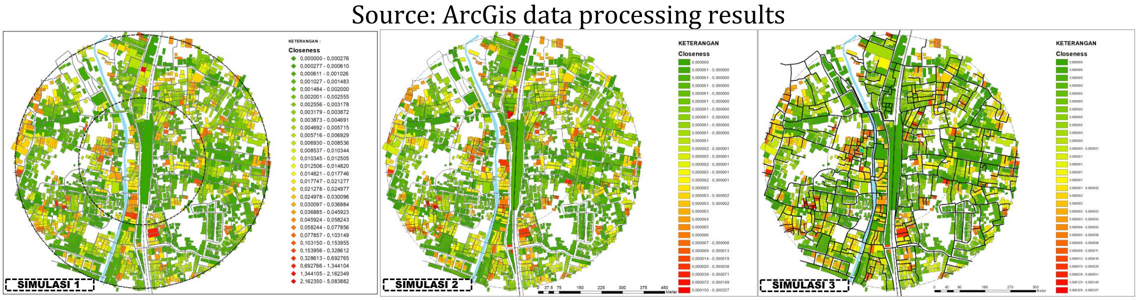
the closeness index simulation with the development of the area regarding the proposed improvements give a low value for the isolation of the area.

4) Straightness *Index*

The first simulation in the image above was done without entering the impact value of activities and building weights. The second simulation was done by adding the weight and impact value of activities and the third simulation with several proposed changes to the area to increase the value of the straightness index.

Figure 13Straightness Index Simulation results in the area

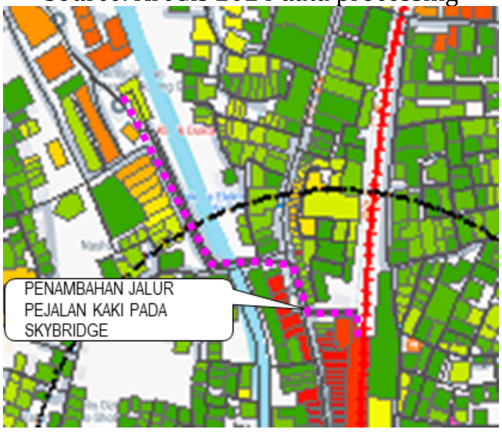
Source: ArcGis data processing results



There is an increase in the index value because the building weight and activity impact value are added in the simulation but there is no change in the straightness status of the building in the research area. Analysis of the existing area based on *the straightness index;* among others, buildings on the Bojong Gede highway network that are straight have a higher index value than buildings on winding roads. The path on the skybridge that is directly connected to the Bogor platform is less popular because to get to the Jakarta platform you have to continue your journey to the Jakarta platform underpass. The eastern area results are yellow to red because the spatial structure is neater (housing complex). The Jl. Ry. Bojong Gede area has a good value for travel purposes and straightness. In the third simulation, a pedestrian path was added to connect the skybridge directly to the station which added an index value to the area.

Figure 14Addition of a pedestrian path to the skybridge that is directly connected to the station platform.

Source: ArcGis 2024 data processing



The change in the station building index value also occurred due to the division of land at the station which was originally one large building which was then divided into three parts as explained in the previous section. The building on the Bojong Gede highway across from the station remains with a low value because the station building which is a large building and dominates the area causes the straightness index value of the area to only focus on one building, namely Bojong Gede station.

The results of the UNA analysis based on the simulation above, are juxtaposed with a general review of the area based on urban design elements, namely land use, building mass intensity, vehicle and pedestrian circulation, open space, parking, and markers that produce potential problems and design proposals. The influence of the UNA index results on urban design elements is as follows:

1. *Reachness Index* affects land use elements and building mass intensity.
2. *Straightness index* affects pedestrian circulation and markings.
3. *Closeness index* affects pedestrian circulation and open space.
4. *Betweenness index* affects the intensity of building mass, pedestrian circulation and open space.
5. *Gravity index* affects vehicle circulation and parking

Urban design elements not included in the UNA analysis are:

1) *Activity Support*, each building has been given a weight according to the activity and has been analyzed based on land use so that activity support is considered to be represented in the simulation.
2) *Preservation,* there is only one building with preservation value in this area, namely Bojong Gede station and it has been represented in the land use elements.

CONCLUSION

The correlation between urban design elements and the results of the UNA analysis is explained through an assessment of the spatial characteristics and connectivity in the existing conditions of the area around Bojong Gede station, simulated with the first and second simulations. Based on these results, several changes are proposed to improve the area's connectivity in the third simulation. Connectivity can be analyzed through simulations of reachness, straightness, and betweenness, where higher permeability leads to a higher index value. Intersections are analyzed through betweenness simulations, with high index values marked in red, indicating more intersections. The UNA simulation results for existing areas show relatively high values, ranging from yellow to red, particularly around Bojong Gede station. Several development proposals are suggested to enhance pedestrian connectivity, including utilizing the river boundary path as a pedestrian route from the south to the Bojong Gede terminal as an alternative to the main highway, using vacant land near the river boundary as open spaces, adding a lane on the skybridge directly to the Jakarta-bound platform, improving circulation routes and reducing dead ends to enhance permeability between the Kalibaru River and Bojong Gede Highway, constructing a bridge across the Kalibaru River to improve access from the western area, and adding a railroad crossing bridge from Jalan Raya Bojong Gede to the eastern area behind Bojong Gede station. The use of UNA tools in analyzing urban areas proves effective in quantitatively assessing pedestrian-friendly environments, particularly in unplanned and complex areas like Bojong Gede, where predicting pedestrian movement patterns is challenging without an initial survey. The pedestrian movement pattern in UNA is translated into variables such as building function, building weight, building volume, and pedestrian paths, with pedestrian travel capacity considered at radii of 450 m and 900 m from the area's center. Integrating building elements and weighting variables into the UNA simulation enables an analysis that closely reflects real environmental conditions.

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