Advances in Social Science, Education and Humanities Research, volume 602
ARTEPOLIS 8 - The 8th Biannual International Conference (ARTEPOLIS 2020)

Walkability Design Study Using Urban Network Analysis in Tanah Abang Station Area Jakarta

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ABSTRACT

In recent years, new urban design regarding walkability has become a major focus of urban planning. Developments in transit areas have generally included walkability as a regional development concept where a walkable design encourages people to walk and switch from using motorized vehicles. Walking is very compatible with the mixed land use profile in Jakarta with compact blocks that pedestrians can easily access. This design study aims to determine the most affected walkability criteria of the existing Tanah Abang transit area based on the RDTR (Detailed Urban Space Management Program) using Urban Network Analysis and design intervention to increase the ridership. The methodology of this design study used UNA simulation as a quantitative analysis tool to determine design interventions in the walkability efficiency criteria in the Tanah Abang transit area. The connectivity and accessibility of the pedestrian path are the major problems. The results of the UNA simulation are used to analyze problems in urban design elements. Reach index affects land use, building mass intensity, and parcel blocks. The straightness and closeness index affect connectivity. The betweenness index affects the placement of open space. The gravity index affects the parking area.

Keywords: *Walkability, Urban Network Analysis, Connectivity, Transit.*

1. INTRODUCTION

Walkability is the key to the urban area's efficiency on ground transportation. Increased motorization dramatically reduces opportunities for walking and biking. While some groups become mobile, more groups feel less mobile and maybe without real choice to get around [1]. Walkability in Indonesia is crucial because of regulations relating to pedestrians in Indonesia, namely Law No. 22/2009 and Minister of Public Works Regulation No. 03/ PRT/M/2014, focusing on aspects of pedestrian facilities on the overall area traversed. The overall experience by pedestrians can encourage people to walk daily [2]. In a study done by Stanford University for the average daily steps by the Indonesian population was only 3.513 per day at 31 out of 46 countries in 2018.

Jakarta is a city with a night population of more than 10 million. A population density is often greater than 130 people per hectare; walking is very compatible with Jakarta's land-use profile. It has limited public space, mixed land-use patterns, and a transit destination. On the other hand, local urban design and planning do not encourage to walk. Tanah Abang Station area is the locus of study. It is famous as the most prominent commercial center for textile wholesale in Central Jakarta. Tanah Abang Station area is included in the Transit-Oriented Development plan stated in the Urban Design Guidelines for the Tanah Abang area in 2004. The Tanah Abang Station TOD has also been carried out the preliminary design by the Indonesian Railway Company (PT Kereta Api Indonesia), where the coverage area is 64,617 ha with a total GFA of 391,900 m2.

Connectivity and accessibility are the design problems in the study area due to the Ciliwung River and Jati Baru Bridge, which separates settlements in the west, railway station in the center, and trade areas in the east. The sky-bridge connects the station with Tanah Abang Market Blocks A, B, and F results in economic inequality at the ground level for shops in Block F2 because visitors no longer pass through the area. The design study aims to improve walkability by comparing the existing Tanah Abang transit area and design interventions based on Urban Network Analysis. This article gives insight into how future efforts in promoting walking through design study in the transit area address several aspects of the urban environment.

2. LITERATURE REVIEW

The heart of urban vibrations is walkability. A mixture of urban functions such as short blocks, population density, diversity, primary mix user, and building ages play their role. A walkway that is often used has characteristics: it is generally denser, better served by transit, more central, and has a different mix of land uses [3]. According to Calthrope [4], pedestrian-friendly environments have been cited as a key factor for transit-oriented development. Cervero and Kockelman [5] mention three features that define walkability, known as "3Ds:" population density, diversity of destinations, and pedestrian-friendly design. In a study done by Litman [6], most current research is part of urban transportation systems study where transportation often focuses exclusively on car travel and transit, ignoring pedestrian travel as an important component. As a result, they do not place walkability as a vital form of urban transportation. A walkable environment can develop without a transit system, but a walkable city is very dependent on the system. The city center's transit system encourages residents to walk more because of its ease in reaching several transportation modes [7].

Based on Untermann [8], a good walking experience can be achieved by improving safety, convenience, and pleasure to increase walkability in the neighborhood area. According to Gehl [9], the quality of pedestrian path must take attention to several aspects: the room to walk, dimensioning of the streets, the 'wheeled' walking traffic, paving materials, streets surface conditions, walking distance, walking routes, space favorable for walking, spatial sequence, pedestrian routes in open space, and level differences. Smart growth from the U.S Environmental Protection Agency [10] mentions the necessary elements for a walkable community have been grouped into four overarching components: quality of the journey, urban form, pedestrian infrastructure, and apply for policies and programs. Woerdjantari et al. [11] provide a literature review for four walkability-criteria that affect walkability and thermal comfort in Bandung Indonesia. They conclude security, safety, efficiency, and comfort are the criteria that impact walking. The research result based on evaluation criteria used Analytic Hierarchy Process; security is the most important criterion, while comfort is the last criterion. The relationship between the walkability criteria and the Network Centrality Measure in Urban Network Analysis, as shown in Table 1, is affecting the efficiency criteria. The sub-criteria are distance, block size, building type, and connectivity. The design study in this paper is to focus on the efficiency criteria that correlate in the Network Centrality Measure of the UNA toolbox.

The Urban Network toolbox can be used to compute five different types of centrality metrics on spatial networks – Reach, Gravity Index, Betweenness, Closeness, and Straightness [12]. Some studies have been used, such as the walking routes to light rail stops in Surabaya, Indonesia. UNA tools were extensively used to predict future walking activity around proposed tram stops and make an informed suggestion about which access streets around future tram stations should be prioritized for infrastructure upgrades, urban design, and landscaping improvements [13]. The analyses of pedestrian accessibility to tram stations only accounted for residential access because of the unavailable data on the distribution of employment location and business establishment in Surabaya. A more holistic evaluation of tram ridership walks – coming from or going home, workplaces, retail, service, or recreation destination. The estimated population catchment of each station was computed with Accessibility Indices using Reach analysis, which summarized the population number that could be reached within the total 800m walk radius. Betweenness analysis is used to evaluate which path is most important to serve pedestrians toward tram stops.

From the efficiency criteria, UNA tools can be used to determine the building activity level, isolation or closeness level of buildings to the surrounding area, the crowd at the crossroads, and transportation accessibility. This study was done in Dipati Ukur Bandung City to compare planned areas in the colonial period and unplanned areas [11]. The data used is different from the study that has been done in Surabaya. The distribution data to represent the employment location and business establishment is taken from the building volume, the impact table value of the activity in Detailed Urban Space Management Program (called ITBX Nilai Dampak Kegiatan RDTR in Indonesia) for each activity on the building that can numerically identify the impact activities on the surrounding environment. Simultaneously, the walking radius is 350 meters as a comfortable walking distance [14].

Efficiency Criteria	Network Centrality Measure				
	Reach	Betweenness	Closeness	Straightness	Gravity Index
Distance	√				√
Block size	√				
Building type	√	√	√	√	√
Connectivity	√	√	√	√	

Table 1 Relationship of Efficiency Walkability Criteria and Network Centrality Measure in UNA tools.

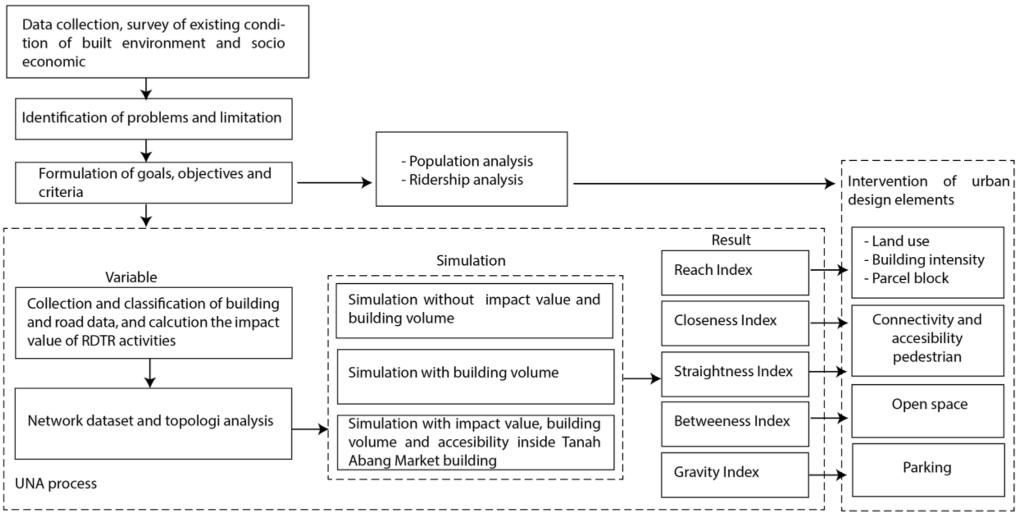


Figure 1 Analysis of processed data.

3. METHODOLOGY

The methodology presented in this design study area uses Urban Network Analysis simulation in existing conditions. It compares the design interventions' results concerning the TOD and recommendations on the Detailed Urban Space Management Program. The walk radius is 350 meters as a comfortable walking distance based on Jakarta Governor Regulation No. 182 (2012) and No. 44 (2017) for the inner ring and 700 meters for the outer ring from Tanah Abang Station. There are two analyzes conducted in the first stage, namely topology analysis and network analysis.

The analysis process data of this study is illustrated in Figure 1. In analyzing spatial walkability data, an analysis tool of the UNA toolbox explains the relationship between the elements in the built environment - nodes, edges, and buildings applied to GIS software. A weighted representation data of spatial network elements come from building and road spatial data, building volume, and the value of activity impact calculation table in Detailed Urban Space Management Program Jakarta City (called ITBX RDTR in Indonesia). This study obtains building data of 10.882 entities and road data of 690 entities. Each building obtains attributes that connect the building in the graph with the corresponding structure's true characteristics in the city [12].

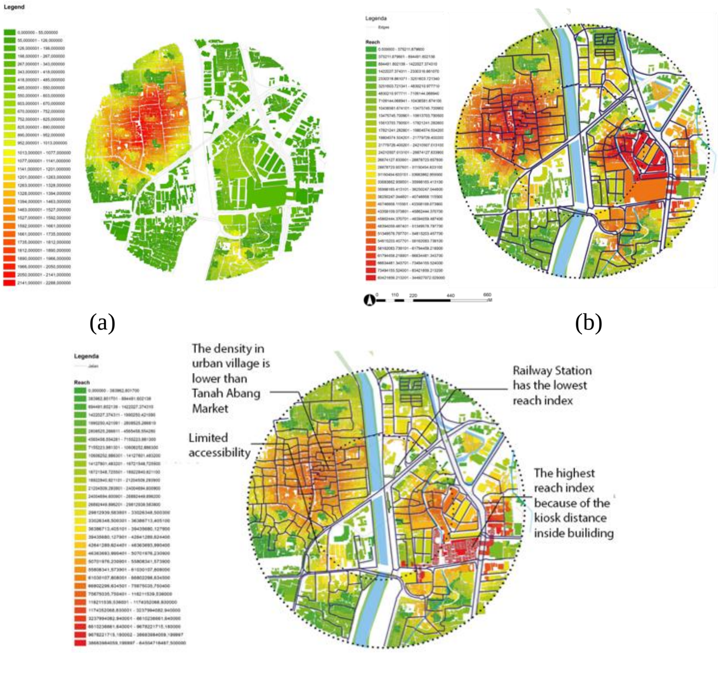
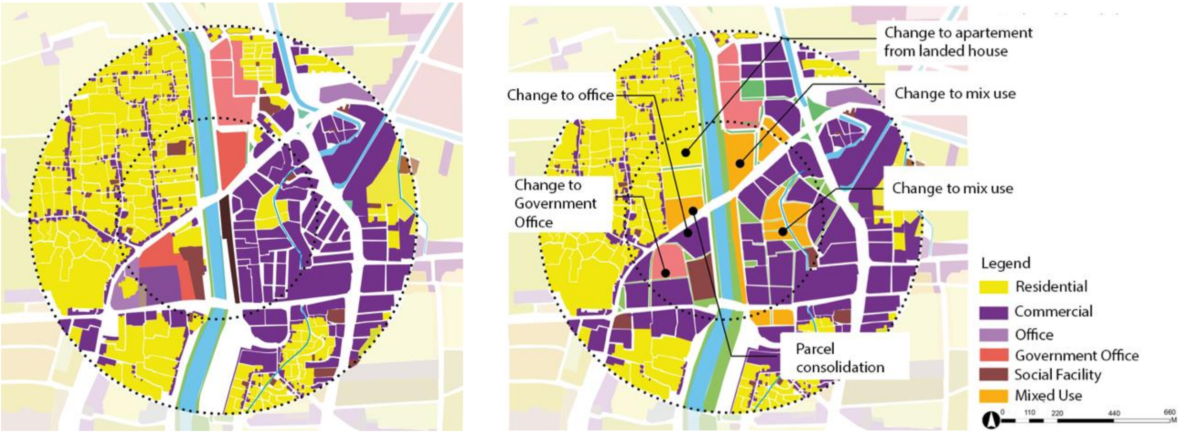
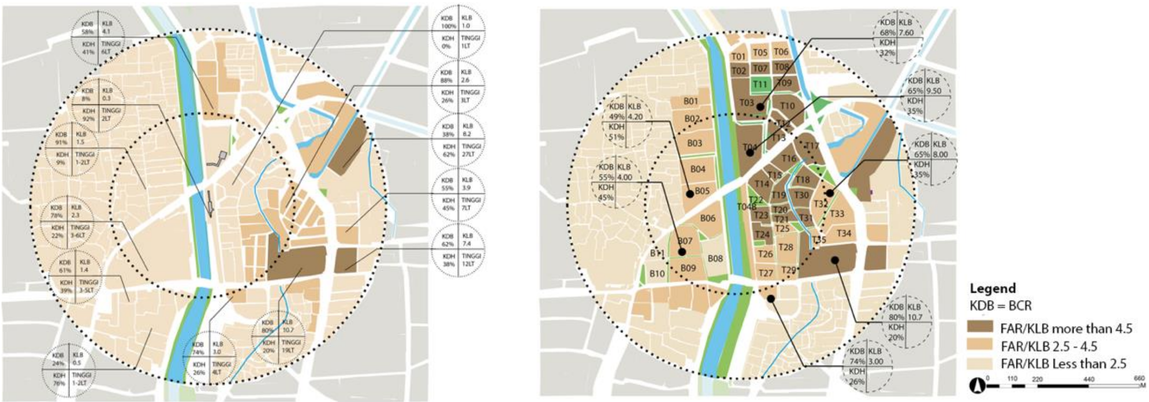


Figure 2 (a) Reach index of the existing area without impact value activity and building volume, (b) Reach index with impact value activity and building volume, and (c) Reach index with adjustment of circulation corridor inside Tanah Abang Market building.



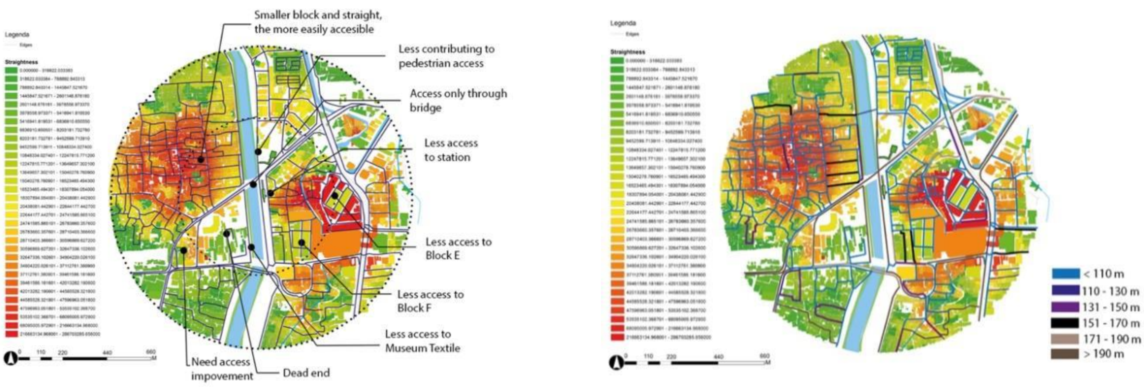
(a) (b)

Figure 3 (a) Existing land use and (b) Proposed Land Use.



(a) (b)

Figure 4 (a) Existing building Intensity and (b) Proposed building intensity.



(a) (b)

Figure 5 (a) Straightness index with impact value and volume to determine connectivity interventions and (b) Straightness index analysis of the assessment of permeability in ITDP.

Topology analysis for building and road data is intended to check the geometric accuracy of each data. As for dead ends, these can be marked as exceptions. In the road network analysis, the road data used is only the centerline of the road. The next process after topology analysis is network centrality measurement. There are five metrics on a spatial network in centrality measure which impact urban design elements. Reach metric influences land use, block size, and building functions. Straightness and closeness metrics affect connectivity; the betweenness metric affects the placement of open spaces; the gravity index affects parking placement.

4. RESULT

After weighing the value of the impact of activities and buildings, the eastern region of trade and services impacts the surrounding environment. However, as shown in Figure 2 (a), it is still illogical that the Tanah Abang Market building should have the highest impact. The simulation results in orange, meaning there needs to be an adjustment to the Tanah Abang Market building by adding circulation in the building connected to the surrounding environment so its activities can spread more to the environment.

Adjustments made on the circulation paths addition in buildings significantly affect the reach index on the environment. It can be seen from the value of the building of Tanah Abang Market Block A, B, F1, F2, Metro Center with the highest value, and dramatically affects the northern part of the environment, as shown in Figure 2 (c). The station area is cantered as a mixed-use zone; therefore, the station area's highest density area as the main redevelopment to a catalyst and stimulates general economic growth with the average floor area ratio increases from 2.69 to 5.26. The reach index was affected by the change in land use and building intensity, as shown in Figures 3 and 4.

After weighing the impact value and volume of the urban village area between the kiosk and the Tanah Abang Market, Block E has a high value due to the influence of the impact of activities, as shown in Figure 5. The straightness index gives a high value to the building, which is at the farthest part of the intersection, to show how easily the building can be accessed from the road.

The closeness index is related to access, which shows the level of isolation of an area from its environment. The isolation color change level after the impact value is calculated, but the isolated location is still the same. It means that buildings accessible from

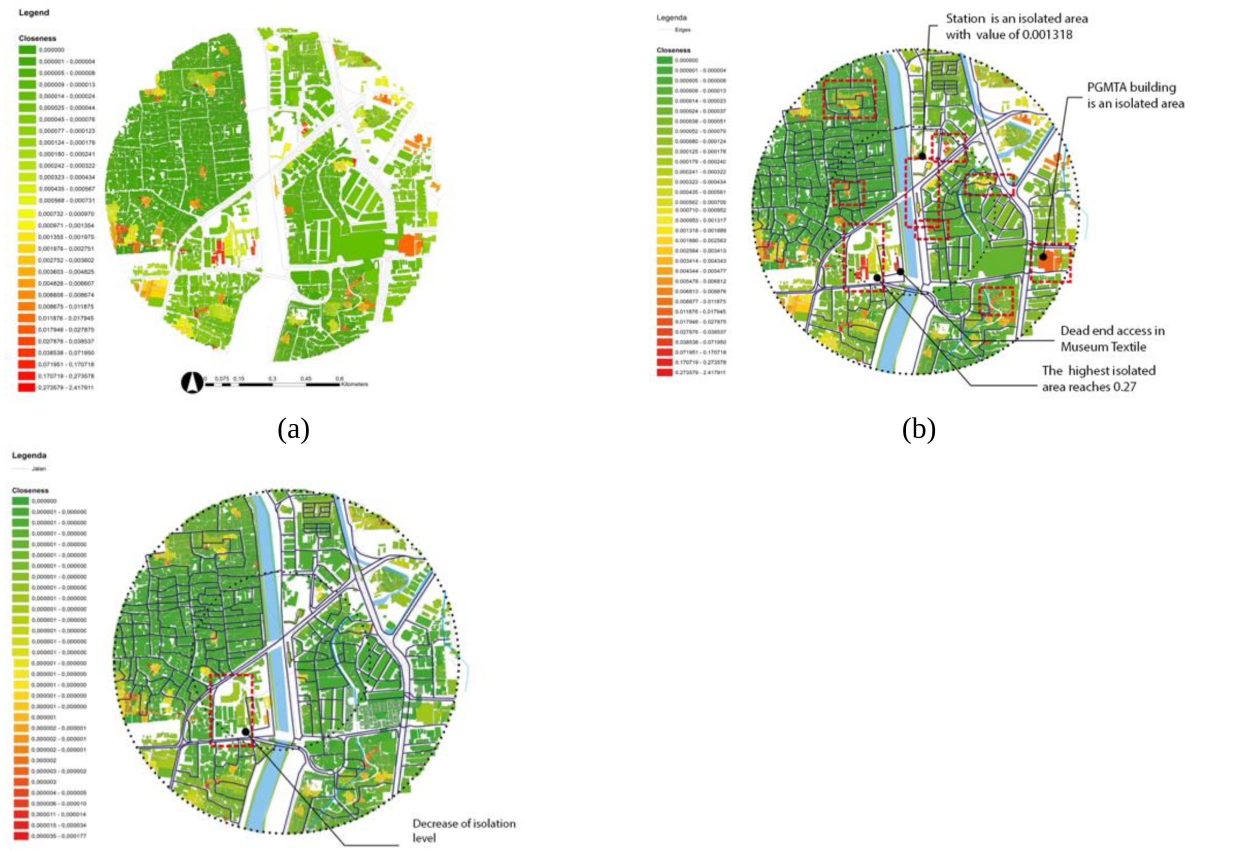
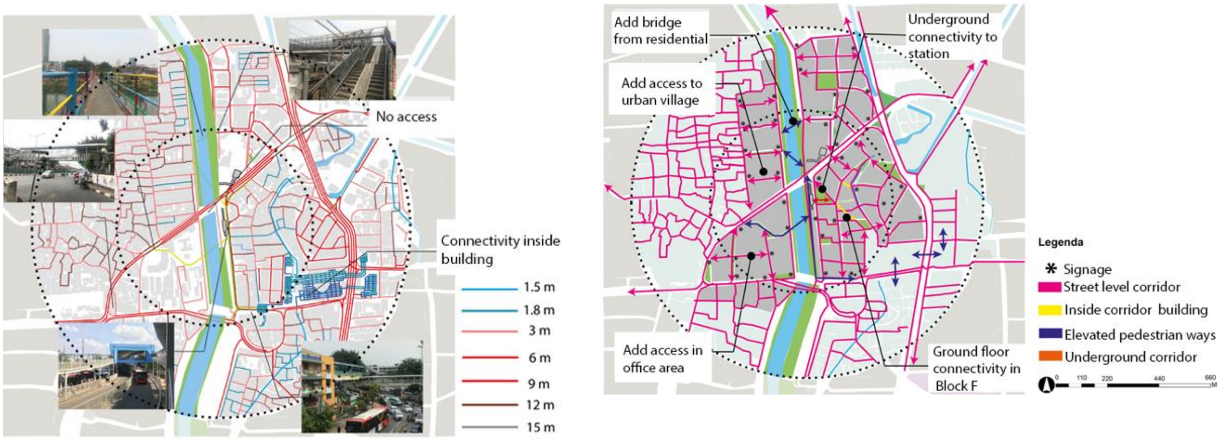
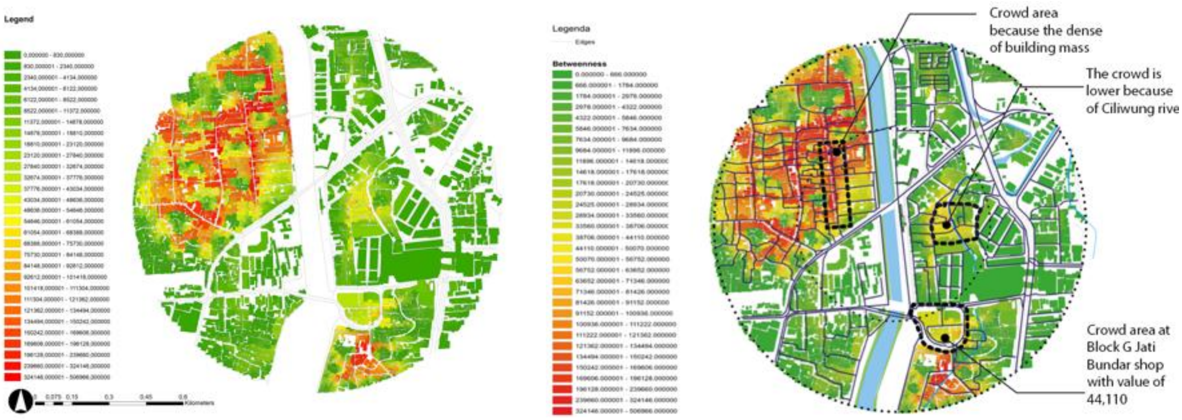


Figure 6 (a) Closeness index of an existing area without impact value activity and building volume, b) Closeness index with impact value activity and building volume, and (c) Closeness index after the addition of the pedestrian path in the west area.



(a) (b)

Figure 7 (a) Existing pedestrian ways and (b) Proposed pedestrian ways.



(a) (b)

(c)

Figure 8. (a) Betweenness index of an existing area without impact value activity and building volume, (b) Betweenness index with impact value activity and building volume, and (c) Betweenness index after the addition of the pedestrian path in the west area.

many ways will still get a high value compared to those with less access even if the impact value of the building activity and volume has been included, as shown in Figure 6. In the design intervention, pedestrian paths are interconnected and continuous to improve multi-mode connections, ensuring transfers can be done quickly, directly, and comfortably. The closeness index is affected in the pedestrian path networks, as shown in Figure 7.

The betweenness index can be a significant determining factor in explaining commercial and services' spatial distribution in urban areas. As shown in Figure 8, after calculating the impact value and building volume, the north and south areas of Tanah Abang Market turn to red color. It shows that the north and south areas of Tanah Abang Market block A, B, and F1 and F2 are influenced by the shopping center so that their betweenness index depends on each intersection's distance and influences the type of activity that exists. Improvement in public space increases life quality, which spurs environmental sustainability and creates pedestrian-friendly public spaces. The betweenness index is affected in public space planning, as shown in Figure 9.

In terms of the sensitivity of distance, the west and south of the study area turn to yellow color, indicating a need for temporary stops or plazas in the urban village area. The distance sensitivity in this gravity index, as shown in Figure 10 and Figure 11, is used in determining the location of the parking area, as shown in Figure 12 and Figure 13.

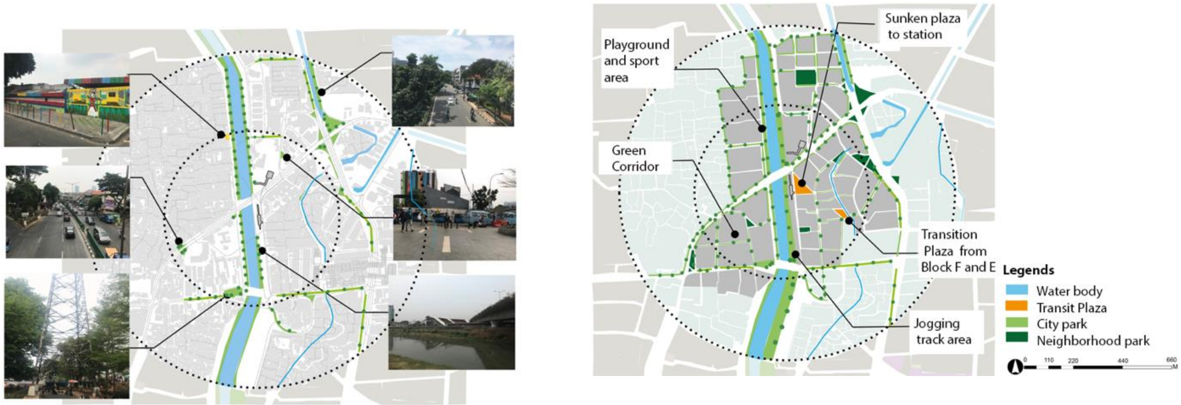


Figure 9 (a) Existing of public space and (b) Proposed public space.

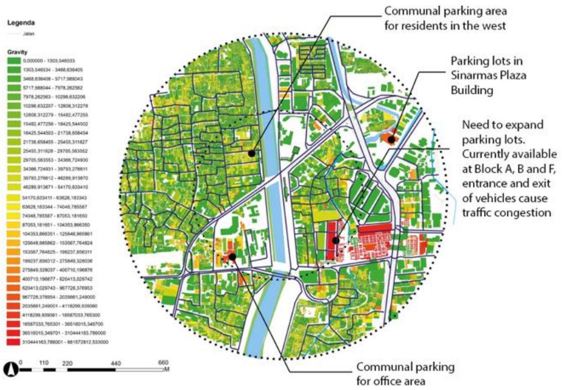


Figure 10 Gravity index Tanah Abang Station area.

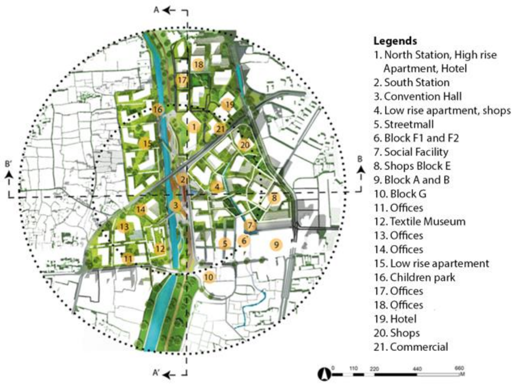


Figure 11 Proposed Masterplan.

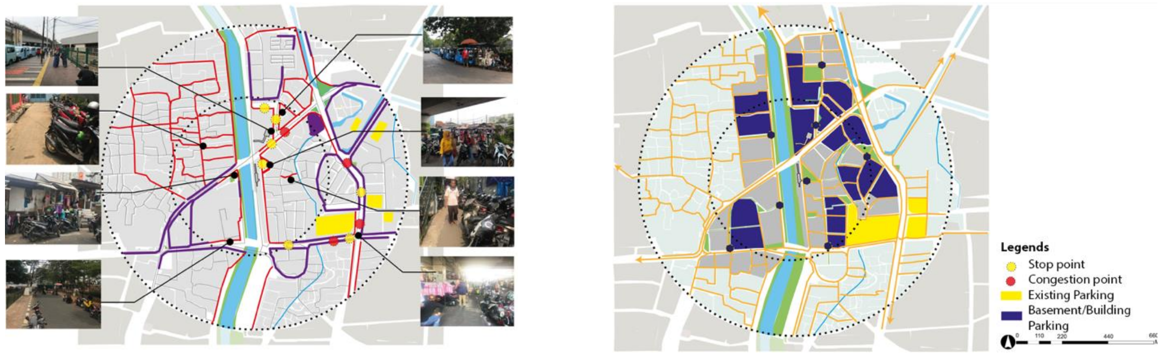


Figure 12 (a) Parking area existing and (b) Proposed parking area.

Figure 13 Site sections.

5. DISCUSSION

Comparison of existing conditions, UNA interventions, and linkages in terms of TOD are different in parking. The Transit-Oriented Development Institute review reduces parking blocks while UNA simulation determines the parking location. UNA simulation found which areas had the highest level of isolation and reach index. If an additional 350 m distance is added in the outermost layer from 700 m of walking radius, it would be good because the residential area in the south district can be analyzed then probably impact the change of building functions.

The UNA simulation needs other analysis, such as driving force analysis, to determine facility programs in land use, population, and ridership analysis, to assume the GFA needed in the future. Assuming 60% of ridership who get off at the train station and do the activities in the Tanah Abang area, the results of this ridership projection will be the basic data for calculating the number of daytime residents around the district. Ridership projections in 2033 will be 1,286,444 per day. At the same time, the projected population growth will be 223,110 in 2033. Land use in the east district is changed; originally R7 (low rise residential) subzone, shifted to a mixed-use zone. The station subzone also changed to a mixed-use zone to support transit ridership, following the recommendation for the Detailed Urban Space Management Program or RDTR the City of Jakarta.

6. CONCLUSION

The west's urban village has a high reach index, which indicates that the area is walkable. The higher the impact value of a building, the higher its reach value if accompanied by a high accessibility level. Land use affects pedestrian routes and destinations. Parcel blocks should be compactly designed to increase permeability. The intervention design results in a total GFA of 3.414.518 m2, with an increase in open space to 14% from 5%. The average building coverage ratio increases from 27% to 68%; the average floor area ratio increases from 2.69 to 5.26.

ACKNOWLEDGMENTS

This research paper is made possible through the help of many. I would like to thank my instructors, Dr. Woerdjantari Kartidjo, and Dr.Eng. Donny Koerniawan for the support and encouragement in this research. Through this research paper, I learned about data analysis as a design base in an urban area. I hope this research paper will help urban designers understand the site by using Urban Network Analysis in Indonesia, developed by City Form Lab, MIT.

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