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Determining the Type Of Skybridge From The Bojonggede Station to The Bojonggede Terminal Considering The Traffic Impact

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ABSTRACT

Bojonggede Station, located in Bogor Regency, is one of the KRL stations used to support the mobility of the surrounding community. This makes Bojonggede station a place with quite complex transportation problems. From the various problems that occur, this research aims to find the right sky bridge to connect the bojonggede station with the bojonggedeTerminall and reduce the impact of traffic in the surrounding location after the sky bridge. The data analysis method used is the 4 step model method consisting of trip generation/attraction, trip distribution, mode selection (Moda Split), trip assist, Indonesian road capacity manual, and descriptive analysis of survey data on visitors Bojonggede station. From the results of the analysis based on the 4 step model and manual of Indonesian road capacity, it is found that the performance of the Bojonggede 2 highway, which is in front of the location, has increased from LOS F during the construction period to LOS C during the sky bridge operations bridged. The benefit of this research is that it can be seen that traffic problems that occur at the study site can be overcome by the existence of an efficient sky bridge design sky bridges Bojonggede station with Bojonggede Terminal, to be further recommended to the Bogor district transportation office, and the Jabodetabek transportation management center (BPTJ).

1. Introduction

Bogor Regency is one of the regencies in West Java that has experienced rapid development. This development must also be followed by growth in the public transportation sector which is used for community mobility in Bogor Regency [1]. Public transportation is an important means for the development of life. One of the transportation facilities in Bogor Regency is the Bojonggede Station. Bojonggede Station is located between Cilebut and Citayem stations, with an altitude of ± 140 meters above sea level. There have been many changes in the appearance of the platform and station because improvements have been made so that the station looks more organized, spacious, and comfortable for KRL.

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KRL is one of the public transportation routes covering the Greater Jakarta area [2]. The importance of the KRL is reflected in the local community's interest, who prefer KRL as a means of transportation in their daily activities compared to using other modes of transportation. The number of requests for the use of KRL is due to the advantages of KRL, which are low pollution, free from congestion, mass vehicles, low cost, and on time. The Bogor Regency Government is currently focusing on preparing for the improvement of Susukan Village, Bojong Gede District [3]. The government should create public facilities, especially public transportation facilities, that make it easier for people to carry out activities in a country, to measure whether a country is seen as a developing country in the future [4][5].

The Bojonggede area can become the main core of the Bogor Regency [6]. And the location will be projected to become a meeting point for public or public transportation from city public transport, buses, to trains. Building stations that support KRL operations is necessary as public transportation that the community enjoys [7][8]. However, in reality, the increase in the appearance of the Bojonggede station has not been followed by an integration facility between KRL modes and other public transportation located at the location of the nearest passenger meeting point, namely the Bojonggede terminal [9]. Currently, Bojonggede station is a passenger stop station that is categorized as very crowded from morning to evening. The density is caused by many bojonggede residents who work and carry out activities outside the bojonggede area. As a result, the dense activity of the Bojonggede station impacts the surroundings, especially the impact on traffic around the Bojonggede station area.

The unintegrated mode of transportation around Bojonggede Station with other public transportation can be seen from the plan to handle the movement of people and intermodal vehicles that have not synergized. Traffic problems that arise on the Bojonggede 2 road include the decreased capacity of the road and the unavailability of pedestrian facilities that have an impact on pedestrian safety. There is a base motorcycle taxi activity, flooding on the Bojonggede road section due to decreased road geometry and poor side channels [10].

From the problems that occurred at the Bojonggede station, the government, in this case, has made a plan to build a pedestrian bridge (sky bridge) that can connect the station and the Bojonggede terminal to overcome the congestion and chaos, which is planned be built in 2021. It is hoped that with the construction of the sky bridge, train passengers can go directly to the terminal switch modes of transportation so as not to interfere with the main road in the Bojonggede Station area [11]. Therefore, this research was conducted to determine the type of sky bridge that is appropriate and efficient to connect Bojonggede Station and Terminal and pay attention to the impact on the surrounding traffic.

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2. Research Method

The type of research in this study is a predictive simulation with a quantitative approach and descriptive analysis. The data needed in this study are secondary data and primary data. Secondary data is obtained from related agencies, while primary data is obtained from direct research in the field. The data analysis method used is the 4 step model method consisting of trip generation/attraction, trip distribution, mode selection (Moda Split), trip assignment, Indonesian road capacity manual, and descriptive analysis of survey data on visitors to Bojonggede station.

2.1 Secondary Data

Secondary data ordered in this study data that will be used to support research on the connecting bridge between the Bojonggede terminal and Bojonggede station, which includes:

1) General Urban Spatial Plan

   This data is useful for knowing the land use around the study location. This data obtained from the Bappeda of Bogor Regency.

2) Site Plan and Master Plan for The Study Site

   Data on the construction site plan and the Master Plan for the Development of Integrated Facilities (Skybridge) from Bojonggede Station to Bojonggede Terminal from the management.

3) Vehicle Ownership Data and Traffic Growth Rate

   Vehicle ownership data and traffic growth rate data are useful for predicting future traffic growth [12]. This data is obtained from the Bogor Regency Transportation Office.

4) Employee Data

   Data on the number of employees and visitors of Bojonggede Station and Bojonggede Terminal were obtained from the manager.

2.2 Primary Data

The primary data needed in this study was obtained from a field survey which includes several data which include:

1) Survey Inventory

   Inventory of land use is carried out to see the allotment and potential use of the land around the area and the surrounding roads that influence awakening and the drag of the existing and will burden the road.

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2) Survey Traffic Counting (TC)

A traffic enumeration survey is a survey that is used to record the volume of traffic on a certain road segment [13][14].

3) Survey Speed and Obstacle

Measurement Vehicle Speed Using Stop Watch and Roll Meter [15].

4) Survey Pedestrian

This survey was conducted on pedestrians who cross and walk in front of the access location in and out of the location study [16].

5) Survey Origin Destination Journey

Take notes on the number of vehicles entering and exiting the intersection in the study area [17].

6) Survey Awakening Journey

Count vehicles in and out of study location [18].

2.3 Descriptive Analysis

The descriptive analysis method obtains the most appropriate bridge design installed to connect the Bojonggede station with the Bojonggede Terminal [19][20]. To connect the Bojonggede terminal with the Bojonggede station with a descriptive analysis method, several components (variables) are used, including connectivity, convenience; safety; security; comfort. From this aspect, a field survey was carried out on visitors to Bojonggede station, and data obtained were processed to know which type of connecting bridge is the most effective for connecting Bojonggede station with Bojonggede Terminal [21].

2.3 Road Service Level Analysis

An analytical method based on calculations with the 4 Step Model consists of trip generation/attraction, trip distribution, mode selection (Moda Split), and trip assignment. The Indonesian Road Capacity Manual determines road capacity and level of service for affected roads around the study site [22]. VC ratio is one aspect in measuring road performance parameters, where the ratio of busy time flows on roads with road capacity. From the VC ratio, the service characteristics of a road segment will be known [23][24]. It is estimated that the roads affected by the construction of a connecting bridge between the Bojonggede terminal and the Bojonggede station will experience changes in road performance between the construction and operational periods. These roads include Bojonggede 1 Highway, Terminal Access Road, Bojonggede 2 Highway, West Abdul Halim Road, East Abdul Halim Road, South New Market

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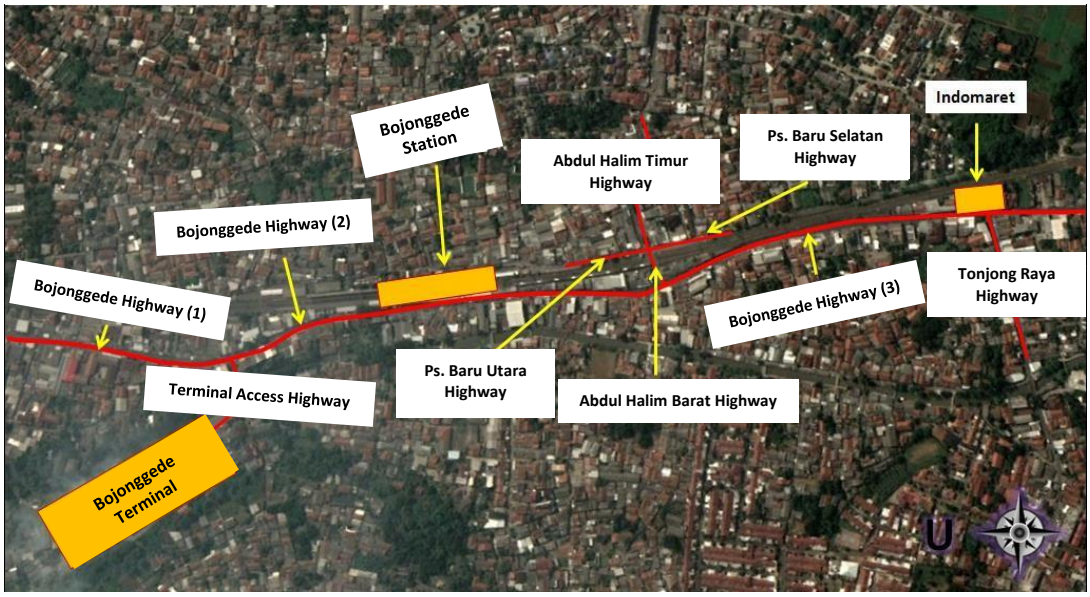
Road, North New Market Road, Bojonggede 3 Highway Tonjong Highway. The following calculation can determine the road level of service: North New Market Street, Bojonggede 3 Highway, Tonjong Highway. The following calculation can determine the road level of service: North New Market Street, Bojonggede 3 Highway, Tonjong Highway. The following calculation can determine the road level of service:

Table 1. Alternative Descriptive Analysis Model I

Service Level	Characteristics	Scope of V/C
A	Free flow conditions with high speed and low traffic volume. The driver can choose the desired speed without a hitch	0.00 – 0.19
B	In the current stable zone. The driver has enough freedom to choose his speed.	0.20 – 0.44
C	In the current stable zone. Drivers are limited in choosing their speed.	0.45 – 0.74
D	Approaching unstable currents where almost all drivers will be restricted. Service volume is related to tolerable (acceptable) capacity	0.75 – 0.85
E	Traffic volume is approaching or is at its capacity. The current is unstable with frequent stops.	0.86 – 1.00
F	Forced or jammed current at low speeds. Long queues and big bottlenecks.	> 1.00

Source: Regulation of the Minister of Transportation Number PM 96 of 2015 [25].

The results of descriptive analysis and calculations from the Indonesian road capacity manual will be used to select the most effective type of connecting bridge. They can reduce problems that occur in the location around the study.



Source: Analysis Result.

Figure 1. Affected Road Section

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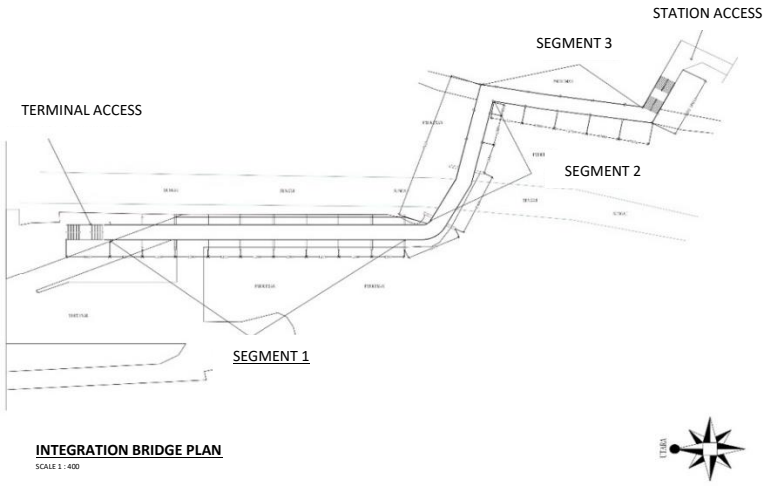
3. Results and Discussions

To overcome traffic problems around the Bojonggede station area, the Jabodetabek Transportation Management Agency (BPTJ) plans to build a sky bridge that connects Bojonggede station with the Bojonggede terminal. Skybridge was built on the Bojonggede highway with a length of 65.88 meters. The plannedsky bridgee design can be seen in the following picture.



Source: analysis result

Figure 2. Skybridge Design Engineering Details

With the plan to build a sky bridge that connects Bojonggede station with Bojonggede terminal, it is necessary to design the right bridge to be built in the area. For this reason, the author provides two alternative types of bridges that are appropriate to build in the Bojonggede area. The alternatives are alternative one bridge type and alternative 2 bridge type.

For the alternative type of bridge I. The concept for the first alternative refers to the provisions for the construction of pedestrian bridges (JPO), as follows; sky bridge made from Bojonggede station terminal and stretches above using two poles and the width of the road (road width 6 meters), but it takes a lot of land clearing to construction because uses two pillars as support, made a station door the new one in the northwest area (the current station entrance is in the northeast), which stick with market, so that minimize disturbance smoothness then cross, The original plan was for the existing northern door. Still, due to an installation, LAA is ± 12 m high, so it's too high if a sky bridge is made in that direction, from the sky bridge length station door position. The new plan is the position closest to the terminal with the most practical consideration for connecting the sky bridge from the station terminal. With a built skybridge with type alternative 1, the width of the roads around the construction will be reduced due to the construction process of sky bridge construction. Below are the results of the current study: conducted construction sky bridge.

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Table 2. Alternative Descriptive Analysis Model I

ASPECT	PRINCIPLES & STANDARD	OBSERVATION UNITS	EVALUATION
CONNECTIVITY	Connectivity and continuity between place one with another place, through planned pedestrian paths or guarantees for pedestrians to easily, safely, and pass through it in an area.	Pedestrian/pedestrian paths connecting terminals and stations Observations are made on pedestrian paths, whether they are defined (planned) or meet the requirements for pedestrian mobility.	Very Good (score:5): 100% Good (score:4) : 80% Enough (score:3) : 60% Less (score:2) : 40 % Bad (score:0):< 20 %
CONVINIENCE	Ease of access to information for users/pedestrians, including people with disabilities, in getting to the transit point from the terminal to the station or vice versa	Observation of the clarity, placement, and design of pedestrian bridges, as well as informative instructions that make it easier to find terminals or stations	Very Good (score:5): 100% Good (score:4) : 80% Enough (score:3) : 60% Less (score:2) : 40 % Bad (score:0):< 20 %
	Ease of visual access or visibility for users/pedestrians in getting to the transit point from the terminal to the station or vice versa.	Observations on the design of bridges or bridge buildings are easily recognized as area markers (landmarks) or road finding markers in the connecting path from the terminal to the station.	Very Good (score:5): 100% Good (score:4) : 80% Enough (score:3) : 60% Less (score:2) : 40 % Bad (score:0):< 20 %
SAFETTY	Physical safety standards with the principle of seamless movement and avoiding obstacles to pedestrian paths. (Also, note the link with ease of physical access)	Observation of surface continuity and quality of pedestrian paths. Observation exists whether or not there are obstacles such as trees/ street furniture/walkers that block the pedestrian path.	Very Good (score:5): 100% Good (score:4) : 80% Enough (score:3) : 60% Less (score:2) : 40 % Bad (score:0):< 20 %
	Safety standard mobility, avoiding conflicts or crossing pedestrians and other modes of transportation	Number of intersections/crossings of pedestrian circulation with a circulation of motorized vehicles that meet the requirements for crossing and safety regulations	Very Good (score:5): 100% Good (score:4) : 80% Enough (score:3) : 60% Less (score:2) : 40 % Bad (score:0):< 20 %
SECURITY	Physical environmental safety standards Social, environmental safety standards (street watching)	Observation of security facilities, especially at night (lighting, etc.) on pedestrian paths. Observation of safety, especially related to the potential/ atmosphere/ environmental services that ensure the safety of pedestrian paths. (Environmental crowd level, environmental security system, etc.)	Very good 100 % Very good 100 %.
COMFORTABLE	The convenience of walking distance for people, Wide comfort of pedestrian paths for all, including the disabled, Comfort of walking in environmental aspects (shade)	Conformance of standard comfortable distance between terminal and station Compatibility of pedestrian path width dimensions. Quality of shade or protection against rain and heat	Very Good Line 0 – 300 m / travel time < 5 minutes Very Good Track width 1.60 – 3.00 meters) Very Good (5 points): 100% Good (4 points): 80% Enough (3 points): 60% Less (score 2): 40%

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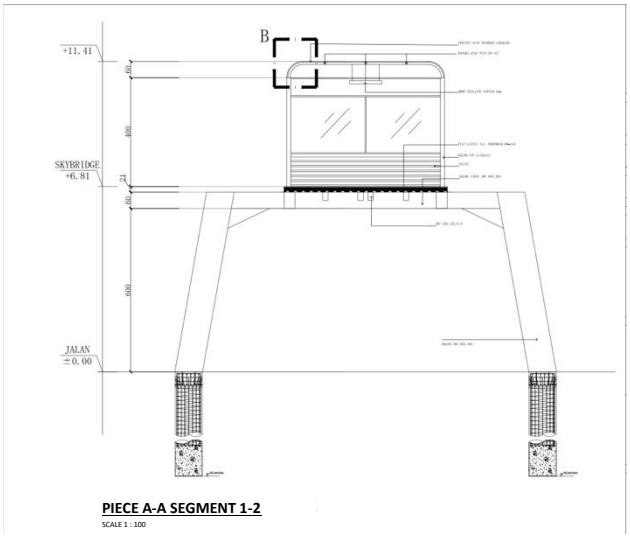
ASPECT	PRINCIPLES & STANDARD	OBSERVATION UNITS	EVALUATION
	Walking comfort from the service aspect for pedestrians (amenity/attractiveness)	Quality of service for pedestrians related to amenities (pedestrian support facilities such as organized sidewalks, shops, parks, public arts, etc.) that do not interfere with the smooth running of people from the terminal to the station or vice versa.	Poor (score 0): <20% Very Good (Rated 5): Good (4 points): 80% Enough (3 points): 60% Less (score 2): 40% Poor (score 0): <20%

Source: Analysis Result (2021)

From the table above, the planned design for an alternative I am shown in **Figure 3.**



*Source: Analysis Resul*t

Figure 3. Cross Cut Skybridge Alternative I

The concept for alternative II refers to the provisions for bridge construction crossing people (JPO), as follows; Skybridge made from Bojonggede station terminal, and stretches above using one pole and is as wide as the road (road width 6 meters), only requires one side of the road shoulder so no need many liberator lands for development his because use two-pole as crutch his, In for Door station which new in area North part West (door station which is now in the northeast), which is attached to the market to minimize disturbance smoothness then cross, Plan to begin indoor existing part North which already now, but because there is an LAA installation as high as ± 12 m. Hence, it is too high if the sky bridge is made towards that. From the long sky bridge, the new station door position plan is the closest position from the terminal, with the most consideration effective for connecting sky bridge from station terminal so that implementation faster and easier development. By building skybridge with alternative type 1I, the width of the roads around the construction will not decrease much due to the skybridge

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construction process. Below is the results of the road service level study Bojonggede on moment conducted construction sky bridge.

Table 3. Alternative Descriptive Analysis Model II

ASPECT	PRINCIPLES & STANDARD	OBSERVATION UNITS	EVALUATION
CONNECTIVITY	The connection and continuity between one place to another, through a planned pedestrian path or ensures that pedestrians are easy, safe, and comfortable to pass through in an area.	Pedestrian/pedestrian path pedestrian paths that connect the terminal and station Observations are made on pedestrian paths, are they defined (planned) or meet the requirements for pedestrian mobility	Very Good (5 points): 100% Good (score: 4) : 80% Enough (score: 3) : 60% Less (value: 2) : 40 % Bad (score: 0) : < 20 %
CONVINIENCE	Ease of access to information for users/ pedestrians, including people with disabilities, in getting to the transit point from the terminal to the station or vice versa.	Observation of the clarity, placement, and design of pedestrian bridges, as well as informative instructions that make it easier to find terminals or stations	Very Good (5 points): 100% Good (score: 4) : 80% Enough (score: 3) : 60% Less (value: 2) : 40 % Bad (score: 0) : < 20 %
	Ease of visual access or visibility for users/ pedestrians in getting to the transit point from the terminal to the station or vice versa.	Observations on the design of bridges or bridge buildings are easily recognized as area markers (landmark) or road turn markers (wayfinding) in the connecting line from terminal to station	Very Good (5 points): 100% Good (score: 4) : 80% Enough (score: 3) : 60% Less (value: 2) : 40 % Bad (score: 0) : < 20 %
SAFETY	Safety standard physical movement with the principle of seamless movement and avoiding obstacles to pedestrian paths. (Also, note the link with ease of physical access)	Observation of surface continuity and quality of pedestrian paths. Observation of the presence or absence of obstacles such as trees/ street furniture/walkers blocking the pedestrian path.	Very Good (5 points): 100% Good (score: 4) : 80% Enough (score: 3) : 60% Less (value: 2) : 40 % Bad (score: 0) : < 20 %
	Mobility safety standards, avoiding conflicts or crossing pedestrians and other modes of transportation.	Number of intersections/crossings of pedestrian circulation with a circulation of motorized vehicles that meet the requirements for crossing and safety regulations	Very Good (5 points): 100% Good (score: 4) : 80% Enough (score: 3) : 60% Less (value: 2) : 40 % Bad (score: 0) : < 20 %.
SECURITY	Physical environmental safety standards Social, environmental safety standards (street watching)	Observation of security facilities, especially at night (lighting, etc.) on pedestrian paths. Observations on security aspects, especially those related to the potential/ atmosphere/environmental	Very Good 100 % Very Good 100 %

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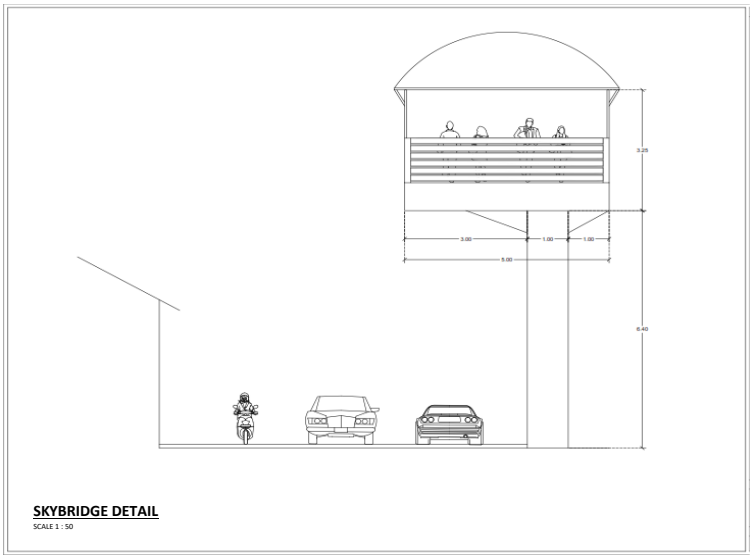
ASPECT	PRINCIPLES & STANDARD	OBSERVATION UNITS	EVALUATION
		services that ensure the safety of pedestrian paths. (Environmental crowd level, environmental security system, etc.)	
COMFORTABLE	The convenience of walking distance for people, Wide comfort of pedestrian paths for all, including the disabled, Comfort of walking in environmental aspects (shade)	Conformance of standard comfortable distance between terminal and station Compatibility of pedestrian path width dimensions. Quality of shade or protection against rain and heat	Very Good Track 0–300 m / travel time < 5 min Very Good Track width 1.60 – 3.00 meters) Very Good (5 points): 100% Good (4 points): 80% Enough (score 3): 60% Less (score 2): 40% Bad (score 0): <20%
	Walking comfort from the service aspect for pedestrians (amenity/attractiveness)	Quality of service for pedestrians related to amenities (pedestrian support facilities such as organized sidewalks, shops, parks, public arts, etc.) that do not interfere with the smooth running of people from the terminal to the station or vice versa.	Very Good (Rated 5): 100% Good (4 points): 80% Enough (3 points): 60% Less (value 2): 40 Bad (score 0): <20%

Source: Analysis Result (2021)

From the table above, the planned design for alternative II is shown in **Figure 4.**



Source: Analysis Result (2021)

Figure 4. Cross Cut SkybridgeAlternative II

Type analysis bridge crossing (sky bridge), Which in proposed in two alternatives each has the following considerations:

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While at the time of development, Skybridge good alternative I or alternative II estimate cause impact then cross in surroundings. The traffic impact occurs because mobility around the Bojonggede station area is disrupted due to construction. To decrease the level of road service during the construction of the sky bridge. The road with the worst level of service is Jalan Bojonggede 2. This road is located in front of the Bojonggede station with a level of service F, which means this road is experiencing congestion. The following is a prediction of the level of road service during the following period: construction sky bridge alternative I or Skybridge alternative II.

Table 4. Performance of Road Sections Affected During Construction I and II

No	Roads	Vol (pcu/hour)	C (pcu/hour)	V/C ratio	LoS
1	Jl. Raya Bojonggede (1)	1121.2	1023,12	1.10	F
2	Jl. Terminal Access	543.0	671.41	0.81	D
3	Jl. Raya Bojonggede (2)	1141.1	1032.12	1.11	F
4	Jl. Abdul Halim Barat	877.5	1001.13	0.88	E
5	Jl. Abdul Halim Timur	878.0	1001.13	0.88	E
6	Jl. Ps. New South	317.1	694.07	0.46	C
7	Jl. Ps. New North	519.9	794.07	0.65	C
8	Jl. Raya Bojonggede (3)	1119.3	1321.68	0.85	E
9	Jl. Tonjong Kingdom	1196.2	1415,36	0.85	E

Source: Analysis Result (2021)

Meanwhile, at the operational stage where the sky bridge has been completed and can be used for the surrounding community, the prediction of the service level of the affected road is as follows.

Table 5. Performance of Road Sections Affected by Operational Periods I dan II

No	Roads	Vol (pcu/hour)	C (pcu/hour)	V/C ratio	LoS
1	Jl. Raya Bojonggede (1)	1156,2	2321.16	0.50	C
2	Jl. Terminal Access	255.1	3041.52	0.08	A
3	Jl. Raya Bojonggede (2)	1198.1	2321.16	0.52	C
4	Jl. Abdul Halim Barat	921.4	2668.00	0.35	B
5	Jl. Abdul Halim Timur	921.9	2668.00	0.35	B
6	Jl. Ps. New South	228.1	1494.08	0.15	A
7	Jl. Ps. New North	545.7	1494.08	0.37	B
8	Jl. Raya Bojonggede (3)	1175.2	2321.16	0.51	C
9	Jl. Tonjong Kingdom	1256.0	2321.16	0.54	C

Source: Analysis Result (2021)

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From the prediction table for the level of road service above, it can be concluded that the level of road service has increased during the operational period. Jalan Bojonggede 2, located right in front of Bojonggede station, has a level of service C where vehicles can still choose their speed even though there are side disturbances. This means that constructing a sky bridge that connects Bojonggede station with Bojonggede Terminal can overcome traffic problems in the Bojonggede station area.

4. Conclusion

Of the two alternative Skybridges that connect Bojonggede Station to Bojonggede Terminal, Alternative II is more appropriate for the type of skybridge that connects Bojonggede Station with Bojonggede Terminal compared to alternative 1. While the performance of the road during the construction period was originally F decreased to C during the operational period. This means that the construction of a sky bridge that connects Bojonggede station with Bojonggede Terminal has succeeded in overcoming traffic problems around the study site.

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