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Analysis of the Fulfillment Transportation Aspects In Potential Transit Oriented Development Areas, Case Study Bendungan Hilir MRT Station 2022

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Abstract: Bendungan Hilir is a Central Business District Golden Triangle in Jakarta with a city-scale area typology having mixed land use functions in the form of housing, offices, trade, and services. This study aims to assess the feasibility of the Bendungan Hilir area being developed into a Transit Oriented Development Area where the area is already supported by high-capacity rail-based transportation modes and bus rapid transit serving short and long-distance travel. Using the Importance Performance Analysis method, Pareto diagrams are included, which are used to identify the characteristics of people's movements, assess the performance indicators of integration facilities, and prioritize the realization of transportation aspects in the potential area of Transit Oriented Development Bendungan Hilir. The results of the study show that there are three aspects of transportation that are the main priority to be realized, namely, Aspects of Transit, Aspects of Walking, and Aspects of Connectivity.

Keywords: Transportation Aspects, IPA, Non-Motorized Transport, Pareto Diagram, Transit Oriented Development.

Introduction

The movement of people in Jakarta, Bogor, Depok, Tangerang, and Bekasi (Jabodetabek) every year has a very high increase and tends to be out of control. According to the Jabodetabek Urban Transportation Policy Integration Phase II study (2018), the number of trips in the Jabodetabek area is around 80 million trips per day and is expected to continue to grow. Based on research conducted by Iskandar et al. (2021), who found the number of people moving in the five areas of the Jakarta Administration as follows: South Jakarta of 704,186 people; Central Jakarta of 652,199 people; East Jakarta of 408,144 people; West Jakarta of 361,439 people; and the North Jakarta area of 303,783 people. Jutpi's research or Jabodetabek Urban Transportation Policy Integration 2 in 2018 found that congestion is increasing with the level of use of public transportation only 12% compared to the use of private vehicles, which is still relatively high, reaching 76.47% of motorcycle use and 21.85% of car use (Department of Transportation DKI Jakarta, 2019) (Nadhira Maudina et al., 2021a).

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This massive movement is dominated by private vehicles, causing traffic jams on the highway because the volume of vehicles has exceeded the available road capacity. This massive movement impacts the expansion of residential areas to suburban areas or the Urban Sprawl phenomenon, caused by the high flow of urbanization and the movement of people who are not accommodated by transportation networks that serve first-mile and last-mile trips. According to (Tanesha Novlita Putri Aden and Ketut Dewi Martha Erli Handayeni, 2019), this problem needs special attention by taking an approach to the development of a mass public transportation system and regional development oriented to the use of public transport (transit) through an integrated regional spatial approach and directly connected to the access and service network of public transportation modes.

According to (Calthorpe, 1993, p. 56), Transit Oriented Development is a form of development of areas that can be traversed on foot, usually having a radius of 600m from transit points, transit stations, or Bus Rapid Transit (BRT) stops, with higher building density concentrated near the station, aiming to provide convenience in transiting intermodal transfers for many people. This development takes the form of utilizing the availability of infrastructure, optimizing the use of the transit network, and creating mobility options for transit users and local communities.

According to Singh et al. (2014), in identifying the characteristics of the Transit Oriented Development Area, the first two problems are found in urban areas that have a high transit orientation but have poor access to transit. The second problem is that the two areas have good transit quality but the transit orientation still needs improvement. The purpose of this study is to identify the characteristics of the people's journey in the Bendungan Hilir area and assess the readiness of the integration of transportation facilities and infrastructure so that the Bendungan Hilir area is feasible to be developed into a Transit Oriented Development Area.

Method

The method used is a quantitative method using two analytical tools, namely Importance Performance Analysis and Pareto Diagrams. The analysis system for assessing the readiness and feasibility of the Downstream Dam area uses the basis of Perka BPTJ No. 377 of 2017 concerning transportation aspects in transit-oriented areas, namely transportation aspects, walking aspects, cycling aspects, connectivity and connectivity aspects, and switching aspects. In assessing the readiness of the area, researchers use performance indicators of integration

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facilities based on research on integration between transportation modes conducted by the Research and Development Center of the Ministry of Transportation. The primary data for this study were gathered through observation and the distribution of questionnaires to the general public as well as MRT and Transjakarta users in Bendungan Hilir. The primary data needed are: demand surveys for MRT and Transjakarta Bendungan Hilir passengers; accessibility and connectivity of the area with transit services, and the completeness or availability of integration facilities. Secondary data in this study is a literature review from journals, previous research, and planning documents. The secondary data needed are: legal references (Perpres 55 of 2018 concerning the Jabodetabek Transportation Master Plan, Permen ATR/BPN Number 16 of 2017 concerning Guidelines for the Development of Transit-Oriented Areas, Perka BPTJ No. 377 of 2017 concerning Technical Guidelines for Transportation Aspects in the Implementation of Development-Oriented Areas Mass Public Transportation in the Jabodetabek Region), socio-economic data through the Central Statistics Agency for Tanah Abang and Setiabudi Sub-districts in 2021, statistical data on Jabodetabek travel and Jakarta transportation growth from the Transportation Service.

Variables and Data Analysis Techniques

Assessment of the readiness and feasibility of the Lower Dam area to be used as a Transit Oriented Development Area is carried out using quantitative methods, and data interpretation is presented descriptively in the form of tables and histograms. The boundaries of the research area are limited by the delineation of the Transit Oriented Development planning area, which is 400 meters from the transit node at the Bendungan Hilir MRT Station. The determination of the transit node is based on Permen ATR/BPN No. 16 of 2017, where the transit node of the Transit Oriented Development area is traversed by a network of high-frequency rail-based transportation modes with heavy rail and light rail types. The following is a table of variables along with the research criteria and indicators in table 1:

Table 1 Variables Along With The Research Criteria And Indicators

Transport Aspect In TOD Area	Integration Facility Performance Criteria	Indicator
	Proximity	Service Frequency

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Transport Aspect In TOD Area	Integration Facility Performance Criteria	Indicator
Public Transportation Aspect		Service Operating Hours
		Minimum Number of Services SAUM
		Short walking distance from activity destination to transit node maximum 500 meters
Walking Aspect	*Proximity* *Connectivity* *Convenience* *Safety* *Security* *Attractiveness* *Healthy*	Pedestrian-friendly and disabled-friendly paths
		Short walking time from activity to transit node (maximum 5 minutes)
		Short walking distance from the residence/activity to the transit node (maximum 500m)
		Utilization of social and ecological functions in the form of social interaction, formal small business activities, exhibition activities and / performances in open spaces and the Green Line
		Pedestrian facilities on the surface and below the ground are integrated and avoid conflicts with the circulation of motorized vehicles such as JPOs, pelican crossings, tunnels connected with access to transit nodes, blocks, and buildings in an area
		Supporting signs affecting pedestrian paths
		barriers between pedestrian and cyclist lanes and motorized vehicle lanes
		Adequate lighting and CCTV monitored area
		Well-organized path space and pedestrian furniture (benches, lighting, trash cans, median plants)
		Cleanliness of lane space and adequate air circulation
Cycling Aspect	*Connectivity* *Convenience* *Safety*	Cycle Path
		Bicycle parking as close as possible to the station/terminal, bus stops, buildings, access to buildings

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Transport Aspect In TOD Area	Integration Facility Performance Criteria	Indicator
	Healthy	Supporting signs affecting bicycle lanes
		Signage or directional signs and travel guides
		barrier between pedestrian and cyclist lanes
		Path room cleanliness
		Adequate air circulation
Connectivity Aspect	Proximity Connectivity Convenience	The shortest route by walking is the proximity between blocks, buildings, connected and integrated to the transit node with a walking time of 5 minutes.
		Access is directly connected to transit nodes and buildings in serving the movement of pedestrians and cyclists from outside, inside and outside and/or within the TOD area.
		Information signs directing connecting facilities
		Continuous and integrated connection of pedestrian and bicycle paths
Shfting Mode Aspect	Convenience	The maximum distance for the provision of public transportation, feeder max 400m, main mode node max 800m.
		Park and Ride is possible, only for people to park their private vehicles to switch to public transportation (must be inside the building)
		Signage and/or directional signs and travel guides (advanced mode of transportation)

Stratified Random Sampling

From the data used in this study, the researchers determined an error value of 10%. With assumptions and calculations, the research sample will be taken from people who access the

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Bendungan Hilir MRT bus stop and station from and to the center of activity and residence. The value of N, or the population, is determined by the researchers based on the average number of passengers per day for MRT Jakarta in 2019, with an average passenger per day reaching 6,345 (Recapitulation of Passengers for MRT Jakarta, MRT Jakarta, 2022).

Determine the number of research samples/respondents:

$n = N:(1+Nxe^2)$……..(3)

n= 6.345 : (1+6.345x0,1x0,1)

n= 6.345 : (1+63,45)

n=6.345 : 64,45

n= 98,44/100 samples/respondents.

Transjakarta passenger strata, 2019 data is used, with an average daily passenger of 8095 (Transjakarta Passengers at Bendungan Hilir Bus Stop, TransJakarta, 2022)). Determine the number of research samples/respondents:

$n = N:(1+Nxe^2)$……..(4)

n= 8095:(1+8095x0,1x0,1)

n=8095:(1+80,95)

n=8095 : 81,95

n=98,77/100 samples/respondents

The number of samples needed basing on the strata used is 200 samples, which are divided into 100 samples of data from MRT Jakarta Bendungan Hilir users and 100 samples of data from TransJakarta Bendungan Hilir users, representing the population in Bendungan Hilir and Karet Semanggi sub-districts who live and operate in the Bendungan Hilir area, especially the people who use the MRT and TransJakarta Bendungan Hilir. The results of the research questionnaire recapitulation are as follows:

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Table 2 The Results Of The Research Questionnaire Recapitulation

No	Characteristics of respondents	Total
1	Age	24-29 Years Old, 84 Person, 42%
2	Gender	Male, 114 Person , 57%
3	profession	private sector employee 105 person, 53%
4	Travel Destination	Bendungan Hilir, 111 person
5	Domisili	Bendungan Hilir, 65 person
6	travel intent	Working, 152 person, 76%
7	User MRT/TransJakarta Bendungan Hilir	MRT BNH 118 person, TJ BNH 82 person
8	Activity location distance to MRT/TransJakarta Bendungan Hilir	<500 meter, 73 person
9	Distance from residential location to node MRT/TransJakarta Bendungan Hilir	1-5km, 65 person, 33%
10	Travel time on foot from activity location to transit node	<10 minute, 100 person, 50%

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Importance Performance Analysis

The results of calculations using SPSS software, a Cartesian diagram is formed with the following results:

Figure 1 Cartesian Diagram

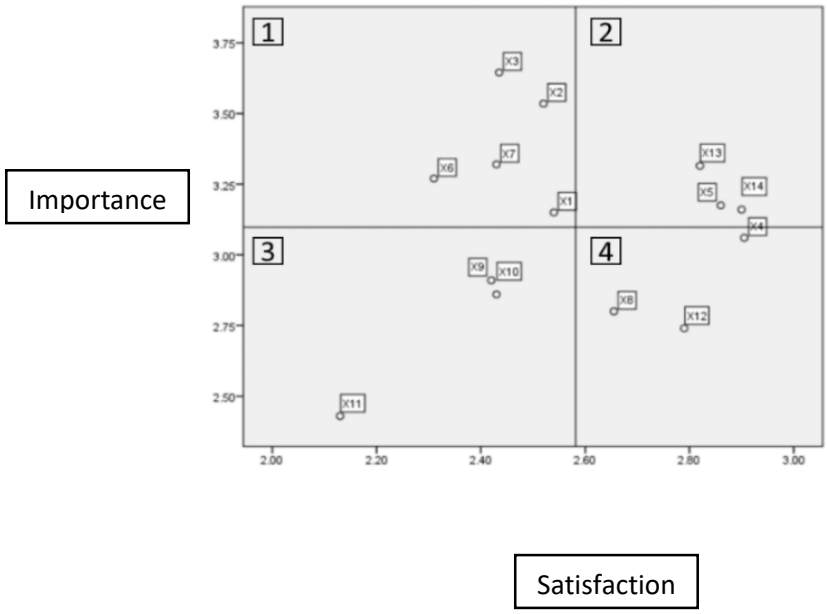

Table 3 The Results Of Calculations Using SPSS Software

Criteria	Indicator	Symbol	Quadrant
Proximity	Short walking distance from residence/activity to transit node	X1	1
	Short Travel Time on foot from residence/activity to transit node	X2	1
Connectivity	Access is directly connected to transit nodes and buildings in serving the movement of pedestrians and cyclists from outside, inside and outside and/or within the TOD area.	X3	1
Convenience	Ease of access for people with disabilities	X6	1
Safety	Crossing facilities both JPO, Tunnel (tunnel) and also zebra cross	X7	1
Criteria	Indicator	Symbol	Quadrant
Convenience	Signage and/or directional signs and travel guides	X5	2
Healthy	Path room cleanliness	X13	2

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Criteria	Indicator	Symbol	Quadrant
Convenience	Signage and/or directional signs and travel guides	X5	2
Healthy	Path room cleanliness	X13	2

Criteria	Indicator	Symbol	Quadrant
Security	Adequate lighting and CCTV monitored area	X9	3
	Pedestrian disturbance reporting facility	X10	3
Attractiveness	Functions of activities along the path	X11	3

Criteria	Indicator	Symbol	Quadrant
Connectivity	Path for pedestrians and cyclists	X4	4
Safety	Protectors and/or barriers between pedestrian and cyclist lanes and motorized vehicle lanes	X8	4
Attractiveness	Well-organized path space and pedestrian furniture (benches, lighting, trash cans, median plants)	X12	4

GAP Testing and Respondent Conformity Level

In the GAP testing stage and the respondent's conformity level (TKi), where the level of conformity has a value of 66% or quite good, up to 101.82%, which is declared very good. The following are the results of the GAP test and the level of suitability of the respondents (TKi). The results are as follows:

Table 4 The Result Of GAP Testing And Respondent Conformity Level

Performance Indicator	Mean		GAP	Respondent Suitability Level (TKi)	Cartesian Quadrant
	Satisfaction	Importance			
X1	2.54	3.15	0.61	80.63%	1
X2	2.52	3.54	1.02	71.29%	1
X3	2.44	3.65	1.21	66.80%	1
X4	2.91	3.06	0.16	94.93%	4
X5	2.86	3.18	0.32	90.08%	2
X6	2.31	3.27	0.96	70.64%	1
X7	2.43	3.32	0.89	73.19%	1
X8	2.66	2.80	0.15	94.82%	4

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Performance Indicator	Mean		GAP	Respondent Suitability Level (TKi)	Cartesian Quadrant
	Satisfaction	Importance			
X9	2.42	2.91	0.49	83.16%	3
X10	2.43	2.86	0.43	84.97%	3
X11	2.13	2.43	0.30	87.65%	3
X12	2.79	2.74	-0.05	101.82%	4
X13	2.82	3.32	0.50	85.07%	2
X14	2.90	3.16	0.26	91.77%	2

Pareto Charts

According to (Heizer, 2014) Pareto Diagram (Pareto Analysis) is a method for managing problems, the main problem helps focus attention on problem solving efforts. In this study, the researchers set performance indicators to be tested using Pareto Diagrams, where the performance indicators tested were the results of the Cartesian quadrant based on quadrant 1, with the following performance indicators:

Table 5 The Results Of The Cartesian Quadrant Based On Quadrant 1

Criteria	Indicator	Symbol	Quadrant
Proximity	Short walking distance from residence/activity to transit node	X1	1
	Short Travel Time on foot from residence/activity to transit node	X2	1
Connectivity	Access is directly connected to transit nodes and buildings in serving the movement of pedestrians and cyclists from outside, inside and outside and/or within the TOD area.	X3	1
Convenience	Ease of access for people with disabilities	X6	1
Safety	Crossing facilities both JPO, Tunnel (tunnel) and also zebra cross	X7	1

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Discussion and Result

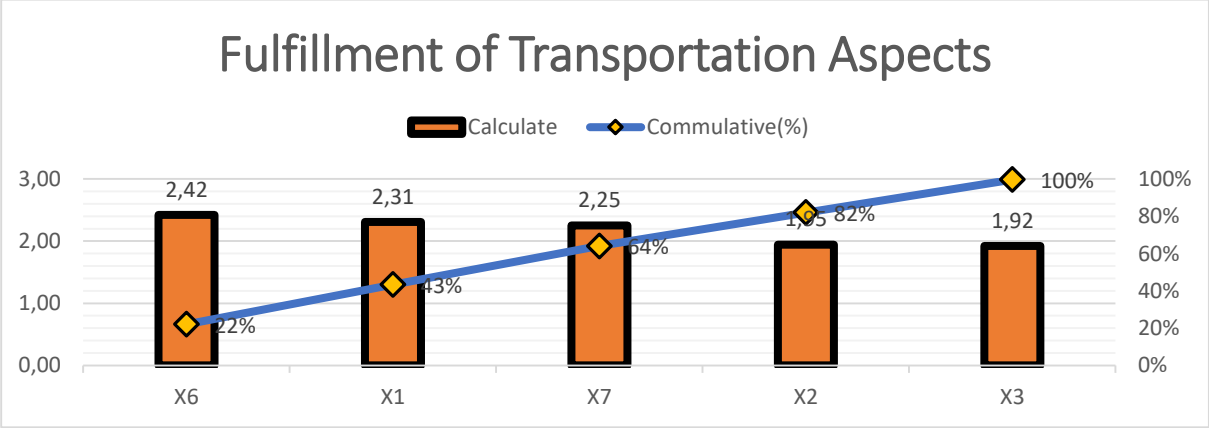
Based on these indicators, the next step is to compile a matrix based on the sum of satisfaction and importance index values, the percentage value of each indicator, and calculate the cumulative value of each indicator, with the calculation matrix as follows:

Table 6 The Result Of Calculate The Cumulative Value Of Each Indicator

Indicator	Mean		Total (xy)	Score Value	**Indicator**	**Calculate**	**Percentage (%)**	**Commulative(%)**
	Satisfaction (x)	Importance (y)						
X1	2.54	3.15	5.69	8	X6	2.42	22%	22%
X2	2.52	3.54	6.06	8	X1	2.31	21%	43%
X3	2.44	3.65	6.08	8	X7	2.25	21%	64%
X6	2.31	3.27	5.58	8	X2	1.95	18%	82%
X7	2.43	3.32	5.75	8	X3	1.92	18%	100%
					Total	**10.8**	**100%**	

From these results, the Pareto Diagram calculation is presented in the form of a histogram so that the following results are obtained:

Figure 2 The Result Of The Pareto Diagram Calculation



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From the histogram of the Pareto Diagram, it is found that there are three performance indicators and criteria that need to be prioritized to be addressed and/or realized in the embodiment of transit-oriented areas, which are shown in the following table:

Table 7 Result Of Three Performance Indicators And Criteria That Need To Be Prioritized

Symbol	Integration Facility Performance Criteria	Indicators based on Transportation Aspects in TOD Area (Perkaban 377/2017) dan Keterpaduan Integrasi Antarmoda Transportasi (Puslitbang)	Implementation Transport Aspect	Calculation and cumulative value
X1	Proximity	Short walking distance from residence/activity to transit node	Public Transportation Aspect, Walk Aspect	2.31 dan 43 %
X6	Convenience	Pedestrian paths for people with disabilities	Walk Aspect	2.42 dan 22%
X7	*Safety*	Crossing facilities both JPO, Tunnel (tunnel) and also zebra cross	Walk Aspect, Connectivity Aspect	2.25 dan 64%

Based on the Pareto diagram and table above, it is known that the dominant integration facility performance indicator is X1: Short walking distance from residence/activity to transit node, with a calculation value of 2.42 and a cumulative value of 22%, X6: Pedestrian paths for people with disabilities. X7 Crossing facilities both JPO, Tunnel (tunnel) and also zebra cross received a calculated score of 2.25 and a cumulative score of 64%.

Conclusion

With a 400-meter delineation from the transit node at Bendungan Hilir MRT Station, the researchers divided into 4 segment areas, namely: Segment 1: Jalan Jendral Sudirman, Jalan Garnisun, and Jalan Masjid Hidayatullah; Segment 2: Jalan Bendungan Hilir; Segment 3: Jalan Prof.Dr Satrio and Jalan K.H. Mas Mansyur; and Segment 4: Jalan Jendral Sudirman in the Karet Kuningan area. The condition of adequate integration facilities is only on Jalan Jendral Sudirman. For other roads, the condition of special lanes for pedestrians and cyclists is inadequate. The results of the Importance Performance Analysis show that there are indicators that require priority handling because they are considered important by the people who live and

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have activities in the Bendungan Hilir area, but in reality, these interests are not directly proportional to the expectations and/or satisfaction of the users. The indicators are as follows: Access is directly connected to transit nodes and buildings in serving the movement of pedestrians and cyclists from outside, inside and outside, and/or within the Transit Oriented Development area; Ease of access for people with disabilities; Good crossing facilities JPO, Tunnel (tunnel) and Zebra Cross. The Pareto Diagram shows that of the five indicators tested based on the calculation of the cumulative value of each indicator, it was found that three indicators became the main priority to be realized and/or prioritized to be addressed, namely: short walking distance from housing and/or activities to transit nodes; crossing facilities, both JPO and Tunnel (tunnel) and also zebra cross; Ease of access for people with disabilities From these indicators, the priority aspects of transportation are realized, namely: transportation aspects, walking aspects, and connectivity aspects.

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