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Sustainable of Network Public Transport Design in Bekasi City

K. Khotimah[1✉], Made Suraharta[2], Bobby A. Hermawan[3]
Ministry of Transportation, Polytechnic of Indonesian Land Transportation
Email: khusnulmanisque31@gmail.com[1✉]

Abstract

The sluggishness of urban transportation in Bekasi City is indicated by a significant decline in public transport users in Bekasi City for trips within the city. This condition requires evaluation to review technical, financing, and management in order to improve the provision of urban public transport services in Bekasi City. Through a priority corridor strategy derived from the analysis of selected corridor profiles from various multi-criteria, an effective and efficient urban transit network design can be implemented. For urban travel, the largest number of public transport users in the existing conditions of the western zone is 82,640 people/day with a switching interest of 80%, the northern zone of Bekasi City is 123,349 people/day with a switching interest of 17%, the eastern zone of Bekasi City is 98,678 people/day with a switching interest of 60%, the southern zone of Bekasi City is 62,420 people/day with a switching interest of 17%, the Pondok Gedhe zone is 126,621 people/day with a switching interest of 47%. Strategies for intermodal route transfer between corridors are required through the western and eastern bus stop interconnection design scheme which is the intermodal hub in Bekasi City. Feeder transportation management through the transfer of urban transportation routes into environmental transportation sub feeders is needed. Ticket integration to accommodate the ease of transit transfer rates in urban areas with a maximum of 2 times transfer with the "One Ticket One Trip" scheme based on "Smart Card" received support from the community of 54.9% for tariffs of Rp. 10,000, - and 30.7% for tariffs of Rp. 10,000, - up to Rp. 15,000, - and 14.4% for tariffs of Rp. 15,000, - Rp. 20,000.

Kata Kunci: Urban Transit; Network Design; Integration, Sustainable Transport,Public Transport, Multicriteria

Abstrak

Lambatnya transportasi perkotaan di Kota Bekasi ditunjukkan dengan menurunnya pengguna angkutan umum di Kota Bekasi secara signifikan untuk perjalanan dalam kota. Kondisi ini memerlukan evaluasi untuk meninjau teknis, pembiayaan, dan manajemen dalam rangka meningkatkan penyediaan pelayanan angkutan umum perkotaan di Kota Bekasi. Melalui strategi koridor prioritas yang diperoleh dari analisis profil koridor terpilih dari berbagai multikriteria, desain jaringan transit perkotaan yang efektif dan efisien dapat diimplementasikan. Untuk perjalanan perkotaan, jumlah pengguna angkutan umum terbesar pada kondisi eksisting zona barat adalah 82.640 orang/hari dengan switching interest 80%, zona utara Kota Bekasi adalah 123.349 orang/hari dengan switching interest 17%. , Kota Bekasi zona timur sebanyak 98.678 orang/hari dengan minat beralih 60%, zona selatan Kota Bekasi sebanyak 62.420 orang/hari dengan minat beralih 17%, zona Pondok Gedhe sebanyak 126.621 orang/hari dengan beralih bunga sebesar 47%. Diperlukan strategi perpindahan jalur antar moda antar koridor melalui skema desain interkoneksi halte barat dan timur yang merupakan hub antar moda di Kota Bekasi. Pengelolaan transportasi pengumpan melalui pengalihan jalur transportasi perkotaan menjadi sub pengumpan transportasi lingkungan sangat diperlukan. Integrasi tiket untuk mengakomodir kemudahan tarif transfer transit di perkotaan dengan maksimal 2 kali transfer dengan skema "One Ticket One Trip" berbasis "Smart Card" mendapat dukungan dari masyarakat sebesar 54,9% untuk tarif Rp. 10.000,- dan 30,7% untuk tarif Rp. 10.000,- s/d Rp. 15.000,- dan 14,4% untuk tarif Rp. 15.000,- Rp. 20.000.

Kata Kunci: *Transit Perkotaan; Desain Jaringan; Integrasi, Transportasi Berkelanjutan, Angkutan Umum, Multikriteria*

INTRODUCTION

A significant decrease in public transportation users in Bekasi City decreased for trips within the city of Bekasi public transportation users by 61% (Khusnul et al., 2022). On the other hand, private vehicle users are increasing and causing congestion that is evenly distributed in Bekasi City during the morning and evening peak hours.

It is necessary to transform public transportation services to be able to increase the enthusiasm of passengers so that the congestion problem can be resolved. In order to review the services of urban mass transit based on buses operating in the Bekasi area, which include the number, type and capacity of the public transport fleet to optimize public transport services in Bekasi City.

RESEARCH METHODS

The research method used in this study is a combination of primary and secondary data collection.

1. Data Collection Method

Primary data collection conducted in this study included the following: Urban travel origin and destination survey, Urban Traveler Interview Survey, Traveler Preference Survey, Survey of Ability and Willingness to Pay Integrated Transit Pricing, Priority Corridor Survey. Secondary data collection is carried out through letters to government agencies and operators in handling the management of public transportation, in this case the Bekasi City Transportation Office and regionally owned company (BUMD) PD Mitra Patriot (PDMP) as the manager of Trans Patriot mass transportation. The data taken include the following: Ticket data of sold urban public transportation users, Urban transportation route data, Data on the number of Urban Transport fleets within permitted routes, Urban transportation data prices.

2. Data Analysis Method

The data analysis method used is as follows:

Analysis of potential public transportation users In determination of retrieval technique the sample you are looking for use formula calculation Slovin as following :

$$N = N/(1+Ne2) \quad \text{.....(I)}$$

Explanations: n = sample size, E = significance value/margin of 10%, N = Total population,

3. Multicriteria analysis

Multicriteria analysis methodology is composed of the following steps:

a. Formulating a decisive problem,
b. Creating variants,
c. Creating a consistent family of criteria,
d. Defining preferences of the decision-maker and of interveners.

The decisive problem was formulated as a multi-criteria problem of ISUPT variant classification. The methodology precisely identifies the main stakeholders in the decision-making process, interested in a given solution aiming at solving the decisive problem. In the

case of the integration of urban public transport, they are:

a. A Decision-Maker – City Authorities,
b. Interveners – Board Of Urban Transport, Operator Of The Urban Public Transport, Passengers Of The Urban Public
c. Transport And Other Traffic Users,
d. Analyst – Transport Expert, A Person Experienced In It. (Nosal & Solecka, 2014)

In determining the selected corridor, it is necessary to determine the criteria and sub-criteria for each indicator. Then each indicator is scored based on the results of recommendations from sample interviews with selected people who are considered qualified in their fields. The description of these indicators is described in the diagram as follows:

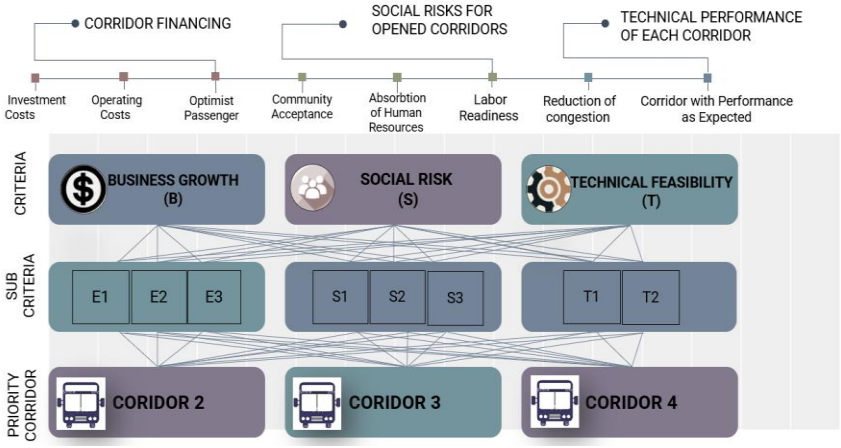


Figure 1 Diagram of Indicator Variables for Analysis of Selected Corridors Based on Multicriteria Analysis

Source: Analysis of Indicator, 2023.

RESULTS AND DISCUSSION

Figures must be original, computer-generated or drafted, and placed on a numbered page, preferably within the text area where they are discussed. Figures and photographs can be in color but the Journal does not print in color. If your figures are in color, make sure they are legible when printed as black and white. Do not refer to the colors in a figure in the text.

Zone-based urban transit demand feasibility analysis

Based on the urban trip destination origin survey, the distribution of people's movement for trips within Bekasi City in 2023 is obtained as follows:

Table 1 Origin and Destination Matrix of Travel Movement within Bekasi City in 2023

DISTRICT NAME	OD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	TOTAL
PONDOK GEDE	1	0	2797	5074	6113	792	792	2277	1485	1856	2797	2277	2277	1262	1559	965	1064	33388
JATI SAMPURNA	2	2846	0	5099	1535	817	817	644	817	520	817	545	644	545	1386	1188	1460	19676
PONDOK MELATI	3	4529	5445	0	2500	569	569	1064	693	866	1337	1089	1064	1411	1535	718	1411	24800
JATI ASIH	4	7029	2054	3861	0	2054	2054	5792	3861	2549	4752	3861	5792	1040	1287	1510	1262	48758
BANTAR GEBANG	5	668	1015	668	1559	0	792	3589	5272	520	2351	1906	2896	644	1163	891	569	24503
MUSTIKA JAYA	6	1064	1634	1064	2525	842	0	5792	8588	866	3836	3119	4727	693	767	1584	817	37917
BEKASI TIMUR	7	2252	767	1188	5049	3416	3416	0	6064	1485	6064	5049	7202	1485	743	495	1337	46010
RAWALUMBU	8	1955	1287	1040	4505	6658	6658	8019	0	1287	5495	4505	6658	1510	1139	1411	545	52668
BEKASI SELATAN	9	4232	1436	2772	5247	1436	1436	4232	2772	0	6460	4232	4232	1139	644	1535	1436	43238
BEKASI BARAT	10	2277	644	1213	2797	1856	1856	4975	3416	1856	0	7475	6856	866	693	1089	1535	39402
MEDAN SATRIA	11	1089	371	569	1658	1089	1089	2995	2030	891	5420	0	4282	1188	1460	1510	842	26483
BEKASI UTARA	12	49297	842	1287	4505	2995	2995	7796	5445	1609	9034	7796	0	545	545	1510	668	96867
EKSTERNAL UTARA	13	1238	1361	1436	1089	693	1361	1312	1535	866	1089	1609	1361	0	1188	817	1609	18563
EKSTERNAL TIMUR	14	1361	817	520	1361	1436	1312	1609	1163	1238	545	1485	891	1436	0	1114	1262	17548
EKSTERNAL SELATAN	15	1163	1139	866	842	1559	792	1386	1287	990	941	1337	842	1460	965	0	1510	17078
EKSTERNAL BARAT	16	1411	842	569	1262	693	1609	1188	1287	1535	941	693	1015	644	1114	1634	0	16434
TOTAL		82413	22448	27225	42545	26903	27547	52668	45713	18934	51876	46976	50738	15865	16187	17969	17325	563330

Source: Analysis Results, 2023

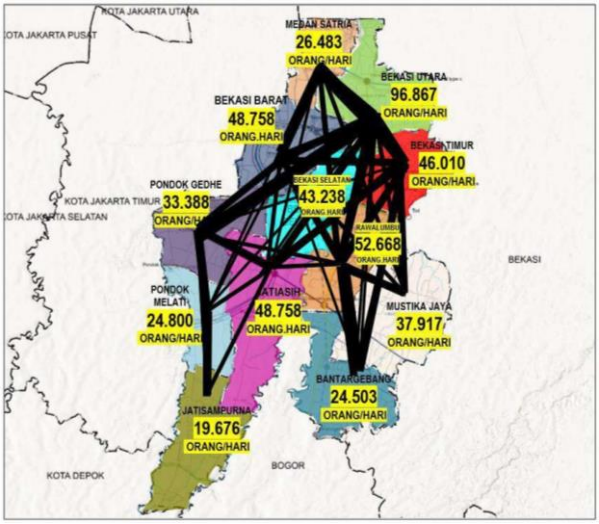


Figure 2 Distribution of Travel Movement Within Bekasi City in 2023

Source: Analysis Results, 2023

From the above destination origin matrix, it can be seen that the areas that have the greatest potential for urban transportation trip generation and attraction come from 5 (five) areas, namely West Bekasi, East Bekasi, North Bekasi, South Bekasi, and Pondok Gedhe. Where the distribution of the center point of the largest trip generation and attraction areas is as follows:

Table 2. Estimated Urban Travel Public Transport Users of Bekasi City 2023

No.	Zone	Demand AU (Person/Day)	Area Spread
1.	Region West Bekasi	82,640	Harapan Indah, Duta Kranji, Perumnas1, Bintara Jaya
2.	Region North Bekasi	123.39	Sumarecon, Harapan Baru, Wisma Asri, Pejuang, Harapan Jaya, Kalibaru
3.	Region East Bekasi	98,678	Duren Jaya, Perumnas3, Rawakalong, Margahayu, Bulak Kapal, Taman Kota Bekasi Jaya

No.	Zone	Demand AU (Person/Day)	Area Spread
4.	Region South Bekasi	62,420	Dukuh Zamrud, Bekasi Timur Regency, Vida Bantar Gebang, Family Urban
5.	Region Pondok Gedhe	126.61	Jatibening, Jatikramat, Jatiasih, Jatiwarna, Jaticempaka, Jatiwaringin

Source: Analysis Results, 2023

From the large number of trips, an interview survey was conducted related to the traveler's preference for their willingness to move from the previous mode of transportation to the public transport mode if bus facilities were provided for urban transportation. Based on interviews with random sampling, data on the willingness to move to bus-based urban public transportation is obtained as follows:

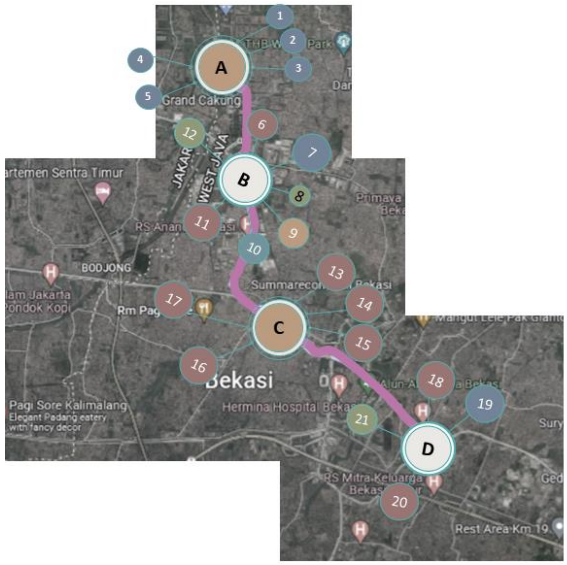
Table 3. Mode Switching Preference to Bus-Based Urban Public Transport

No.	Zone	Interest Switch To mode buses (Person/Day)	Proportion (%)
1.	Region West Bekasi	66,112	80%
2.	Region North Bekasi	20,969	17%
3.	Region East Bekasi	59,207	60%
4.	Region South Bekasi	10611	17%
5.	Region Cottage big	59,512	47%

Source: Analysis Results, 2023

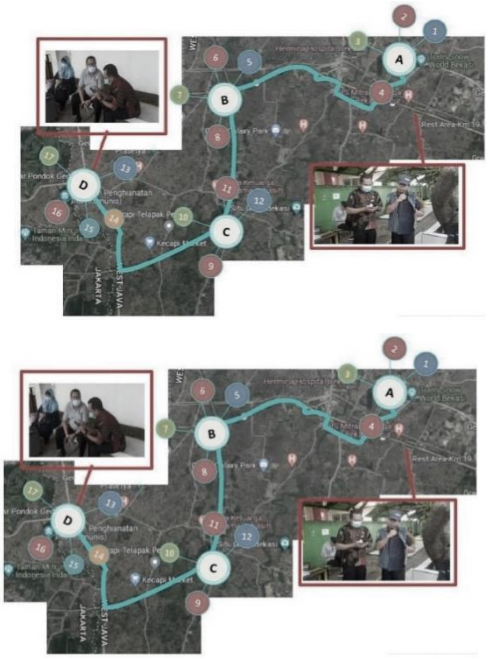
From the table above, it can be seen that the northern area and the southern area of Bekasi have a very small proportion of people who want to switch modes. So this should be reconsidered in the implementation of bus-based urban transportation for the two regions. Optimistic Passenger Profile Based on Cathment Area Passenger catchment along priority corridors can be seen in the following table:

Table 4. Passenger Potential of BTS Catchment Area Highest Demand Corridor (West of Bekasi City)

Point of End	Optimist LF	Spread Point Highest Demand Potential
A (Harapan Indah) 23passenger/hour	1. 6passenger/hour 2. 2passenger/hour 3. 3passenger/hour 4. 7passenger/hour 5. 5passenger/hour	
B (St.Karanji, GranMall) 23passenger/hour	6. 4passenger/hour 7. 3passenger/hour 8. 6passenger/hour 9. 2passenger/hour 10. 2passenger/hour 11. 3passenger/hour 12. 2passenger/hour	
C (Bekasi Terminal), St. East Bekasi, Bulak Kapal) 14passenger/hour	13. 3passenger/hour 14. 2passenger/hour 15. 4passenger/hour 16. 3passenger/hour 17. 2passenger/hour	
D (BTC,DPR, Unisma) 16passenger/hour	18. 4passenger/hour 19. 3passenger/hour 20. 5passenger/hour 21. 4passenger/hour	
Pessimistic Average Passenger/Trip	53 passenger/hour	

Source: Analysis of Data, 2023

Table 5. Passenger Potential of BTS Catchment Area Lowest Demand Corridor (Pondok Gedhe)

Point of End	Optimistic LF	Spread Point Lowest Demand Potential
A (Terminal Bekasi, Bekasi Town Square, Unisma)	1. 3 passenger/hour 2. 2 passenger/hour 3. 4 passenger/hour 4. 3 passenger/hour	
B (Pekayon, Galaxy, Pondok Mitra Lestari)	5. 4 passenger/hour 6. 3 passenger/hour 7. 6 passenger/hour 8. 2 passenger/hour	
C (Pasar Jati Asih, Ruko	9. 3 passenger/hour 10. 2 passenger/hour	
Pathabo , Mitra10)	11. 4passenger/hour	
	12. 3passenger/hour	
D (Toll Jati Asih, Pondok Gedhe Mall)	13. 4passenger/hour 14. 3passenger/hour 15. 5passenger/hour 16. 4passenger/hour 17. 2passenger/hour	
Pessimistic Average Pnp /Trip	57passenger/hour	

Source: Processing Results Data, 2023

Analysis of priority corridors

Corridor analysis is based on the zoning of Bekasi City. In this case Bekasi City is divided into 5 service sections, namely the western area (corridor 1), northern area (corridor 2), eastern area (corridor 3), southern area (corridor 4), and pondok gedhe area (corridor 5). For corridor 1, the Bekasi-Harapan Indah terminal route already has a good operating value in accordance with the existing conditions, namely Transpatriot Corridor 1. In this study, it is

not reviewed, but is automatically included in services that must be maintained. As for other corridors, an assessment will be carried out based on priority corridors to be organized based on optimistic demand and the highest diversion of public transportation users. Multicriteria analysis is carried out to obtain priority corridors whose results can be seen in the following table:

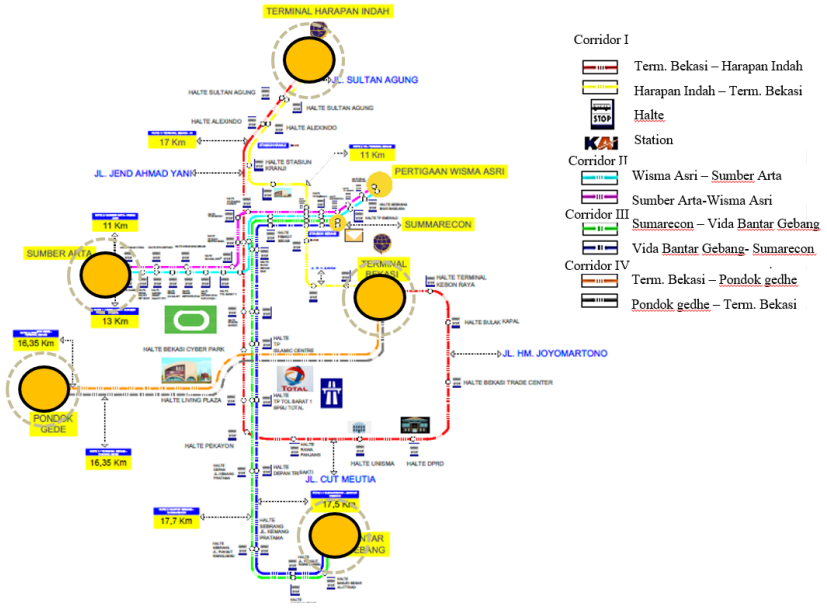


Figure 3: Bekasi City Urban Transportation Route Network Design

Source: Data Processing Results, 2023

Tab.6. Multicriteria Analysis (MCM) Value of Urban Public Transport Priority Corridors Bekasi City 2023

Corridor priority	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	Criteria 6	Criteria 7	Criteria 8	Rating	
	Investment cost good means (vehicle), infrastructure (terminal, stop/shelter) to unlock corridor	Operating costs (direct cost (bbm, crew vehicles, tickets) and cost no direct (maintenance, building, tax, kir, etc.) for operate corridor	Number of passengers optimistic rise, based on route opening existing or area potential which served	Social risk related reception public against the corridor opened will raises conflict	Social risk regarding absorption on labor and field business	Associated social risk which ready for operation corridor with buy the service scheme	more corridors can be reduce traffic jam f operated	the corridor considered capable have performance which are expected (high demand, stable speed, precise travel time, short headway)	Total	Rank
Corridor 2	28	40	27	34	26	33	33	38	261	3
	4%	5%	3%	4%	3%	4%	4%	5%	32.58%	
Corridor 3	35.75	30	33	48	26	33	33	23	263	2
	4%	4%	4%	6%	3%	4%	4%	3%	32.81%	
Corridor 4	36.25	30	40	18	48	33	33	38	277	1
	5%	4%	5%	2%	6%	4%	4%	5%	34.60%	

Source: Data Processing Results, 2023

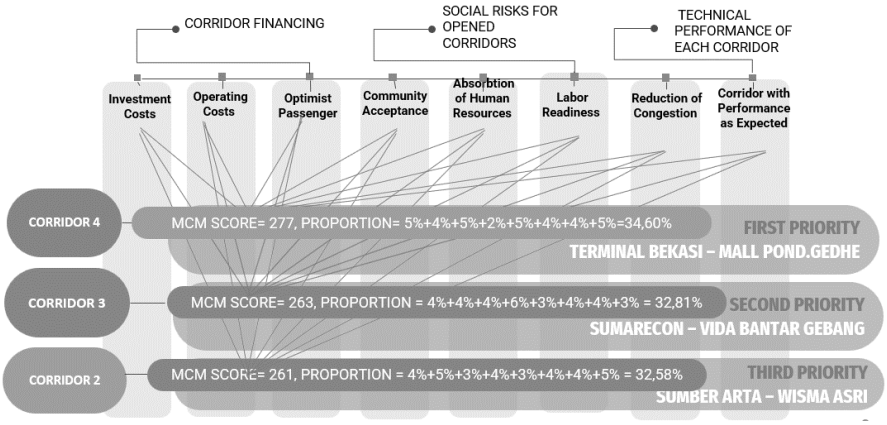


Figure 4. Diagram of Multicriteria Analysis Results (MCM) of Urban Transport Corridors in Bekasi City 2023

Source: Data Processing Results, 2023

Analysis of integration nodes

Public transport is sometimes jokingly referred to as transportation "that takes you from where you are not, to where you do notwant to be, on a vehicle in which you do not wish to ride".(Sagaris & Arora, 2016). There are numerous service integration policies and practices either directly or indirectly impacting transit passengers. Among those having a direct or more immediate impact on passengers include infrastructure (route, transfer centers), fare payment (universal transit fare card or passes), schedule (coordination and synchronization of arrival and departure times), information (single one-stop delivery of information to transit customers such as trip itinerary planning and real time information about transit delays and incidents), and special event/emergency condition integration (coordinated multi-organizational policies of implementable action plans during or in response to events). (Miller, 2003). In another study said that integration therefore needs a normative component, so as to ensure implementation. The important normative component in this context can be construed as discourses and rationales concerning transport and the urban development of which public transport forms part.(Hrelja, 2015)

The suggestion presented by most authors is to provide a safe, comfortable and continuous network of dedicated and protected lanes for micro-vehicles. As also stated in the ITF report on Safe Micromobility (2020), motorised vehicles are involved in 80% of fatal micro-vehicle accidents, meaning that reducing the potential for conflicts between the two modes can drastically improve safety for micromobility users. (Oeschger et al., 2020)

International experience suggests that public transport planners must recognize two integration dimensions: (a) integration among all modes and routes comprising the multi-modal public transport network, (b) integration of the physical and operational elements of

each respective mode and service, e.g., metro or bus. Successful integration in both dimensions will provide a more customer-friendly experience and make public transport more efficient and cost-effective. This will help maximize public transport ridership and revenue, increase customer satisfaction, reduce costs and subsidies and generate environmental, social and economic benefits for the investment. (Fang & Zimmerman, 2015). The Openbaar Vervoer-fiets (Public Transport–Bike) (OV-fiets) system was implemented to increase the number of train riders on the Dutch railway. The system offers commuters access to bicycles for travel from the train station to their final destination. The system has been very successful. The Nederlandse Spoorwegen (the main passenger railway operator in the Netherlands) found through internal analyses that train users were willing to trade a trip by vehicle for a train–OV-fiet trip and that there was an increase in bicycle–transit users. (Villwock-Witte & Van Grol, 2015)

For choice riders who are still reluctant to migrate, respondents from public transportation users are mostly chaptive riders. To improve the convenience of public transportation users, the redesign of the integration of urban service hub Bekasi City is carried out:

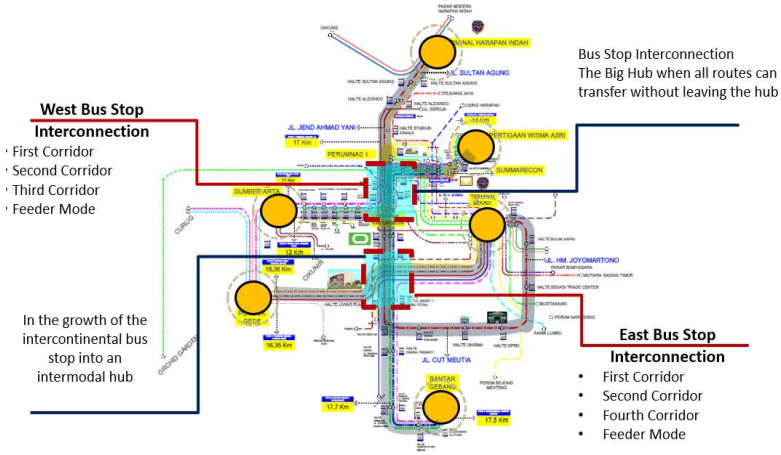


Figure 5. Bekasi City Public Transportation Hub Integration Design

Source: Data Processing Results, 2023

Analysis of feeder management

Feeder transit services are broadly divided into two categories depending on the demand levels – the fixed route transit (FRT) for high demands and the demand responsive transit (DRT) for low demands. (Chandra et al., 2013). An optimal cycle length must exist to balance two opposite effects: too long cycles would result in excessive riding and waiting time for passengers; too short cycles would cause an oversaturation of the system unable to serve all demand for excessive driving to/from the terminal. (Chandra & Quadrifoglio, 2013)

Feeder management analysis to reduce the level of demand competency, congestion, and conflicts between main urban transport and neighborhood transport (existing routes). Some overlapping routes will be eliminated and diverted as subfeeder transport buffering the main urban transport. The following diagram shows the route data that must be reviewed to be analyzed as sub feeder transport.

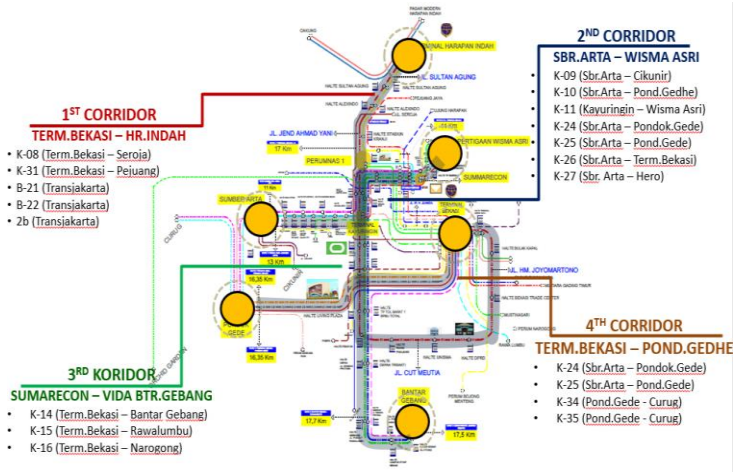


Figure 6. Overlapping Transpatriot with Local Public Transportation in Bekasi City

Source: Data Processing Results, 2023

Ticket integration analysis

The characteristics of urban travel are short, and the location of the destination varies, so it is necessary to accommodate the ease of transportation transfer rates in urban areas with a maximum of 2 times the transfer with the "One Ticket one Trip" scheme based on "Smart Card". Tariff integration is planned to combine tariffs for several services so that payment is only required once. The following are the responses of Bekasi City respondents regarding the fare integration plan for urban transportation services:

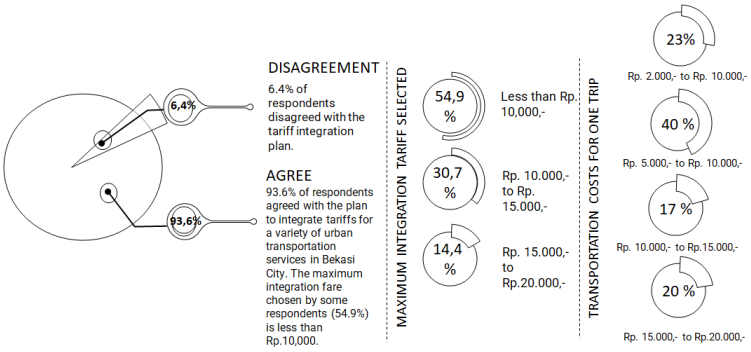


Figure 7. Bekasi City Public Transportation Pricing Integration Strategy

Source: Data Processing Results, 2023.

CONCLUSION

The authors would like to thank fellow lecturers of the Land Transportation Polytechnic-STTD for their input, as well as the team of surveyors who assisted in the study process and data search. Based on the data and results of the analysis that has been carried out, the following conclusions can be reached:

1. The feasibility of demand for urban travel in West Bekasi City is 82,640 people/day, north Bekasi City 123,349 people/day, east Bekasi City 98,678 people/day, south Bekasi City 62,420 people/day, and Pondok Gedhe 126,621 people/day.
2. Urban Travel mode-switching preference for West Bekasi City is 80%, north is 17%, south is 60%, south is 17%, and Pondok Gedhe is 47%.
3. Priority Corridor Evaluation based on the results of multicriteria analysis with financing criteria, social risk for the opened corridor, and technical performance for the opened corridor, it was found that the Bekasi Terminal - Harapan Indah and Bekasi Terminal - Pondok Gedhe corridors had the first priority to be opened as Public Transport corridors, followed by the Sumarecon - Vida Bantar Gebang corridor, then the Sumber Arta - Wisma Asri corridor.
4. To improve service performance, it is necessary to improve the system through a strategy of hub integration, ticket integration, feeder transportation management.

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