

Optimisation of Operation System Integration between Main and Feeder Public Transport (Case Study: Trans Jakarta-Kopaja Bus Services)

M. Miharja¹, Y N Priadi²

¹ Regional and City Infrastructure System Research Group, School of Architecture, Planning and Policy Development, Institut Teknologi Bandung, Bandung, Indonesia

² Undergraduate Program in Regional and City Planning, School of Architecture, Planning and Policy Development, Institut Teknologi Bandung, Bandung, Indonesia

Corresponding author: mimingm@pusat.itb.ac.id

Abstract. Promoting a better public transport is a key strategy to cope with urban transport problems which are mostly caused by a huge private vehicle usage. A better public transport service quality not only focuses on one type of public transport mode, but also concerns on inter modes service integration. Fragmented inter mode public transport service leads to a longer trip chain as well as average travel time which would result in its failure to compete with a private vehicle. This paper examines the optimisation process of operation system integration between Trans Jakarta Bus as the main public transport mode and Kopaja Bus as feeder public transport service in Jakarta. Using scoring-interview method combined with standard parameters in operation system integration, this paper identifies the key factors that determine the success of the two public transport operation system integrations. The study found that some key integration parameters, such as the cancellation of “system setoran”, passenger get in-get out at official stop points, and systematic payment, positively contribute to a better service integration. However, some parameters such as fine system, time and changing point reliability, and information system reliability are among those which need improvement. These findings are very useful for the authority to set the right strategy to improve operation system integration between Trans Jakarta and Kopaja Bus services.

1. Introduction

The topic of “transport integration” has been discussed in different contexts of transport both theoretical and practical. Among others, [1-8] point out that transport integration can be seen from various perspective such as technical, economic, organizational, policy-based and so on. However, the basic purpose of every transport integration analysis is to assure the connection among different transportation modes operating in a certain transportation. Transport integration system is intended to facilitate passengers/goods transfer between the modes and assure the safe, smooth and efficient flow of passengers/goods from their origins to their destinations [3,9]. In particular topic of public transport integration, the EU projects [10-11] define urban public transportation as an organizational process by which elements of the passenger public transportation system (network and infrastructure, fares and ticketing systems, information and marketing components) and a variety of carriers which serve



different transportation modes to interact more closely and efficiently to generate an overall improvement in service quality level and enhance the performance of the combined public and individual transportation. According to [12], the implementation of different transport integration solutions may result in the following benefits: reduction of travel times, transportation costs, traffic congestion and environmental pollution. Transport integrating solutions may improve the accessibility of urban public transportation system and overall competitiveness, and assure better utilization of different transportation means and infrastructure.

The topic on the optimization of urban public transport integration is very important in Indonesian urban transport plan and development. This urgency is due to the fact that today's urban transport problem is basically triggered by predominant use of private car in this area transport service system. Thus, serious effort to increase public transport service quality, including inter public transport mode integration, is crucial to attract more private car user to use public transport. As an effort to improve public transport service quality in Jakarta Capital Region, since June 2015 the Government of Jakarta Province has introduced an operational integration program between PT Transjakarta and Kopaja. Through this program, it is expected that an integrated service system between the feeder and the main transport will improve the quality of public transport service as part of the grand strategy to attract private car users. Feeder transport is a type of bus service which is designed to transport passengers in the local area and delivers passengers to the transfer point where they continue their journey in the main corridor [13]. In its implementation, the operational integration between PT Transjakarta with Kopaja has been proceeded through the reordering of bus route integration, tariff adjustment, e-ticket development and new payment system by replacing kilometer based payment to "setoran" (the daily-based fee the driver must pay) payment system.

This study focuses on the optimization analysis of operation system integration of main-feeder transport in the case of operation integration between PT Transjakarta and Kopaja. The perspective of operation integration parameter is based on the existing optimization theory of public transport operation integration. More specifically, the objectives of this paper are: (1) to know the fulfilment level of the operation system integration by Transjakarta-Kopaja operator based on the parameters of operational integration, and (2) to set the optimization strategy of Transjakarta-Kopaja main bus-feeder operation system.

2. Method

2.1. Data Collection Method

In this research, primary and secondary data are both examined. Primary data were obtained from a questionnaire filled by an operational officer in the field and in-depth interview with the shareholders using purposive sampling method; whereas, secondary data were obtained from Transportation Agency of DKI Jakarta, PT Transjakarta and Kopaja. Secondary data were used to analyze empirical facts in their suitability with the stated target in the operational integration plan that has been stipulated.

2.2. Data Analysis Method

Questionnaire data analysis was performed through descriptive qualitative analysis method, whereas the analysis of interviews data was performed using content analysis method. Secondary data analysis were developed to analyze system performance by comparing the empirical evidence with the operation system parameters. Meanwhile, the content analysis would produce parameter priority that is still to be optimized based on company policy consideration. Shareholders were also asked to give their score on the degree of operational integration with a scale of 1-5 (1 = very weak; 5 = very strong). This step is done as part of triangulation method through cross-check of analysis results of two different analytical methods. Finally, a component in the operational integration parameter was

analyzed thoroughly to formulate recommendation in the form of proposal of handling priority as an effort to optimize main-feeder transport operation system integration in the future.

3. Literature Review on the Integration of Public Transport System

Public transportation planning or other public services should be composed of several aspects such as efficiency, effectiveness, and satisfaction [14]. According to [15] the concept of smart feeder is a system with easy access to fast transportation by studying the market demand for short-haul feeders or short-range feeders. This feed system will provide services that operate reliably and quickly as part of a door-to-door passenger transport by means of a good and synchronized transfer. The integration of public transport system occurs in three important levels, i.e. institutional, operational and physical. In line with the focus of this research, integration that will be discussed is in operational level which involves the application of management technique to optimize the allocation of public transport resources and services coordination.

There are nine criteria of system arrangement in the process of public transport operational integration in [16], i.e:

- 1) *Rationalization of Redundant Services*, i.e. an effort to reduce duplication in public transport operation to increase competitiveness and efficiency of resources usage through reduction of headways at the existing route and expand services to new areas
- 2) *Matching Modes to Service Requirements*, i.e. an effort to arrange the service pattern where large capacity supply system is operated in the main area with high density and corridor with high level of demand, while park-and-ride facility is provided in low density area
- 3) *Unification of The Fare Structure*, i.e. the stipulation of tariff system that enables customers to buy one ticket at the beginning of the trip and to transfer freely among all modes and services network in a system.
- 4) *Fare Discount*, i.e. an effort to reduce tariff to achieve three objectives, i.e. (a) tariff subsidy to a certain user group, such as elderly, physically handicapped, weak economy; (b) divert some of the users to off-peak time; (c) simplification of weekly or monthly payment procedure.
- 5) *Honor Payment Fare Systems*, i.e. developing an honorarium system to save operational cost by eliminating ticket checking process by the conductor to be more efficient by increasing the number of entrance gate rather than only one entrance gate as the main control point.
- 6) *Coordinated Public Information Systems*, i.e. development of integrated information system on route, schedule, tariff, and point of transfer by publishing route map, vehicle schedule, tariff schedule and promotion information, road signage and vehicle identification, stop point, transfer point, station location, etc.
- 7) *Reserved Bus Lanes and Streets*, i.e. limited use of special lane and street for bus with the purpose of promoting the use of public transport and limiting the use of private vehicle from entering Central Business District (CBD) area.
- 8) *Parking Controls Transit Ridership*, i.e. support for the public transport user through controlling the number of parking space and fee for private vehicle. Arrangement through parking disincentive scheme is generally more effective than increasing gasoline tax or vehicle ownership cost.
- 9) *Changes of Work Schedules*, i.e. development of strategy through the distribution of user peak demand so that the amount of demand can be adjusted with the capacity of public transport. Included in this scheme is work schedule arrangement. Scheduling is one of the strategic policy stages in achieving user satisfaction of public transport [17] scheduling system with maximum synchronization level aims to provide bus services on the main route network in accordance with the demand at that time [18].

4. Optimization Analysis on the Integration of Transjakarta-Kopaja Bus Operation System

4.1. Rationalization of Unnecessary Service

This parameter is divided into two, i.e. passenger loading-unloading system and tariff payment system. Currently, there are still many passenger loading-unloading systems outside the official bus stop related to bus stop infrastructure insufficiency, many of the stopping points are only equipped with signage, such as in Karet, Casablanca City, and Pantai Indah Kapuk bus stops, without adequate facilities. Second, tariff payment is still a dual system with ‘stick and go’ payment method using electronic card or e-money and cash payment in the vehicle using EDC.

Table 1. Analysis of Rationalization of Unnecessary Service

Parameter 1	Rationalization of Unnecessary Service
Changes in service system of Kopaja, then vs transjakarta feeder bus, now Passenger loading-unloading system; Tariff payment system	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
- Tariff payment system is still divided into two; payment at the ticket box and in the bus - Passenger transport system: at the bus stop and appropriate signage	- Passenger unloading system: unloading is still conducted freely near the last bus stop - Information system for bus users: 4 out of 9 bus stops do not install information on Transjakarta Feeder Bus route; 2 out of 9 bus stops do not install information on feeder bus ticket at the ticket box 7 out of 9 bus stops do not have real-time information screen on transjakarta feeder bus

4.2. The Appropriateness of Feeder Transport to Support Main Transport

Based on the survey, out of nine main transjakarta feeder bus stops, only seven have access to facilitate a transfer to another mode within the radius of 400-800 meters with the percentage of public transport availability of 31.08%.

Table 2. Matrix of Public Transport Availability

Public Transport Radius 400-800 Meter	KOPAJA	Metromini	Angkot	Mikrolet	KRL station
National Monument	X	X	X	X	X
Pantai Indah Kapuk	X	X	X	X	X
Ragunan	1. P-19 2. S-68 3. S-602 4. 605A 5. S-612	S-77	KWK S-15A	M-42	X

Public Transport Radius 400-800 Meter	KOPAJA	Metromini	Angkot	Mikrolet	KRL station
Dukuh Atas	X	X	X	X	Dukuh Atas Train Station
Lebak Bulus	1. P-20 2. B-86 3. S-615	X	X	X	X
Senen (through Cikini station)	1. P-20 2. U-27 3. S-615	X	X	X	Dukuh Atas Train Station
PGC	1. T-57 2. S-68 3. T-505 4. T-503 5. T-501	1. 58 2. 60 3. S-64	Cililitan Bus Stop 1. T-02 2. T-17	Cililitan Bus Stop 1. M-19 2. M-29 3. M-04	X
Harmoni	X	X	X	1. M-12 2. M-08	X
Tugas	X	1. T-47 2. 077	X	X	X

Table 3. Analysis of Appropriate Transportation Mode as Main Transportation Support

Parameter 2	Transportation Mode Appropriate as Main Transportation Support
Supporting transportation around the KOPAJA feeder bus stop is to connect the trip of Transjakarta bus users (example: regular KOPAJA, metro mini, angkot, mikrolet, KRL.)	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
There are seven transjakarta feeder bus stops within the radius of 400-800 meters that enable users to continue the trip	There are two bus stops of the feeder bus in National Monument and Pantai Indah Kapuk that do not have supporting transportation mode.

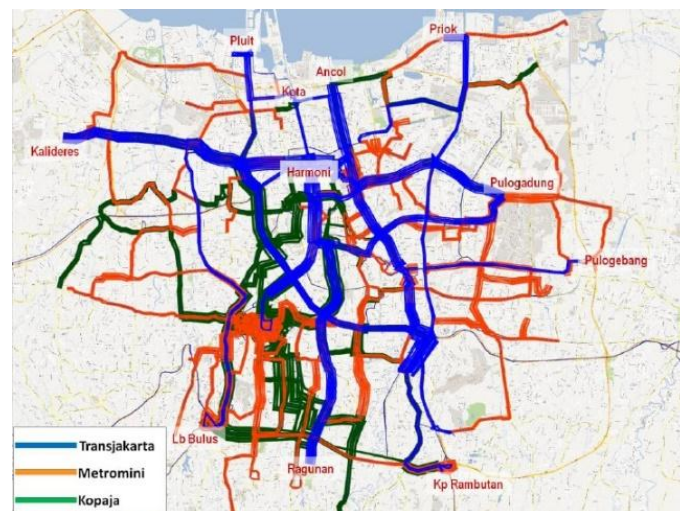


Figure 1. Service coverage of Transjakarta, Kopaja, Regular and Metromini Transport

4.3. Unification of Transport Tariff Structure

Kopaja that becomes the operator of Transjakarta bus feeder experiences tariff adjustment integrated with the tariff structure owned by PT Transjakarta. The tariff structure of regular transjakarta bus (not feeder) has two-time divisions, i.e. 05.00 – 07.00 is Rp. 2,000, whereas 07.00 – 23.00 is Rp. 3,500. However, Kopaja feeder bus does not have time-based tariff division. During the operation from 05.00 – 23.00, Kopaja bus has similar tariff to regular transjakarta bus, i.e. Rp. 3,500. The entire ticket payment systems for Kopaja bus are done by officials from PT Transjakarta and given to on-board officials of PT Transjakarta and the data are stored using EDC. With this system, PT Transjakarta has full responsibility for managing ticket money of the bus users and tariff that has been stipulated.

Table 4. Analysis of the Unification of Transportation Tariff Structure.

Parameter 3	The Unification of Transport Tariff Structure
The making of one integrated payment system for the bus users; Comparison between the KOPAJA tariff bus, then and transjakarta feeder bus tariff, now	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
Transport tariff structure has been fulfilled by paying the same tariff as regular transjakarta bus with a tariff of Rp. 3,500	-

4.4. The Enactment of Tariff Discount

According to Chien & Yang (1999), the criterion for optimizing feeder routes on non-regular networks (not dedicated lines) is to lower total costs, including supply and passenger costs. Tariff discount is enacted to facilitate minority users, such as elderly, physically handicapped using wheel chair, and toddlers. However, both on regular transjakarta bus and feeder bus there is no discount for those minority users, except for children under two years old are exempt from paying duty; whereas, tariff discount for off-peak hour is only enacted for regular transjakarta bus service. Since the number of transjakarta feeder bus route is still too few to reach profit level, discount for user group above is not enacted.

Table 5. Analysis of the Enactment of Tariff Discount

Parameter 4	The enactment of Tariff Discount
- Discount for elderly, physically handicapped, and under age; - Tariff discount during the off-peak hour. - simplification of feeder bus ticket payment system (weekly or monthly system)	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
In general, there is no tariff discount for transjakarta feeder bus, or for off-peak hour, except on DKI Jakarta birthday on June 22 enacting free of payment for the entire transjakarta transport.	-

4.5. Fine Payment System for the Users

The fine payment system of the users is enacted to the Kopaja bus users who violate the payment obligations. However, since transjakarta bus corridor is relatively small and directly close to ticket gateway, there is not much violation. Likewise, inside the feeder bus during the trip, on-board officials make sure that passengers have payment receipt from the EDC. If there is a violation, the users are given sanction by having to pay directly to the officials of PT Transjakarta. This system prevents the possibility of a free rider.

Table 6. Analysis of Fine Payment System for Bus Users

Parameter 5	Fine Payment System for Bus Users
Monitoring system of the feeder user and fine for violation by the users	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
Not many violations from the users at the transjakarta bus stop.	There is no official sanction yet for fine payment of bus users.

**Figure 2.** Static Information for the user of Smart Jakarta Card



Figure 3. Static Information of the Transjakarta Passenger code of conduct

4.6. Information System of Coordinated Public Transportation

Bus passenger satisfaction is closely related to the reliability of information system informing the time of departure and arrival from and at every bus stop. With the support of digital technology, it is easier to develop a real-time information system for users in the form of electronic panel, digital information on LED panel and other dynamic information that can be accessed with cellular phone or smartphone. In addition to dynamic information, static information for users is also important such as signage leading to the bus stop, sticker of route number on the bus, bus network map installed at the bus stop, bus route map, local area map, emergency indication, and other information.

Analytical result of the performance of operational integration on this aspect shows that the first and dynamic information currently installed at the Transjakarta bus stop, particularly information for Kopaja feeder bus, is still minimal. Digital information screen notifying the estimation of bus arrival with bus fleet and delay information is only installed at the main corridor. Official information provided by PT Transjakarta regarding the operation Schedule of Transjakarta bus and its feeder uses official account of PT Transjakarta twitter at @pt_transjakarta that provides an update transjakarta bus activities and all changes from the account. However, this account system is still categorized as manual and has a very low control system.

The second option in obtaining information on integrated feeder transport is by using GO-BUSWAY which is an application of GO-JEK. GO-BUSWAY has better information platform. It is easy to use through smartphone and integrated with the use of GO-JEK. The current GO-BUSWAY application is a real-time application capable of looking at transport trip through GPS tracker. However, the disadvantage of this application is that it cannot show real-time changes due to information management factor which is indirectly done by PT Transjakarta.

Table 7. Analysis of Information System of Coordinated Public Transportation.

Parameter 6	Information System of Coordinated Public Transportation
Are the information on route, schedule, tariff and transfer point for Transjakarta feeder bus adequate or not?	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled

Parameter 6	Information System of Coordinated Public Transportation
Go-Busway application is available There is an update of transjakarta bus trip on twitter account; There is a digital information board on the main route of transjakarta bus.	Official application directly held by PT Transjakarta provides real-time information of bus trip.



Figure 4. Real-time Information Screen of Transjakarta Bus.

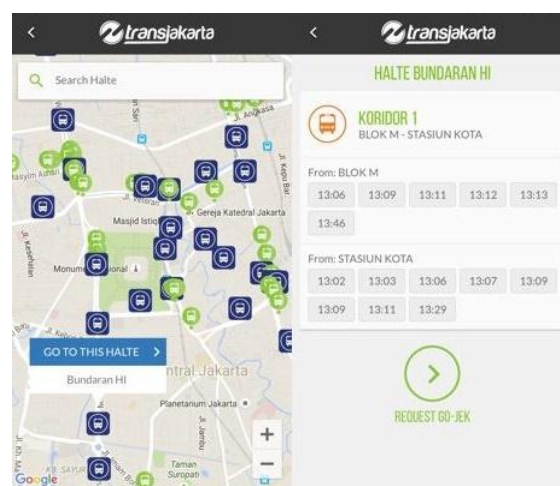


Figure 5. Application of Go-Busway from Go-Jek Application

4.7. Specific Street and Lane for Bus

According to [20], in a more operational sequence, the transport carrier operating system may use a "Demand Adaptive System" consisting of a service line defined by trip scheduling serving the predefined core corridor. Basically, feeder transport is intended to carry feeder outside the main corridor, therefore, PT Transjakarta has fleet with wide service coverage in the urban area. Currently, feeder transport operation is still in the main corridor route until undetermined time. The presence of

feeder transport in the same corridor as regular transjakarta bus will add headway time and the corridor will be congested.

Specific lane can be segregated and applied in different ways according to permeability (example: delineator, lane with different color, etc. In a certain design, the bus stop can have a role as a barrier. Several systems using permeability can be suggested since sometimes the broken bus can blockade busway corridor and should leave the corridor.

Table 8. Analysis of Information System of Coordinated Public Transportation

Parameter 7	Specific Street and Lane for Bus
Specific lane designed for bus in certain areas, reliability, and speed of public transportation to fix the quality of transjakarta bus service	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
-	Clear route for feeder transport

4.8. Parking Control for Public Transportation Users

The percentage of private users in Jakarta reached 45.2%, a combination of two-wheeler and four-wheeler. This fact underlies the importance of parking facility development for the convenience of the transit of private vehicle user to public transport, including transjakarta bus.

Out of nine bus stops that were observed, there are three bus stops owning parking location that can be accessed by bus users. The criteria for the calculated parking location are the location that is close to the bus stop; normal parking tariff is Rp. 4,000 – Rp. 5,000 per hour and it does not need ID card to park. Dukuh Atas bus stop is located next to Car Insurance Office with no parking area for two-wheeler vehicle that is commonly used by 72% of the transjakarta bus users. Meanwhile, the National Monument bus stop is located close to government offices that require specific ID to park. Finally, the TU Gas bus stop is new route so that the location makes it difficult to get access to a good parking space.

Tabel 9. Parking control for Public Transport Users

Parameter 8	Parking control for Public Transportation Users
The presence of parking location which is accessible to transjakarta bus user around transjakarta feeder bus stop.	
Description of factor that has already been fulfilled	Description of factor that has not been fulfilled
Pantai Indah Kapuk	
Ragunan	Dukuh Atas
Lebak Bulus	National Monument
Senen (Cikini Station)	TU Gas
PGC	
Harmoni	

5. Analysis on the Selection of Transport System Optimization of Jakarta Feeder Bus

The optimization assessment of Transjakarta Feeder Bus is a process of assessing the result of observation on feeder bus conducted in the field. The form of optimization system selected is an optimization system with the most critical score to be developed for transjakarta feeder bus. This shows that the selected form is an optimization form of transjakarta feeder bus that is the most potential one to increase feeder transport service aggregately and to attract more new users. The range of component point is 1 – 5 (minimum point 1 and maximum point 5) with the definition as follows:

1 = Very unnecessary to be optimized

2 = Unnecessary to be optimized

3 = Maybe optimized or not

4 = Necessary to be optimized

5 = Very necessary to be optimized

The assessment of each criterion is also considered by the shareholder from PT Transjakarta and Kopaja. There are some assumptions used to conduct an assessment of every parameter. First, rationalization parameter of unnecessary service means that to optimize Transjakarta feeder transport; the emphasis should be on the rationalization of unnecessary service because of critical factor to be fixed and should have an impact significantly on the convenience of transjakarta bus users.

Second, parameter of transportation mode that is appropriate as feeder of main transportation explains that the most important factor to be optimized for transjakarta bus transportation is the one that facilitates users to transfer between bus stops by using other transportation.

Third, the unification of the most appropriate transport tariff structure as parameter of optimization system of transjakarta feeder bus is meant to use transjakarta with similar tariff to regular transjakarta bus, and cheaper than regular transport such as Kopaja, Metromini, angkot, and Microlet.

Table 10. Optimization Assessment of Transjakarta Feeder Bus System by PT Transjakarta

NO.	PARAMETER	ASSESSMENT
1	Rationalization of unnecessary service	5
2	Appropriate mode of transportation as main transportation support	5
3	Unification of transport tariff structure	1
4	The enactment of tariff discount	1
5	System of user fine payment	3
6	Information system of coordinated public transportation	5
7	Specific street and lane for bus	2
8	Parking control for public transportation users	1

6. Conclusion

The analysis of optimization system of Transjakarta feeder bus transport shows that the integration of operation system implemented by PT Trans Jakarta for Kopaja feeder transport has not yet run at maximum level. The analysis result shows that feeder transport still operates at the main corridor of Transjakarta bus and has not fulfilled its function as feeder system that serves the main Transjakarta service corridor.

The number of feeders targeted to operate is 320 Kopaja buses, but only 200 buses are in operation. It shows the failure of Kopaja management to fulfil the operational requirement that has been stipulated by PT Transjakarta.

Based on the assessment of the second parameter, transjakarta feeder bus has increased its quality service, such as passenger loading and unloading in bus stop with orderly tariff payment system at the bus stop ticket box only, and uses electronic card to reduce cash money by the officials. However, feeder transport operation still needs integration with another mode of transportation from regular Kopaja, Metromini, angkot and mikrolet whose fulfilment is not maximal due to the overlapping inter mode route.

Third parameter fulfilment shows that, in general, the tariff structure of the feeder is the same as transjakarta bus, i.e. Rp. 3,500. Thus, it is quite successful. The fourth parameter has not really been achieved, special tariff for elderly and children under five years old has not been equated to the system of transjakarta bus. The fifth parameter has not really been achieved as well, the system of fine payment for those who violate rules at the bus stop or inside the bus is not clear. PT Transjakarta has only installed a poster not to violate the rules. It should show a clearly stated fine and is not limited to verbal reprimand for those who violate.

Sixth parameter achievement, information on feeder bus at the transjakarta bus stop is still minimal. This is measured by the presence of poster, digital information screen and smartphone for Transjakarta bus information. The manual poster that is normally used for tariff notification and route information is not installed equally at feeder bus stops. It causes users' ignorance regarding the availability of the feeder service, which results in the decline in feeder passenger. Currently, information screen is only available in the main corridor due to high maintenance cost. This information screen provides departure and arrival time of buses passing certain bus stops which is important for the bus service reliability. Currently, the crucial aspect of Transjakarta bus information system is the unavailability of official application from PT. Transjakarta for regular Transjakarta and its feeder system. Considering the smartphone is now the most practical information media, it is predicted that, if all required information regarding the Transjakarta service system, such as schedule, seat capacity, etc. is accessible through smartphone, the number of passengers using transjakarta will most probably increase.

The seventh parameter is a special lane of transjakarta bus that explains whether the presence of feeder transport is fully within the special lane of transjakarta bus corridor or it is a mixed-traffic way with other vehicles. The analysis shows that the majority of feeder transport should operate in a mixed-traffic way because it will reach locations that do not have transjakarta bus corridor in the feeder area.

Finally, parking control parameter is useful for bus users to support park-and-ride scheme. It supports private car user accessibility to transfer to public transportation. However, at the moment, there is no parking control officially provided by PT Transjakarta for the users and officials at the bus stop.

In general, it can be concluded that optimization system of feeder bus transport operation which involves PT Transjakarta as an institution overseeing Kopaja shows that the parameter operational integration is not been fully applied, so that the feeder operation system is not optimum.

Meanwhile, based on the scoring done by the management of PT Transjakarta, there are critical parameters that require optimization programs for a better operation system integration, i.e.: 1) rationalization of unnecessary service; 2) appropriate mode of feeder transportation as the support of main transportation; and 3) a better information of integrated public transport services system.

References

- [1] Hine J 2000 Integration planning for sustainable and integrated transport systems in the new millennium *Transport Policy Elsevier* **7(3)** 175-177
- [2] Janic M and Reggiani A 2001 *Integrated transport systems in European Union: An overview of some recent developments* *Transport Reviews* **21(4)** 469-497
- [3] Ibrahim M 2003 Improvements and integration of a public transport system: the case of Singapore *Cities* **20(3)** 205-216
- [4] Stead D 2003 Transport and land use planning policy in Britain really joined up? *International Social Science Journal* **55(2)** 333-347
- [5] Potter S and Skinner M 2000 On transport integration: a contribution to better understanding *Futures* **32** 275-287
- [6] Hull A 2005 Integrated transport planning in the UK: from concept to reality *Journal of Transport Geography* **13** 318-328
- [7] Dydkowski G 2005 *Integration of the local collective transportation Proceedings of the*

- National Conference: Transportation systems Theory and practice* (Gliwice: Silesian University of Technology) 107-116
- [8] Givoni M and Banister D 2010 *Integrated transport: from policy to practice* (Abingdon: Routledge)
 - [9] GUIDE 1999 *Urban interchanges - A good practice guide project funded by the European Commission under the Transport RTD Programme of the 4th Framework Programme Final Report*
 - [10] Hilferink P, Roest Crolius A and Van Elburg J C 2003 *Integration and regulatory structures in public transport Final Report Study commissioned by European Commission DG TREN Rijswijk*
 - [11] Żak J, Fierek S and Kruszyński M 2014 Evaluation of different transportation solutions with the application of macro simulation tools and multiple criteria *Procedia Social and Behavioral Sciences* **111** 340–349
 - [12] PROSPECTS 2003 *European Union research project: Procedures for recommending optimal sustainable planning of European city transport systems Final Report Leeds.*
 - [13] Verma A and Ramanayya T V 2015 *Public Transport Planning and Management in Developing Countries* (Florida : CRC Press).
 - [14] Savas E S 1978 On Equity in Providing Public Services *Management Science* **24(8)** 800-808
 - [15] Yim Y B and Ceder A 2006 Smart Feeder Feeder/Shuttle Bus Service: Consumer Research and Design *Journal of Public Transportation* **9(1)**
 - [16] Vuchic V R 2007 *Urban Transit Systems and Technology* (Canada : John Wiley & Sons, Inc)
 - [17] Ceder A and Wilson N H M 1986 Bus Network Desain *Transportation Research Part B: Methodological* **20(4)** 331-344
 - [18] Ceder A 2001 Operational Objective Functions in Designing Public Transport Routes *Journal of Advanced Transportation* **35(2)** 125-144
 - [19] Chien S and Yang 1999 Optimal Feeder Bus Routes on Irregular Street Networks *Journal of Advanced Transportation* **34(2)** 213-248.
 - [20] Malucelli F, Nonato M and Pallottino S 1999 Demand Adaptive Systems: Some Proposals On Flexible Transit *Operations research in industry* 157-182