

Urban Transportation: Performance and Problems (Case Study: Route of ABG, CKL, and AT)

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Abstract—ABG, CKL, and AT are public transportation (called *angkot*) with the longest route in Malang. The length of the routes of ABG, CKL, and AT is 26m, 22Km, and 18Km. This research aims to determine the performance of three public transportation and to provide a new route recommendation. The operational performance is assessed from headway, load factor, and travel time. The service performance is assessed from safety, comfort, affordability, and regularity. Result of the operational performance shows that the load factor of three public transportation has met the specified standard, the headway and the travel time of ABG and AT has met the standards, however, CKL's headway and travel time have not met the standard. The Importance-Performance Analysis (IPA) shows that there are some service attributes which need to be improved. The recommendations that can be given are shortened the trajectory of ABG and extend the track for CKL and AT.

Keywords: *Importance Performance Analysis, operational performance, public transportation, routes, service performance*

I. INTRODUCTION

Transportation is a type of service that can be used to move goods from an area (origin) to another area (destination) [1], [2]. Transportation requests will arise if there is a purpose in the request, for example, the desire for recreation, the desire to work or go to school, the desire to shop and so on [3]. Transportation requests are inseparable from the needs and availability of transportation that serves the movement of people and goods.

One of the urban transportations that can be used by society is city transportation [4]. City transportation (*angkot*) is a facility that serves the movement of both passengers and goods in an urban area. *Angkot* is in the form of motorized vehicles and used by the community with certain fares collected directly or indirectly [5]. *Angkot* has a predetermined route and different travel times in serving community movements.

Malang has 25 public transportation routes with the number of vehicles in operation is 1153 vehicles [6]. Each *angkot* has different routes and destinations. The optimal city transportation route can be seen from the distance and travel time of a trip by paying attention to the density of the road at a certain time [7], [8]. The density of the road at a certain time can affect the travel time of an *angkot* from its origin to the destination. If the traffic volume exceeds the existing

road capacity, it will cause transportation problems which are called congestion [9].

ABG, CKL, and AT are *angkot* with the longest routes compared to other *angkot* in Malang City. The length of the ABG route is 26 Km which stretches from the northern part of Malang City to the south. The length of the CKL route is 22 km that stretches from the east to the west of Malang City. Whereas AT has a route length of 18 Km that stretches from the north to the west of Malang City. The three *angkot* pass through the road sections which often experience congestion at certain times (peak time), namely Sunandar Priyo Sudarmo Street, Kol. Sugiono Street, Gatot Subroto Street, Ranu Grati Street, and Panji Suroso Street [6]. Those roads are not only passed by ABG, CKL, and AT but also by many other *angkot* with different routes so that overlapping routes occur. The overlapping route can affect service performance and operational performance of ABG, CKL, and AT.

The operational performance of ABG, CKL, and AT have not met the standards set by the Director-General of Land Transportation in 2002, i.e. the standard for load factor is 70% during peak hours and non-busy hours and the headway set is 2-5 minutes during peak hours and 5-10 minutes when the hours are not busy. The load factor for ABG routes is only 31% with 19 minutes of headway [10]. The CKL route load factor is 34% with 18 minutes headway while the load factor AT route is 43% with 27 minutes headway [6].

The objectives of this study are twofold. The first is to determine the performance of public transportation in Malang City, especially the ABG, CKL, and AT routes, by assessing the operational performance of public transportation and service performance. The second is to provide recommendations for optimal city transport route in Malang City based on the trip generation of Malang residents.

II. RESEARCH METHODOLOGY

Stratified Random Sampling is used to calculate the samples. The sample size is determined using the Slovin formula [11].

$$n = (N / (1 + N(e)^2)) + (77 / (1 + 77(10\%)^2)) \quad (1)$$

where,

n = number of sample

N = population

e = significance level =10%

Sample for each *angkot* can be calculated using (2). Summary of research sample is shown in TABLE I.

$$n = (\text{angkot/population}) \times \text{Sample} \quad (2)$$

TABLE I. SUMMARY OF RESEARCH SAMPLE

No.	Route	Angkot Sample	Passengers Sample
1	ABG	20	83
2	CKL	10	72
3	AT	14	77
Total		44	232

Headway analysis is used to determine the difference in time needed between two city transports with the same route [4], [13].

$$\text{Headway (H)} = 60/\text{Frequency} \quad (3)$$

Load Factor Analysis is used to compare the number of passengers in city transportation with the transport capacity [4], [12].

$$\text{Load Factor (LF)} = (\text{No. of Passengers/Capacity}) \times 100\% \quad (4)$$

Travel Time Analysis aims to determine the effectiveness of public transport by calculating the travel time of public transport trips from origin to destination [4], [13].

$$W = T/J \quad (5)$$

where,

W = Travel time (minute/km)

J = Distance between segment (km)

T = *Angkot* travel time (minute)

Importance-Performance Analysis (IPA) used to measure the level of importance along with the satisfaction of *angkot* customers towards the services of security, safety, comfort, affordability, and regularity of *angkot* in Malang City [14]. The level of conformity is calculated using:

$$Tki = (Xi/Yi) \times 100\% \quad (6)$$

where,

Tki = Level of conformity

Xi = Performance score

Yi = Importance score

The average score for each variable was plotted in the two-dimensional state space to create the IPA diagram. The vertical axis illustrates the importance score, while the performance score is labeled by the horizontal axis. The IPA diagram consists of four quadrants, i.e., concentrate here, keep up with the good work, low priority, and possibly overkill. The first-quadrant, i.e., concentrate here, which is located in the north-west corner is the one with low

performance but importantly perceived by the customers, therefore the company should invest more to improve these attributes so the customers will be delighted. The second-quadrant is kept up with the good work. It is the one that is considered as important and the customers are fond of the performance of the service. The third-quadrant is a low priority. The attribute belongs here are performing well but customers perceive them as less important when compared with other attributes. The last or the fourth-quadrant is considered less important by the customers and felt too excessive so that need to be reduced due to the excessive investment. Trip Generation Analysis aims to estimate the amount of movement from the origin zone to the destination zone [3], [7]. Malang City is divided into 27 zones spread in each sub-district.

III. RESULT

A. Passenger Profile

The participants of this survey were required to have been experienced in doing transactions with the object of the study. The potential participants were first approached and asked if they agreed to participate in the survey. The profile of the passengers is shown in TABLE II.

TABLE II. SUMMARY OF PASSENGER PROFILE

No.	Question Item	Most Answers		
		ABG	CKL	AT
1	Age in year	21-30	21-30	31-40
2	Sex	Female	Female	Female
3	Occupation	Employee	Student	Employee
4	Income level	Rp 1.000.000 – Rp 1.500.000	< Rp 1.000.000	Rp 1.000.000 – Rp 1.500.000
5	Intention	Transport to work	Transport to work	Transport to work
6	Travel time	<30 minutes	<30 minutes	<30 minutes
7	Fare	< Rp 10.000	< Rp 10.000	< Rp 10.000

B. Headway Analysis

The headway of ABG, CKL, and AT is declared correspond if it meets the standards set by the Director-General of Land Transportation in 2002 which are shown in TABLE III. TABLE III summarizes the headway of ABG, CKL, and AT.

TABLE III. SUMMARY OF HEADWAY OF ABG, CKL, AND AT

Route	Operational Hour	Weekday (in minutes)	Weekend (in minutes)	Explanation
Arjosari – Gadang	Busy	3.58	3.18	Met the standard
	Non-busy	4.5	5.43	Met the standard
Gadang – Arjosari	Busy	3.66	4.1	Met the standard
	Non-busy	4.84	5.16	Met the standard
Cemoro Kandang – Landungsari	Busy	11.68	8.81	Haven't met the standard
	Non-busy	20.15	22.70	Haven't met

Route	Operational Hour	Weekday (in minutes)	Weekend (in minutes)	Explanation
				the standard
Landungsari – Cemoro Kandang	Busy	11.28	13.18	Haven't met the standard
	Non-busy	16.62	18.96	Haven't met the standard
Arjosari – Tidar	Busy	5	5.78	Haven't met the standard
	Non-busy	7.71	8.15	Met the standard
Tidar – Arjosari	Busy	5	5.48	Haven't met the standard
	Non-busy	8.21	7.91	Met the standard

C. Load Factor Analysis

The load factor of ABG, CKL, and AT is declared correspond if it meets the standards set by the Director-General of Land Transportation in 2002 which are shown in TABLE IV. TABLE IV summarizes the load factor of ABG, CKL, and AT.

TABLE IV. SUMMARY OF LOAD FACTOR OF ABG, CKL, AND AT

Route	Operational Hour	Weekday	Weekend	Explanation
Arjosari – Gadang	Busy	25%	23.81%	Haven't met the standard
	Non-busy	12.62%	17.14%	Haven't met the standard
Gadang – Arjosari	Busy	21.43%	27.3%	Haven't met the standard
	Non-busy	17.97%	23.96%	Haven't met the standard
Cemoro Kandang – Landungsari	Busy	19.68%	13.75%	Haven't met the standard
	Non-busy	20.06%	11.7%	Haven't met the standard
Landungsari – Cemoro Kandang	Busy	21.35%	22.22%	Haven't met the standard
	Non-busy	23.65%	19.84%	Haven't met the standard
Arjosari – Tidar	Busy	34.67%	35.28%	Haven't met the standard
	Non-busy	24.55%	21.08%	Haven't met the standard
Tidar – Arjosari	Busy	30.15%	34.30%	Haven't met the standard
	Non-busy	24.09%	22.92%	Haven't met the standard

D. Travel Time Analysis

The travel time of ABG, CKL, and AT is declared correspond if it meets the standards set by the Director-General of Land Transportation in 2002 which are shown in TABLE V. TABLE V summarizes the travel time of ABG, CKL, and AT.

TABLE V. SUMMARY OF TRAVEL TIME OF ABG, CKL, AND AT

Route	Operational Hour	Weekday (In minutes)	Weekend (In minutes)	Explanation
Arjosari – Gadang	Busy	55	52.5	Met the standard
	Non-busy	73	70	Met the standard
Gadang – Arjosari	Busy	55.5	53	Met the standard
	Non-busy	62	65	Met the standard

Route	Operational Hour	Weekday (In minutes)	Weekend (In minutes)	Explanation
Cemoro Kandang – Landungsari	Busy	90	68.5	Met the standard
	Non-busy	115	113	Met the standard
Landungsari – Cemoro Kandang	Busy	90.5	109	Haven't met the standard
	Non-busy	106	120	Met the standard
Arjosari – Tidar	Busy	55	58	Met the standard
	Non-busy	76	72	Met the standard
Tidar – Arjosari	Busy	59.5	64.5	Met the standard
	Non-busy	70	75	Met the standard

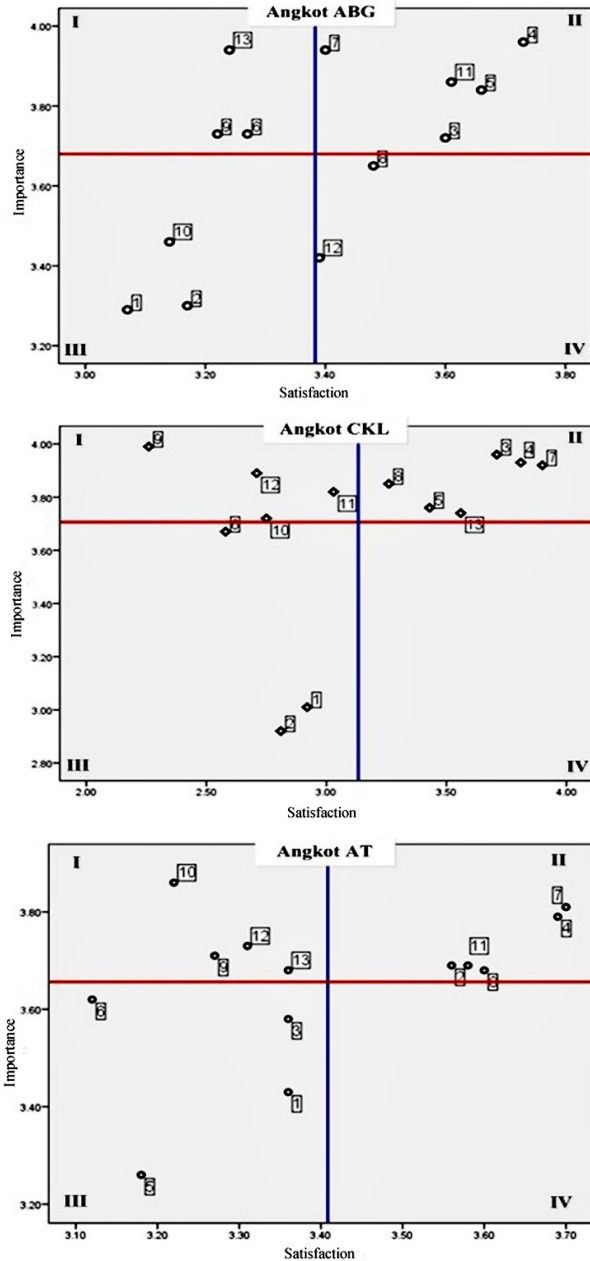
E. Service Performance of ABG, CKL, and AT

The IPA diagram of the result of the ABG study is shown in Fig. 1. The item statements belong to the first quadrant are smoking prohibition (6), waiting time (9), and route conformity (13). It means that the service provider (ABG) needs to pay attention to those item statements and invest more to gain satisfactory from the customers. The statements belong to the second quadrant are exit and entrance (3), load factor (4), windows (5), fares (7), and travel time (11). Since the second quadrant shows the attributes that have high performance and high importance values, the ABG needs to keep up its good work to maintain a satisfactory level from the customers. The statements belong to the third quadrant are lighting (1), window film usage (2), and headway (10). The ABG *angkot* does not need to invest more on those item statements because the customers do not consider them as important. The last, the statements that belong to the fourth quadrant are *angkot* availability (8) and arrival schedule (12). These attributes need to be reduced due to excessive investment.

The IPA diagram of the result of the CKL *angkot* study is shown in Fig. 1. The item statements belong to the first quadrant are waiting time (9), headway (10), travel time (11), and arrival schedule (12). It means that the service provider (CKL *angkot*) needs to pay attention to those item statements and invest more to gain satisfactory from the customers. The statements belong to the second quadrant are exit and entrance (3), load factor (4), windows (5), fares (7), *angkot* availability (8), and route conformity (13). Since the second quadrant shows the attributes that have high performance and high importance values, the CKL *angkot* needs to keep up its good work to maintain the satisfactory level from the customers. The statements belong to the third quadrant are lighting (1), window film usage (2), and smoking prohibition (6). The CKL *angkot* does not need to invest more on those item statements because the customers do not consider them as important. The last, there are no statements that belong to the fourth quadrant.

The IPA diagram of the result of the AT *angkot* study is shown in Fig. 1. The item statements belong to the first quadrant are waiting time (9), headway (10), arrival schedule (12), and route conformity (13). It means that the service provider (AT *angkot*) needs to pay attention to those item statements and invest more to gain satisfactory from the customers. The statements belong to the second quadrant are window film usage (2), load factor (4), fares (7), *angkot* availability (8), and travel time (11). Since the second quadrant shows the attributes that have high performance and high importance values, the CKL *angkot* needs to keep up its

good work to maintain the satisfactory level from the customers. The statements belong to the third quadrant are lighting (1), exit and entrance (3), windows (5), and smoking prohibition (6). The AT *angkot* does not need to invest more on those item statements because the customers do not consider them as important. The last, there are no statements that belong to the fourth quadrant.



Remarks:

- | | |
|--------------------------|---------------------------|
| 1. Lighting | 8. Transport availability |
| 2. The use of glass film | 9. Waiting time |
| 3. Doorway | 10. Headway |
| 4. Load factor | 11. Travel time |
| 5. Angkot window | 12. Arrival schedule |
| 6. Smoking ban | 13. Route suitability |
| 7. Tariff | |

Fig. 1. IPA Diagram of ABG, CKL, and AT.

F. Trip Generation Analysis

- ABG passes through settlements and public facilities. Whereas public facilities that are passed are offices, educational facilities, trade and services, religious facilities, health facilities, and recreational facilities.
- CKL passes through settlements, public facilities, and agriculture that located on Cemoro Kandang Street. The public facilities that passed by CKL are in the form of offices, educational facilities, trade and services, health facilities, and recreational facilities.
- AT passes used lands in the form of settlements and public facilities. Whereas public facilities that are passed by AT *angkot* are in the form of offices, educational facilities, trade and services, religious facilities, and recreational facilities.

G. Route Recommendations

- Route for ABG *Angkot*

The new route recommended for ABG *angkot* is from Arjosari Terminal to Martadinata Street. The length of the new ABG *angkot* route reaches 22 Km, while the route to Gadang Terminal reaches 26 Km. This is because customers who are driven to Kol. Sugiono Street and Raya Gadang Street declined. Here is the routes recommendation for ABG *angkot*:

1. Departure Route

Arjosari Terminal – Blimbing Indah Utara Street – Simpang Raden Panji Suroso Street – Raden Intan Street – Jend. A. Yani Street – Borobudur Street – Sukarno Hatta Street – Bunga Coklat Street – Cengkeh Street – Kalpataru Street – Melati Street – Bungur Street – Mawar Street – Sarangan Street – Tawamangu Street – Kaliurang Street – WR. Supratman Street – Panglima Sudirman Street – Pattimura Street – Trunojoyo Street – Gatot Subroto Street – Laks. Martadinata Street.

2. Return Route

Laks. Martadinata Street – Gatot Subroto Street – Trunojoyo Street – Cokroaminoto Street – Dr. Cipto Street – Panglima Sudirman Street – WR. Supratman Street – Kaliurang Street – Tawamangu Street – Sarangan Street – Mawar Street – Bungur Street – Melati Street – Kalpataru Street – Cengkeh Street – Bunga Coklat Street – Sukarno Hatta Street – Borobudur Street – Jend. A. Yani Street – Raden Intan Street – Arjosari Terminal.

- Route for CKL *Angkot*

The length of the new recommended route for CKL *angkot* is 22.3 Km which was previously only 22 Km. The route passes Candi Panggung Barat Street, which along the way there are housing, trade and services, government and public services, and educational facilities. The following is the recommended CKL *angkot* routes:

1. Departure Route

APK Cemoro Kandang – Raya Cemoro Kandang Street – Raya Madyopuro Street – Raya Ki Ageng Gribig Street – Danau Jonge Street – Simpang Terusan Danau Sentani Street – Danau Sentani Street – Danau Tigi Street – Kerinci Street – Danau Limboto Street – Tondano Street – Raya Sawojajar Street – Ranu Grati Street – Mayjen M. Wiyono Street – Kesatrian Terusan Street – Mayor Hamid Rusdi Street – Raden Tumenggung Suryo Street – Sunandar Priyo Sudarmo Street – Ciliwung Street – Letjen S. Parman Street – Kedawung Street – Kalpataru Street – Cengkeh Street – Coklat Street – Sukarno Hatta Street – Candi Panggung Street – Candi Panggung Barat Street – Vinolia Street – Keramik Street – MT. Haryono Street – Raya Tlogomas Street – Landungsari Terminal.

2. Return Route

Landungsari Terminal – Raya Tlogomas Street – MT. Haryono Street – MT. Haryono Gg 13 Street – Vinolia Street – Candi Panggung Barat Street – Candi Panggung Street – Sukarno Hatta Street – Coklat Street – Cengkeh Street – Kalpataru Street – Kedawung Street – Letjen S. Parman Street – Ciliwung Street – S. Priyo Sudarmo Street – Raden Tumenggung Suryo Street – Mayor Hamid Rusdi Street – Kesatria Street – Mayjen M. Wiyono Street – Ranu Grati Street – Raya Sawojajar Street – Danau Tondano Street – Danau Limboto Street – Danau Kerinci Street – Danau Paniai Street – Danau Sentani Street – Simpang Terusan Danau Sentani Street – Danau Jonge Street – Raya Ki Ageng Gribig Street – Raya Madyopuro Street – Raya Cemoro Kandang Street – APK Cemoro Kandang.

The transfer of the route from Simpang Candi Panggung Street to Candi Panggung Barat Street increased the load factor of the CKL *angkot* from 35.71% to 59.74%. While the load factor of the CKL public transportation when passing Candi Panggung Street increased from 35.71% to 71.4%. On this road, the load factor of CKL *angkot* is under the standard set at 70%. Fig. 2 shows the route recommendation for CKL *angkot*.

• Route for AT *Angkot*

The recommendation of the new AT *angkot* route is the transfer of AT *angkot* routes from Gading Street and Sanggabuana Street to Dieng Highway and the transfer of routes from Bukit Barisan Street and Lokon Street to Galunggung Street. Land usage passed by CKL *angkot* is more varied including housing, trade and services, as well as government and public services. The recommendations for AT *angkot* routes are as follows:

1. Departure Route

Arjosari Terminal – Blimbing Indah Utara Street – Simpang Raden Panji Suroso Street – Raden Panji Suroso Street – Raden Intan Street – Jend. A. Yani

Street – Letjen. S. Parman Street – Ciliwung Street – Letjen. Sunandar Priyosudarmo Street – Raden Tumenggung Suryo Street – Panglima Sudirman Street – Pattimura Street – Belakang RSU Syaiful Anwar Street – Kahuripan Street – Semeru Street – Arjuno Street – Kawi Street – Panderman Street – Wilis Street – Raya Dieng Street – Galunggung Street – Raya Tidar Street – Puncak Mandala Street – Puncak Yamin Street – Esberg Street – APK Tidar.

2. Return Route

APK Tidar – Esberg Street – Puncak Yamin Street – Puncak Mandala Street – Raya Tidar Street – Galunggung Street – Raya Dieng Street – Wilis Street – Street Panderman – Kawi Street – Arjuno Street – Semeru Street – Kahuripan Street – Belakang RSU. Syaiful Anwar Street – Patimura Street – Thamrin Street – Cokroaminoto Street – Dr. Cipto Street – Panglima Sudirman Street – Raden Tumenggung Suryo Street – Sunandar Priyosudarmo Street – Ciliwung Street – Letjen. S. Parman Street – Jend. A. Yani Street – Raden Intan Street – Arjosari Terminal.

The recommended route has a length of 18.5 Km which was previously only 18 Km. The transfer of the AT *angkot* route from Gading Street and Sanggabuana Street to Dieng Highway increased the load factor of the AT *angkot* from 28.57% to 57.13%. Whereas the transfer of routes from Bukit Barisan Street and Lokon Street to Galunggung Street increases the load factor from 28.57% to 41.06%. Fig. 2, Fig. 3 and Fig. 4 show the route recommendation.

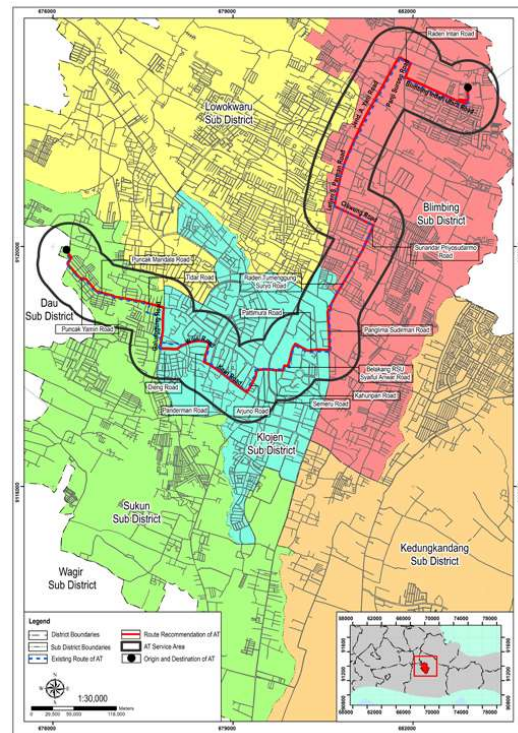


Fig. 2. Map of Route Recommendation for AT.

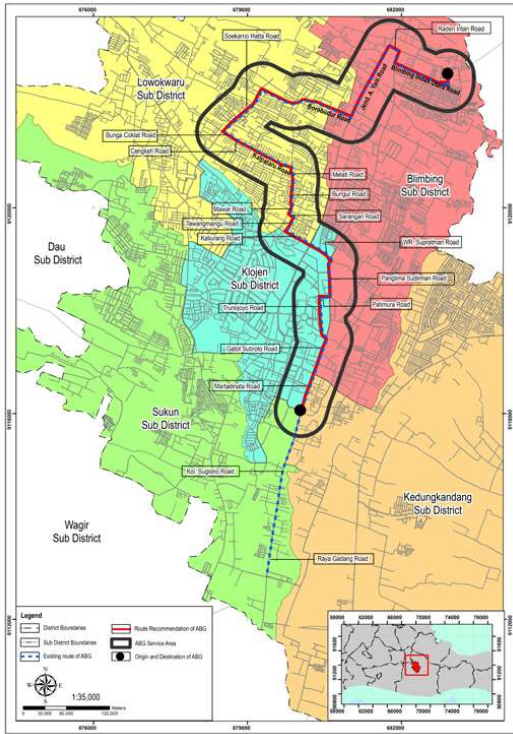


Fig. 3. Map of Route Recommendation for ABG.

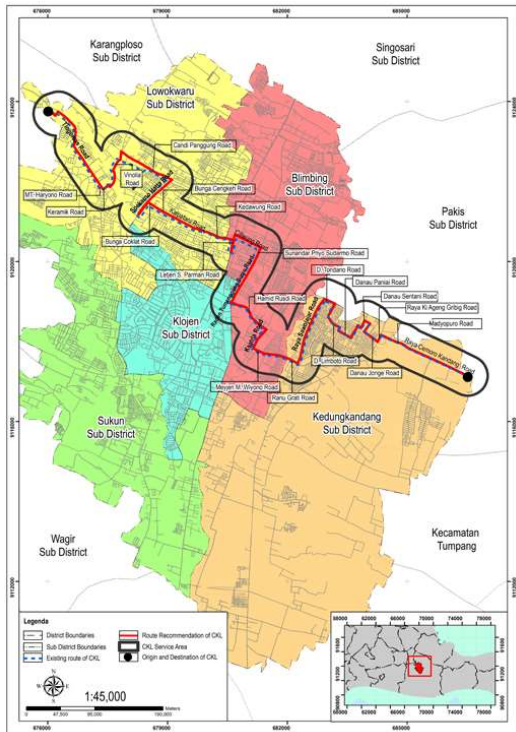


Fig. 4. Map of Route Recommendation for CKL.

IV. CONCLUSIONS

From the analysis of operational performance using headway, load factor, and travel time analysis, it is known that the ABG and AT headways are in line with service

standards while the CKL headway still has not met headway standards. The load factor for this *angkot* is still below 70%, it means that the load factors are not under the standard. While the travel time for these three *angkot* has met the standard except for the travel time for CKL in the direction of Landungsari - Cemoro Kandang Terminal on weekends and weekdays. From the analysis of service performance using IPA, the attributes of ABG *angkot* services that need to be improved are smoking prohibition, waiting time, and route conformity. The attributes of CKL public transportation services that need to be updated are waiting time, the time between, travel time, and arrival schedule. While the attributes of AT *angkot* services that need to be improved are waiting time, the time between, arrival schedule, and route conformity. The route recommendations for the ABG is to shorten the route from a length of 26 Km to 22 Km. Where as the other two *angkot* routes are extended from 22 Km to 22.3 Km for CKL *angkot* and from 18 Km to 18.5 Km for AT *angkot*.

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