Improvement of the Malang Transport Operation System: A Malang Review of the Angkot Performance Service system

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M. Iqbal HABIBI[a)], Hiroshi SHIMAMOTO[b)], Chikasi DEGUCHI[c)], Achmad WICAKSONO[d)], Agus SUHARYANTO[e)]

Abstract

ANGKOT (from **ANG**kutan=transportation and **KOT**a=city) is a public transportation system in Malang, East Java Province, Indonesia. The increasing population there is not matched by the growth of transportation producing traffic congestion, accidents, and air pollution. The population growth also has increased of the rate of private vehicle ownership. The growth and development of the urban population has affected the balance between the size and needs of the population and the Angkot service, resulting in a lack of efficiency. This research compares the demand and the frequency of Angkot with the travel demands of the populace and the directness of the service of Angkot in Malang. It finds that some of streets in Malang like "Jalan Soekarno Hatta", "Jalan Mt. Haryono", and "Jalan Kyai Tamin" present a mismatch between demand and frequency of Angkot, therefore there is room to rearrange the Angkot network and improve the Angkot service.

Keywords: Angkot, Service Demand, Service Frequency, Travel Demand, Directness of Service

1. INTRODUCTION

Transportation plays a vital role in the development of all cities. Adequate, well-maintained streets facilitate the traffic flow of automobiles, truck, and emergency vehicles. Highways allow suburban commuters to access downtown jobs and amenities, and they also permit the import and export of essential goods, further connecting urban center to outlying areas and thus boosting economies. New middle-class housing developments in and around the city expand and are treasured for having spacious homes, superior schools, and diverse shopping venues all easily accessible by car.

Cities and metropolitan areas are centers of diverse activities that require efficient and convenient transportation of persons and goods. It is often said that transportation is the lifeblood of a city. The high density of activities makes it possible, indeed necessary that high capacity modes like, buses, light rail, and metro, be used because they are the most economical, more energy efficient and require much less space for transportation efforts than private cars do. Moreover, public transportation provides service to all persons, while those who are able to own and drive them can only use cars. Thus, cities need public transportation services and can benefit greatly from them, as they offer the greatest mobility to the greatest population. Transit systems are also needed in urbanized areas to make the high-density of diverse activities like residences, business offices, factories, etc., physically accessible and successfully, while still keeping cities livable and attractive for the people.

Xumei Chen et.al. [1)] Analyzed urban bus service reliability at the stop, route, and network levels in Beijing, China. It indicated low service reliability for buses in Beijing and a high correlation between service reliability and route length, headway, distance at the stop to the origin terminal, and the provision of exclusive bus lanes. Agarwal, P.K [2)] briefly discussed the issues related to inefficient operation of existing bus systems in Indian cities and identified solutions for improvement in the performance of these urban bus systems. This study also presented indicators that to use to evaluate the efficiency and effectiveness of urban bus service. Olav Hauge[3)] suggested that better more efficient and faster bus service might increase the use of public transport. It appears that people are willing to pay for improved public transport service as positive and effective travel time is more important than price.

Angkot is public transportation system in Malang. Public newspaper opinion [4)] cost, time, and traffic jams caused the people in Malang leave this public transportation and prefer the use private vehicle instead of Angkot for their activities. Thus, Objective of this research is to study Angkot's performance in Malang and compare to the demands and the frequency of use of the

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Malang transit operation system in order to identify mismatches between demand and frequency. In doing so, this analysis will look for ways in Malang where Angkot has trouble with the Demand and frequency of Angkot and also compare the travel demands of persons to the found there is a directness of the service of Angkot in Malang in order to highlights potential areas for improvement. This analysis found there is a directness of Angkot service zones with a malfunction of Angkot service and suggest rearranging the Angkot network to stabilize both the Demand and the Frequency in the Angkot system in Malang. The aim of this paper then is to improve Angkot's performance in the Malang transit operation system by undertaking these two analyses.

The rest of the paper is organized as follows: Chapter 2 will provide an overview of Malang. Chapter 3 then explains the data and study routes used for the analyses. Chapter 4 offers an analysis of Angkot performance in Malang using data presented in Chapter 3, applying a 2-step analysis, first identifying the mismatch between the demand and the frequency from a field survey and secondly identifying the travel demands of persons and the directness of the Angkot service in Malang from OD pairs being surveyed. Finally, Chapter 5 will conclude with both findings and suggestions for the further research.

2. AN OVERVIEW OF MALANG

2.1 Location of Malang

Fig.1 shows Malang at the coordinates 112 º 06' - 112 º 07' East longitude and 7º06' - 8º02' South latitude. Area scope of 110, 06 km^2, Malang is the second wide region in East Java after Surabaya. Administratively, Malang City is divided into 5 districts areas: Klojen, Lowokwaru, Blimbing, Sukun, and Kedung Kandang. Malang is popularly called as city of flowers, because it is supported by good soiled land and a friendly climate, so plants and flowers can grow well. This condition could be a strong magnet for urban people in big cities who choose Malang as a place for rest and business. Malang has 31, and more than 10 universities hold a valuable reputation in Indonesia. Recently, Malang has experienced traffic because each year more students come to Malang for studying. In 2009-2010 along, 19,762 people arrived [5].

Fig. 1. Location of Malang

Malang has a large intercity bus terminal, Arjosari, located in Northern Malang. The primary means of public transportation is the blue microvan called *ANGKOT* (from ***ANG****kutan*=transportation and ***KOT****a*=city). Fig.2 depicts the Angkot in Malang. It is the main source of urban transit. Angkot is a small van re-designed to accommodate more passengers. All back seats have been removed and replaced with two long dark benches covered with foam. Normally, Angkot can carry 12 passengers, although sometimes it does carry more.

Table 1 shows the Angkot Route and the Route roads, In Malang there are 25 Angkot Routes. Angkot runs services from 6 am-9 pm. Angkots are run and managed by individuals, cooperatives, and private owners, usually operating as single-person enterprises. The fare for Angkot in Malang is Rp. 3000 for the general public and Rp. 2000 for students. The role of the government (performed by the municipal authorities in charge) is to issue Angkot permission to operate on the selected designated routes and decide the number of cars that run each designated route. Angkot are owned and operated by individuals or multiple operators. There is no financial support or subsidy from the government, and the Angkot driver only signs a contract to pay

a fixed amount of money to the owner on a daily basis. Recently, the urban transit system has faced great competition from motorcycles and private cars. The ease of buying motorbikes and the ease of their use on roads through a leasing system lets many people own a motorcycle, thus making urban transit in Malang less attractive.

Fig. 2. Angkot in Malang

Table 1. Twenty-Five Angkot Routes in Malang

No	ANGKOT NAME	ANKOT ROUTE
1	AG	Arjosari Terminal Gadang Terminal
2	ADL	Arjosari Terminal-Dinoyo-Landungsari Terminal
3	GA	Gadang Terminal-Arjosari Terminal
4	MK	Madyopuro-Karang Bcsuki
5	MM	Mulyorejo Madyopuro
6	AJG	Arjosari Terminal-Janti-Gadang
7	AMG	Arjosari-Mergosono-Gadang
8	CKL	Cemoro kandang-Kedung kandang-Landung sari terminal
9	AT	Arjosari Terminal-Tidar
10	LG	Landungsari Terminal Gadang Terminal
11	AL	Arjosari Terminal-Landung Sari Terminal
12	GML	Gadang Terminal-Mergan-Landungsari Terminal
13	GL	Gadang Terminal-Landung Sari Terminal
14	ABB	Arjosari Terminal-Borobudur-Bunul
15	ABG	Arjosari Terminal Borobudur Gadang Terminal
16	TGT	Tlogowaru-Gadang Terminal-Trifosari
17	JPK	Joyogrand-Piranha-Karanglo Indah
18	MKS	Mulyorejo-Khyatan-Sukun
19	JDM	Joyogrand-Dinoyo-Mergan
20	TST	Tlogowaru Sarangan Tasikmadu
21	GM	Gadang Terminal-Mulyorejo
22	ASD	Arjosari Terminal-Soekarno Hatta-Dieng
23	MT	Mulyorejo-Tlogowaru
24	TSG	Tawangmangu-Sockarno Hatta-Gasck
25	LDG	Landungsari Terminal Dinoyo Gadang Terminal

3. DATA AND STUDY ROUTES

3.1 Data Used

This research used a qualitative method to gather information and data and used a field survey conducted by the Ministry of Transportation Malang on weekdays in 2006 to identify the real conditions of Angkot in Malang. The survey was conducted from two viewpoints, namely, the "dynamic" and "static" aspects.

The dynamic survey included an onboard survey on every route. A surveyor recorded the number of boarding and alighting passengers as well as travel time for each segment. The vehicles for the dynamic survey were randomly selected on weekdays from Monday through Thursday, during morning peak, daytime, and evening peak hours.

The static survey included a survey held in one spot, calculating every Angkot that crossed the road there in each direction. The purpose of this survey is to analyze the performance of Angkot along every route to ensure that the numbers of vehicles operating were in accordance with the number permitted to operate. This static survey was conducted on weekdays from Monday through Thursday, from 6:00 am to 9:00 pm, including the peak times of 6:00 am to 8:00 am and 4:00 pm to 6:00 pm.

Dynamic surveys generated data like, the frequency data at major road segments and load factor data, which is the number of passengers divided by the vehicle capacity and speed for each segment. The static survey generated data like the load factor of Angkot for each route, frequency, and headway.

3.2 Study Route

Fig.3 shows how 25 Angkot routes lines in Malang integrate with each other. In this study area, there are 3 big Terminal inside: Arjosari terminal, Landung Sari terminal, and Gadang terminal. Arjosari terminal is the main terminal in Malang City and services buses from local area and regional area outside Malang. The red color in the figure is refers to a quasi-terminal beside the three big terminals in Malang. In this case, the quasi-terminal functions to persuade Angkot service east and west of Malang. There are 25 Angkot routes in Malang, and the service for each area is shown in Fiq.4 as five district areas; Blimbing(1), Lowokwaru(2), Klojen(3),

Sukun(4), and Kedung Kandang(5). One district (3) (Klojen) is the center city of Malang, which has a large business center called “Pasar Besar”; many traffic jams are observed during the peak hours because many vehicles cross this location. The district (2) (lowokwaru) is a residential, commercial, and educational area in Malang and there are more than 15 universities including University of Brawijaya. Residential areas and commercial area in this district are spread around the university. Districts (1), (2), and (4) are the suburban areas in Malang. These districts are center of factories that have many workers working in them.

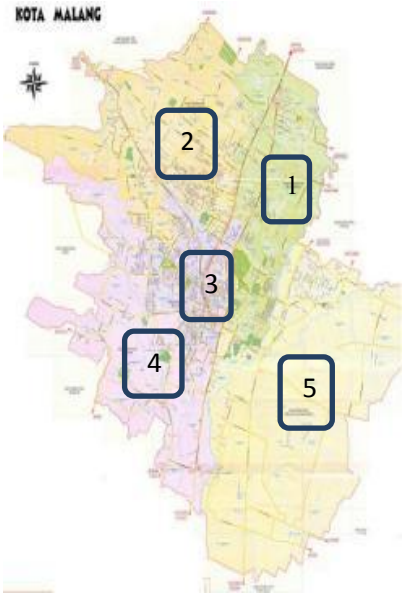

Fig. 3 Five Districts in Malang

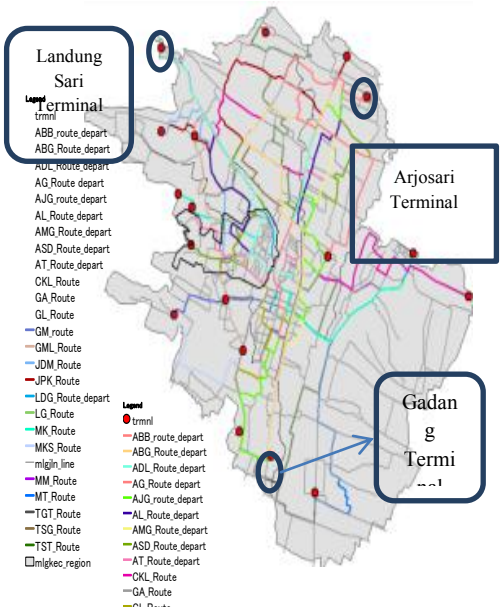

Fig. 4 Twenty-Five Routes for Angkot in Malang

JDM_Route
JPK_Route
LDG_Route_depart
LG_Route
MK_Route
MKS_Route
mlgjln_line
MM_Route
MT_Route
TGT_Route
TSG_Route
TST_Route
mlgkec_region

4. OVERVIEW OF ANGKOT PERFORMANCE IN MALANG

This overview examined Angkot performance in Malang to compare the demand and the frequency in the Malang transit operation system and identify mismatches between demand and frequency and compare the travel demands of persons to the directness of the Angkot service in Malang in order to highlights potential areas for improvement.

4.1 Comparing Demand and Frequency of Angkot in Malang

4.1.1 Demand each Segment of Route Line

The demand of each segment along the route line was calculated from the demand data for each route. Comparing the demand and the frequency of Angkot in Malang, the study to find Demand of each route, and used the demand data from dynamic survey done on each route line. In this case, Fig.4 show 25 Route lines for Angkot in Malang divided into the 277 segments of each line**.** Separating 277 segments delivered all demands for each segment. To calculate the Angkot trip in each segment, the formula below was used [6];

$$Demand = \frac{number\ passengers\ boarding}{capacity\ of\ Angkot}\ x\ 100 \ldots (1)$$

where: 1. Number passenger boarding was calculated from passengers boarding on each segment of route line. 2. Capacity of Angkot was 12 Passengers.

Table 2(a) Demand routes of Angkot in Malang

AG	DEMAND (%)	ABG	DEMAND (%)
Term ARJOSARI	12.50	Term ARJOSARI	37.50
JL. Simp. Panji Suroso	0.00	Jl. Panji. Suroso	75.00
JL. Raden panji suroso	0.00	Jl. R. Intan	37.50
JL. R. Intan	41.67	Jl. A. Yani	75.00
Jl. Ahmad Yani	29.17	Jl. Borobudur	91.67
JL. Let Jend S. Parman	16.67	Jl. Sukarno Hatta	70.83
JL. Let Jend Sutoyo	25.00	Jl.Cengkeh	58.33
JL. Agung Suprapto	25.00	Jl. Kalpataru	62.50
JL. Basuki Rachmat	25.00	Jl. Melati	25.00
JL. Merdeka Utara	25.00	Jl. Mawar	75.00
JL. Merdeka Timur	25.00	Jl. Sarangan	87.50
JL. Sukoharjo Wiryopranoto	25.00	Jl. Tawamanggu	95.83
JL.Pasar Besar	8.33	Jl. Kaliurang	83.33
JL. Sersan Harun	16.67	Jl. Ws Supratman	83.33
JL. Kyai Tamiz	16.67	Jl. P Sudirman	83.33
JL. Prof Moh Yamin	25.00	Jl. Pattimura	83.33
JL. Sartono SH	8.33	Jl. Trunojoyo	83.33
JL. KOL. Sugiono	0.00	Jl. Jembatan Pahlawan	79.17
JL. Irian Jaya	58.33	Jl. Gatot Subroto	75.00
JL. Tanimbar	41.67	Jl. L Martadinata	54.17
JL. Sulawesi	41.67	Jl. Kol Sugiono	29.17
JL. Yulius Usman	25.00	Jl. Cokroaminoto	83.33
JL. Syarif AL Qodri	25.00	Jl. Dr Cipto	83.33
JL. KH Wahid Hasyim	25.00	Jl. Bungur	91.67
Term GADANG	0.00	Term GADANG	20.83

Table 2(b) Comparing Demand for Each Segment of Route Line

NO SEGMENT	NAME OF ROUTE	NAME OF SEGMENT	DEMAND %	FREQUENCY VEH/HOUR
1	AG	JL. Simp. Panji Suroso	0.00	6.34
		JL. Raden panji suroso	0.00	6.34
	ADL	JL. Simp. P. Seroso	41.67	2.38
		Simp.RP.Suroso	125.00	2.38
	AL	Jl.RP Suroso	125.00	1.94
	AT	Jl. RP. Suroso	75.00	1.21
	ABG	Jl. Panji. Suroso	75.00	2.14
	AJG	JL. Simp. Panji Suroso	0.00	2.18
	AMG	Jl. RP Seroso	100.00	4.52
	ASD	Jl.Simp.Rp.Suroso	41.67	0.61
		Jl.Rp.Suroso	70.83	0.61
		TOTAL	654.17	30.63
NO SEGMENT	NAME OF ROUTE	NAME OF SEGMENT	DEMAND %	FREQUENCY VEH/HOUR
2	AG	Term GADANG	0.00	4.39
	LDG	Term GADANG.	50.00	1.89
	AJG	Term GADANG.	16.67	2.18
	AMG	Term GADANG	66.67	4.52
	GA	Term GADANG	0.00	4.39
	ABG	Term GADANG	20.83	2.14
	LG	Term GADANG	0.00	2.10
	GL	Term GADANG	8.33	1.07
	GM	Term. Gadang	0.00	7.90
	GML	Term.Gadang	20.83	0.63
		TOTAL	183.33	31.20

(b)

Table 2(a) summarizes the findings of the dynamic survey. The dynamic data showed Angkot performance, which shows demand for 2 Route lines in Malang and AG and ABG for 25-route line of Angkot in Malang. AG and ABG route departures from the Arjosari Terminal to Gadang Terminal shows as the destination. Table 2(b) shows the demand segment of route, notes that the road segment was selected from high/medium and low demand levels. (The location of the selected intersection is shown in Fig.4). Then continually all Angkot trip for each segment and its total demand are shown for each part of the segment.

4.1.2 Frequency for Each Segment of Route Line

Service frequency can vary markedly between peak and non-peak commuting times. Several studies have included measures or used an independent measure. There are two general approaches to measuring transit service frequency. The first excludes public transit that does not meet a minimum standard of service[7].

Frequency is the number of Angkot crossings of the segment route in Malang, calculated by vehicle/hour (veh/hour). The frequency was taken in a static survey that calculated every Angkot that crossed a road in each direction. The Frequency in this study was calculated as follows [8]:

$$Freq.\,each\ segment = \frac{frequency\ in\ each\ route}{length\ of\ route} \quad (2)$$

Table 3(a) shows the frequency for the route and the frequency for the segment. The frequency of the route is defined as the frequency of Angkot use taken from a static survey. The frequency of each segment is the frequency of Angkot use divided by the length of each route. Table 3(b) shows the demand and the frequency for each segment. In this table there is also total demand and frequency used to find all the mismatches between demand and frequency in all segments.

Table 3 Frequency for Each Segment of Route Line

NO	ANGKOT Route	FREQUENCY Route	FREQUENCY Segment
1	LDG	28.38	1.89
2	ADL	34.50	2.38
3	AG	88.75	6.34
4	GML	11.24	0.63
5	LG	34.60	2.10
6	GL	16.63	1.07
7	AL	33.29	1.94
8	CKL	21.79	1.11
9	AMG	71.00	4.52
10	ABG	33.61	2.14
11	AJG	26.79	2.18
12	GA	64.10	4.39
13	TGT	1.05	0.21
14	GM	47.40	7.90
15	ABB	12.60	0.95
16	ASD	10.93	0.61
17	AT	15.33	1.21
18	MT	12.27	1.86
19	MK	56.22	6.46
20	TSG	8.40	0.84
21	JPK	8.30	0.83
22	JDM	8.44	0.84
23	MKS	2.89	0.43
24	MM	28.69	1.89
25	TST	14.30	0.55

(a)

Table 3 Demand and Frequency for Each Segment of a Route Line

NO SEGMENT	NAME OF ROUTE	NAME OF SEGMENT	DEMAND %	FREQUENCY VEH/HOUR
1	AG	JL. Simp. Panji Suroso	0.00	6.34
		JL. Raden panji suroso	0.00	6.34
	ADL	JL. Simp. P. Seroso	41.67	2.38
		Simp.RP.Suroso	125.00	2.38
	AL	Jl.RP Suroso	125.00	1.94
	AT	Jl. RP. Suroso	75.00	1.21
	ABG	Jl. Panji. Suroso	75.00	2.14
	AJG	JL. Simp. Panji Suroso	0.00	2.18
	AMG	Jl. RP Seroso	100.00	4.52
	ASD	Jl.Simp.Rp.Suroso	41.67	0.61
		Jl.Rp.Suroso	70.83	0.61
		TOTAL	654.17	30.63
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	AJG	Term GADANG.	16.67	2.18
	AMG	Term GADANG	66.67	4.52
	GA	Term GADANG	0.00	4.39
	ABG	Term GADANG	20.83	2.14
	LG	Term GADANG	0.00	2.10
	GL	Term GADANG	8.33	1.07
	GM	Term. Gadang	0.00	7.90
	GML	Term.Gadang	20.83	0.63
		TOTAL	183.33	31.20

(b)

4.1.3 Comparing Demand and Frequency in Malang Transit Operation System

Fig. 5 shows the comparison between the demands on each segment and the frequency of each segment to determine any mismatch for 277 segments in Malang. From this figure, we used 10 segments that had a large difference in their values. Note that we assume there is mismatch between the demand and the frequency of those 10 segments as shown in Table 4.

Fig. 6 and 7 shows the location of "Jalan Soekarno Hatta" and "Jalan Mt. Haryono", 2 locations replete with 10 segments where we assume there is a mismatch in demand and frequency. This location of the study in Malang indicates in that, there are 3 Universities and many student residential and commercial areas. The demand of "Jalan Soekarno Hatta" is 479.17% and the frequency of this segment is 5.52 vehicles/hour, similarly the demand of "Jalan Mt. Haryono" at 620.83% and the frequency of this segment is 14.46 vehicles/hour.

Fig.8 shows the location of "Jalan Kyai Tamiz" whose demand is 375% and frequency in this segment is 33.24 vehicles/hour. This area has such traffic because the center of business area is called "Pasar Besar" and there are many Angkot Crossing in this area. In reality, sometimes Angkot stops on the side of streets to wait for the passengers until all the Angkot seats equipped.

Table 4 Ten Mismatched segments with large difference values of 277 segments in Malang

No	Name of Segment	Demand	Frequency
1	JL. KOL. Sugiono	166.67	23.00
2	JL. Raden Intan	162.50	20.98
3	TERMINAL GADANG	183.33	31.20
4	JL. Kyai Tamiz	375.00	33.24
5	JL. Cokroaminoto	375.00	32.87
6	JL.Dr. Cipto	441.67	32.87
7	JL. Soekarno Hatta	479.17	5.52
8	JL. MT. Haryono	620.83	14.46
9	JL. Pattimura	670.83	16.12
10	JL. Kawi	508.33	32.72

From this reason, we can presume that many Angkot services gather in this place, and there is room to move some of the services to other areas. From those three facts, we conclude that in the Malang transit operation systems, there are troubling segments in Malang that need to be improved.

Fig. 6. Jalan Soekarno Hatta

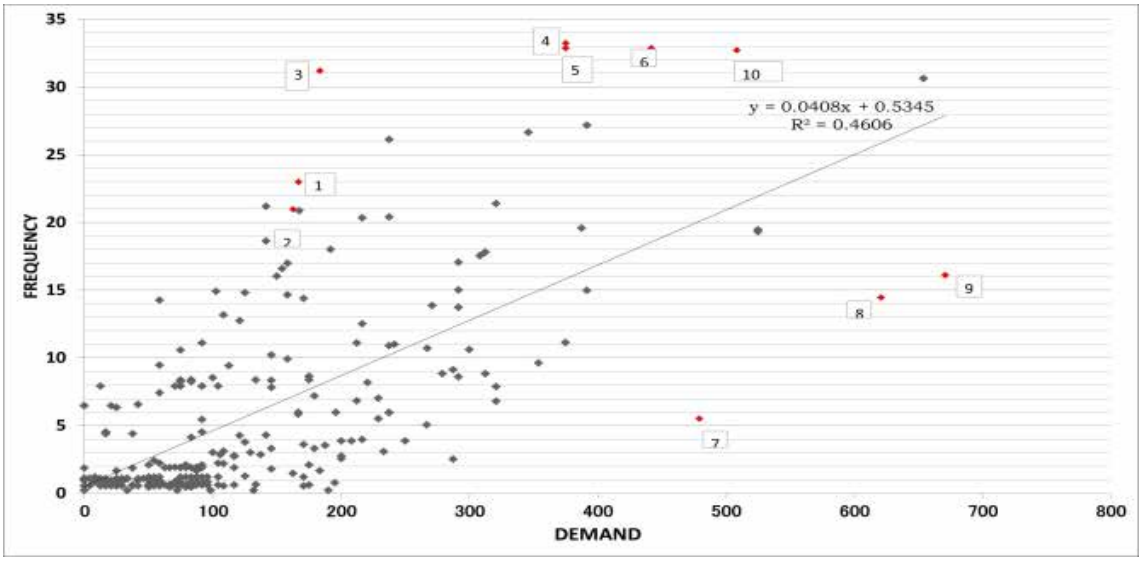

Fig. 5. Comparing the Demand and Frequency of Each Segment of Angkot in Malang

Fig. 8. Jalan Kyai Tamiz

Fig. 7. Jalan Mt. Haryono

4.2 Travel Demand and Direct Service for Angkot in Malang

4.2.1 Travel Demand

Trip generation is the process of estimating the number of trips that are produced and attracted by discrete subareas, within an urban area. These trips are classified into two principal categories, home based and non-home based. A home-based trip is a trip for which either the origin or the destination is home. All other trips are non-home based. The zone where a home-based trip is produced is the zone where the home is located, regardless of whether it is the zone for the trip. The zone where a non-home based trip is attracted is the non-home zone. The zone where a non-home based trip is attracted is the destination zone. These definitions are significant because they form the basis for generating the trip generation models[9].

To determine the use of various roadway facilities and assessing their level of service for vehicle counts are taken at selected locations along roadways. Short-count techniques are useful provided appropriate expansion factors are based on previous or ongoing research into the fluctuations of traffic by hour, weekday, and month to analyze the use of transit service. These

Table 5 Travel demand of OD pairs in Malang

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	29680	8680	1680	7000	4200	4200	5320	2800	3360	4200	1400	3080	1960	0	4200	0	2800	0	0	7000	560	0	1400	840	2800	840	2240	30100	7046	25576	16846	12040
2	11480	5880	2240	2800	1120	3920	6160	3360	0	1400	560	1120	0	0	0	840	0	840	0	2800	0	0	840	280	1120	560	560	31763	4660	12411	12298	8482
3	3080	3640	19040	10080	1960	280	2240	840	4480	1400	840	1120	1960	280	1680	280	560	0	0	1680	1680	0	1400	280	840	0	1680	31752	787	6367	8796	1232
4	29960	10640	4200	41440	3920	1400	1960	0	280	4480	1120	1120	840	0	3080	1960	560	0	0	4200	840	280	2240	3640	1680	0	2240	19279	5136	49223	85226	12759
5	8120	3640	1400	2800	15120	2800	2240	840	560	1400	0	1120	0	0	2240	840	840	560	560	7000	1400	0	1120	1400	4200	1120	1400	77017	5953	69433	40390	4362
6	7840	3640	560	560	4200	17640	10080	0	0	0	0	560	0	0	0	1120	6720	3360	0	3920	0	0	560	0	280	1120	560	26298	310	12529	24108	3736
7	20720	10920	5320	7000	3920	8120	21280	5040	3640	1960	1120	1400	1400	0	1120	0	3640	1120	1680	14000	1680	560	3640	840	5040	1400	3080	18220	691	33852	39210	20308
8	6160	5600	2800	840	840	3080	9800	18480	1400	1400	280	560	0	0	840	560	0	560	0	4200	3920	0	840	280	3080	560	1400	11780	840	26262	19173	4408
9	4200	3360	6720	3640	560	560	2240	7560	21000	2800	840	560	1680	0	1120	560	0	0	0	1120	560	0	560	1120	560	0	1680	8871	280	294	4383	280
10	7560	7280	4200	3080	1400	0	1680	1120	840	29120	5320	4480	1120	0	840	560	0	1400	0	2800	0	0	1680	0	3080	0	4760	42915	1400	8470	15536	26264
11	1120	1680	1680	1400	0	0	1120	0	280	2800	41160	4200	0	0	560	0	3360	0	0	840	840	0	1120	0	1400	0	0	6753	0	5355	2086	1944
12	840	1960	560	2800	0	0	0	1120	0	280	1680	25480	3640	0	560	0	0	0	0	1960	0	0	0	0	1680	0	0	9318	4856	15262	6456	0
13	1400	840	0	2800	560	0	840	0	0	0	2240	6720	10080	2520	2520	840	0	0	0	0	0	0	0	840	0	840	560	10092	0	1116	2240	0
14	280	840	1680	280	1120	0	840	560	0	1120	840	1680	1960	7280	2240	840	0	0	0	1680	0	0	280	280	280	0	0	840	560	13359	11452	280
15	1400	1120	0	3360	4760	0	1400	1400	0	1120	1120	2240	560	2800	12040	3080	2520	0	0	1960	0	0	1400	0	1120	0	0	64708	8629	106497	71930	5311
16	16240	6160	3640	5040	4200	4760	6440	3360	0	4480	0	0	2800	280	5040	16520	4760	0	1120	5880	0	0	1400	1960	2240	0	0	37817	3969	61298	72730	7427
17	1680	840	280	560	0	2800	6440	0	0	0	280	1400	280	0	560	1680	17920	1400	0	2520	0	0	560	0	1120	0	0	11196	0	29741	20534	10558
18	1400	1960	560	0	1120	1120	2240	1960	0	1120	560	0	0	0	0	0	1680	13160	1680	4480	0	280	280	0	280	0	280	280	0	0	280	2438
19	840	560	560	560	840	0	1400	0	280	0	0	0	0	0	0	0	0	2240	11760	12320	1680	0	0	1120	0	0	0	2706	280	2823	0	3577
20	6440	3360	1680	1400	1120	1120	8960	2520	0	3080	0	0	0	0	1120	0	0	1960	9800	95480	12600	1680	1120	560	1400	0	1680	72522	23201	14800	27142	178069
21	2520	2240	0	0	1120	1120	1680	3920	0	0	0	1680	1120	1400	1960	1680	840	1400	3360	17360	29680	8400	15960	14840	14280	4760	1400	70770	19195	840	1552	6224
22	560	560	280	560	280	0	0	0	0	0	0	0	0	0	560	0	0	0	0	3920	840	3360	560	840	1400	0	560	32509	8302	0	0	6111
23	2800	2520	0	280	1120	0	1680	1120	560	0	0	280	280	0	1680	560	560	0	560	2800	2520	1120	14280	6440	6160	1120	840	220707	26298	4219	2056	2865
24	3640	3360	1960	3640	0	840	3640	1400	1960	560	0	0	0	0	1960	0	0	840	0	9520	2800	1400	5880	21560	8400	1680	1400	43029	24811	9870	6484	0
25	1960	1680	560	840	840	0	560	840	560	0	0	0	0	0	1400	0	0	0	0	1400	3360	280	1400	1960	7280	840	840	323618	171621	16295	1080	5334
26	3360	1960	840	840	1120	560	1400	560	560	840	0	840	0	0	1680	560	840	280	840	5320	3080	1120	3080	2240	3360	6720	4200	44045	25334	0	280	840
27	6160	3080	1680	1680	2800	1400	3360	2800	1400	840	840	840	0	0	2520	280	0	840	2240	6720	7000	3360	3640	2520	6440	5600	11760	36528	10440	5927	1560	4501
28	21577	73789	7170	4266	5879	556	26960	7379	244	1064	667	0	0	0	7365	556	222	0	667	58102	28987	44	54067	2884	86581	730	3478	0	23423	69530	27981	3467
29	9426	6906	1831	0	1408	804	7695	5860	0	0	0	0	0	0	3792	0	238	0	0	33977	21405	5498	18220	21165	80766	8826	10899	77451	0	11449	11977	14962
30	97695	35235	9653	120264	96746	17401	72851	25317	0	17289	135	410	0	0	156809	91741	77078	0	0	92329	39053	8586	16861	4023	107563	0	42308	127847	10315	0	48395	21991
31	96419	51211	17556	163337	141120	41166	125777	36265	0	85535	8965	20641	8456	32319	122317	132884	66766	1052	0	208619	45575	0	32594	49296	184110	0	16227	179378	410	54904	0	84182
32	20329	20831	9663	10186	9663	3274	29242	4831	0	2773	2416	2416	0	0	10879	5188	2416	3053	7383	241085	15770	2552	5188	4831	5324	0	2795	29035	7393	19147	34837	0
33	40	120	50	20	20	70	50	0	100	0	10	0	10	20	10	10	0	0	260	50	0	50	0	120	0	0	70	120	80	50	120	160

passenger counts can be taken on board a transit vehicle or at a selected stop or station.

This case study finds the data of travel demand, first arranging the zone areas in Malang with GIS Tools. GIS tools here have a function for mapping each zone and finding a route from origin and destination. There are 2 types of zones, namely, internal and external zones. Table 5 shows the OD pairs of 32 zone areas in Malang. Secondly, an arrange zone is used for internal and external surveying. Zones 1-27 are for internal and Zones 28-32 are for external surveying. Survey for this case used household Interview for the internal zones and RSI (Road Side Interview) for the external survey.

4.2.2 Direct Service Area Capability of Angkot in Malang

Direct service Angkot has a function to find the number of Angkot services. This case needs to find direct service for Angkot service crossing zone origin to zone destiny without any transfer. A GIS tool helps separate zone origin and destination and combines the Angkot networking system and the 32-zone map in Malang.

Fig.9 shows a combined map of the Angkot networking system and zoning map in Malang with GIS tools. This figures indicated there are 32 zones areas and 25 Angkot network. This figure shows Direct Service from zone origin to zone destination. For example, going from zone 1 to zone 4, on this map there are 11 Angkot direct service crossings this 2 zone. “ABG route”, “AG route”, “AJG route”, ”GL route”, ”GM route”, ”GML route”, ”LDG route”, ”LG route”, ”MT route”, ”MK route”, and ”MM” route have a direct service crossing 2 zones.

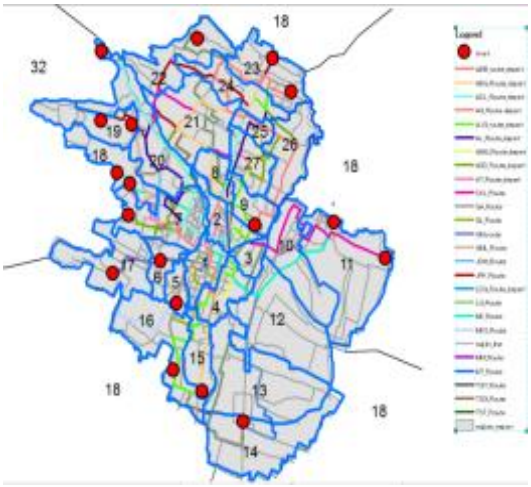

Fig. 9. Zones Areas in Malang and Angkot Route Networks

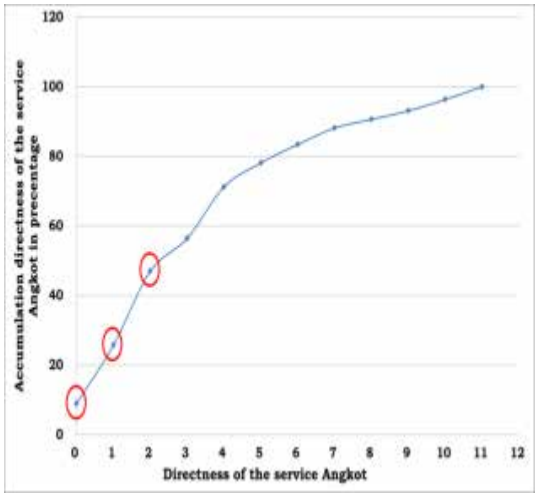

Fig. 10. Direct Service Capability of Angkot in Malang

Fig.10 shows the analysis of the direct service capability in Malang. There are some zoned that limited Angkot service. This figure show zone origin to zone destination and that some zones have limited of Angkot Service with 0 direct services having a value of 8.92%, 1 direct service having value of 25.74%, and a 2 direct service, 46.99%. There is thus need for further arrangements in some areas with a high frequency of Angkot movement to this area.

4.2.3 Comparing between Travel Demand and Direct Service Area Capability of Angkot in Malang

Fig.11 shows the direct service area capability between zone 1 and zone 4. Zone 1 and 4 is the downtown areas in Malang. There are 4 sub-districts in zone 1, inside are Kasin, Sukoharjo, Kauman, and Kidul dalem as sub-districts. In zone 4 there are 4 sub-districts, Jodipan, mergosono, Kota Lama, and Cipto mulyo. In these zones there are 11 Angkot service, “ABG Route”, “AG Route”, “AJG Route”, “GL Route”,”GM Route”, ”GML Route”, “LDG Route”, “LG Route”, “MK Route”, “MM Route”, and “MT Route” crossing these zones. In this situation 2 zones has many Angkot crossing frequencies.

Comparing travel demand and direct service from OD pair travel demand between zone 1 and zone 4 has 7000-travel demand value and 11 Angkot Services, while Angkot service for zone 7 and zone 1 has 20,720 of travel demand value and 9 direct services of Angkot in Malang. This result certain

indicates that zone 1 and zone 4 have a malfunctioning Angkot service.

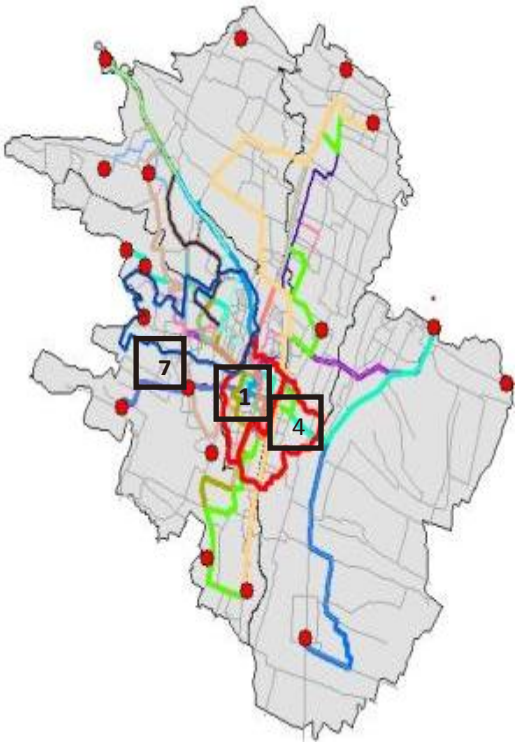

Fig. 11. Directness Angkot route, between zone 1 and zone 4 and zones 7 and zone 1

Fig.12 compared between travel demands and the direct service capability of Angkot in Malang, in this figure, there are 6 points where number of direct zone origins and zone destination have mismatch points. Zone 1 to zone 4 has value 7000 travel demand and 39 direct services, 39 direct services in are here, meaning there are 11 Angkot services with a total of frequency of Angkot crossings of these zones is 39 vehicle/hours.

In this analysis, there are 3 zones that have many Angkot services, as shown with red circle in Fig.12. On the other hand, some zone have limited service for Angkot, Table 5 shows zones with a limited Angkot service. Zone 16 and zone 17 are suburban areas in Malang, and there there are 5 sub-districts inside these zones. Zones 16 and zone 17 have 4,760 of travel demand and zero value of Angkot Service. Based on this circumtance, we can move some zones with much Angkot service to zones that have limited Angkot Service. Fore case zone 1 and zone 4 have 11 Angkot services, and in this condition, there is a recommendation that Angkot like the "GL route", "GML route", "GM route", and "MT route", rescheduling the crossing zones 16 and zone 17 again based on location. As we conclude in Malang transit operation system there are some troubling aspects in certain zones' experiencing malfunctions and limited of Angkot service. In this case, they need to be improved.

Table 5 zone areas with 0 Frequency

Zone		Travel	Frequency
Origin	Destination	Demand	of Angkot
16	17	4760	0
16	10	4480	0
26	1	3360	0
27	22	3360	0
10	25	3080	0
8	6	3080	0

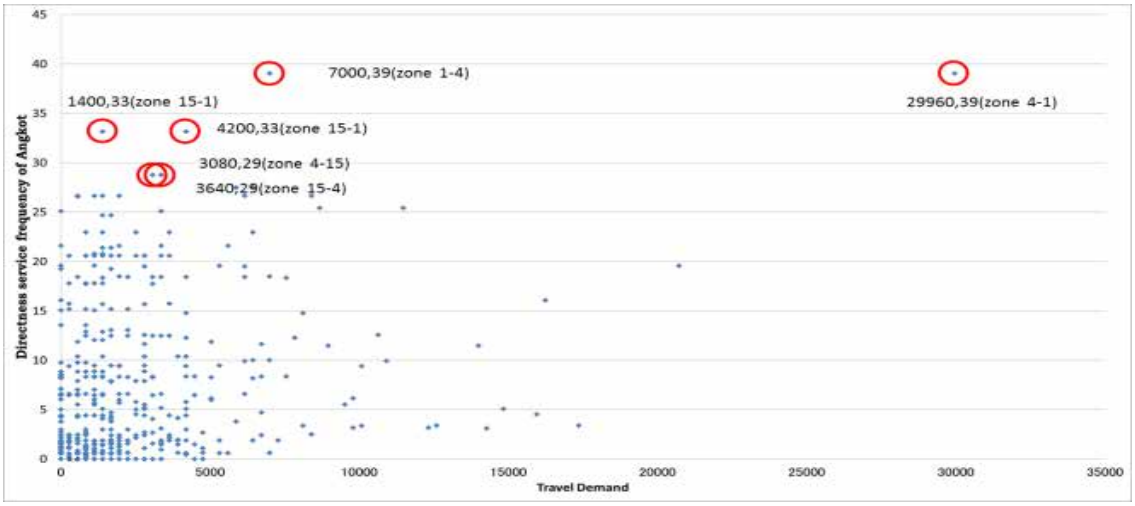

Fig. 12. Comparing the Directness Angkot Service and Travel Demand in Malang; Zone origins and destinations

5. CONCLUSION AND DISCUSSION

This research had two object to analyses, a comparison between Demand and Frequency of Angkot service in Malang to segments of routes that are mismatched and comparison between Travel Demand and Direct Service of Angkot in Malang to find area called zones that have a malfunctioning direct service to move into an area with have a limited Angkot Service, as we conclude from the analyses:

1. "Jalan Soekarno Hatta", "Jalan Mt. Haryono" haves similar problem of Angkot service. These streets, there is mismatch between demand and frequency. In this case "Jalan Soekarno Hatta" has a value of demand at 479.17% and a value of frequency 5.52 vehicles/hour. "Jalan Mt. Haryono" has value of demand at 620.83% and value of frequency 14.46 vehicles/hour. "Jalan Soekarno Hatta" and "Jalan Mt. Haryono" are locations in center of study location in Malang; there are 3 Universities and many student residential and commercial areas, causing "Jalan Soekarno Hatta" and "Jalan Mt. Haryono" to have a big demand value.
2. "Jalan Kyai Tamiz" has value of demand of 375% and value of frequency of 33.24. This area was noted as a traffic area where there is business area center and a major market place. On the other hand, this area also has high frequency Angkot service because sometimes Angkot has to keep passengers waiting on some side road until all seats are equipped. From this reason we assume there are many Angkot service requirements in this area and a need to move reduce traffic area. These reasons indicate a mismatch between demand and frequency of Angkot here. We conclude that in the Malang transit operation system there are some troubling segments in Malang that still need to be improved.
3. There are 3 zones that have many Angkot services is zone 1 and zone 4, zone 1 and zone 15, and zone 4 and zone 15. On the other hand, some zone has limited service for Angkot. This is indicated need some improvement of service of Angkot in Malang.
4. Comparing travel demand and direct service from OD pair travel demand between zone 1 and zone 4 has 7000-travel demand value and 11 Angkot Services, while Angkot service for zone 7 and zone 1 has 20,720 of travel demand value and 9 direct services of Angkot in Malang. This result certain indicates that zone 1 and zone 4 have a malfunctioning Angkot service. This result suggests that the Angkot service zone 1 and zone 4 need to rearrange service to another zone that has a limited service area. For example, zones 16 and zone 17 have limited Angkot service, and thus the Angkot "GL route", "GML route", "GM route", and "MT route" could be rescheduling to have crossing zones 16 and 17 because based on location.

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