The planning of campus bus in Islamic University of Indonesia with geographic system information

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Abstract

Islamic University of Indonesia (UII) has more than 23.000 active students during 2018/2019 period. With the large number of students, there are high mobility on campus. Traffic jam often occurs in UII during rush hour since students have classes on campus. Additionally, the parking lot always reach the maximum index. Therefore, one of many solutions can be done to reduce traffic jam and lack of parking lot is by planning a campus bus in UII so that students do not need to ride a vehicle to campus. The planning of campus bus in UII consists of demand analysis, route analysis, bus stop analysis, and calculate the number of campus bus needed. Demand analysis were by distributed 500 questionnaires to respondents. The route analysis considered of demands, potential areas, and road width. Bus stop analysis based on Decree of Directorate General of Transportation number 271 of 1996, catchment areas, and demands. Analysis for calculating the number of bus campus based on Decree of Directorate General of Transportation number 271 of 1996. The result of this research were 3 routes for campus bus in UII. Route 1 had 20 bus stops, route 2 had 19 stops, and route 3 had 17. The type of bus used were 16 seats of Isuzu Elf, there were 6 units for route 1, 7 units for route 2, and 5 units for route 3.

1. Introduction

Islamic University of Indonesian (UII) is a university in Yogyakarta that located on Jalan Kaliurang Km. 14,5. It was noted on the official website of the Islamic University of Indonesia that UII received approximately 4.800 new students and had more than 23.000 active students in 2018/2019 period. For this reason, there were many students who cause high mobility on this campus. That is because access to the campus is very limited due to the limited public transportation that passes and can only be reached by private vehicles and online transportation. Thus, many students use private vehicles like motorcycles or cars to campus, and causing traffic jam. Congestion on campus occurs during certain hours caused by a long queue for motorcycle when entering the parking lot, as well as limited parking space for cars, so students must looking for several times to find an empty parking space. Limited parking space on campus has hampered student activities. The reason students prefer to use private vehicles to get to campus is because of the limited public transportation that serves the route to campus.

Based on problems above, the UII campus bus transportation planning will be able to support and improve all activities carried out by students, lecturers, and employees in the area around the UII campus. Because compared to private modes, public transport provides higher capacity and safer environment [1]. The planned bus lane will have a special route network that connects the UII region

from the south with a radius of 10 km and to the west with a radius of 5 km. Research conducted by Hashim R et al. and Apriyudha R et al. regarding the procurement of campus buses for environmentally friendly, not only for green campus to minimize gas emissions but also for handling the increase population of students [2,3]. The reasonable design of campus bus routes can meet the travel needs of campus personnel, and at the same time it can realize the green, safe and harmonious campus traffic [4]. Reducing greenhouse gas emissions caused by motor vehicles also important. Therefore, sustainable transport system is an alternative to save energy by utilizing mass transportation system [5]. This research is using geographic information system as model. A model can be defined as a form of simplification of a reality (or the real world), including physical model (architect model, civil engineering model, etc.), maps and diagrams (graphics), statistical and mathematical models [6]. Geographic information systems are digital computer design applications that are used to retrieve, store, manipulate, analyze, and display geographic information [7]. For more details, geographic information systems are computer-based systems that have four capabilities to handle geographic reference data, namely data entry (store), data storage management and retrieve, analysis and manipulation, and produce data (output) [8].

2. Research Methods

The method used in this research is descriptive quantitative analysis. There are two types of data that will be taken, there are primary data and secondary data. Primary data is taken directly from the original field data conducted by interviews and questionnaires to students, lecturers, and UII employees. The stages in planning the UII Campus Bus are as follows.

2.1. Demand Analysis

Islamic University of Indonesia (UII) has 16.764 students and 1.057 lecturers and employees from 2018/2019 period. Demand analysis was obtained from questionnaires and distributed to respondents that consists of students, lecturers, and employees of UII. The questionnaires mainly investigates about intention of campus bus, address, and type of campus bus. To get a valid sample questionnaires which represents the entire campus, number of respondents determined in questionnaires sampling was calculated based on the following Slovin (1960) formula [9].

$$n = \frac{N}{1+Ne^2}$$

In the formula, n is the number of samples; N is the number of population; E is limit error tolerance.

Questionnaires that had been distributed to students, lecturers, and employees are total 500 questionnaires. Data from the questionnaires were processed and recapitulated. Respondent's addresses are plotted on Google Earth to find out travel demands.

2.2. Route Analysis

Route analysis in this study based on certain considerations as follows.

1. Respondent's travel demands results. Higher demands, the greater the potential for the area to be passed by campus buses.
2. Areas that have potential public facilities such as health centers, sub-district offices, shopping areas and traditional markets.
3. Road width.

Next, modeling on the ArcGIS Network Analyst is done by entering road network data of Yogyakarta and potential locations in the form of shapefiles. This platform solves the tasks of data pre-processing, processing and publishing very efficiently, because it consists of several components [10]. ArcGIS has functions such as to model the interaction between traffic information data, route selection, and the appearance of route results and the addition of other parameters in its analysis with the help of a network analyst toolbox. Network Analyst tool helps the decision-makers determine the best routes among all of the existing road networks for transportation [11]. Display the Network Analyst toolbar to do network analysis. After matching map information, the operating track could be divided into highway, arterial

road, and subsidiary road [12]. Continue to solve the analysis. It will produce a route that can be seen on the map, can be chosen based on the shortest route or the route with the fastest travel time.

2.3. Location of Bus Stop Analysis

The bus route network is a system of bus lanes, stops, terminals, and infrastructure needed for the safe and efficient movement of buses and passengers [13]. In this study, there are 3 bus routes for Islamic University of Indonesia. The route uses a radial network pattern, which is from the Central Business District (CBD) to the suburbs. Bus stop location must be guided by three guidelines as follows.

1. The maximum distance of bus stops to pedestrian crossing facilities is 100 meters, the minimum distance of bus stops from intersections is 50 meters, and the minimum distance of bus stops from buildings that requires calm (for example hospitals) is 100 meters away [14].
2. Number of travel demands.
3. Catchment area. The catchment area in this study is an area that has great potential demand for UII's Campus Bus planning. Catchment area is made to find out which locations are included in that area. In this study, the selection of a large catchment area states that the convenience for pedestrians to reach public transportation stops is 500-1000 m [15]. Therefore, a radius of catchment area of 500 m is used for locations that have a lot of demands and 1000 m for a particular point that has a small demands.

2.4. Number of Bus Needed

The number of campus bus to be used is based on the number of passengers, vehicle capacity, circulation time, and headway on each route [16]. Demands on route 1 are 444 passengers, route 2 are 531 passengers, and route 3 are 477 passengers.

2.4.1 Cycle Time

The deviation is 5 percent of travel time and stop time is 10% of travel time [17]. Then, the circulation time can be calculated by the following formula.

$$CT_{ABA} = (T_{AB} + T_{BA}) + (\sigma_{AB}{}^2 + \sigma_{BA}{}^2) + (T_{TA} + T_{TB})$$ [17,18]

In the formula, CT_{ABA} is circulation time from A to B, back to A again;
T_{AB} is average cycle time from A to B;
T_{BA} is average travel time from A to B;
σ_{AB} is deviation of travel time from A to B;
σ_{BA} is deviation of travel time from B to A;
T_{TA} is vehicle downtime in A
T_{BA} is vehicle downtime in B

2.4.2 Headway

Headway is the difference between the arrival time of one vehicle and the next vehicle. When the passenger demands increases, the optimal headway must be inversely proportionally shortened to ensure the satisfied service of operation[19]. The ideal headway is 5-10 minutes[17]. In this study, a 10 minute headway design was used to determine the number of passengers per hour. Load factor calculation using load factor 0.7 with dynamic conditions.

2.4.3 Number of Campus Bus

The number of campus bus per cycle time calculated using the formula below.

$$K = \frac{CT}{H \times FA}$$ [17,18]

In the formula, K is bus needed per cycle time;

CT is cycle time (minutes);
H is headway (minutes);
FA is vehicle availability factor (assumed 1).

3. Result

The result of this research were 3 routes for campus bus in UII. Route 1 serves the trip from UII along Kaliurang st. before the ringroad and back to UII. Route 2 serves trips from UII - Kaliurang st. - ringroad - Palagan st. - Kapten Haryadi st. - Kaliurang st. - Sunan Pandanaran st. - UII. Route 3 serves trips starting from UII – Kaliurang st. – Damai st. – Palagan st. – Rejodani st. - Sunan Pandanaran st. - Kaliurang st. - UII. Routes in this study uses ArcGIS as modelling seen in Figure 1.

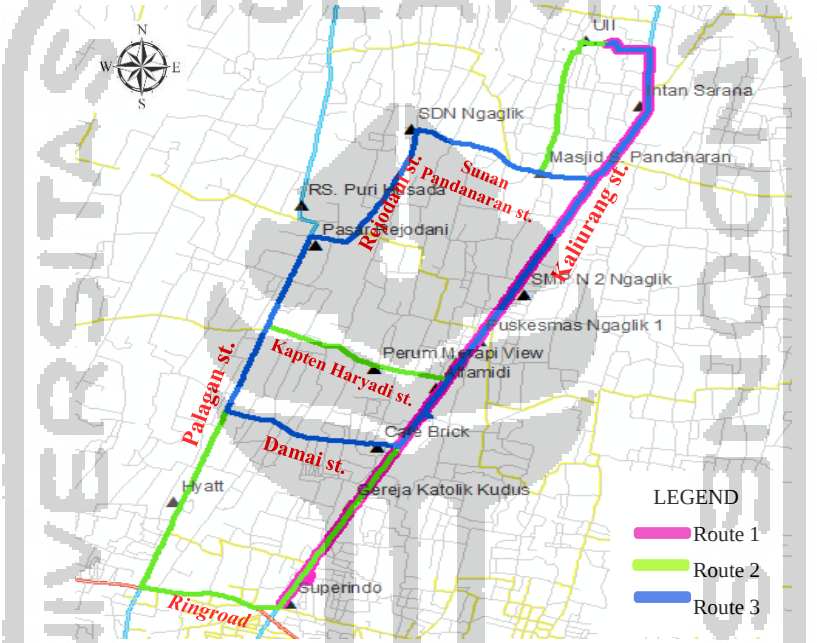

Figure 1. Routes for Campus Bus in UII

According to Figure 2, there were location of bus stops below.

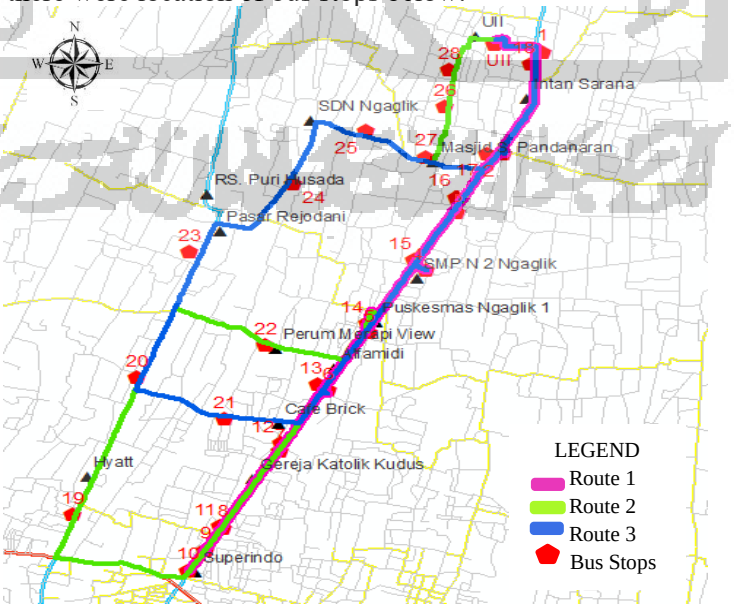

Figure 2. Bus Stops Location

Bus stop 1 had 53 demands, bus stop 2 had 112 demands, bus stop 3 had 3 demands, bus stop 4 had 15 demands, bus stop 5 had 2 demands, bus stop 6 had 10 demands, bus stop 7 had 13 demands, bus stop 8, 9, 10 had 2 demands, bus stop 11 had 3 demands, bus stop 12 had 14 demands, bus stop 13 had 10 demands, bus stop 14 had 10 demands, bus stop 15 had 7 demands, bus stop 16 had 12 demands, bus stop 17 had 108 demands, bus stop 18 had 66 demands, bus stop 19 had 11 demands, bus stop 20 had 8 demands, bus stop 21 had 9 demands, bus stop 22 had 4 demands, bus stop 23 had 9 demands, bus stop 24 had 17 demands, bus stop 25 had 16 demands, bus stop 26 had 82 demands, bus stop 27 had 49 demands, and bus stop 28 had 131 demands. This is a stop and demand diagram to illustrate data above.

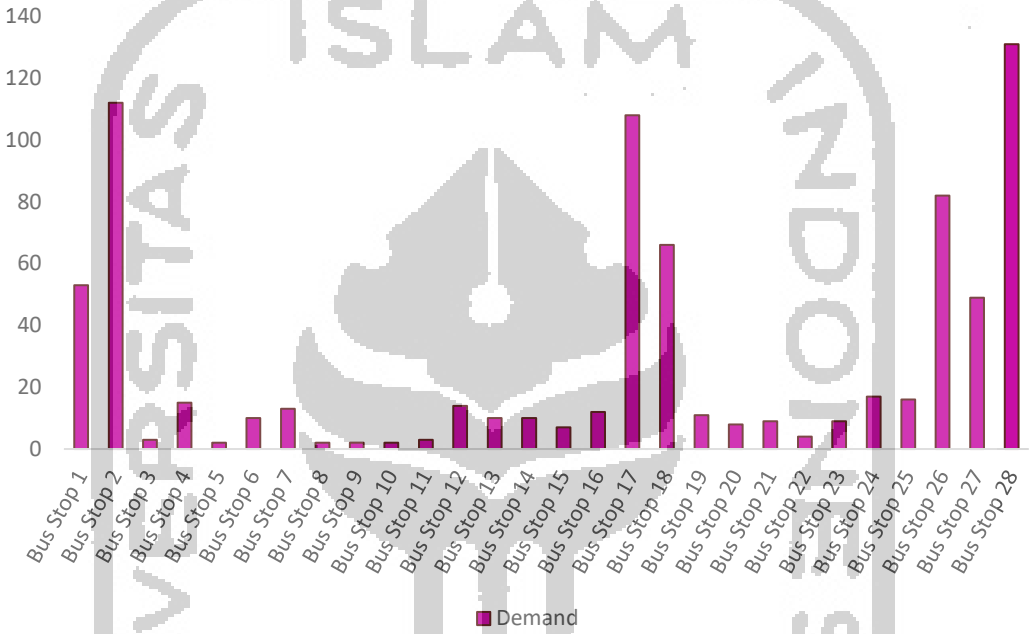

Figure 3. Diagram of Bus Stops and Demands

The final calculation for number of campus bus needed are :

Table 1. Number of Bus Campus Needed

	Load Factor	Cycle Time (minutes)	Headway (minutes)	Number of bus needed (unit)
Route 1	0,7	50,643	10	6
Route 2		62,1	10	7
Route 3		49,224	10	5

4. Conclusion

Based on the analysis that had been done in Islamic University of Indonesia, the following conclusions can be obtained.

1. There are 3 routes for UII Campus Bus planning. Route 1 has a length of 18,349 km with 20 bus stops, starting at UII - Kaliurang st. KM 6 - UII. Route 2 has a length of 22,5 km with 19 bus stops, starting at UII - Kaliurang st. - ringroad – Palagan st. - Kapten Haryadi st. – Kaliurang st. - Sunan Pandanaran st. - UII. Route 3 has a length of 17,835 km with 17 bus stops, starting at UII – Kaliurang st. - Damai st. - Palagan st. – Rejodani st. - Sunan Pandanaran st. – Kaliurang st. - UII.

2. There are a total of 28 bus stops in this study, with details of 18 bus stops on Kaliurang st., 3 stops on Palagan st., 1 stop on Damai st., 1 stop on Captain Haryadi st., 1 stop on Rejodani st., and 4 bus stops on Sunan Pandanaran st.
3. The total number of campus bus needed is 18 units with details of 6 units for route 1, 7 units for route 2, and 5 units for route 3, with the type of vehicle 16 seats Isuzu Elf.

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