Traffic management of intersection with more than four road segments

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Abstract. Simpang Tujuh Ulee Kareng is one of the intersection that are crowded by local people who always doing movement in this area. The method of this research to calculated level of service this intersection by using SIDRA Intersection as a software, then it will merger of intersection be four road segments. The result and discussion of this intersection for existing condition based on Degree of Saturation (DS) for JD’s street is F. DS for TICI’s street is A. DS for LG’s street is A, DS for LR’s street is B, DS for MT’s street is A, DS for KR’s street is C, and DS for TIBPKP’s street is D. After the geometric merger into four road segments in unsignalized condition, DS for JD’s street and TIBPKP’s street is E, DS for TICI’s street is A, DS for LG’s street and LR’s street is F, and DS for MT’s street and KR’s street is F. For signalized condition, DS for JD’s street merger with TIBPKP’s street is E, DS for TICI’s street is E, DS for LG’s street merger with LR’s street is E, and DS for MT’s street merger with KR’s street is F.

1. Introduction
The transportation sector is a major part of any modern economic system and has a significant impact on economic growth [1]. The economic growth has affects development of the transportation sector [2]. Intersections are usually bottlenecks for traffic flows in an urban road network [3]. Intersections are usually controlled by anyone of the followings: regulatory signs, such as two-way stop control (TWSC) and all-way stop control (AWSC); signalization (SIG) and roundabout (RAB) [4]. Traffic control is one of the most important components of traffic management as an efficient operation could increase traffic capacity at a very low cost and there are beneficial environmental impacts in terms of reduced delays and congestion, and improved air quality [5]. Car ownership and car usage have continued rapid growth into the current decade in Indonesia. Consequently, most urban areas are suffering from unmaintained externalities such as excessive travel times, air pollution, unnecessary energy consumption, and even serious economic loss due to the extraordinary traffic congestion. A forementioned phenomena also have evoked urban transportation problem in several big cities in Indonesia including Banda Aceh, a capital of Aceh province [6].

Development of transportation infrastructure in Banda Aceh City, namely sub-district Jaya Baru, Lueng Bata and Kuta Alam. The sub-districts and rural roads have the shortest percentage of 8%, and 9% of the total city roads 552,789 km, and 9% of the village road length 56.65 km, the district that has the longest city street percentage is Kuta Alam 17% and 14% rural road, Meuraxa sub-districts 16% of
urban roads and 14% of village roads, Syiah Kuala subdistrict 13.55% of urban roads and 1.62% of village roads, and Ulee Kareng sub-district 14% of urban roads and 1.09% of village roads [7]. This resulted is not being integrated between existing sub-districts and between centers of activity, resulting in the performance of down road networks causing congestion in some sub-districts during rush hour, at Ulee Kareng sub-district with level of service (LOS) E-F (V/C ratio = 0.98) with the meaning of current not stable and dominant stop, and the current started unstable at Banda Raya, Jaya Baru, Baiturrahman, Lueng Bata with LOS D (V/C ratio = 0.8-0.9) [8].

Simpang Tujuh Ulee Kareng is one of the intersections that are crowded by local people. This indicated by V/C ratio in 2018 is 0.98 [8] with the number of vehicle ownership in the Ulee Kareng sub-district varies annually is 21,896 vehicles [9]. Simpang Tujuh Ulee Kareng has seven and asymmetrical road segments, so there are 195 crossing, 42 merging, and 42 diverging, because the seven road segments have no traffic regulation, such as traffic lights, roundabouts, and other signs, so it is prone to conflicts between vehicles such as delays and congestion. Therefore, this research aims to find out more about performance intersection in existing conditions, after a change is made, which is merger of intersection geometry road segments in both unsignalized and signalized by using SIDRA Intersection as software.

2. Methodology by using SIDRA intersection’s software
SIDRA Intersection (analytical model) is a fixed minimum capacity for each minor movement is set by the user. This does not inflict any capacity decrease or delay to the major movements. Gap acceptance models are used to model capacity and delays, but the gap acceptance parameters may be traffic responsive [10].

2.1. Technique collection data
The data was collected from previous research Saleh, from a video survey using fixed camera at key location in research area [6]. A series of variables was included traffic volume, speed, distances (upstream, downstream, and negotiation), and travel time. Traffic volume data based on the origin of the movement for one hour in 3x24 hours every fifteen minutes. This data is grouped according to the type and direction of the vehicle, namely from Kebon Raja’s street (KR), Mesjid Tuha’s street (MT), Lamreung’s street (LR), Lamgapang’s street (LG), T. Iskandar (Cot Irie) ’s street (TICI), Jurong Dagang’s street (JD), and T. Iskandar (BPKP) ’s street (TIBPKP). This data has been converted from vehicle units per hour to passenger car units per hour using the equivalent value of passenger cars. The equivalent value of a motorcycle is 0.4 for opposing conditions and 0.2 for protected conditions. The percentage of heavy vehicles can also be seen based on the total calculation that has been done. Vehicle’s speed can be calculated based on calculation of distance on existing conditions and time on CCTV footage. Based on the comparison of the two values obtained speed. The speed calculated in this study is the speed of upstream, downstream and negotiation in each approach. For vehicle’s speed can be calculated based on calculation of distance on existing conditions and time on CCTV footage. Based on the comparison of the two values obtained speed. The speed calculated in this study is the speed of upstream, downstream and negotiation in each approach. For the upstream distance is calculated from the start of the final vehicle in the longest queue until the stop line of the approach is reviewed, while the downstream distance is calculated from the stop line to the intersection exit based on the goal of each movement and distance negotiation is calculated from the stop line to the destination stop line. Distance measurement is done by using a length meter. For travel time calculations in this case study are observed for one-way roads based on upstream, downstream, and negotiation distances. Travel time is obtained from videos recorded by using CCTV taken on each road segment, from the video the initial travel time (t1) and the final travel time (t2) are obtained.

2.2. Technique analysis
Geometry data at Simpang Tujuh Ulee Kareng is used to determine the state of geometry intersection obtained based on the origin-destination movement on each intersection road segments. Geometry data obtained are approach data (segment name, median width) and lane configuration (lane discipline, lane
type, short lane, and lane length). Data of movement in each lane on each road segments is divided into two parts, namely exclusive lanes and shared lanes. Exclusive lanes consist of L (left), T (through), and R (right), while shared lanes consist of LT (left through), TR (through right), LR (left right), and LTR (left through right). In addition, for the needs of movement data input in SIDRA Software also requires a data queue space, vehicle length, and arrival type.

3. Results and discussion

The results of intersection analysis whether it is performance by using Software SIDRA Intersection. This software determines the intersection performance by knowing degree of saturation (DS) and level of service (LOS) intersection. The initial stage in determining intersection performance is knowing the volume of vehicles. The volume to be entered is the volume distributed according to the movement on each road segments. SIDRA has limitations in entering traffic volume data, the volume of vehicles that can be included in the program is only the volume of light vehicles (LV) and heavy vehicles (HV), so for unsignalized intersections of motorcycles must be multiplied by the equivalent of passenger cars which is 0.5, while for signalized intersections, it must be multiplied by the equivalent of passenger cars, which is 0.2 for protected conditions and 0.4 for opposing conditions so that motorcycle volumes can be added to the volume of light vehicles and can be analyzed by the program.

The geometry existing condition of the intersection consists of seven road segments with T. Iskandar’s street (BPKP) and T. Iskandar’s street (Cot Irie) is the major road, Kebon Raja’s street, Mesjid Tuha’s street, Lamreung’s street, Lamgapang’s street, and Jurong Dagang’s street as a minor road. Traffic movements in these intersections are divided into two, namely exclusive lanes (L, T, and R) and shared lanes (LT and TR). The geometry after merger into four road segments with Jurong Dagang’s street merger with T. Iskandar’s street (BPKP) is the major road, Kebon Raja’s street merger with Mesjid Tuha’s street is the minor road, Lamreung’s street merger with Lamgapang’s street is the minor road, and T. Iskandar’s street (Cot Irie) as a mayor road. Volumes is obtained from secondary data, it is known that the peak traffic volume on Monday during the afternoon rush hours is 18.15-18.30 WIB. This volume is produced at the intersection based on the parameters of the number of vehicles. The traffic volume is used as a parameter to determine the performance at the intersection. According to BPS, vehicle growth is increasing every year by 5% to represent the current traffic volume. Space Mean Speed is obtained by looking at the speed of the vehicle that crosses each road segments. Speed data is obtained after calculating distance and travel time data. Traffic data includes upstream, downstream and negotiation distances.

Table 1 shows the intersection level of service based on degree of saturation in existing condition, after merger of geometry into four road segments unsignalized and signalized conditions. If < 0.6 is LOS A, 0.6-0.7 is LOS B, 0.7-0.8 is LOS C, 0.8-0.9 is LOS D, 0.9-1.0 is LOS E, and >1.0 is LOS F. For signalized condition, there is four phase. The time of each phase is varies, while the intergreen is 6 seconds for each phase (see table 2).

Table 1. The intersection level of service based on degree of saturation.

| Conditions | Approaches | Intersection |
|------------|------------|--------------|
|            | TIBPKP     | JD   | TICI | LG | LR | MT | KR |
| Existing   | 0,88       | 1,02 | 0,31 | 0,43| 0,54| 0,38| 0,71| 1,02|
| Unsignalized| 0,95       | 0,55 | 1,83 |     |     | 1,53| 1,83|     |
| Signalized | 0,99       | 0,99 | 0,98 |     |     | 0,97| 0,99|     |

Table 2. Phase and cycle time for signalized condition.

| Phase        | Green Time (sec) | Red Time (sec) | Intergreen (sec) |
|--------------|------------------|----------------|-------------------|
| TIBPKP and JD| 46               | 88             | 6                 |
| TICI         | 27               | 107            | 6                 |
| LG and LR    | 23               | 111            | 6                 |
| MT and KR    | 20               | 114            | 6                 |
Based on previous research Fadhly, it is known that the peak traffic volume on Monday during the morning rush hours is 07.00-09.00 WIB [11]. The level of service based on degree of saturation at intersection for existing condition is 1.598. The level of service after merger into four road segments is 1.245 for unsignalized condition and 0.956 for signalized condition.

4. Conclusions
Simpang Tujuh Ulee Kareng has seven road segments. The level of service this intersection in existing conditions is F. To improve intersection performance is merger into four road segment. The level of service after merger road segments is F for unsignalized condition and E for signalized condition.

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