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MODELS AND SIMULATIONS OF COORDINATED AND SUSTAINABLE CROSS-SECTION QUEUE SENSORS IN MAKASSAR CITY

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Abstract

In this study, modeling was carried out by queuing sensors using the main theory, namely line equation theory by determining one reference deviation as the starting point of the working sensor. Although this sensor works in real time, it still uses maximun values for queue length and red time. By using the optimization of queue length and red time lysed by genetic algorithm (GA) method based on the guidelines of the 1997 Indonsia Road Capacity Manual (MKJI) set in the python program for limits in choosing alternatives that are early fulfilled the maximum queue length or maximum time to signal the traffic lights in the arm. In this study, a simulation of queue sensors with queue panjag in accordance with the ability of the sensor range, namely 30-meters converted to the number of stop vehicles at the referesi interchange, namely the Jl. S Saddang Baru interchange arm obtained fuel consumption savings (KBB) which is 89.34% and vehicle exhaust emissions are 94.71%. In an effort to overcome the problem of CO2 pollutants caused by vehicles at the time of delay analyzed based on fuel consumption (KBB) with the LAPI-ITB meteode, mitigation was carried out with vegetation technology on their respective interchange arms by fulfilling the number of tree types of trees based on co2 absorption capabilities analyzed by the Brown 1997 method. The selection of formations and types of trees in this study is based on pu candy regulation No.5/PRT/M/2012 and Road Landscape Engineering Planning to provide comfort to road users.

Keywords: Model; Sensor Simulation; Cross-Legged Deviation

INTRODUCTION

The number of motor vehicles in Indonesia reached more than 133 million units in 2019. The data is summarized in the records of the Central Statistics Agency (BPS). The number of vehicles is up about 5 percent since two years ago. In 2019, the number of vehicles increased by 7,108,236 units or an increase of 5.3 percent to 133,617,012 units from the previous year of 126,508,776 units. The number of vehicles in 2018 rose 5.9 percent from 2017 of 118,922,708 units.

The passenger car (passanger car) accounts for 11.6 percent of the total vehicles in Indonesia. The number of passenger cars reached 15,592,419 units in 2019. This number is up from the number in 2018 of 14,830,698 units and in 2017 reached 13,968,202 units. Motorcycles are the most popular vehicles in Indonesia. In fact, the number continues to grow every year. Until 2019, the number of motorcycles in Indonesia reached 112,771,136 units. In 2018, the number of motorcycles was recorded at 106,657,952 units, and in 2017 as many as 100,200,245 units.

In addition to motorcycles and passenger cars, the data 'Development of the Number of Motor Vehicles by Type' collected from the Police Traffic Corps also includes freight cars. The

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number of freight cars in Indonesia in 2019 was 5,021,888-units or 3.7 percent of the total vehicles. Meanwhile, the number of buses in 2019 reached 231,569. The proportion is about 0.17 percent of the total vehicles in Indonesia. In 2018 buses amounted to 222,872 units, while in 2017 there were 213,359 units. The number of vehicles paving during certain hours, especially in the morning, afternoon and evening which is categorized as rush hour increases. This increase resulted in long queues on roads and intersections, although at intersections it has been arranged using traffic lights (traffic ligth). There are piles of vehicles and long queues in the intersection area due to traffic arrangements that are still done manually (offset) to trigger an increase in fuel consumption concentration.

Queues of vehicles and long delays in the interchange area cause disruption of activity, so that the travel time to the work location becomes long. In addition, it can cause externalization in the form of increased fuel use and vehicle emissions in the form of CO or CO2 concentrations. This can cause disruption of the health of road users (motorcyclists, pedestrians) and the community around the intersection. Therefore, the management of the interchange must receive more attention because of the tendency of the number of vehicle queues to increase and delay the vehicle longer and coordination between the nearest intersections.

Several previous studies have been conducted on vehicle exhaust gases (CO2) and calculations of the amount of fuel based on the time of delay (idle) of the vehicle and the length of the queue at the gate of the fire rubber crossing, Hadith & Sumarso (2013). This can be a benchmark for the amount of fuel consumption in general.

In general, the cross-section control device still uses an isolated deviation arrangement system, so there is often a lack of vehicle movement between the nearest intersections and causes a large delay. Most cities in Indonesia have a relatively short segment length (less than 800-meters between intersections). Coordination of signals with minimassion of queue displays and delays in principle get offset signals so that the length of queues and total delays at the nearest intersections are coordinated to be minimal. The length of the queue and the minimum delay when the group (platoon) of vehicles arrives at the intersection along with the light on the green light on the intersection. In order for this to be achieved, efforts must be carried out to optimize signal regulation between the nearest intersection so that it becomes optimal, namely signal offsets that provide minimal queue length and delays that will have an impact on controlling fuel use and vehicle exhaust emissions more efficiently.

Some crossroads in Jakarta use a four-lane traffic light setting system using four-phase movement currents. The model of the traffic light setting system is based on the length of the vehicle queue and can be monitored wirelessly using Radio Frequency (RF) waves. The traffic light model to be created will be equipped with a countdown timer that serves to provide information on the length of traffic light change to road users (users). Monitoring the density level of traffic flow at intersections using display modules in the form of indicator lights or light emitting diodes (LEDs).

According to the results of the survey (Jeffri1, Tjandra Susila2 and Hartono Haryadi3) in the journal TESLA Vol. 17 No. 2 of October 2015 that the regulation of traffic lights in Indonesia

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is currently static, namely by taking into account various factors, including road width, vehicle type, level of road traffic flow density, degree of slope of land level, size of the city or number of residents, the flow of vehicle movements, and so on.

Similarly, the regulation of traffic lights (traffic lights) in the city of Makassar is currently still static irony regulated based on the density of road traffic flow carried out by programming the traffic lights in accordance with the predetermined time. This is considered less effective because if the density of traffic flow at a crossroads outside of what is expected to cause externalization impacts, it is necessary to reset with the model of the continuous coordinated non-static traffic light regulation program. The use of technology in overcoming transportation problems, especially at intersections, has been widely used, but the technology is still focused on regulating road users and traffic, not accommodating the need for information on the condition of the tool itself. In the city of Makassar there is no tool to find out the current condition of APILL is still used manual system that makes officers overwhelmed because they have to check one by one APILL conditions in the field, so a new system is needed that can inform APILL conditions automatically and flexibly.

To overcome this requires a system that can give longer time on a lane according to the level of vehicle density. Many flexible traffic light control systems have been designed. One of them is traffic light control using queue sensors.

According to Zulfikar et al, (2015) conducted research on "Adaptive Traffic Light Control System Design at Siemens PLC-Based Junction Four". This study raises the problem of the traffic light system that exists today still using fixed time as a controller of the lights. But this system has shortcomings, one of which is during rush hour vehicles have to wait a long time in one lane. So, it requires a traffic light control system that can prioritize the vehicle's denser lanes. Adaptive traffic light control works by detecting the number of vehicle queues on a lane. The system works with sensors that detect the length of the vehicle queue.

Based on the description above to achieve the performance of coordinated and sustainable intersections, research will be carried out with the concept of modeling and simulation with queue sensor media at intersections in one road lane in the city of Makassar.

RESEARCH METHODS

Research on mathematical models of coordinated and continuous junction queue sensors according to the level of explanatory and data type and analysis includes quantitative descriptive research, which is research that intends to describe the phenomenon that occurs based on the results of exploration of the side-by-sided deviations conducted in this study in makassar city.

Coordinated and sustainable circuit queue sensor model and simulation research using the system approach for the integration of various transportation concepts, technical performance of convinced intersections, queue sensors, economy, environment. The transportation system is an operational mechanism while the technical performance system is a procedure or procedure that is expected to synergize, both in economic, environmental aspects. This

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approach was chosen, because the intersection system as a research base has characteristics: 1) complex, 2) dynamic, and 3) probabilistic.

The basic concept of model research and simulation of coordinated and sustainable queue sensor is built from the methodology of system science which is closely related to the basic principles of management and is an activity that transforms resources (inputs) into desired results (outputs) systematically and organized. The purpose of modeling 117 is to achieve the level of effectiveness and efficiency of the design in the form of formulations or decision recommendations that have implications for planning, management, and operations.

The type of data needed in the writing process, also determines the data collection techniques that must be done in data collection. As for the data collection techniques carried out in this study, namely observation-Questionnaire-interview.

RESULTS AND DISCUSSIONS

Existing Condition of Chewy Deviation Performance

a. Geometric Conditions of The Supple Deviation

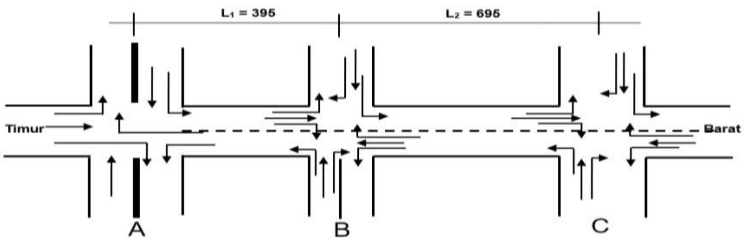
The results of the geometric survey of the intersections crossed from the three intersections studied obtained the following data:

Table 1: Geometrically Supple Supples

Name Save	Road Pendekat	Direction	Wide	Line	Strip	Configu Rasi
			(m)	(bh)	(bh)	Line
Save A	JL. S.Saddang	East	12,9	1	4	4/1 OUT
	Jl.Veteran North	North	22	2	6	6/2 D
	JL. S.Saddang	West	11,7	2	4	4/2 OUT
	Jl. Veteran South	South	20	2	6	6/2 D
Save B	JL. S.Saddang	East	12,2	2	4	4/2 OUT
	Jl.G. Latiomojong	North	14	2	6	6/2 D
	JL. S.Saddang	West	10,8	2	4	4/2 OUT
	Jl.G. Latiomojong	South	13,8	2	4	4/2 OUT
Save C	JL. S.Saddang Jl. Jend. Sudirman JL. Karunrung	East North West	12,5 18,8 9	2 2 2	4 6 4	4/1 OUT 6/2 OUT 4/2 OUT
	Jl. Sam Ratulangi	South	15	2	6	6/2 OUT

The direction of movement of the vehicle at junctions A, B and C. can be seen in figure 1 as follows:

Figure 1: Direction of Traffic Vehicle Movement



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b. Volume of Existing Traffic of The Supple Intersection

Traffic data collection is observed for 3 days, namely Monday, Wednesday and Saturday at peak morning hours (06.0009.00), noon (12.00-14.00) and afternoon (16.00-19.00). The data collection location consists of three adjacent intersections, namely jln. S.Saddang Baru – Jl. Veteran Utara/Selatan, jln. S.Saddang Lama – Jl. G.Latimojong and the sided intersection Jl. S.Saddang Lama – Jl. Jend.Sudirman / Jl / Sam Ratulangi. After verification of the data is taken the largest daily traffic volume data for analysis.

The largest traffic data for jl. S.Saddang Baru – Jl. Veteran Utara /Selatan was taken on Monday, April 13, 2021 as follows:

Figure 1: Number of Vehicles at Peak Morning Hours at junction A (Jl. S Saddang Baru – Jl. Veteran

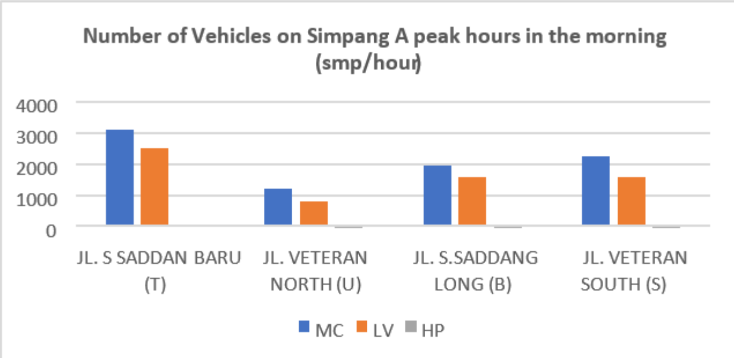

Figure 2: Number of Vehicles Peak Noon at junction A (Jl. S Saddang Baru – Jl. Veteran)

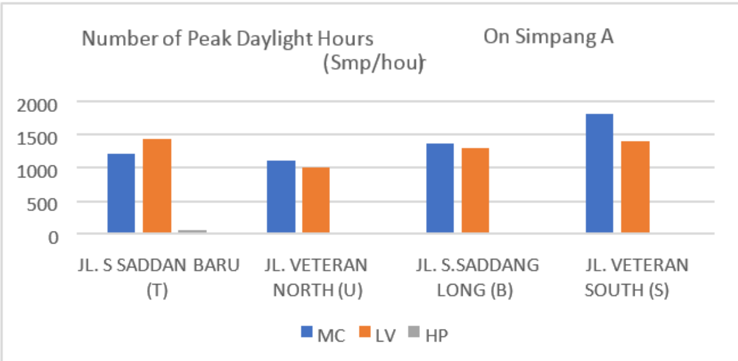

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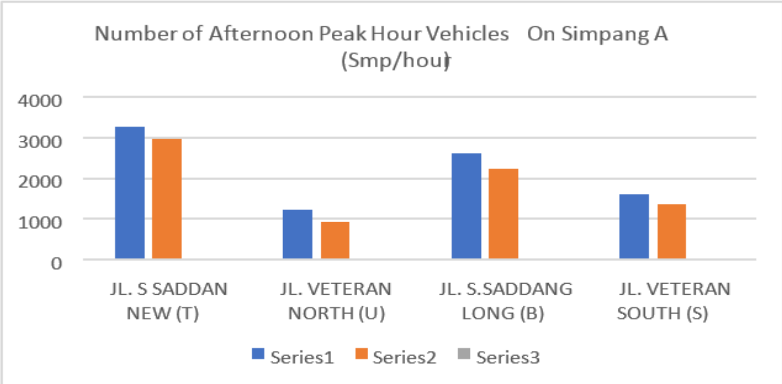
Figure 3: Number of Vehicles Peak Afternoon Hours at junction A (Jl. S Saddang Baru – Jl. Veteran)



Traffic data on jl. S.Saddang Lama – Jl. G. Latimojong was taken on Monday, April 13, 2021 as follows:

Figure 4: Number of Vehicles at Peak Morning Hours at junction B (Jl. S Saddang Lama – Jl. G. Latimojong)

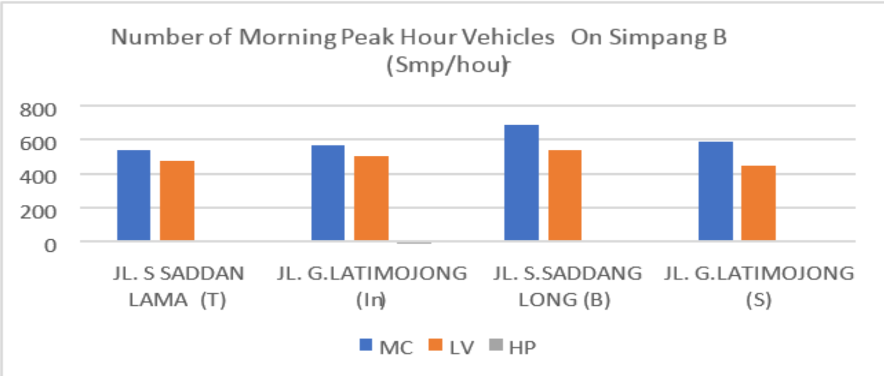


Figure 5: Number of vehicles Peak Daylight Hours at junction B (Jl. S Saddang Lama – Jl. G. Latimojong)

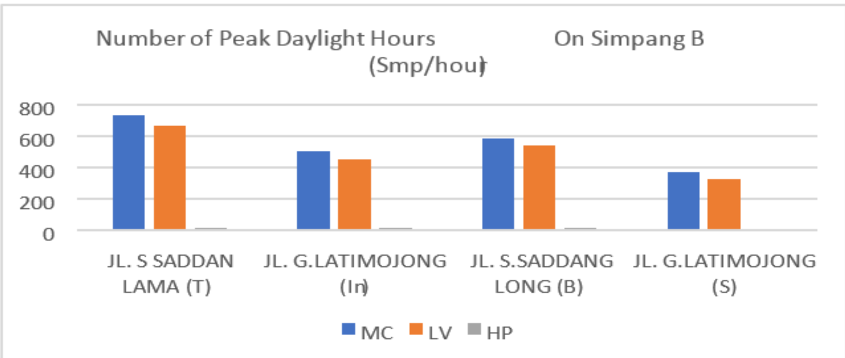


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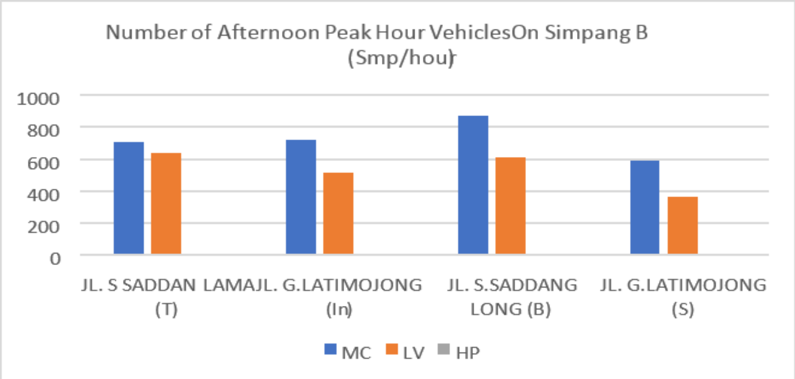
Figure 6: Number of vehicles Peak Afternoon hours at junction B (Jl. S Saddang Lama – Jl. G. Latimojong)



Traffic data on jl. S.Saddang Lama – Jl. Jend. Sudirman / Jl. Sam Ratulagi was taken on Monday, April 13, 2021 as follows:

Figure 7: Number of Vehicles at Peak Morning Hour at junction C (Jl. S Saddang Lama – Jl. Jend Sudirman / Sam Ratulangi)

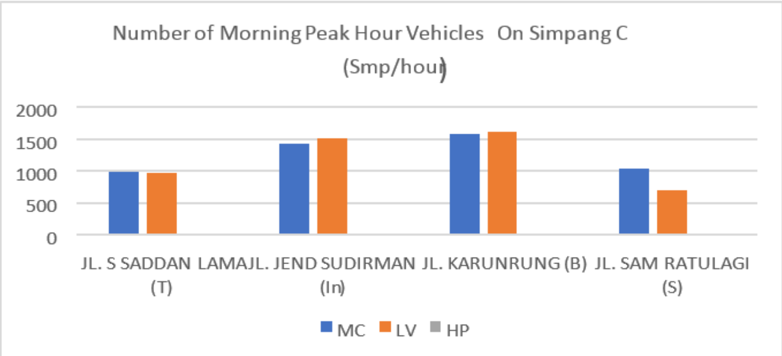


Figure 8: Number of vehicles Peak Daylight hours at junction C (Jl. S Saddang Lama – Jl. Jend Sudirman / Sam Ratulangi)

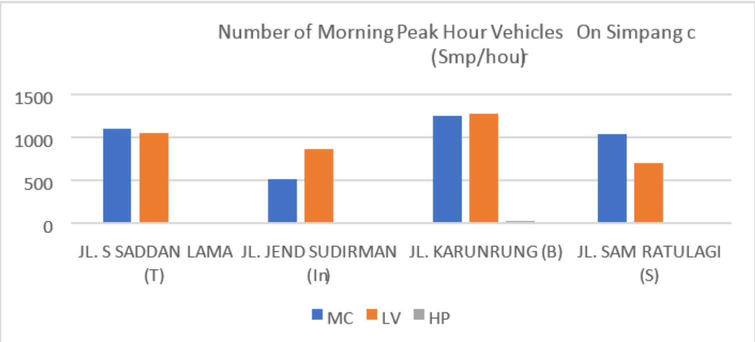


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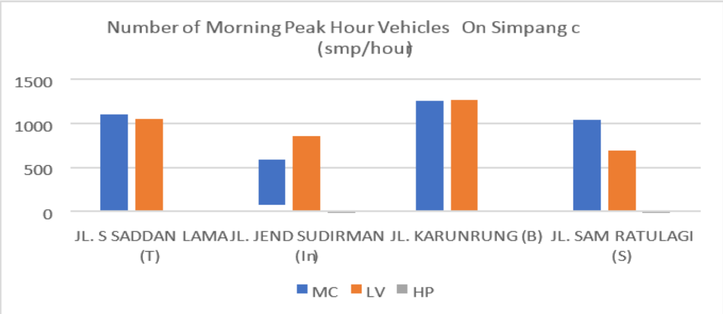
Figure 9: Number of vehicles at Peak Afternoon Hours at junction C (Jl. S Saddang Lama – Jl. Jend Sudirman / Sam Ratulangi)



c. Green Time and Number of Phases of Existing Tangled Deviations

Observations of green, yellow, and red time and the number of phases are carried out in each conlinched intersection each with the number of cycle times. Cycle time is obtained by summing the green, yellow, and red time. The time of each deviation has a difference as table 5.2 below:

Table 2: Green time and cycles exist at A-sided junctions in the morning, afternoon and evening

Simpang Name	Pendekat/ Aproach	Time			
		Green	Yellow	Red	Cycle
A	Jl. S.Saddang Baru	32	3	84	119
	Jl. Northern Veteran	35	3	81	
	Jl. S.Saddang Old	30	3	86	
	Jl. Veteran South	35	3	81	

Table 3: Green time and cycles exist at the B-sided junction in the morning, afternoon and evening

Simpang Name	Pendekat/ Aproach	Time			
		Green	Yellow	Red	Cycle
B	Jl. S.Saddang Old	25	3	63	91
	Jl. G. Latimojong	20	3	68	
	Jl. S.Saddang Lama	25	3	63	
	Jl. G.Latimojong	20	3	68	

Table 4: Green time and cycles exist at C-sided intersections in the morning, afternoon and evening

Simpang Name	Pendekat/ Aproach	Time			
		Green	Yellow	Red	Cycle
C	Jl. S.Saddang Old	22	3	66	91
	Jl. Jend Sudirman	25	3	63	
	Jl. Karunrung	23	3	65	
	Jl. Sam Ratulagi	25	3	63	

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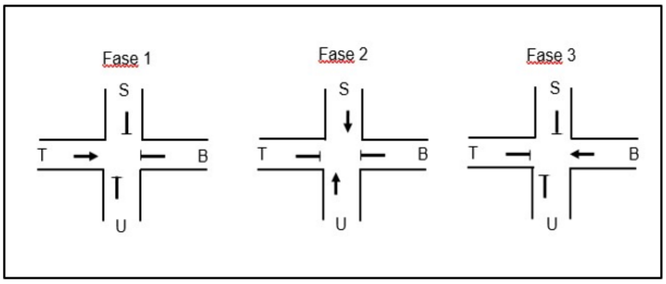
The number of phases in the A-sided junction there are three phases, namely phase 1 direction from the east, namely Jl. S.Saddang Baru, phase 2 direction from north to south, namely Jl.Veteran Utara to Jl Veteran Selatan and south to north, namely jl Veteran Selatan to Jl.Veteran Utara, and phase 3 direction from west, namely Jl. S.Saddang Lama.

The number of phases in the B-sided junction there are three phases, namely phase 1 direction from the east, namely Jl. S.Saddang Lama, phase 2 direction from north to south, namely Jl.G. Latimojong to Jl G.Latimojong and south to north, namely Jl Jl.G. Latimojong to Jl G.Latimojong, and phase 3 direction from the west, namely Jl. S.Saddang Lama.

The number of phases in the C-sided junction there are three phases, namely phase 1 direction from the east, namely Jl. S.Saddang Lama, phase 2 direction from north to south, namely Jl.Jend Sudirman to Jl. Sam Ratulangi and south to north, namely Jl. Sam Ratulangi to Jl.Jend Sudirman, and phase 3 directions from arat, namely Jl. Karunrung.

Figure 2: Existing phase on A, B, C-sided junctions



d. Capacity and degree of saturation (DS) exist

The capacity of the junction arm is calculated based on the initial capacity (So) multiplied by adjustment factors, green time and existing cycle time in units of passenger cars per hour (smp / hour). So obtained from the entry width (We) multiplied by 780. The capacity of the junction arm can be described in the form of a graph as follows:

Figure 10: Conlinquered deviation capacity A

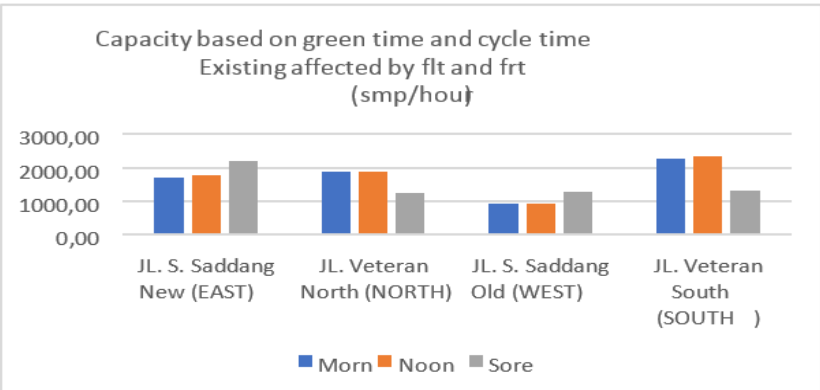


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Figure 11: Cross-sided junction capacity B

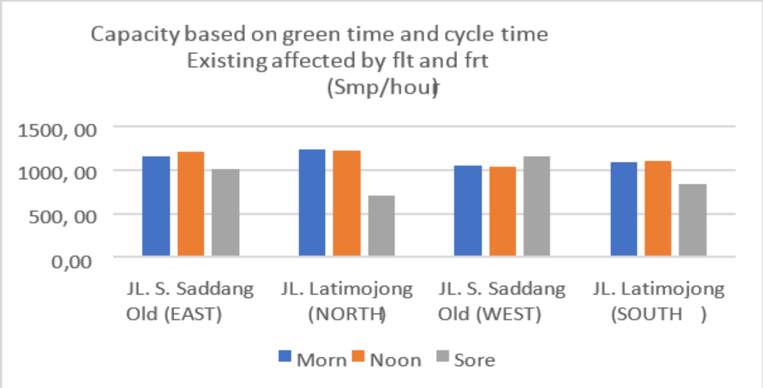
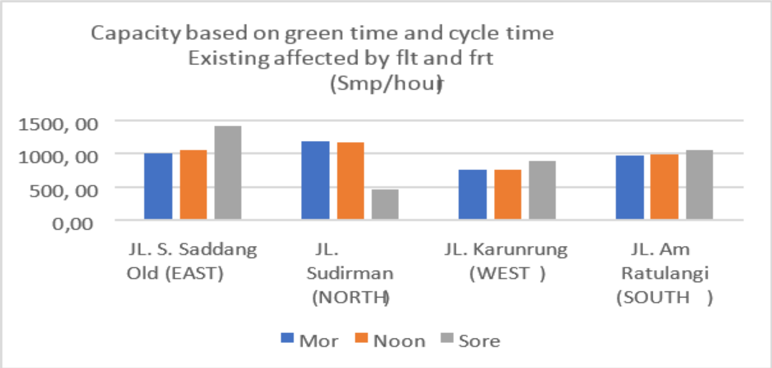


Figure 12: C-sided interchange capacity



The degree of saturation of each arm of the junction indicates a different ratio – different. Degrees of saturation (DS) are obtained as a result of comparing traffic flow (Q) to Capacity (S) based on green time. The ratio of the degree of saturation of each arm can be seen in the following table;

Figure 13: Degree of Saturation Ratio (DS) at A-sided junction

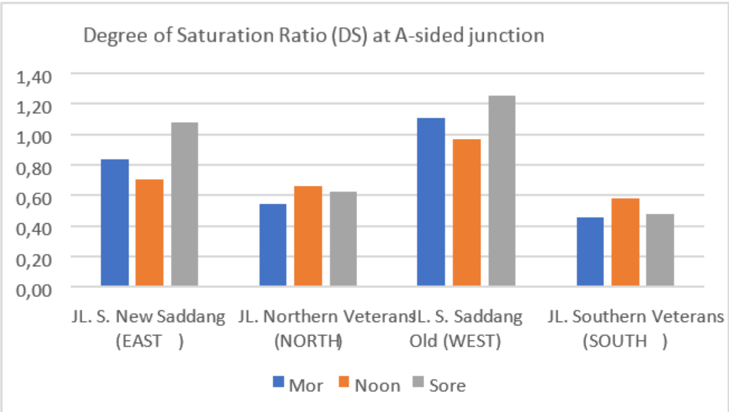


Figure 14: Degree of Saturation Ratio (DS) at the B-sided junction

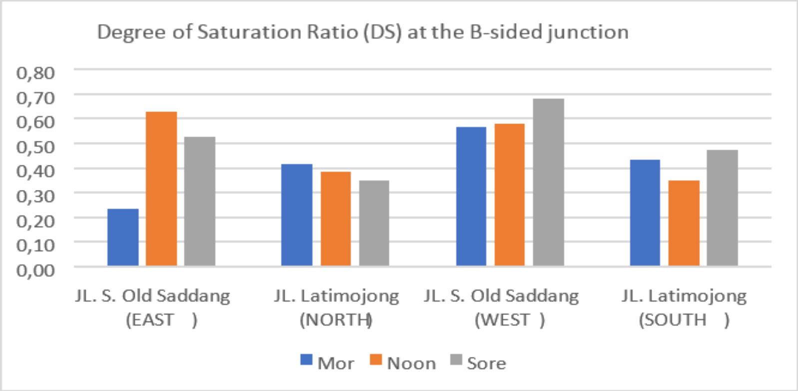
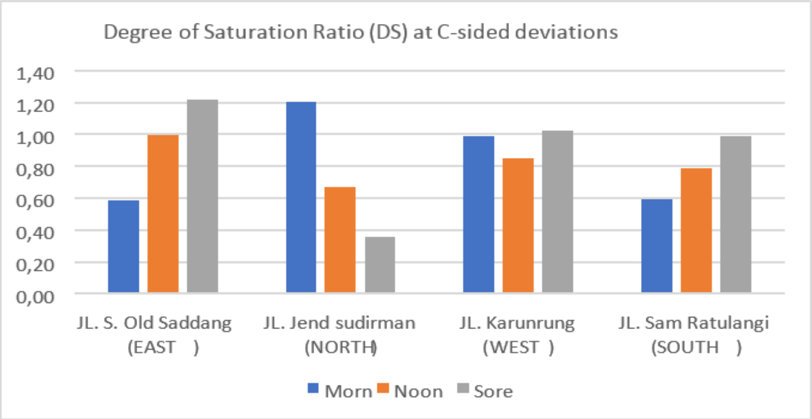


Figure 15: Degree of Saturation Ratio (DS) at C-sided deviations



e. Delay

The results of the delay analysis (DT) obtained based on the volume of traffic on each arm of the bversinyal intersection in the peak hours of morning, afternoon and evening as follows:

Table 5: Existing Delay on A-Sided Deviation

Delay Existing On Deviation A (Seconds/Smp)			
	Morning	**Noon**	**Sore**
JL. S. Saddang Baru (EAST)	45,15	40,59	192,39
JL. Northern Veterans (NORTH)	35,50	37,78	37,02
JL. S. Saddang Lama (WEST)	255,91	81,65	514,95
JL. Veteran South (SOUTH)	34,09	36,00	34,41

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Table 6: Existing Delay on C-Sided Deviation B

Delay Existing On Saver B (Seconds/Smp)			
	Morning	Noon	Sore
JL. S. Saddang Lama (EAST)	24,48	29,91	28,11
JL. Latimojong (NORTH)	30,05	29,69	29,33
JL. S. Saddang Lama (WEST)	28,87	29,10	31,32
JL. Latimojong (SOUTH)	30,21	29,26	30,73

Table 7: Existing Delay on C-Sided Deviation

Existing Delay On The Deviation C (Seconds/Smp)			
	Morning	Noon	Sore
JL. S. Saddang Lama (EAST)	31,17	88,25	445,45
JL. General sudirman (NORTH)	413,47	30,83	25,39
JL. Karunrung (WEST)	88,92	43,27	125,35
JL. Am Ratulangi (SOUTH)	29,43	35,30	78,82

f. Queue Length

The results of the queue length analysis (QL) obtained based on the volume of traffic on each arm of the bversinyal intersection at the peak hours of morning, afternoon and evening as follows:

Table 8: Existing Queue Length on A-Sided Deviation

Existing Queue Length On Deviation A (Seconds/Smp)			
	Morning	Noon	Sore
JL. S. Saddang Baru (EAST)	132,30	115,76	295,61
JL. Northern Veterans (NORTH)	96,97	121,21	111,52
JL. S. Saddang Lama (WEST)	304,27	191,45	553,85
JL. Veteran South (SOUTH)	71,03	104,67	82,24

Table 9: Existing Queue Length on C-Sided Deviation

Existing Queue Length On Junction B (Seconds/Smp)			
	Morning	Noon	Sore
JL. S. Saddang New (EAST)	39,34	98,36	78,69
JL. Northern Veterans (NORTH)	51,95	46,75	41,56
JL. S. Saddang Lama (WEST)	88,89	88,89	111,11
JL. Veteran South (SOUTH)	52,17	40,58	57,97

Table 10: Existing Queue Length on C-Sided Deviation

Existing Queue Length On Junction C (Seconds/Smp)			
	Morning	Noon	Sore
JL. S. Saddang Lama (EAST)	64,00	134,40	272,00
JL. Jend sudirman (NORTH)	546,67	93,33	53,33
JL. Karunrung (WEST)	195,56	106,67	168,89
JL. Sam Ratulangi (SOUTH)	80,00	160,00	484,00

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g. Number of Existing Maksimun Vehicles

The results of the analysis of the Number of Sensing (Nqmax) obtained based on the volume of traffic on each arm of the bversinyal deviation at the peak hours of morning, afternoon and evening as follows:

Table 11: Number of Existing Vehicles on A-Sided Interchange

Number Of Vehicles Existing In Simpang A (Seconds/Smp)			
	Morning	**Noon**	**Sore**
JL. S. Saddang Baru (EAST)	64,00	56,00	143,00
JL. Northern Veterans (NORTH)	40,00	50,00	46,00
JL. S. Saddang Lama (WEST)	89,00	56,00	162,00
JL. Veteran South (SOUTH)	38,00	56,00	44,00

Table 12: Number of Existing Vehicles on Junction B

Number of Vehicles Existing In Junction B (Seconds/Smp)			
	Morning	**Noon**	**Sore**
JL. S. Saddang Lama (EAST)	12,00	30,00	24,00
JL. Latimojong (NORTH)	20,00	18,00	16,00
JL. S. Saddang Lama (WEST)	24,00	24,00	30,00
JL. Latimojong (SOUTH)	18,00	14,00	20,00

Table 13: Number of Existing Vehicles on C-Sided Interchanges

Number Of Vehicles Existing At Junction C (Seconds/Smp)			
	Morning	**Noon**	**Sore**
JL. S. Saddang Lama (EAST)	31,17	88,25	88,25
JL. Jend sudirman (NORTH)	413,47	30,83	30,83
JL. Karunrung (WEST)	88,92	43,27	43,27
JL. Sam Ratulangi (SOUTH)	29,43	35,30	35,30

Fuel Consumption (KBB)

The results of fuel oil analysis (KBB) obtained based on the volume of traffic on each arm of the bversinyal interchange in the peak hours of morning, afternoon and evening as follows:

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Figure 16: Fuel Consumption Oil (KBB) Exists At A-Sided Deviation

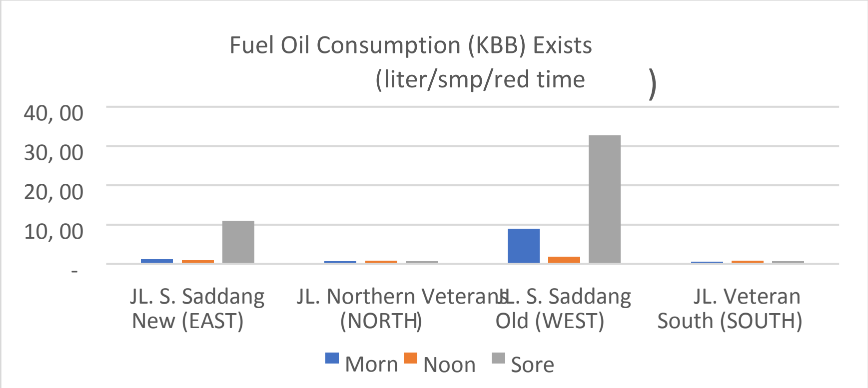


Figure 17: Fuel Consumption Oil (KBB) Exists At The B-Sided Deviation

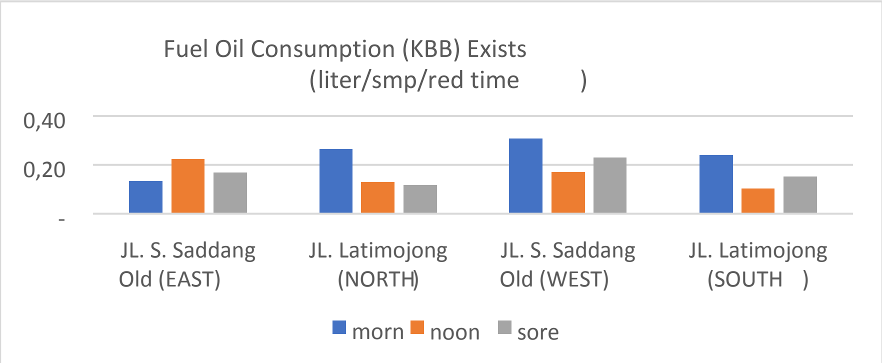
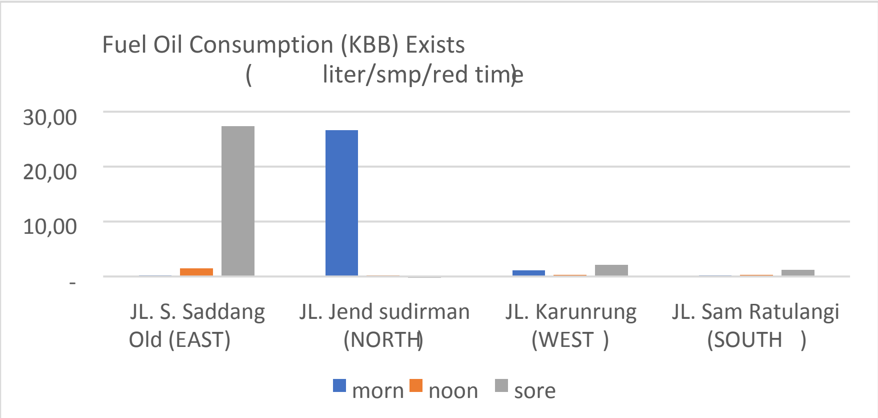


Figure 18: Fuel Consumption Oil (KBB) Exists At C-Sided Deviation



The Amount of Vehicle Exhaust Emission Value (CO2)

The results of the analysis of Vehicle Exhaust Emissions (CO2) obtained based on the Number of KBB with Vehicle emission factors based on the type of fuel in each arm of the bversinyal interchange in the peak hours of morning, afternoon and evening as follows:

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Figure 19: Vehicle Exhaust Emissions (CO2) Existing At A-Sided Deviation

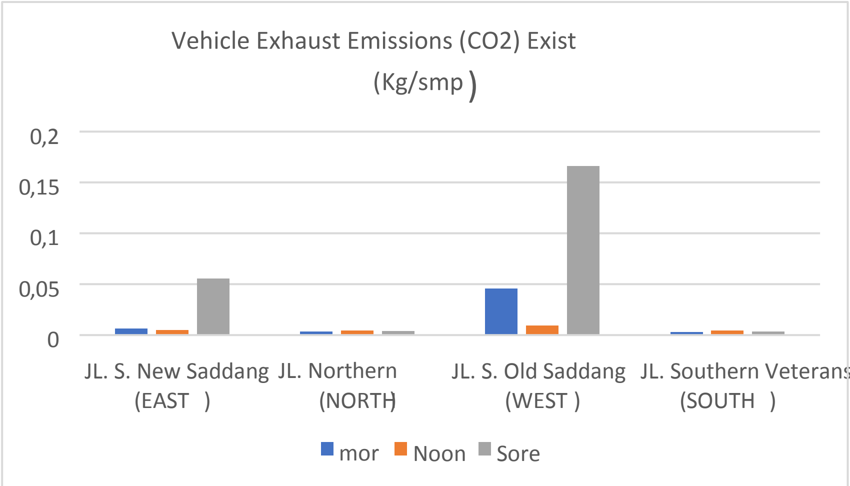


Figure 20: Vehicle Exhaust Emissions ($_{CO2}$) Existing At the B-Sided Deviation

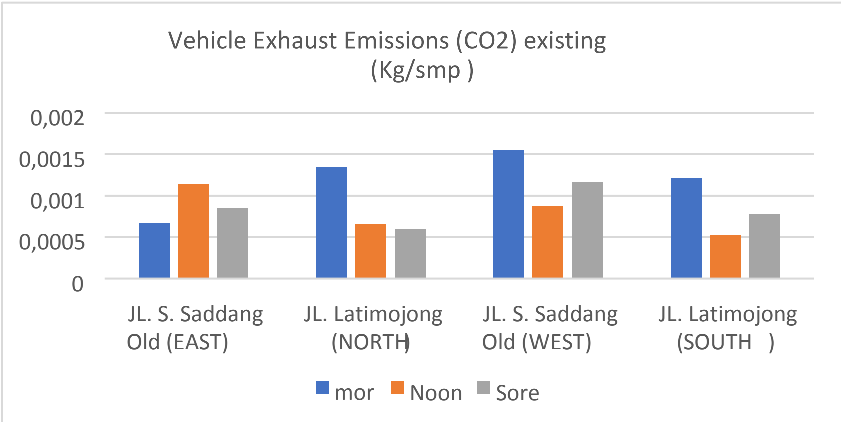
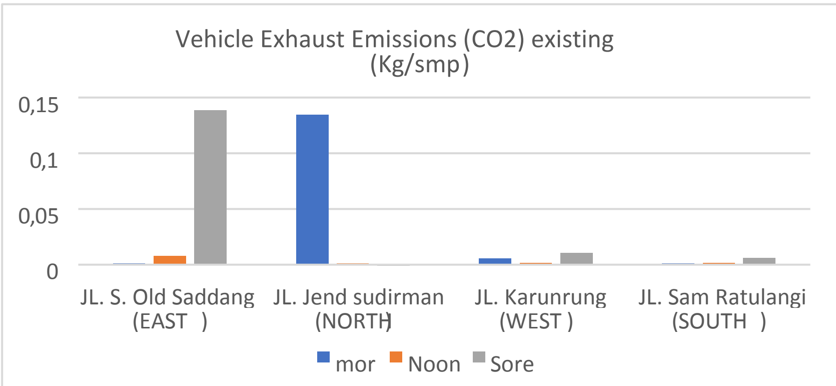


Figure 21: Vehicle Exhaust Emissions ($_{CO2}$) Existing At the B-Sided Deviation



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Vegetation Conditions in the Iron Depository

Using the Brown 1997 method of calculating the Biomass of each plant based on the diameter of the trunk (DBH) of the tree above 1.3 meters, the CO2 absorption of each type of tree is obtained at the intersection as follows:

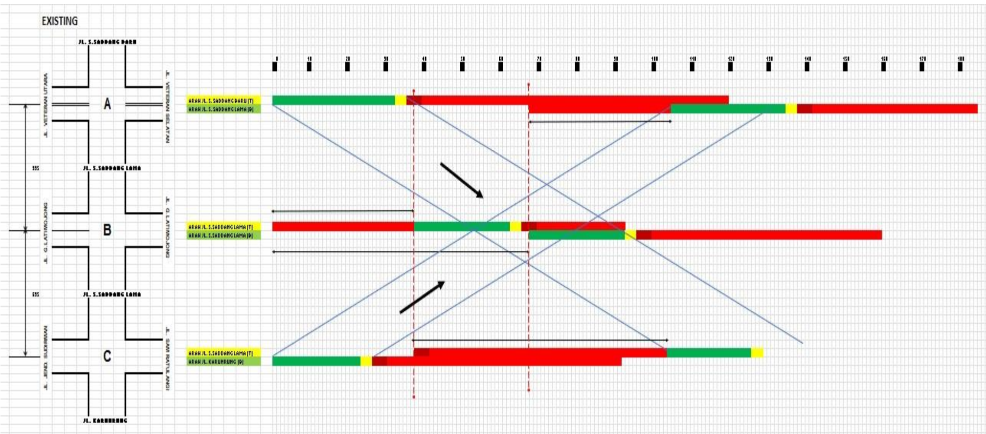
Table 14: Vegetation Conditions on A-Sided Deviations

Simpang Arm	Biomass (AND) Brown,1997	Carbon content Cb = Y* %C organic ... (0,47-0,50)	CO2 = 3,667 Cb
	Kg/Year	Kg/year	Kg/Year
Jl. S. Saddang Baru (T)	283,51	133,5	488,63
Jl. Veteran North (U)	998,16	469,14	1.720,32
Jl. S.Saddang Lama (B)	299,64	140,83	516,44
Jl. Veteran South (S)	669,10	314,48	1,153,19

Coordination conditions between Existing Supples

From the results of the analysis of the coordination of the circuit using the offset method by taking into account the distance (L) and the average vehicle speed ($V_{rata\text{-}average}$) between intersections, the conditions are not coordinative between the a,B and C-sided intersections.

Figure 3: The condition of the intersection (existing) is not coordinative before the application of the queue sensor



Real-Time Queue Sensor on the cross-legged intersection

The queue sensor is assumed to work on the main road by not paying attention to the condition of the other junction arms. The sensor works at the reference point (cross-legged deviation A). The sensor works to detect any vehicles entering on the A-sided junction arm assuming based on the length of the queue. The model used in this analysis is a mathematical model that is a development of the linear interpolation model. This model is used to determine the time to the

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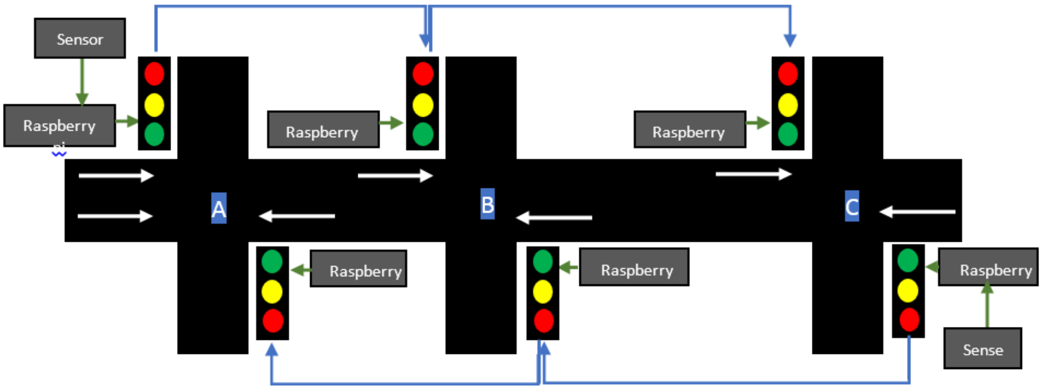
length of the queue to provide a limit on traffic light time in real time based on the density of the vehicle on the sided junction arm.

a. Coordinated Real-Time Queue Sensor Model.

Figure 4: Coordination of Simpang side by using sensors



The length of the queue is assumed to be a straight line so that it can be completed using linear interpolation methods. Linear interpolation method is a method used to find out the value of a point in a straight line.

Delay and length of queue with Queue sensor

After the application of queue sensors at the intersection with the dimples obtained based on geometric conditions and the direction of traffic deployment at the intersection of Jl. Saddang Baru – Jl Veteran Utara / Selatan (A), the intersection of sided jl.S.Saddang – Jl.G.Latimojong / Jl. G.Latimojong (B), and the intersection of jl. Jend.Sudirman -Jl. Karunrung (C) there is a difference where the use of queue sensors can reduce the delay time and queue panjag. This can be seen in table 15.

Table 15: Number of Vehicles (NQ), Delay (DT) and queue length (QL) with queue sensors

Traffic Behavior	Existing	Sensor
NQ	46 smp	18 vehicles
QL	132 meters	30 meters
GERMAN	45 seconds/smp	11 seconds

The sensor is 30 meters, so many vehicles

$$NQ = \times \mathit{banyak\ lajur}\ \frac{30}{5}$$

$= 6 \times 3$

$= 18$ vehicles

By comparison of existing time with Delay sensor (DT)

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$132 : 45 = 30 : t$

$132\ t = 45 * 30$

$t = \frac{1350}{132}$

t = 11 seconds

The comparison of existing QL of 132 meters is fulfilled with a time of 80 seconds so that,

$132 : 80 = 30 : t$

$132\ t = 80 * 30$

$t = \frac{2400}{132}$

t = 18 seconds

This means that to reach a queue length of 30 meters it takes 18 seconds, so that the red time will be obtained cycles.

$18 \times 3 = 54 + LTI$

= 54 + 21

= 75 seconds

Table 16: Comparison of Number of Vehicles (NQ), Delay (DT) and queue length (QL) with queue sensors

Traffic Behavior	Existing	sensor
NQ	46 smp	27 vehicles
QL	132 meters	45 meters
GERMAN	45 seconds/smp	17 seconds

Cycle on existing at reference deviation (A) 119 seconds. So that efficiency with sensors more quickly decomposes the density of the deviation by 1.5 times faster. So that from the table above multiplied by two

Simulation of Queue Sensors using phyton programs

Using the phyton program, the simulation of the queue sensor in controlling the time of the traffic light on the main line in the study provides an overview of traffic arrangements on the cross-legged intersection based on 3 phases according to the existing phase. This simulation was carried out on the media using sensors with a range limit of 30 meters (limited) and using miniature types of vehicles in accordance with the type of vehicle at the research site, namely motorcycles (MC), kendarana light sedan type (LV) and heavy vehicles type trucks and buses (HV). The results of the simulation on one of the intersection arms of Jl. S.Saddang Baru on the A-sided intersection as a reference deviation. Coordination between ab and B-C sided

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deviations can be done by referring to the green time in the reference deviation by taking into account the waiting vehicle time at the next intersection.

Figure 5: Simulated illustration when the vehicle is empty on the arm of the reference junction (A)

Figure 6: Simulated illustration at the time the vehicle is waiting on the reference junction arm (A)

Figure 7: Simulated illustration when the vehicle is queuing on the reference junction arm (A)

DISCUSSION

Existing Condition of Chewy Deviation Performance

The existing condition of the performance of the side-by-sided interchange is a traffic behavior that lasts during research conducted on the sided junctions of Jl. S,Saddang Baru- Jl.Veteran Utara/Selatan (A), sided intersections Jl.S.Saddang – Jl.Latimojong / Jl.Latimojong (B) and

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intersections with jl. S.Saddang – Jl. Jend.Sudirman / Jl. Sam Ratulangi (C). The three side-by-sided intersections are arranged with 3 phases of time in order to reduce the conflite at the intersection.

From the results of the study divided into three peak hours, namely the peak hours of the morning (06.00-09.00), noon (12.00-14.00) and afternoon (16.00-19.00) gives an idea of the amount of delay (seconds / middle), queue length (m) and the number of vehicles (smp) that vary significantly on the arm of each deviation. This difference occurs due to the loading of cross volume in the junction arm at certain times. This difference is also influenced by the function of the space where the position of this line is in the middle of the city of Makassar which is a link to urban activity centers, so that in this panelitian obtained the amount of delay, the length of the queue and the largest number of vehicles in the morning and evening east to west (round trip direction) and eastward (direction of going home) even though the arm is chimpanzee jl. S Saddang Baru in the morning and evening is a one-way street that is to the west.

A long delay at the peak hour of the morning is a condition of congestion on the eastward intersection arm (Jl,. S Saddang Baru) on junction A and eastward junction arm (Jl S.Saddang) at junction C. Long delay at the peak hour of the afternoon occurs on the intersection arm Jl. S Saddang Baru (east direction) and the junction arm Jl, S.Saddang (west direction) at junction A. This also occurs at the peak afternoon hours in the intersection arm Jl. S.Saddang (east direction) and Jl. Karunrung (west direction).

Fuel Consumption (KBB) and Exhaust Emissions ($_{CO2}$)

The condition of the large queue length on the arm causes a large delay that has an impact on fuel oil consumption (KBB) and vehicle exhaust emissions in the form of carbon monoxide (CO) which turns into carbon dioxide ($_{CO2}$) which can cause health problems to road users and surrounding communities. The greater the delay that occurs the greater the amount of fuel consumption (KBB) so that vehicle exhaust emissions both use gasoline and large diesel as well.

The amount of fuel consumption (KBB) in this study showed that the type of gasoline vehicle was higher than that of diesel vehicles even though the diesel fuel factor was greater. This is because users of gasoline vehicles, namely motorcycles (MC) and light vehicles (LV) are larger than heavy vehicles (HV) (trucks and buses).

Coordination conditions between inter-existing inter-junctions

From the results of the study, it was also obtained that triggered the large queue length on the arm of the interchange due to the three intersections of S.Saddang Baru – Jl.Saddang , The North Veteran (A), the S.Saddang - Jl. G.Latiomojong / Jl.Latimojong (B) and the sided intersection of Jl. Jend Sudirman – Jl. Karunrung (C) were not coordinated with each other. This is because the timing of the trafiic ligth in the intersection is still semi-manual controlled in a certain space with the Intelegent Traffic Control System (ITSC) system.

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Vegetation Conditions on the iron deposits

The condition of vegetation on the deviation arm at the S.Saddang Baru – Jl,Veteran Utara (A) intersection, namely Jl. S Saddang baru (east) consists of several mango trees. The amount of CO2 is caused by a long delay where L.A. is above 1.0 and the queue length is greater with CO2 absorption by existing trees so that it requires an increase in the number of CO2 absorbent trees. Thus the thing on the arm of Jl. S.Saddang (West) at the same intersection occurs the difference between the amount of CO2 caused by a long delay and the length of the queue so that an increase in the number of CO2 absorbing trees is needed.

The condition of vegetation on the arm of the Jl.S Saddang (east) intersection on the side of Jl.S.Saddang – Jl. Jend Sudirman / Sam Ratulangi (B) consists of several trees of a kind of dating. The absorption of existing trees is still smaller than the size of CO2 which occurs due to long delays and the length of the queue on the arm is specifically during the peak hours of the morning and evening. Thus hakl with vegetation conditions on the intersection arm Jl. Karunrung (west) consists of trees that have a large CO2 absorption such as trambessi and angsana, so it only needs a few trees. For the intersection area jl S. Saddang – Jl.G Latimojong / Jl. G. Latimojong at the intersection sided (B) although the delay and length of the queue is not too large or LOS ranges from 0.6, still given a number of CO2 absorbent trees on their respective arms, especially the east arm, namely Jl, S. Saddang and the west direction, namely Jl. S. Saddang. Reference (A).

CONCLUSION

In the study conducted on three adjacent intersections in the city of Makassar, the following conclusions were drawn: The performance of the intersections on three intersecting intersections is the side-by-sided intersection of Jl. S.Saddang-Jl Veteran Utara / south (A), the intersection is interspersed Jl. S.Saddang – Jl G.Latimojong / Jl.G.Latimojong (B) and the intersection of jl.S.Saddang- Jl. Jend.Sudirman / Jl.Sam Ratulangi (C) based on the results of analysis by the MKJI method (1997) in the morning peak hours (06.00-09.00), noon (12:00-14:00), and afternoon (16.00-19.00). The three peak clock times showed different traffic behavior at each junction arm. The delay conditions and the largest queue length occur at junction A, namely Jl. S Saddang Baru (east) and Jl. S. Saddang (West) at the peak hour of the afternoon. Where both arms have a Level of Service (L.A.) based on the degree of saturation (DS) between 1-1.3 or very poor conditions. The largest delays and queue lengths that occur in Simpang C are jl. S.Saddang (east) and Jl. Karunrung (west) intersection arms, where both arms have a Level of Service (LOS) between 1-1.2 or very bad conditions. The delay condition and length of the queue at junction B which is between the A-sided junction and the B-sided deviation has the magnitude of the delay and the length of the queue on the junction arm (east) and the junction arm (west) is smaller. Of Service (LOS) Level Condition < 1.0 or condition 166 is not saturated. The occurrence of delays and large queue lengths on the east and west intersection arms on the road segments studied caused the amount of fuel oil consumption (KBB). On the arm of the iron junction A is jl. S.Saddang Baru raises KBB every time red in the existing cycle time of 10.92 ltr / smp while jl S.Saddang (west) 32.69 lt / smp. For the C-

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sided junction arm, Jl. S Sadang (east) causes KKB of 27.35 liters / junior high school. Jl.karunrung (west) arm of 2.05 liters / smp.

The amount of fuel oil consumption (KBB) in the largest peak hours, namely the afternoon, causes the loading of exhaust gases, namely victims of monoxide (CO) who will become victims of dioxide (CO2) after merging with the air which will have an effect on environmental conditions in the form of health disorders of road users and the surrounding communities. The amount of fuel oil consumption (KBB) affects the amount of CO2. In calculating the amount of CO2 is done by separating the types of gasoline and diesel vehicles because these two types of fuel have different emission factors. The greater the fuel consumption (KBB) the greater the CO2 produced.

In existing conditions, the three intersections A, B and C have not been coordinated, where each circuitous deviation is still working alone so that there is a time that is not optimal where the junction arm that receives a large density receives a fast time and sometimes the junction arm that does not occur density gets a long green time.

The occurrence of uncoordinated conditions of the three intersections is the intersection of Jl.S Saddang Baru -Jl.Veteran Utara /Selatan (A), the intersection of Jl.S.Saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) dasimpang Jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C). The results of the optimization of queue length carried out using genetic algorithms show the length of the queue of 95 meters on the arm of junction A, namely Jl.S Saddang Baru (east) to be a reference (reference point) in coordinating between the intersection of A and B, B and C. in addition to the results of green time optimization obtained by genetic algorithms are used to regulate traffic when the sensor tool used in detecting vehicles is impaired due to the impact. The environment, especially when there is a change in light (dark) automatically.

The performance of the side-by-sided interchange exists at jl.s Saddang Baru Jl.Veteran Utara/Selatan (A), jl.s.saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) junction jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C) is still controlled manually in certain spaces to set the traffic light time to work. At

Makassar City used the concept of Intelegent Traffic Control System (ITCS) by using human power by looking at CCTV installed at each intersection. In this study, the concept of queue sensors was applied that worked in real time to time traffic lights based on the traffic density of each junction arm and coordinate between the intersectional intersections jl.S Saddang Baru -Jl.Veteran Utara/Selatan (A), jl.s.saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) dasimpang Jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C). These two concepts are different ways of working where ITCS still uses cycle time more, while the concept of queue sensors does not use cycle time but works in real time so that the interchange arm that receives a large density load occurs a decrease in density. This has an impact on reducing the amount of fuel oil consumption (KBB) and loading dioxydo (CO2) victims on the arm.

The coordination of the intersection of Jl.S Saddang Baru -Jl.Veteran Utara/Selatan (A), the intersection of Jl.S.Saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) and the intersection of

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Jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C) using the concept of queue sensors has an influence on the decrease in the number of delays and queue lengths, where vehicles passing through the intersection of Jl.S Saddang Baru -Jl.Veteran Utara / Selatan (A) as a reference interchange leading to the Jl.S.Saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) intersection did not experience delaysThe implementation of models and simulations carried out using queue sensors in this study at.

jl.s Saddang Baru Jl.Veteran Utara/Selatan (A), jl.S.Saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) dasimpang Jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C) provides a decrease in the amount of fuel oil consumption (KBB) which affects the decrease in the amount of carbon dioxide (CO2) in the seasoning so that savings occur.

Environmental mitigation carried out in this study on the amount of victims of diokasida (CO2) caused by delays and long queues on each arm of the intersection jl.s Saddang Baru -Jl.Veteran Utara/Selatan (A), jl.s.saddang – Jl. G.Latimojong / Jl.G.Latimojong (B) and jl. S.Saddang – JL. Jend.Sudirman / Jl Sam ratulangi (C) after the model is applied, namely vegetation technology by choosing the type of tree or plant and the appropriate amount of CO2 absorption needs by paying attention to the speed of driving to the stopping point. The selection of the type of tree on the arm of the deviation, especially a certain distance from the intersection point used by shrubs so as not to reduce visibility and then selected palm plants or the like.

References

❖ Aminah, S., 2006. Public transportation and accessibility of urban communities. Airlangga University. Surabaya.

❖ Anonymous. 1997. Indonesian Road Capacity Manual (MKJI). Directorate General of Bina Marga Center for Road Research and Development. Bandung

❖ Anonymous. 1999. Guidelines for Planning and Operation of Traffic in Urban Areas. Directorate of BSLLAK. Jakarta Anonimus. 1985. Highway Capacity Manual.

❖ National Research Council. Washington D.C.

❖ Atmajaya, A., 2011 "The Influence of Transportation Development in Economic Growth". In unm journal, Makassar;

❖ National Spatial Coordination Agency. 2003. Berlin Declaration of the City of the Future. Jakarta.

❖ Banister,D., 1995. Transport and Urban Development. E & FN Spon. London. Berck,P., Helfand, G.E. and Kim,H.J.,1999. “Spatial Variation in Benefits and Cost, or Why Pollution Isn’t Always for Sale”. In Paper for Workshop on MarketBased Instruments for Environmental Protection.AERE.Harvard University. Michigan: pp.1-36.

❖ Berling-Wolff,S. and Wu,J., 2004. Modeling Urban Landscape Dynamics: A Review. Ecological Research 19:119-129.

❖ Bernard,M.J. and Collins,N.E., 2001. “Shared, Small, Battery-Powered Electric Cars as a Component of Transportation System Sustainability”. In Annual Report of Transportation Research Board Meeting. January. New York. pp.1-10.

❖ Brotodewo, N., 2010, "Assessment of Sustainable Transportation Indicators in Metropolitan Areas in Indonesia". In the Journal of Regional and Urban Planning, Vol. 21 No. 3, December 2010, pp.165 – 182.

ISSN 1533-9211

DOI 10.17605/OSF.IO/KXT23

- Brüel and Kjær. 2015. Hand-held Analyzer 2250 Light. Brüel and Kjær Sound & Vibration Measurement A/S
- Chavarria,S., 2002. Transportation System Management in Champaign, Illinois. Department of Urban and Regional Planning University of Illinois. Urbana Champaign: pp.1-7.
- Chaeran, Mochammad. 2008. Noise Study Due to Activities at the Airport (Case Study of Ahmad Yani Airport Semarang). Semarang: UniversitasDiponegoro
- C. J. Khisty and Kent Lall. 2003. Basic Engineering Transportation. Volume
- 1 and 2. Erlangga. Jakarta
- Clarckson C. and Hicks G. R. 1999. Highway Engineering. Volume 1. Erlangga. Jakarta
- Deakin,E., 2001. "Sustainable Development and Sustainable Transportation:
- Strategies for Economic Prosperity, Environmental Quality, and Equity". In Working Paper 2001-03 for the Califronia Futures Network. UCLA. Berkeley: pp.5-17.
- Departement of Transport Welsh Office HMSO. 1988. Calculation of Road Traffic Noise. London.
- Dikun, S., 2002. "Urban Transport Reforms". Dalam Paper Presented at the Seminar on City of Makassar Urban Transport in August 5, 2002. PAJ Indonesia.Makassar: pp.1-10.
- Djalante, Susanti. 2010. Analysis of Noise Levels On Highways Using Traffic Signaling Tools. Kendari: Halualeo University.
- Haryani, Pratiwi. 2015. Study of Traffic Noise Levels at Intersections in Makassar City. Makassar : Hasanuddin University
- Hensher,D.A., and Button,K.J., 2003. Handbook of Transport and Environment. Elsevier. New York.
- Hong,K.L., 2005. Road Pricing Modeling for Hyper-Congestion. Transportation Research Part B: Methodological Elsevier, New York. 39 (9 November 2005): 769-795.
- Hustim, Muralia., et al. 2012. Traffic Noise Analysis on Roads in Makassar City. Makassar: Hasanuddin University.
- Jeffri, Tjandra Susila, Hartono, Haryadi, 2015 Model Monitoring and Setting Traffic Lights By Wirelles Based on The Length of Vehicle Queues, T E S L A.Vol. 17 No. 2oktober 2015
- Junior, Paulutu. 2013. Environmental Quality Analysis. Retrieved via http://xavrianto.blogspot.com/2013/04/makalah-kebisingan-mkanalisakualitas.html on February 23, 2016
- Ministry of Environment of the Republic of Indonesia. Decree of the Minister of Environment Number 48 of 1996 concerning Noise Level Quality Standards, 1996.
- Kusbiantoro, B.S., 2004. "The Role of Transportation on the Development and Growth of Cities". In the Hms FT-UNDIP National Transportation Seminar Paper. Semarang: pp.1-10.
- Kutner, M.H., Nachtsheim, C.J., and Neter, J., 2004. Applied Linear Regression Models. 4thed. New York: McGraw-Hill Companies, Inc.
- Mansyur, U., 2008. Makassar City Non-Bus Passenger Public Transport Management Model. Doctoral Dissertation. Natural Resources and Environmental Management Study Program. IPB.
- Mediastika, Christina. 2005. Acoustics of Building Principles and Their Application in Indonesia. Jakarta: Erlangga.
- Miro,F. 2005. Transportation Planning for Students, Planners, and Practitioners. Erlangga. Jakarta.

ISSN 1533-9211

DOI 10.17605/OSF.IO/KXT23

- Miyamoto,K., Udomsri, R., Sathyaprasad, S. and Ren,F., 1996. A Decision Support System for Integrating Land Use, Transport and Environmenta Planning in Developing Metropolises. Computer, Environment, and Urban Systems Elsevier Science Ltd. Britain.20 (4/5): 327-338.
- Mohan,D. and Tiweeri,G., 1998. “Sustainable Transport Systems: Linkages between Environmental Issues. Public Transport, Non-Motorised Transport and Safety”, Economic and Political Weekly.Elsevier Science Ltd. Britain. XXXIV (25/6):1580-1596.
- Murlina, E. 2013. Prediction of Putting Pickaxes in Maros County. Makassar:
- Hasanuddin University
- Nababan, Goddess Sriastuti. 2014. Heterogeneous Traffic Noise Prediction Model That Considers the Sound of the Sensory Horn. Makassar: Hasanuddin University.
- Najid, S.H.T., Tamin, O.Z. and Sjafruddin, A., 2001. "Analysis of Needs of Land Use and Transportation Interaction Models: Municipal Case Studies
- Bandung" In the Fourth Symposium Paper FSTPT Univ.Udayana.Denpasar: pp.1-10.
- Newman, P., Kenworthy, J. 1999. Sustainability and Cities Overcoming Automobile Dependence, Island Press
- Ningrum, Ulfa Dwi. 2016. Analysis of Noise Levels of Four-Sided Intersections on Jalan Veteran Selatan Makassar. Makassar: Hasanuddin University
- Oriza Candra, Elfizon 2018 Four Phase Traffic Light Control System with Violation Sensor, Electrical Engineering FT UNP Padang State University, Indonesia
- Prabu, son. 2008. Types and Causes of Noise. Retrieved via http://putraprabu.wordpress.com/2008/12/30/jenis-dan-penyebab-kebisingan/ on January 21, 2016 at 19:40 AM
- Rahmadani, F., 2015. "ANALYSIS OF MODEL OF THE RISE OF TRAFFIC MOVEMENTS IN THE LAND USE OF JUNIOR HIGH SCHOOLS IN PADANG CITY".
- In The 18th FSTPT International Symposium, STTD, Lampung, 2015
- Rahmania,U., 2000. Analysis of Transportation Development and Spatial Interaction Systems in Bogor City. Thesis. IPB Regional and Rural Development Study Program. Bogor.
- Saaty, T.L., 2001. Creative Thinking, Problem Solving & Decision Making. University of Pittsburgh: USA.
- Santosa,I. 2005. Model of Air Pollutant Spread from Motor Vehicles Using the Finite Volume Method: Bogor City Case Study Doctoral Dissertation. PS. Ipb Natural and Environmental Resource Management. Bogor.
- Sitangan, Lamhot HS., and Joni Harianto. 2013. Analysis of the Performance of the Crossed Deviation). Medan: University of North Sumatra.
- Sjafruddin, A., Ridwan, U.S., Ismanto, B., Kosasih, D., Rashid, H., Hidayat, H., Pasaribu, H., Santoso, I., Kusumantoro, I.P., Kusbiantoro, Sadono, M., Tamin, O.Z., Widodo, P., Partosiswoyo, Karsaman, R.H., Hendarto, S., Supangkat, S.H., Soedirdjo, T.L., and Tumewu, W., 2000. "Challenges and Problem Solving of the Transportation Sector in Indonesia: Itb Thought Contribution". In the ITB Proceedings 'Status, prospects and problems of Science and Technology Ahead of the 21st Century'; Supplement Vol. 32, No. 2,
- 2000, Hal 89-123, ISSN: 0125-9350
- Soedomo, M. 2001. Air Pollution. Bandung: ITB
- Sterner,T. 2003. Policy Instruments for Environmental and Natural Resource Management. RFF Press. Washington.

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- Sunyoto, D., 2007. Bivariate Regression and Correlation Analysis: Summary and Case. Amara Books. Yogyakarta.
- Sutriadi,R. 2006. "Control of Large and Metropolitan Cities, Their Implications for Sustainable Transportation". In Kusumantoro, I.P. et al. (Editors). Essays in Sustainable Transportation: A Handbook in Honor of Prof. Dr .BS. Kusbiantoro. KK-PPK, SAPPK ITB. Bandung: 259-282.
- Tamin, O.Z., 2005. Some Alternatives to Solving Urban Transportation Problems in Major Cities in Indonesia. URDI. 4. URDI. Jakarta.
- Tamin, O.Z., 2007. "Towards the Creation of a Sustainable Transportation System in Major Cities in Indonesia". In The Journal of Transportation Vol. 7 No. 2 December 2007: 87-104.
- Tamin O. Z. 2000. Transportation Planning and Modeling. ITB. Bandung
- Tanvir, M,.and Rahman, M. M. 2011. Development of Interruped Flow Traffic Noise Prediction Model for Dhaka City. Bangladesh
- Tuman, 2001," Overview of GIS", http://www.gisdevelopment.net/tutorials/ tuman006.htm [23/12/17]
- Wardika, ketut., et al. 2012. Traffic Noise Analysis on Arterial Roads (Road Case Study Prof. Dr. IB. Mantra on KM 15 to KM 16. Udayana University. Denpasar
- Winarso, Haryo, 2006. Metropolitan in Indonesia: Reality and Challenges in Spatial Planning. Jakarta: Director General of Spatial Planning, Department of Public Works.
- Wunas, S., and Natalia, V.V., 2015. "Construction of Transportation Infrastructure in Makassar City". In The Journal of Transportation Vol. 15 No. 3 December 2015: 169-178
- Zubair, H., 2000. "Environmental Carrying Capacity and Regional Development". In the BAPEDALDA Empowerment Workshop Paper. Makassar: pp.1-5