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Traffic Performance Optimization at Batanghari Intersection Using Microsimulation

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ABSTRACT

The Batanghari 1 Bridge serves as a vital link connecting Jambi City and Muaro Jambi Regency. Currently, the traffic density at the Batanghari intersection is notably high, particularly during peak hours, resulting in frequent traffic jams. To address this issue, the Perencanaan dan Pengawasan Jalan Nasional (P2JN) and Planning Consultants executed a Detailed Engineering Design (DED) Planning for the Duplication of the Batanghari 1 Bridge in 2021. The Duplication DED transformed the original intersection into a combination of an intersection and a U-turn. However, a notable challenge emerged during rush hours, especially for Jalan KH.A. Majid, where a U-turn is essential to cross the Batanghari Bridge. In this study, a traffic microsimulation was initiated at the Batanghari intersection. Using PTV Vissim software, microsimulations were conducted under three scenarios: Existing Condition, Detailed Engineering Design (DED), and an Alternative scenario, which involved incorporating a Flyover for KH.A. Majid Road towards Batanghari Bridge. Furthermore, traffic microsimulations were conducted to anticipate conditions over the next two decades. The analysis involved microsimulation using Vissim software, encompassing calibration, trial and error validation of the intersection model considering driver behavior, and GEH tests on traffic volume. The microsimulation results at the Batanghari intersection revealed that the alternative model effectively reduced queues, minimized delay times, and improved overall travel time compared to the proposed model.

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1. INTRODUCTION

The development of the transportation system has a great impact on the progress of a city and must operate efficiently at all times. The increasing activity of the population in an area causes an increase in the movement of people, goods, and services. This causes an increase in the need for transportation services [1]. Transportation problems cover various things, one of which is the need for mobility. This need arises because people have to reach places such as workplaces, education, and others [2]. If these mobility needs are not met, there will be traffic jams, delays, or even road accidents. These problems often occur at busy intersections [3].

An intersection is a point where two or more highways meet or cross, including all the facilities and lanes necessary for the movement of traffic in the area[4]. The main function of an intersection is to allow vehicles to change directions or cross different roadways. Intersections have a crucial role in the road system because to a large extent the efficiency, safety, speed, operating costs, and traffic capacity are highly dependent on how they are planned and operated [5].

Delays and congestion on various roads are caused by the growth in the number of vehicles which is not proportional to the increase in road capacity which tends to remain constant [6]. Traffic conditions are often characterized by high density, especially at intersections, which means that the capacity of the intersections is no longer in line with the volume of vehicles, causing congestion on main roads [7]. By the increasing volume of motorized vehicles from year to year but not accompanied by growth in road infrastructure, there will be long vehicle queues, long travel delays, and congestion which results in increased travel time [8], [9]. Based on these conditions, improving the intersection service is very necessary. The National Road Planning and Supervision Party (P2JN) and Planning Consultants have carried out Detailed Engineering Design (DED) Planning for the Duplication of the Batanghari 1 Bridge in 2021 to solve the congestion problem that occurs at the Batanghari intersection. In DED Duplication of the Batanghari 1 Bridge, which was originally an intersection turned into an intersection and a U-turn. However, according to the author, the most volume during rush hour is from the road where you are required to make a U-turn to pass through the Batanghari 1 Bridge.

Traffic microsimulation is a technique for modeling and analyzing road traffic systems with a high level of detail. In microsimulation, each vehicle is represented and treated as a single entity that has unique behavior and properties [10]. This allows analysts to study how different vehicle actions and interactions affect traffic flow and identify trends and patterns that are not apparent with simpler traffic analysis methods. Traffic microsimulation models have come to the fore with the increasing computational power of nowadays computers and their capability to model the complex dynamics of traffic flow [11]. The benefits of microsimulation over traditional traffic analysis techniques are categorized into three main areas: clarity, accuracy, and flexibility [12].

The limitations of this research problem include several important points. First, data was collected over two days, one on weekdays and one on weekends, starting from 06:00 to 18:00 WIB. The focus of this research is on the analysis of the Batanghari intersection.

The method of measuring the intersection geometry is carried out directly in the field. Data analysis uses primary data obtained through direct surveys at the intersection. In analyzing the performance of the intersection, Vissim PTV software is used to measure the delay value and the length of the vehicle queue [13]. In addition, the analysis of the performance of this intersection will be focused on peak traffic hours.

This research has several significant benefits. First, this study provides a deeper understanding of the performance of intersections in the Batanghari Intersection through simulations using the Vissim software. The simulation is carried out in three conditions, namely Existing conditions, proposed geometric change plans, and Alternatives. In this way, we can understand how the intersection is currently performing and potential changes in the future. Second, this research also looks into the future by analyzing the performance of intersections in the Batanghari Intersection Area in the next 20 years. Through simulation using the Vissim software, this study allows us to predict how traffic performance will evolve over time in the same three scenarios: Existing, Proposed geometric change plan, and Alternative. Third, the results of this study have a practical impact on policy-making by the Government and the Jambi City Transportation Service. The findings and analysis from this study will be valuable input to direct better policies related to traffic management at the intersections in the Simpang Batanghari area. Thus, it is hoped that this research can contribute to creating smoother and more efficient traffic conditions in the area.

This study aims to analyze traffic performance at the Batanghari Intersection using the Vissim software in three conditions: Existing conditions, Proposed geometric change plans, and Alternatives. In addition, this study also aims to analyze traffic performance in these three conditions for the next 20 years. The results of the traffic performance analysis of the three scenarios will be used to generate relevant recommendations. These recommendations will be based on the results of analysis using the Vissim software, both for current conditions and forecast conditions for the next 20 years.

2. MATERIALS AND METHODS

This research was conducted by collecting various literature that is in accordance with the research to be carried out. Starting from the formulation of characteristic problems, intersection performance, research objectives, and literature review related to the research to be carried out, then a preliminary survey is carried out to find out the real conditions that occur in the field and determine the point of placement of survey equipment.

A survey was then carried out which included an intersection geometric survey, a vehicle volume survey, a vehicle speed survey, and a queue length survey. Then collect secondary data, namely Google Earth satellite imagery maps and other data needed in conducting surveys, and collect primary data, namely intersection geometric data, traffic volume, vehicle speed, and queue length obtained from direct survey results in the field using survey equipment that has been provided. The final stage involves processing and analyzing data using Ms. Excel and PTV Vissim software at the intersection of Batanghari

1 Bridge. Subsequently, it is calibrated and validated to generate intersection performance outputs in the form of queue lengths, vehicle delays, and travel time. The following is the research procedure :

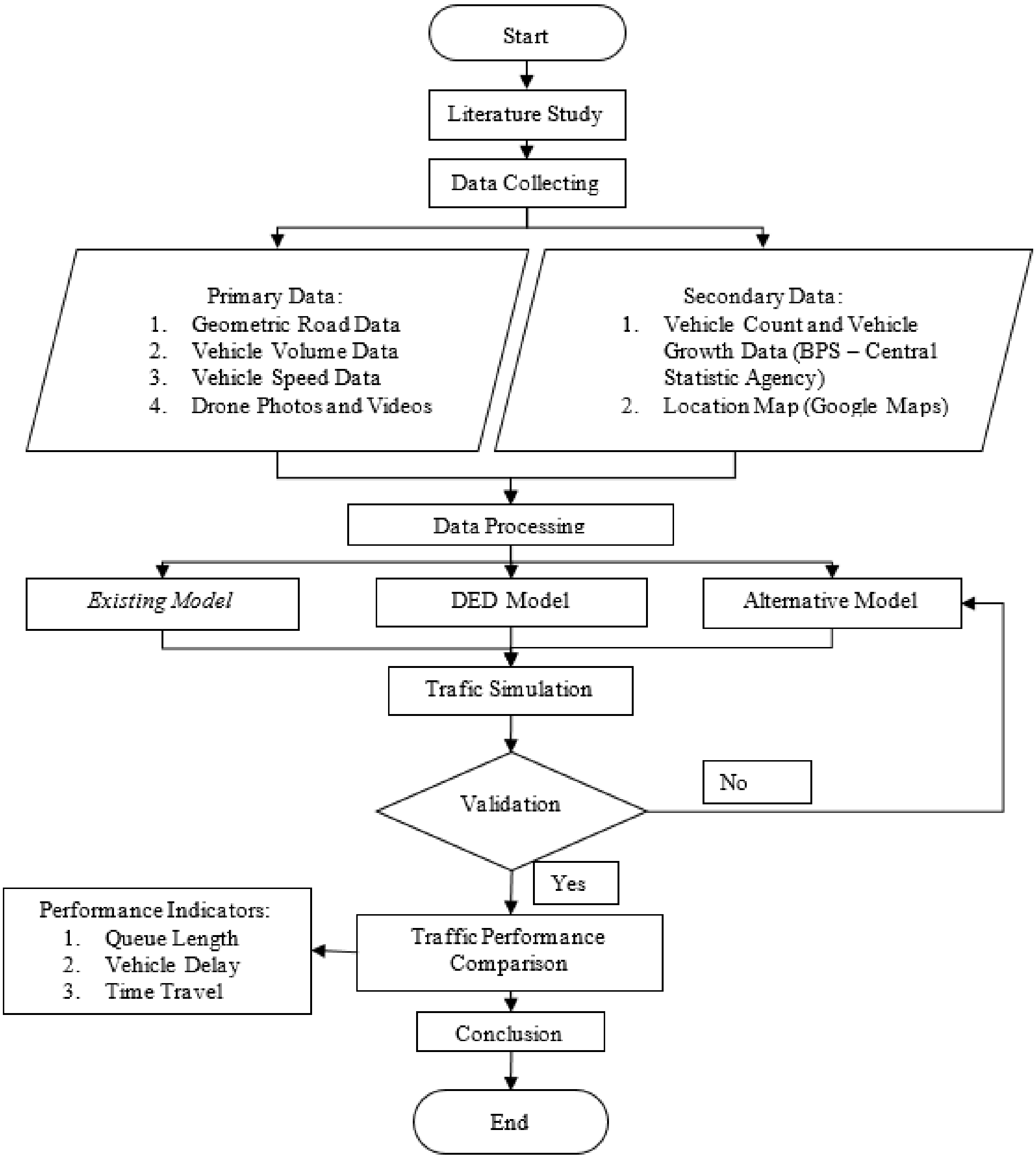

Figure 1. Research Flowchart

3. RESULTS AND DISCUSSION

3.1 Intersection Geometry

This geometric data contains the dimensions of the road and lanes at each intersection approach. This intersection is an unsignalized intersection consisting of Lintas Sumatra (s) Rd, Lintas Sumatra (u) Rd, KH. A. Majid Rd, and Penyengat Rendah Rd.

Table 1. Geometric Intersection

Intersection Geometry	Lintas Sumatra(S) Rd		Lintas Sumatra(U) Rd		Kh. A. Majid Rd		Penyengat Rendah Rd	
	Left	Right	Left	Right	Left	Right	Left	Right
Number of Lanes	1	1	1	1	2	2	1	1
Number of Lines	1	1	1	1	1	1	1	1
Lane Width	3	3	3.5	3.5	4.5	4.5	2	2

3.2 Traffic Volume at Intersections

Traffic volume indicates the number of vehicles passing through a single observation point within a unit of time [14], [15]. The data was taken from direct survey results. The vehicle volume data for each approach is calculated from 06.00 – 08.00, 12.00-14.00, 16.00-18.00 WIB. The outline is described in the table below :

Table 1Traffic Volume

Traffic Volume																
Weekday																
Lintas sumatera(U) Rd				**Lintas sumatera(S) Rd**				**KH. A. Majid Rd**				**Penyengat Rendah Rd**				
Time	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**
06.00-07.00	948	235	96	1279	526	203	80	809	330	229	9	568	245	19	0	264
07.00-08.00	1213	237	74	1524	593	194	54	841	419	311	7	737	231	23	0	254
12.00-13.00	536	456	182	1174	323	152	136	611	417	230	13	660	46	24	0	70
13.00-14.00	523	503	207	1233	337	143	134	614	382	233	6	621	54	27	0	81
16.00-17.00	**731**	**516**	**180**	**1427**	**296**	**211**	**147**	**654**	**402**	**270**	**10**	**682**	**90**	**29**	**0**	**119**
17.00-18.00	692	493	163	1348	283	184	151	618	426	294	8	728	80	26	0	106
Weekend																
Lintas sumatera(U) Rd				**Lintas sumatera(S) Rd**				**KH. A. Majid Rd**				**Penyengat Rendah Rd**				
Time	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**	**MC**	**LV**	**HV**	**Sum**
06.00-07.00	645	94	93	832	293	81	103	477	369	154	11	534	42	21	0	63
07.00-08.00	732	109	123	964	290	91	68	449	340	157	10	507	48	19	0	67
12.00-13.00	596	329	200	1125	414	118	85	617	407	247	9	663	46	9	0	55
13.00-14.00	517	332	209	1058	453	144	91	688	428	235	14	677	42	24	0	66
16.00-17.00	**918**	**545**	**109**	**1572**	**430**	**266**	**66**	**762**	**595**	**372**	**7**	**974**	**106**	**15**	**2**	**123**
17.00-18.00	525	269	90	884	349	197	91	637	638	339	9	986	69	33	0	102

The volume of vehicles in Table 2 shows that the largest volume of vehicles on weekdays occurs at 16.00-17.00, namely on Lintas Sumatra (U) Rd as many as 1427 vehicles, on Lintas Sumatra (S) Rd as many as 654 vehicles, on KH. A. Majid Rd as many as 682 vehicles and Penyengat Rendah Rd as many as 119 vehicles. The largest volume of vehicles on Weekend occurs at 16.00-17.00, namely on Lintas Sumatra (U) Rd as many as 1572 vehicles, on Lintas Sumatra (S) Rd as many as 762 vehicles, on KH. A. Majid Rd as many as 974 vehicles and on Penyengat Rendah Rd as many as 123 vehicles.

3.3 Traffic Composition at Intersections

The composition of vehicles greatly influences the results of calculating the performance of intersections, especially the queue length of vehicles, so it is necessary to know the percentage (%). The percentage (%) composition of vehicles at peak hour according to their type is presented graphically in the figure below :

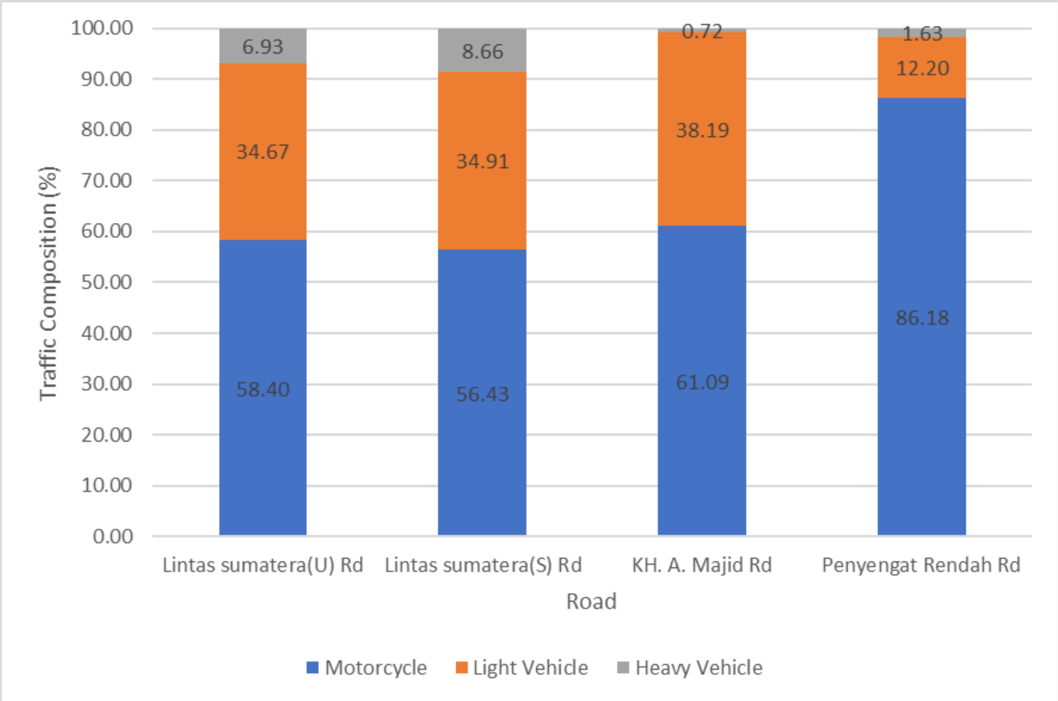

Figure 2 Composition of Vehicles at peak hour

Figure 2 shows that the type of motorcycle vehicle ranges from 58.40% -86.18%, the type of Light Vehicle vehicle ranges from 12.20% -38.19%, and the type of goods car vehicle ranges from 0.72% -8.66%.

3.4 Vehicle Speed

Speed is an indicator of the quality of traffic movement, described as a distance that can be covered in a specific amount of time and usually expressed in units of km/h; this speed represents the rate of motion of vehicles [16], [17]. Based on the survey results in the field, speed data for each type of vehicle was obtained, for motorcycle types the speed was between 28 km/hour – 33.07 km/hour, then for Light Vehicle the speed was between 24.6

km/hour–35 km/hour, and for heavy vehicle, the speed is between 19.1 km/hour – 30.7 km/hour.

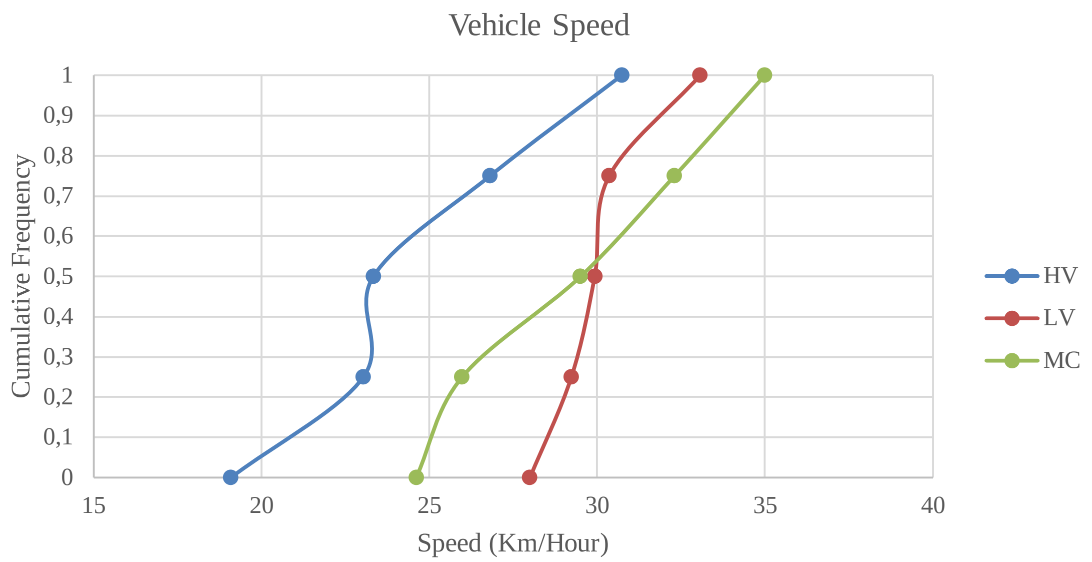

Figure 3. Vehicle Speed

3.5 Traffic Volume at the Intersection 20 Years to Come

Traffic growth is an important factor for understanding regional project development. In this regard, the future trend of increasing traffic can be developed by studying the history of vehicle trends [18]. Thus, this trend analysis of traffic increase can be calculated by considering registered vehicles as well as vehicles currently running on the road. In general, the Gross Regional Domestic Product (GDP) is an indicator of the economic strength of a region, which also reflects traffic growth and economic performance, in that area.

Table 3. Number of Motorized Vehicles

Year	PDRB (Billion Rp)	i	Year	LV	i	HV	i	MC	i
2016	130,501.13		2016	111,857		75,881		1,549,747	
2017	136,501.00	4.60%	2017	126,452	13.05%	81,374	7.24%	1,657,018	6.92%
2018	142,902.00	4.69%	2018	142,648	12.81%	88,271	8.48%	1,776,187	7.19%
2019	149,111.09	4.34%	2019	157,957	10.73%	88,035	-0.27%	1,882,425	5.98%
		4.54%			12.20%		5.15%		6.70%
	Regression (i)				**7.64%**		**5.11%**		**5.71%**

Table 3 shows the number of registered motorized vehicles in Jambi Province, which shows an average growth rate for Light Vehicles of 12.20%, heavy vehicles of 5.15%, and motorcycles of 6.70%. After obtaining the regression results, the coefficients are then applied. As a result, the projected number of vehicles for the next 20 years. Next, the growth rate (i) for goods vehicles is determined. After obtaining the growth rate (i) influenced by Jambi's Gross Regional Domestic Product, the number of vehicles passing through the Batanghari intersection can be calculated, as shown in Table 4.

Table 4. Vehicle Volume for the Next 20 Years

Traffic Volume																
Weekend																
	Lintas sumatera(U) Rd				Lintas sumatera(S) Rd				KH. A. Majid Rd				Penyengat Rendah Rd			
Time	MC	LV	HV	Sum	MC	LV	HV	Sum	MC	LV	HV	sum	MC	LV	HV	Sum
16.00 - 17.00	**2359**	**1400**	**280**	**4039**	**1105**	**684**	**170**	**1959**	**1529**	**956**	**18**	**2503**	**273**	**39**	**6**	**318**

3.6 Intersection Simulation Modeling

Simulation modeling with Vissim software is performed following the steps of simulation modeling, which involve inputting processed data. The input data includes the vehicle model used, the distribution of vehicle speeds, travel routes, vehicle compositions, and the number of vehicles for each lane, based on observational data.

3.7 Simulation Modeling Calibration and Validation

Calibration in microsimulation is a process of establishing appropriate parameter values so that the model can replicate traffic conditions as closely as possible. The calibration process can be based on the observed behavior of drivers in the area. The method employed is trial and error, referring to previous research on calibration and validation for microsimulation [19].

Table 5. Calibration Value at the Intersection

Average Standstill Distance	Additive Part of Desired Safety Distance	Mutiplic. Part of Desired Safety Distance	Lane Change Rule	Desired Lateral Position	Lateral Distance Driving	Lateral Distance Standing	Safety Distance Reduction factor
0.6 m	0.6 m	1	Free Lane Selection	any	0.5 m	0.5 m	0.5

Microsimulation validation is the process of testing the accuracy of calibration by comparing observation results with simulation results. The validation process is based on the volume of traffic flow and queue length. The method used involves employing the basic Chi-squared formula, specifically the statistical formula by Geoffrey E. Havers (GEH) [20]. The results of the analysis after calibration with the GEH test on vehicle volume based on the parameter values above are shown in Table 6 :

Table 6. Validation Results with the GEH Test on Traffic Volume

	Road Name	Vehicle Volume
Observasion	Lintas sumatera(U) Rd	1572
	Lintas sumatera(S) Rd	762
	KH. A. Majid Rd	974
	Penyengat Rendah Rd	123
Model	Lintas sumatera(U) Rd	1440

	Road Name	Vehicle Volume
(Average)	Lintas sumatera(S) Rd	720
	KH. A. Majid Rd	890
	Penyengat Rendah Rd	110
GEH Test	Lintas sumatera(U) Rd	2.76%
	Lintas sumatera(S) Rd	1.25%
	KH. A. Majid Rd	2.23%
	Penyengat Rendah Rd	0.97%
Results	GEH < 5, Accepted	Accepted

Based on Table 6, it can be concluded from the calibration values in Table 5 that the modeling results are accepted. Calibration and validation are two important stages in the simulation modeling process. Calibration is the process of adjusting model parameters based on empirical data to increase the precision and accuracy of the model. The main objective of calibration is to ensure that the simulation model can represent the behavior of the system according to the available empirical data. This process involves a comparison between the model output and empirical data to identify differences and change the model parameters so that the model output matches the empirical data.

3.8 Existing Intersection Simulation Modeling, Proposals and Alternatives

Figure 4. The existing Model is a model for current conditions

Figure 5. Model of the proposed geometric change plan

Figure 5 is a model for the conditions of the proposed geometric change plan, where changes occur due to the proposed bridge duplication plan which was originally an intersection changed to a U-Turn

Figure 6. Alternative Models

Figure 6 is a model for alternative conditions, where changes occur due to the proposed plan for duplicating the bridge which was originally an intersection changed to a U-Turn and the authors added a Ramp in the form of a flyover on the KH road. A. Majid went straight to the Batanghari bridge.

3.9 Analysis of Microsimulation Results at Intersections

The results of the parameters in Table 5 will then be used to calculate the performance of intersection traffic. The analysis is carried out by taking the value of queue length, delay, travel length, and vehicle travel time at the Vissim output. Observation results can be seen in Table 7-9 below:

Table 7. Vehicle Queue Length

Direction	Queue Length (m)						
	Existing	**Existing (Side Disturbance)**	**Proposal**	**Alternative**	**Existing +20 years**	**Proposal +20 years**	**Alternative +20 years**
KH. A. Majid - Lintas Sumatera (U)	12,73	46,42	0,66	0,31	246,43	185,63	96,23
KH. A. Majid - Lintas Sumatera (S)	12,73	110,42	0,66	0,63	246,43	185,63	107,73
KH. A. Majid - Penyengat Rendah	39,6	46,42	0,66	0,63	315,27	185,63	107,73
Lintas Sumatera (U) - KH. A. Majid	8,96	6,44	22,85	0,06	239,89	360,28	31,13
Lintas Sumatera (U) - Lintas Sumatera (S)	35,35	37,86	0,03	0,06	280,14	271,15	1,83
Lintas Sumatera (U) - Penyengat Rendah	34,68	36,93	45,67	0,06	279,71	449,41	1,83
Penyengat Rendah - Lintas Sumatera (U)	0,53	3,2	0	0,07	55,75	0	30,31
Penyengat Rendah - KH. A. Majid	0,8	3,4	0,27	0,1	55,97	2,97	30,31
Penyengat Rendah - Lintas Sumatera (S)	0,91	3	0,12	0,07	55,77	2,1	30,31
Lintas Sumatera (S) - Lintas Sumatera (U)	29,48	238,36	0,54	0,12	216,02	5,93	60,44
Lintas Sumatera (S) - KH. A. Majid	27,51	233,53	6,42	0,12	211,96	83,92	60,44
Lintas Sumatera (S) - Penyengat Rendah	27,51	233,53	6,42	0	211,96	83,92	10,41
Average	**19,06**	**83,2925**	**6,69**	**0,14**	**195,69**	**125,03**	**44,22**
Queue Length Decreasing from *Existing* (%)		**-337,00%**	**64,90%**	**99,27%**		**36,11%**	**77,40%**

From Table 7, the average queue length of vehicles at the Existing Intersection is 19.06 m, at the Proposal is 6.69 m, and at the Alternative is 0.14 m, where there is a decrease in the queue length from the Existing with the Proposal by 64.9%, a decrease in the queue length from the Existing with an Alternative of 99.27% and addition of Queue Length from Existing to Existing (Side Disturbances) of 337%. In the conditions of the next 20 years, the average length of the vehicle queue at the Existing Intersection is 195.69 m, at the Proposal it is 125.03 m, and at the Alternative it is 44.22 m, where there is a decrease in the queue length from the Existing with the Proposal by 36.11% and a decrease queue length from Existing with an alternative of 77.4%.

Table 8. Vehicle Delay

Direction	Vehicle Delay (s)						
	Existing	**Existing (Side Disturbance)**	**Proposal**	**Alternative**	**Existing +20 years**	**Proposal +20 years**	**Alternative +20 years**
KH. A. Majid - Lintas Sumatera (U)	36,03	70,97	32,23	0,14	256,32	191,29	16,85
KH. A. Majid - Lintas Sumatera (S)	17,86	107,87	39,6	5,16	339,16	227,62	45,47
KH. A. Majid - Penyengat Rendah	45,05	100,6	41,11	5,2	299,94	193,32	46,32
Lintas Sumatera (U) - KH. A. Majid	9,96	30,74	0,52	5,21	69,23	78,66	3,69
Lintas Sumatera (U) - Lintas Sumatera (S)	45,85	31,24	42,48	11,19	140,61	210,59	5,94
Lintas Sumatera (U) - Penyengat Rendah	44,12	8,81	20,68	0,19	108,63	83,73	9,61
Penyengat Rendah - Lintas Sumatera (U)	8,64	18,73	0,33	0,7	146,33	1,05	12,76
Penyengat Rendah - KH. A. Majid	13,11	50,37	4,1	0,5	203,44	10,82	31,07
Penyengat Rendah - Lintas Sumatera (S)	22,33	19,80	45,2	0,91	214,79	224,89	36,47
Lintas Sumatera (S) - Lintas Sumatera (U)	22,83	212,56	16,79	4	32,44	79,91	34,89
Lintas Sumatera (S) - KH. A. Majid	19,67	196,15	15,73	1,06	31,25	74,47	20
Lintas Sumatera (S) - Penyengat Rendah	18,95	251,35	14,98	0,35	25,42	85,15	2,48
Average	**24,63**	**91,60**	**20,74**	**1,16**	**79,85**	**110,58**	**14,84**
Vehicle Delay Decreasing from *Existing* (%)		**-271,90%**	**15,79%**	**95,29%**		**-38,48%**	**81,42%**

From Table 8, the average vehicle delay at the Existing Intersection is found to be 25.37 seconds, at the Existing Intersection (Side Disturbance) is 91.6 seconds, in the Proposed scenario is 22.81 seconds, and in the Alternative scenario is 2.88 seconds. There is a reduction in delay from the Existing to the Proposed by 10.07%, a reduction in delay from the Existing to the Alternative by 88.63%, and an increase in queue length from the Existing to the Existing (Side Interference) by 271.9%.

In the condition of 20 years into the future, the average vehicle delay at the Existing Intersection is projected to be 155.63 seconds, in the Proposed scenario is 121.79 seconds, and in the Alternative scenario is 22.13 seconds. There is a reduction in queue length from the Existing to the Proposed by 21.74% and a reduction in queue length from the Existing to the Alternative by 85.78%.

Table 9. Vehicle Travel Length

Direction	Travel Length (m)						
	Existing	Existing (Side Disturbance)	Proposal	Alternative	Existing +20 years	Proposal +20 years	Alternative +20 years
KH. A. Majid - Lintas Sumatera (U)	332,5	332,5	634	347,6	332,5	634	347,6
KH. A. Majid - Lintas Sumatera (S)	312,75	312,75	610	610	312,75	610	610
KH. A. Majid - Penyengat Rendah	337	337	337	337	337	337	337
Lintas Sumatera (U) - KH. A. Majid	239,8	239,8	187,5	187,5	239,8	187,5	187,5
Lintas Sumatera (U) - Lintas Sumatera (S)	373,15	373,15	378,3	378,3	373,15	378,3	378,3
Lintas Sumatera (U) - Penyengat Rendah	340,4	340,4	651,16	651,16	340,4	651,16	651,16
Penyengat Rendah - Lintas Sumatera (U)	335	335	335	335	335	335	335
Penyengat Rendah - KH. A. Majid	313,5	313,5	325,5	325,5	313,5	325,5	325,5
Penyengat Rendah - Lintas Sumatera (S)	353,24	353,24	491,75	491,75	353,24	491,75	491,75
Lintas Sumatera (S) - Lintas Sumatera (U)	373,2	373,2	373,2	373,2	373,2	373,2	373,2
Lintas Sumatera (S) - KH. A. Majid	346,3	346,3	364	364	346,3	364	364
Lintas Sumatera (S) - Penyengat Rendah	350	350	350	350	350	350	350

From Table 9, the increase in travel length from Existing to Proposed is observed :
KH. A. Majid - Penyengat Rendah: Increases from 312.75 m to 610 m.
KH. A. Majid – Lintas Sumatera (U): Increases from 332.5 m to 634 m.
Lintas Sumatera (U) - Penyengat Rendah: Increases from 340.4 m to 651.16 m.
Penyengat Rendah - Lintas Sumatera (S): Increases from 353.24 m to 491.75 m.
Additionally, there is a decrease in travel length from Lintas Sumatera (U) to KH. A. Majid, reducing from 239.8 m to 187.5 m.

Table 10. Vehicle Travel Time

Direction	Vehicle Travel Time (s)						
	Existing	Existing (Side Disturbance)	Proposal	Alternative	Existing +20 years	Proposal +20 years	Alternative +20 years
KH. A. Majid - Lintas Sumatera (U)	75,46	176,3	113,97	39,36	278,39	267,05	52,95
KH. A. Majid - Lintas Sumatera (S)	80,98	142,29	122,02	76,09	293,25	268,77	98,57
KH. A. Majid - Penyengat Rendah	57,45	81,52	88,48	45,40	272,14	272,64	67,32

Direction	Vehicle Travel Time (s)						
	Existing	Existing (Side Disturbance)	Proposal	Alternative	Existing +20 years	Proposal +20 years	Alternative +20 years
Lintas Sumatera (U) - KH. A. Majid	39,60	36,47	22,19	22,21	94,43	91,84	30,04
Lintas Sumatera (U) - Lintas Sumatera (S)	91,26	91,24	96,58	46,28	166,45	264,19	68,69
Lintas Sumatera (U) - Penyengat Rendah	64,10	88,86	105,08	75,53	124,83	170,50	97,00
Penyengat Rendah - Lintas Sumatera (U)	47,39	53,13	39,21	39,20	180,93	39,59	48,28
Penyengat Rendah - KH. A. Majid	51,15	88,89	43,32	44,29	206,67	49,92	73,61
Penyengat Rendah - Lintas Sumatera (S)	64,23	98,23	110,38	66,69	202,41	289,29	97,52
Lintas Sumatera (S) - Lintas Sumatera (U)	66,23	283,04	54,12	44,17	123,73	68,50	71,25
Lintas Sumatera (S) - KH. A. Majid	67,55	219,38	55,68	48,44	122,82	75,19	98,53
Lintas Sumatera (S) - Penyengat Rendah	62,32	290,55	50,29	39,48	114,97	57,18	45,19
Average	63,98	137,49	75,11	48,93	181,75	159,55	70,75
Vehicle Travel Time Decreasing from *Existing* (%)		-114,91%	-17,40%	23,52%		12,21%	61,08%

From Table 10, the average vehicle travel time at the Existing Intersection is found to be 63.32 seconds, at the Existing Intersection (Side Disturnce) is 137.49 seconds, in the Proposed scenario is 75.11 seconds, and in the Alternative scenario is 48.93 seconds. There is an increase in travel time from the Existing to the Proposed by 17.4%, an increase in travel time from the Existing to the Existing (Side Disturbance) by 114.91%, and a decrease in travel time from the Existing to the Alternative by 23.52%.

In the condition of 20 years into the future, the average vehicle travel time at the Existing Intersection is projected to be 181.75 seconds, in the Proposed scenario is 159.55 seconds, and in the Alternative scenario is 70.75 seconds. There is a decrease in travel time from the Existing to the Proposed by 12.21% and a decrease in travel time from the Existing to the Alternative by 61.08%.

4. CONCLUSION

Based on the analysis that was carried out, several conclusions can be drawn, namely from the results of the microsimulation carried out on the Proposed model, it is found that there is a 64.9% decrease in Queues, 10.07% decrease in Delays, and 17.4% additional Travel time from the Existing model, and in the Alternative model in get 99.27% decrease in Queue, 88.63% decrease in Delay, and 23.52% decrease in Travel time over the existing model. From the results of the microsimulation carried out for the next 20 years, we get a decrease in Queues of 36.11%, a decrease in Delays of 21.74%, and a decrease in Travel

Time of 12.21% from the Existing model, and in the Alternative model we get a decrease in Queues of 77.40%, a decrease in Delays of 85.78%, and 61.08% reduction in travel time from the Existing model. From the results of the microsimulation carried out, it can be concluded that the proposed model of the geometric change plan can reduce queue length and vehicle delays but there is an increase in travel time, while the alternative model can reduce queue length, delays and travel time better than the proposed geometric change plan, the authors recommend Alternative Models.

The suggestions that can be given from the results of this study are that there is a need for further research to improve the traffic management system, both management at intersections and roads around intersections and further research on driver behavior in more detail. In addition, it is necessary to review the proposed geometric change plan prior to implementation. Finally, there needs to be regulation and firmness of the agencies involved in the traffic rules at the Batanghari intersection.

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