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Strenghtening the Performance of Unsignalized Intersections in Dinoyo District

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Abstract. Malang City is widely acknowledged as one of the big cities that has a fairly high population density, centered as an educational city and a tourist city. The population density is proportional to the increasing volume of traffic flow which causes congestion at various points of the city, one of which is at the intersection of three streets, including: MT. Haryono XXI, Pisang Kipas and Vinolia, in Dinoyo. The intersection accommodates a large volume of vehicles but the narrow road infrastructure makes this intersection a source of congestion that can affect the performance of the surrounding roads. The uneven geometric condition of the road adds to the condition of the intersection, prone to accidents, thus it is necessary to analyze the traffic improvement at the intersection. This study utilizes the manual traffic counting method to solve problems at the intersection. The results of the study indicated that the degree of saturation was one point zero nine on MT. Haryono XI, was one point zero nine on Pisang Kipas, and was zero point nine two on Vinolia. The three intersections fall into the category of low service level (F), this category level of service explains that traffic flow is obstructed and traffic delays are long. To solve this problem, traffic flow diversion is utilized which can reduce the accumulation of the number of vehicles at the intersection. The three intersections fall into the category of low service level (F), this category level of service explains that traffic flow is obstructed and traffic delays are long. To solve this problem, traffic flow diversion is used which can reduce the accumulation of the number of vehicles at the intersection. The three intersections fall into the category of low service level (F), the service level of this category explains that traffic flow is obstructed and traffic delays are long. To solve this problem, traffic flow diversion is applied which can reduce the accumulation of the number of vehicles at the intersection.

PRELIMINARY

Transportation infrastructure becomes one of the supporting factors for the growth and development of the city. Cities that have good infrastructure planning and design can increase community productivity. The growth and development of the city affects various sectors including the social, economic, educational sectors[1][2]. Roads are the most frequently used transportation infrastructure by the community, but the road transportation infrastructure available in Indonesia is not yet effective. Congestion that usually occurs on the main road is currently also found on alternative roads, in which the source of congestion is centered on the intersection area[3].

An intersection refers to a meeting point of various traffic flows that serves to connect two or more intersecting road segments[4][5][6]. If the problem at the intersection is not addressed, it will affect the performance of the surrounding road and can hinder the movement of vehicles at the intersection[7]. Such problems also occur at the intersection of Pisang Kipas, Vinolia, and MT. Haryono XI, Malang, which is a meeting point that connects the three alternative roads that people are most interested in. This intersection connects the Dinoyo village and Karangploso sub-district with the closest route. Hence, this intersection offers an alternative route for students to reach the Polynema University.

The large volume of passing vehicles is not supported by adequate facilities, the small capacity of the road can only accommodate a part of the total volume of vehicles. The width of Jalan MT. Haryono XI is six meter, the width of the Pisang Kipas is six meter wide and Vinolia is eight meter. Ineffective road facilities lead to the unexpected outcome, presenting a high risk of congestion and accidents. The solution to the intersection problem is analyzed by implementing various methods, one of which is the method used in intersection at Pontianak using the Gap Attendance method[8][9]. The Gap Attendance method or the acceptance of the critical time is utilized to measure gap between the trajectory of a vehicle and the arrival of the next vehicle. This method uses time difference analysis of passing vehicles in assessing intersection performance[10].

The condition of the intersection that has a vehicle capacity exceeding the road capacity requires an analysis of the vehicle capacity and road capacity which can be obtained in the traffic counting calculation method. Traffic counting

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is a method of processing the value of road capacity and vehicle volume to get the value of intersection saturation (level of service). The level of saturation or level of service (DS) is the ratio of the volume of vehicles that pass by the limit that can be accommodated by the road[11]. Traffic counting method is more suitable to be used to analyze the intersection of Pisang Kipas, Vinolia and MT. Haryono XI street is compared with gap attendance analysis which requires more complex problems than the three intersections above. The purpose of this study is to analyze the degree of saturation at the intersection and provide alternative solutions to the problem of the intersection on Pisang Kipas, Vinolia, and MT. Haryono XI.

RESEARCH METHODS

The research at this intersection performs an analysis of the manual traffic counting calculation method based on the Indonesian Road Capacity Manual (MKJI) guidelines. The data required for this traffic counting calculation are vehicle volume, road volume, and road capacity. The following is a description of the geometric data of the intersection of Pisang Kipas, Vinolia, and MT. Haryono XI Street in Dinoyo, Malang. The survey was conducted from 4pm to 5pm in one day.The geometric data was found by the survey which is described in the figure 1.

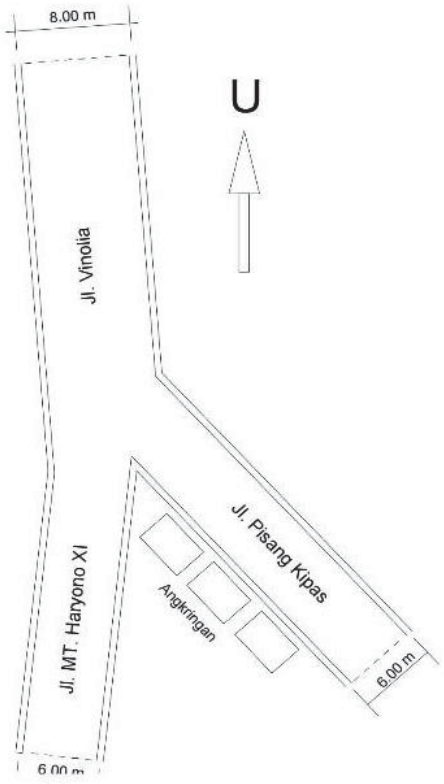

FIGURE 1. Survey Location

The results of the survey describe the conditions on Vinolia is a densely populated residential area directly adjacent to the road, dense settlements fill the area on the right and left side of the road. At the right end of the road there is a motorcycle wash that uses the sidewalk as their parking lot. MT. Haryono XI, has a slightly uphill geometric road, but there are no side obstacles on this road segment. Pisang Kipas presents side obstacles on the right side of the road, with the right shoulder is used as parking lot.

RESULTS AND DISCUSSION

Analysis of the Degree of Saturation of the Road Service Level

The results of the research survey of vehicle volume and road geometry indicate the saturation value as a reference for the level of road service. The results of data processing are illustrated in Table 1, Table 2, Table 3, Table 4, and table 5

TABLE 1. Calculation of Vehicle Volume on MT Haryono XI Street

Intersection MT Haryono (6m)			
Transportation type	15 minutes	60 minutes	emp Factor
Motorcycle	382	1528	764
Car	31	124	124
Heavy vehicle	0	0	0.0

TABLE 2. Calculation of Vehicle Volume on Vinolia Street

Intersection Vinolia (8m)			
	15 minutes	60 minutes	emp Factor
Motorcycle	402	1608	804
Car	60	240	240
Heavy vehicle	1	4	5.2

TABLE 3. Calculation of Vehicle Volume on Pisang Kipas Street

Pisang Kipas Intersection (6m)			
	15 minutes	60 minutes	emp Factor
Motorcycle	278	1112	556
Car	30	120	120
Heavy vehicle	0	0	0.0

Table data on the volume of vehicles crossing three interconnecting road are calculated in two times, the first time is fifteen minutes then the second time is sixty minutes. Calculation of the number of vehicles is divided into three categories, which are motorcycles, heavy vehicles such as small buses, combined trucks with six wheels, and low vehicles such as micro buses, pick-ups and small trucks. The results of the volume of vehicles are then equalized into one type of passenger vehicle called the EMP factor. The EMP factor refers to a factor that equals the number of vehicle volumes by multiplying the equivalence value.

TABLE 4. Road Volume Calculation

Road Description	Distance (m)	Motor (sat)	car (sat)	Heavy Vehicle (sat)	emp Factor	emp
MT. Haryono XI St.	6	764	124	0	888	
Vinolia St.	8	804	240	5.2	1049	2613
Pisang Kipas St.	6	556	120	0	676	

The overall data for the EMP factor produced is 2613, which means the number of vehicles passing through the intersection is considered very dense. On Vinolia St. has the highest number of vehicle volumes, which is 1049, there is a buildup of vehicles passing from the direction of MT. Haryono XI St. and Pisang Kipas St. on Vinolia St. The vehicle volume data will then be compared with the road capacity data contained in table 5 to find the saturation level value

TABLE 5. Calculation of Road Capacity

Information	Co	FCw (Out of Town)	FCsp	FCcs	FCsf	C	DS	Level Service
MT. Haryono XI St.	3000	0.91	1	0.94	0.93	2386.57	1.09	F
Pisang Kipas St.	3000	0.91	1	0.94	0.93	2386.57	1.09	F
Vinolia St.	3000	1.08	1	0.94	0.93	2832.41	0.92	E

From the road capacity calculation table data, it is explained that the level of road service produced at three intersections is very low, the DS value which touches the number one point zero nine concludes that the level of service on two roads gets an F value while the service level on Vinolia is at level E. Service levels E and F have obstructed traffic flow, slow speeds, and long traffic delays. The level of road service describes the characteristics of road traffic flow according to its category.

Value of Degree of Saturation (DS)

Conditions that occur at the intersection of Pisang Kipas St., Vinolia St. and Dinoyo St., Malang are very congested, long vehicle delays and inadequate road conditions make this crossroads area prone to accidents. From the results of the research, the researchers obtained the following data:

- The DS value is one point zero nine; thus, the Road Service Level of MT. Haryono XI St. has an F value, which means that the road has the characteristics of obstructed flow, low speed, volume above capacity, congestion often occurs for quite a long time.
- The DS value is one point zero nine; thus, Road Service Level of Pisang Kipas St. has an F value, which means that the road has the characteristics of obstructed flow, low speed, volume above capacity, frequent congestion for a long time
- The DS value is zero point nine two; thus, the Road Service Level of Vinolia St. has an F value, which means that the road has unstable current characteristics, low speeds and varies, the volume is close to capacity. From the resulting Road Service Level, there are several factors that influence it, such as from the capacity of the road, the type of road, the number of vehicles that pass, and the type of road that is passed.

Alternative Design of Unsignalized Intersection

The research at this intersection uses an analysis of the manual traffic counting calculation method based on the Indonesian Road Capacity Manual (MKJI) guidelines. From the results of the analysis, a solution for diverting traffic flows is found that can reduce obstacles to intersection traffic of MT. Haryono XI St. and Pisang Kipas St. on Vinolia St. The traffic flow diversion plan is described in the Figure 3.

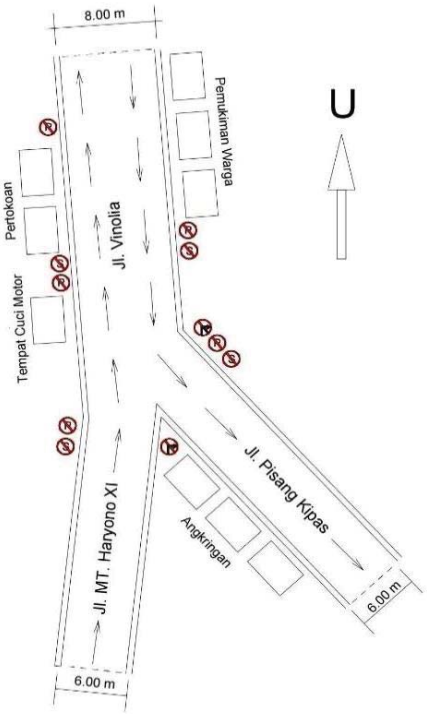

FIGURE 3. Alternative Design Drawing

The alternative planning of the unsignalized intersection depicted in Figure 3 has updated the results of the road capacity calculation, described in Table 6.

TABLE 6. Alternative Calculation of Vehicle Volume

Road Description	Distance (m)	Motor (sat)	car (sat)	Heavy Vehicle (sat)	emp factor	emp
MT. Haryono XI St.	6	382	62	0	444	1306.6
Vinolia St.	8	402	120	2.6	524.6	
Pisang Kipas St.	6	278	60	0	338	

The alternative road capacity data in Table 6 has a number of vehicle volumes that are less than the original vehicle volume calculation, this planning analysis is able to reduce a lot of vehicle volume from the original vehicle volume data. The vehicle volume data will then be compared with the road capacity data contained in Table 7 to find the saturation level value

TABLE 7. Calculation of Alternative Road Capacity

Information	Co	FCw (OUT OF TOWN)	FCsp	FCcs	FCsf	C	DS	Service Level
MT. Haryono XI St.	3000	0.91	1	0.94	0.93	2386,5660	0.5474812	A
Pisang Kipas St.	3000	0.91	1	0.94	0.93	2386,5660	0.5474812	A
Vinolia St.	3000	1.08	1	0.94	0.93	2832,4080	0.4613036	A

The table above informs the result of the calculation of the traffic flow diversion design at the intersection of MT. Haryono XI, Pisang Kipas and Vinolia Street. This design is capable of reducing almost half of the vehicle volume and produce a fairly high level of service. This design effort can be done by installing a left turn prohibited sign on the side of MT. Haryono XI St., as well as the installation of a right turn sign on the side of Vinolia St.

CONCLUSION

In the traffic counting calculations that have been carried out in research at the intersection of MT. Haryono XI, Pisang Kipas and Vinolia Street. It is concluded that the level of service of the roads connected at the intersection is significantly low, the DS results that have been obtained are one point zero nine and zero point nine two, indicating that the service quality of the three roads forming the intersection has been low and is at the service of level F. This result indicates that the level of comfort and safety at the intersection is significantly low.

To achieve the goal of increasing the level of service at the intersection, an alternative solution is suggested in the form of diverting the traffic flow at the intersection. The results of calculations with the experiment of diverting traffic flow at this intersection resulted in a low DS value, indicating that this alternative design could increase the level of service up to an A value.

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