**THE ANALYSIS OF TRAFFIC DELAY AND VEHICLE QUEUE DUE TO SHUNTING ACTIVITY OF PERTAMINA TRAIN IN TEGAL CITY**

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**ABSTRACT**

An intersection formed from a meeting between two types of transportation infrastructure which are a highway and a railroad is form of a meeting that often causes traffic delay, such as at the crossing on Abimanyu Street in Tegal city. It often occurs traffic jams, long queue vehicles at the railroad crossing which is caused by shunting activity of PT Depo Pertamina Tegal. This research aims to analyze the traffic volume, delay and length of queue vehicles on each traffic road that comes to a standstill due to the closing of railroad crossing gate during shunting activity, as well as providing the best alternative that is acceptable both from the side of Pertamina's management and from the side of the road users. In this study, the data obtained is calculated by using the method of Indonesian Road Capacity Manual (MKJI 1997) to find out v/c ratio analysis, queue analysis and delays. Based on the research, the results of the analysis show the existence of vehicle queues and delays in each segment of the road section. The highest queue occurs on the Abimanyu street, which is 70.5 pcu with the delay time 581.5 seconds/pcu. The road segment of the Menteri Supeno I street, the vehicle queue reached 47.8 pcu with the delay time 441 seconds/pcu, then the vehicle queue on the Semeru street is 17 pcu with the delay 395.6 seconds/pcu, and the last queue is at the Menteri Supeno II street 10.8 pcu with a delay time of 368.5 seconds/pcu. The impacts of the shunting activity of the Pertamina petrol train are the traffic jams and long queue of the vehicles. One key to overcome the problems is to divide the shunting activity into 2 phases according to alternative analysis II which the vehicle queue becomes fewer at 35.3 pcu and the delay time is 290 seconds /pcu, and change the schedule of shunting process which is at *off peak* time (when traffic is not busy).

Keywords : V/C Ratio, Delay, Queue Length

1. **INTRODUCTION**

Transportation is a tool that is very important in supporting people's and economic activities in a region or city, because indirectly transportation has become a main necessity for every human as a tool to fulfill the needs of life. In a day, every person travels on average more than once with different destinations such as workplace, school, shopping area, recreation and others. Of course to reach the trip destination, people has to do the process of transportation that involved vehicles as a tool, as well as involving roads as infrastructure.

In reality, the transportation doesn’t always run smoothly, traffic jam and obstacle on road become one of the inhibiting factors. Finally, it causes disadvantages such as wasting time, loss of opportunity, air pollution, and the waste of fuel. That's the reason we have to overcome this problem to minimize the traffic jam, even though we know that it's not going to work one hundred percent.

From the result of traffic flow observation, Tegal city has the characteristics of the traffic that is relatively smooth, only in certain conditions the traffic doesn't flow smoothly. Especially at the intersection and railroad crossing gate that cause long queue of vehicles so that the traffic comes to a standstill. Traffic jams usually occur during rush hour where there are many vehicles since people are on their way home after working which causes queue and delay at the railroad crossing. The worst condition happens when there is a shunting activity of Pertamina petrol train which causes the delay time about 13-15 minutes/shunting activity, while the queue of vehicles reaches 200 meters on Abimanyu street, Tegal city. (Result of field observations, 2019)

Since the railroad crossing gate is closed, the other roads also get the impact of shunting activity. Traffic jam doesn't only happen on Abimanyu Street but it also occurs on Supeno I street, on Semeru street, and on Supeno II street. That condition causes disadvantages for people as road users because it wastes their time on the street. Therefore, the writer is interested to conduct a research about **THE ANALYSIS OF TRAFFIC DELAY AND VEHICLE QUEUE DUE TO SHUNTING ACTIVITY OF PERTAMINA TRAIN IN TEGAL CITY.**

1. **REVIEW OF THE RELATED LITERATURE**
   1. **Railroad crossings**

Railroad crossing or also known as level crossing is a meeting point for highways with mutually cut railroad tracks.  In Indonesia, a level road meeting between a railroad tracks with a highway is known as a crossing. Crossing that has lower frequencies usually for reasons of safety for road users and users of rail freight then the path equipped with signs for “ *stop* " or " *cross bugs*". But when the volume of currents becomes large between the incoming and outgoing traffic from the track, the installation of a control system becomes very necessary.

* 1. **Shunting Activity**

Shunting activity (or more popular as shunter ) is the movement of a series of [trains](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/wiki/Kereta) , [carriages](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/wiki/Gerbong) , or just [locomotives](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/wiki/Lokomotif) to change [rail](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/wiki/Rel) lines . Change of lane is mainly needed to separate or assemble trains or carriages. Because the shunting process requires special expertise so that it can take place safely, the shunting activities are usually guided by a shunter. The shunter can do directly in the [yard sidings](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/w/index.php%3Ftitle%3DHalaman_langsir%26action%3Dedit%26redlink%3D1) or control the shunting process from [home sidings](https://translate.google.com/translate?hl=jw&prev=_t&sl=id&tl=en&u=https://id.wikipedia.org/w/index.php%3Ftitle%3DRumah_langsir%26action%3Dedit%26redlink%3D1) . While the steering control is on the machinist who sits in the locomotive moving the train by following the instructions from the shunter. The length of time of the shunting activity can also be determined by the expertise and skills of the machinist and the shunter.

* 1. **The objective of the yard**

Langsir activities are very possible to happen both at the station, at the Depo (train workshop) and at other train stops, while in general the purpose of the yard trip is as follows:

1. Arranging a series of trains
2. Add or decrease the number of carriages in the series
3. Eliminating the series for trains that want to return to the train depot.

The purpose of the shunting activity which happened on Jl. Abhimanyu Tegal City itself is part of a series of activities to take empty tankcars from inside the Pertamina Depot yard and enter tankcars which has been filled with fuel.

* 1. **Yard Time**

In one day, Pertamina does the shunting activities 3 times, the first at 10:00 WIB until finish, the second at 13.30 WIB until finish, the third at 18.30 WIB until finish.

* 1. **Analysis of V/C Ratio**

VC ratio is one of the aspects in measuring the performance parameters of road section, which the ratio of heavy traffic flow on the road section and traffic capacity. Traffic volume is the number of vehicles that pass a certain point or line on a cross section of the road (Sukirman, 1994).

1. **Traffic Volume**

To calculate the traffic volume can be done by classifying the type of vehicle first and then converting it into a Passenger Car Unit (pcu). For more details, see the table 2.1 below:

**Table I.**  Value of PCE (Passenger Car Equivalency)

|  |  |
| --- | --- |
| Type of Vehicle | Passenger Car Equivalency  (pcu/hour) |
| Heavy Vehicle (HV) | 1,3 |
| Light Vehicle (LV) | 1,0 |
| Motorcycle (MC) | 0,4 |

*Source* : Indonesian Road Capacity Manual 1997

1. **Road Capacity**

Capacity is the maximum volume of traffic flow that can be accommodated in a highway facility during a given time period under prevailing roadway, traffic and control conditions. It is better known as "maximum capacity" of road section to the volume of traffic that passes. Road capacity has various abilities, depending/influenced by the width and use of the road (one or two directions). The value of road capacity is referred to pcu/hour (Passenger Car Unit per hour). The calculation of capacity for urban road is as follows:

*C = C ox FC wx FC spx FC sfx FC cs(pcu / hour)*……… . (2.3)

Which :

C : Capacity (pcu / hour)

C o : Basic capacity (pcu / hour)

FC w : Traffic lane width adjustment factor

FC sp : Directional separation adjustment factor

FC sf : Side drag adjustment factor

FC cs : City size adjustment factor

**Table II.** Level of Service based on V/C ratio

|  |  |  |
| --- | --- | --- |
| **Scope Limit V/C** | **Level of Service** | **Characteristics of Traffic Flow** |
| 0,0 s/d 0,19 | A | free traffic flow conditions with the speed of at least 80 km / hour, traffic density is very low, the driver can maintain the speed without or with a slight delay. |
| 0,20 s/d 0,44 | B | the current traffic flow condition is stable with the speed of at least 70 km / hour, low traffic density, internal traffic obstacles have not affected to the speed, the driver still has enough freedom to choose his speed and the lane used. |
| 0,45 s/d 0,69 | C | the traffic flow is stable but the movement of the vehicle is controlled by higher traffic volume and speed of at least 50 km / hour, moderate traffic density, due to internal traffic barriers increase, drivers have limitations to choose speed, move lane or overtake. |
| 0,70 s/d 0,84 | D | the traffic flow is approaching unstable with high traffic volume and speed of at least 50 km / hour, moderate traffic density but traffic volume fluctuations and temporary obstacles can cause very large speed decreases, the driver has very limited freedom in driving, this conditions is still tolerated for a short time. |
| 0,85 s/d 1 | E | The traffic flow is approaching unstable with traffic volume approaching road capacity and speed of at least 30 km / hour on inter-city roads and at least 10 km / hour on urban roads, high traffic density due to high internal traffic barriers, drivers start feel jams with short duration. |
| > 1,0 | F | The traffic flow is approaching unstable with traffic volume approaching road capacity and speed of at least 30 km / hour, high traffic density and congestion occurring for a long duration, both in queue of speed and volume falling to zero. |

* 1. **Vehicle Queue**

The length of the queue is measured when the railroad crossing gate starts to be closed until the gate is opened, whereas to calculate the average queue is as follow:

NQ = Σn / n ....... .................. ( 2. 7 )

Which :

NQ = Average number of queues (junior high)

Σn = Total number of vehicles in the queue (smp

N = Number of tracks closed

* 1. **Ratio of Vehicles that stop**

The ratio of stopped vehicle Nsv is the ratio of vehicle that must stop due to a red signal before passing an intersection, i is calculated as:

***N sv = Q x NS (junior high / hour)***........................... ..... (2.13)

Which NS is the stop number and an approximation while Q is the traffic flow (pcu / hour).

* 1. **Delay**

The average traffic delay in a j approach can be determined from the following formula (based on Akcelik 1988):

Which :

DT = the average traffic delay (sec/pcu)

c = cycle time that is adjusted (sec) from Form SIG-IV

A = 0,5 x (1 – *GR*)2 Look the picture E-4:1 below

(1 – *GR* x DS)

GR = green ratio (g/c) from Column 5

DS = degree of saturation from Column 4

NQ1 = the remaining number of pcu from the previous green phase from Column 6

C = capacity (pcu/hour) from Column 3

* 1. **Thinking Framework**

**Shunting activity**

(Shunting activity happens at railroad crossing)

Shunting activity causes the railroad crossing gate is closed

The closing duration of railroad crossing gate is too long

Shunting activity impact

1. Traffic jam
2. Long queue of vehicle
3. Long delay time
4. Comparing traffic volume and capacity of road
5. Queue of vehicle when shunting activity
6. Delay time when shunting activity
7. Analysis of V/C Ratio
8. Analysis of Queue
9. Analysis of Delay
10. Phase of Alternative 1
11. Phase of Alternative 2
12. Phase of Alternative 3

**Solution**

Choose the best alternative among the three alternatives

**Recommendation**

Time of Shunting activity is divided into several phases to reduce the queue and delay

(**Picture 1 :** *Thinking Framework*)

**3.1. RESEARCH METHODOLOGY**

* 1. **Research Location**

The study was conducted around the railroad crossing gate nearby PT. Pertamina Tegal. The researcher did the observation and field survey in several points of location or road section that has been divided into several segments including:

Segment 1 : Abimanyu street. It is in front of PT Pertamina Tegal.

Segment 2 : Semeru street

Segment 3 : Menteri Supeno I street (towards Senior High School 1 Tegal)

Segment 4 : Menteri Supeno II street (towards Yos Sudarso Stadium)



Picture 3.1. roads section affected by shunting activity

**3.3. Data Requirement**

In conducting research, it is definitely need data related to the object to be studied. Based on their needs the data is divided into 2 (two) types:

1. Secondary Data

Data secondary can be obtained through literature, journals, government, private, or of the reference print / electronic. Secondary data include schedule of traffic, road network maps, and picture / image maps.

1. Primary data

Data primer derived from observation and survey data on the location of the shunt. The primary data needed include:

* 1. Traffic Volume Survey

Counting the volume of traffic on the affected road sections, namely by counting the number of vehicles passing through the road and classifying them based on the type of vehicle.

* 1. Road Inventory Survey

Check road conditions by measuring the road and its equipment directly using a roll meter gauge. The data of the road condition is used to calculate the capacity of existing road sections.

* 1. Queue and Delay Surveys

The data of queue and delays were obtained when the process of shunting activity by recording, counting and measuring according to the conditions that occur in the location.

**3.4.  Data analysis**

1. Calculate the amount of traffic volume on the affected road sections due to shunting activity at the research location by classifying vehicles based on their type.
2. Calculate the capacity of the road on the road segments that are affected due to shunting activity. Calculate capacity by carrying out an inventory of roads and equipment based on the actual conditions in the field such as the width of the lane, the width of the lane, the shoulder of the road, the sidewalk, and others. There are several factors that need to be considered in calculating the capacity of a road section using the following calculation:

*C = C o  x FC w  x FC sp  x FC sf  x FC cs(junior / hour)*

1. Calculate the vehicle queue when shunting activity occurs during the closing of the railroad crossing gate, then make an alternative phase related to the closing time of the railroad crossing gate. For example, the first phase is calculated when the locomotive train enters the depot to transport or pull the empty carriages / tanks out of the depot, then sequence after the last train series passes through the crossing gate then the crossing gate is reopened.

***NQ = NQ1 + NQ2***............................................. ........... (5)

The second phase, the locomotive re-enters the Pertamina depot carrying 16 series of fuel-filled train cars, then the crossing gate is closed again, 8 carriages are released first to line 1 then the remaining 8 cars are pulled back through the crossing gate, when the last circuit passes the crossing gate then the railroad crossing gate is opened again to release the queue.

*NQ1*= 0.25 x C x                                                                       ................ (6)

In the third phase, the remaining 8 train cars were brought back into the depot, and the crossing gate was closed again. The car enters the second lane then the locomotive exits the depot, until the locomotive passes through the crossing gate then the railroad crossing gate is reopened, the shunting process is finished.

Calculating the delay, from each phase the delay is also calculated so that each phase has its own delay value.

                            ............................. (12)

1. Choose the best phase with the fewest queue value and delay, which later will be recommendation to be applied when the shunting activity is running.
2. An alternative selection method was carried out with interviews involving 2 elements, namely the road user and Pertamina, who were directly involved in the shunting activity.

**3.5  Alternative Determination**

1. **Alternative Distribution**

In conducting the analysis, the researcher divides the shunting activity into several alternatives based on the shunting activity itself and the duration of the shunting activity. **Alternative I** is the existing shunting activity, **Alternative II** is the shunting activity is divided into 2 cycles (pick up the empty tanker car, enter the filled fuel tank car), **Alternative III**, divide shunting activity into 4 cycles (take the first set of 8 empty tanker car, take the second set of 8 empty tanker car, put the first set of 8 tanker car, insert the second set of 8 tanker car). The alternative division aims to find the ideal queues and delays to be applied in the shunting activity of pertamina petrol train.

1. **Alternative Selection**

An alternative selection method was done by interviewing 2 elements involved in the shunting activity which are the road user and Pertamina.

* 1. **ANALYSIS**

**4.1. Analysis of V/C Ratio**

V/C Ratio is the way to calculate or measure the level of service of road section, which the traffic volume will be divided by road capacity on existing condition. From the calculation of the volume and capacity, the V / C Ratio results are obtained as follows:

**Table II**. Calculation V/C Ratio

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Road** | **Co** | **FCw** | **FCsp** | **FCcf** | **FCcs** | **C** | **V** | **VC Ratio** |
| Abimanyu Street | 2900 | 1,14 | 0,97 | 0,94 | 0,9 | 2.713 | 2090,1 | 0,77 |
| Menteri Supeno I Street | 2900 | 1,25 | 1 | 0,92 | 0,9 | 3.002 | 1308,0 | 0,44 |
| Semeru Street | 2900 | 0,87 | 1 | 0,92 | 0,9 | 2.089 | 857,0 | 0,41 |
| Menteri Supeno II Street | 2900 | 0,87 | 1 | 0,96 | 0,9 | 2.180 | 682,8 | 0,31 |

(Source : Analysis 2020)

From the calculation V/C Ratio above, it shows that the lowest of level of service of road section is the road section that has the value of V/C Ratio approaches to 1,00 which is on Abimanyu Street with the value 0,77. Based on the table II The Level of Service of Road, belongs to category D. Meanwhile for the road section that has the best level of service is on Menteri Supeno II Street which is 0,31 belongs to category of level of service B.

**4.2. Queue of Vehicle**

The vehicle queue happens because of the closing of railroad crossing gate due to the shunting activity. In one day, Pertamina does the shunting activities 3 times, the first at 10:00 a.m, the second at 13.30 p.m, the third at 18.30 p.m.

**Table III**. Analysis Result of Queue and Delay

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **No** | **Road section** | **Shunting activity** | **Time schedule** | **duration** | **Length of queue** | **Amount of queue** | | | | | | | | |
| **MC** | **LV** | **HV** | **UM** | **Emp** | **Emp** | **Emp** | **Emp** | **Total of Queue** |
| **1** | **Abimanyu Street** | **morning** | **09.30 a.m** | **900** | **177** | **149** | **20** | **2** | **41** | **44,7** | **20** | **2,6** | **16,4** | **83,7** |
| **Afternoon** | **16.00 p.m** | **780** | **110** | **166** | **14** | **2** | **1** | **49,8** | **14** | **2,6** | **0,4** | **66,8** |
| **Evening** | **20.30 p.m** | **720** | **90** | **107** | **26** | **1** | **4** | **32,1** | **26** | **1,3** | **1,6** | **61** |
| **Average** | | **800** | **126** | **Average** | | | | | | | | **70,5** |
| **2** | **Menteri Supeno I Street** | **Morning** | **09.30 a.m** | **900** | **79** | **50** | **21** | **3** | **0** | **15** | **21** | **3,9** | **0** | **39,9** |
| **Afternoon** | **16.00 p.m** | **780** | **182** | **79** | **43** | **3** | **5** | **23,7** | **43** | **3,9** | **2** | **72,6** |
| **Evening** | **20.30 p.m** | **720** | **92** | **36** | **20** | **0** | **0** | **10,8** | **20** | **0** | **0** | **30,8** |
| **Average** | | **800** | **118** | **Average** | | | | | | | | **47,8** |
| **3** | **Semeru Street** | **Morning** | **09.30 a.m** | **900** | **30** | **20** | **7** | **0** | **5** | **6** | **7** | **0** | **2** | **15** |
| **Afternoon** | **16.00 p.m** | **780** | **15** | **23** | **1** | **1** | **7** | **6,9** | **11** | **1,3** | **2,8** | **22** |
| **Evening** | **20.30 p.m** | **720** | **10** | **18** | **6** | **0** | **4** | **5,4** | **6** | **0** | **1,6** | **13** |
| **Average** | | **800** | **18** | **Average** | | | | | | | | **16,7** |
| **4** | **Menteri Supeno II Street** | **Morning** | **09.30 a.m** | **900** | **30** | **10** | **4** | **1** | **4** | **3** | **4** | **1,3** | **1,6** | **9,9** |
| **Afternoon** | **16.00 p.m** | **780** | **15** | **14** | **6** | **0** | **4** | **4,2** | **6** | **0** | **1,6** | **11,8** |
| **Evening** | **20.30 p.m** | **720** | **10** | **7** | **5** | **1** | **6** | **2,1** | **5** | **1,3** | **2,4** | **10,8** |
| **Average** | | **800** | **18** | **Average** | | | | | | | | **10,8** |

  Source: Analysis Results 2020

**4.3. Delay**

The amount of delays and queues of vehicles due to the presence of Pertamina's yard yard can be seen in the table below:

**Table IV.** Choice of Alternative

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Matrix** | **Abimanyu Street** | | | **Menteri Supeno I Street** | | | **Semeru Street** | | | **Menteri Supeno II Street** | | | **Priority** |
| **Queue**  **(pcu)** | **Stopped vehicle (pcu/hour)** | **Delay (sec/pcu)** | **Queue**  **(pcu)** | **Stopped vehicle (pcu/hour)** | **Delay (sec/pcu)** | **Queue**  **(pcu)** | **Stopped vehicle (pcu/hour)** | **Delay (sec/pcu)** | **Queue**  **(pcu)** | **Stopped vehicle (pcu/hour)** | **Delay (sec/pcu)** |
| **Alternative 1** | **70,5** | **285,5** | **581,5** | **47,8** | **193,5** | **441** | **17** | **42,8** | **395,6** | **10,8** | **31,3** | **368,5** |
| **Alternative 2** | **35,3** | **142,8** | **290,8** | **23,9** | **96,7** | **220** | **8** | **21,4** | **197,8** | **5,4** | **15,7** | **184,2** |
| **Alternative 3** | **17,6** | **71,4** | **145,4** | **11,9** | **48,4** | **110** | **4** | **10,7** | **98,9** | **2,7** | **7,8** | **92,1** |
| **Lowest** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Alt III** | **Road user** |
| **Highest** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Alt I** | **Relevant Institute** |
| **Median** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Alt II** | **Road user & relevant institute** |

 (*Source: Analysis Results 2020)*

From the results of analysis above, it can be seen that the highest queue of vehicles and the delays occur on Abimanyu Street and for the highest alternative for the value of the queue of vehicles and the time delay are in Alternative I.

The results of interviews conducted with road users and Pertamina's company can be seen in the table below:

**Table V.** Choice of Alternative

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number of respondent** | **Choice of Alternative I** | **Choice of Alternative II** | **Notes** | **Reasons** |
| 1 | Alternative I | Alternative II | Respondent from Pertamina | shorten fuel loading time, save the time so that fuel can be more quickly distributed to gas stations, wasteful of energy because of the slow process of shunting activity that will take a long time |
| 2 | Alternative I | Alternative II | Respondent from Pertamina |
| 3 | Alternative I | Alternative II | Respondent from Pertamina |
| 4 | Alternative I | Alternative II | Respondent from Pertamina |
| 5 | Alternative I | Alternative II | Respondent from Pertamina |
| 6 | Alternative III | Alternative II | Respondent from road user | waiting time is too long, inhibit the flow of traffic, especially motorcycle users feel the heat because they are too long to wait, for online taxibike often feel disadvantaged because customers sometimes cancel the order, feeling bored of waiting for the shunting activity, it often causes friction between vehicles when the railroad crossing gate is opened |
| 7 | Alternative III | Alternative II | Respondent from road user |
| 8 | Alternative III | Alternative II | Respondent from road user |
| 9 | Alternative III | Alternative II | Respondent from road user |
| 10 | Alternative III | Alternative II | Respondent from road user |
| 11 | Alternative III | Alternative II | Respondent from road user |
| 12 | Alternative III | Alternative II | Respondent from road user |
| 13 | Alternative III | Alternative II | Respondent from road user |
| 14 | Alternative III | Alternative II | Respondent from road user |
| 15 | Alternative III | Alternative II | Respondent from road user |

From the result of interview shows that Alternative II can be recommended because the number of respondents agree to choose Alternative II as a second choice. It means that all respondents agree if the schedule of shunting activity is divided into 2 phases.

* 1. **CONCLUSIONS**

1. The result of the analysis of the traffic volume on the affected road due to shunting activity in Tegal City has 3 busy times (*peak hour / rush hour)*, which are rush hour in the morning, rush hour in the afternoon and rush hour in the evening. On the Abimanyu Street, rush hour occurs in the **afternoon** at 12:45 - 13.45 pm with traffic volume 2,774.3 pcu/hour. On the Menteri Supeno I Street, rush hour occurs in the **evening**at 16:30 to 17:30 pm with traffic volume 1.549 pcu/hour. On the Semeru Street, rush hour occurs at 16:00 - 17:00 pm in the **evening**with traffic volume of 899 pcu/hour and the last one is on the Menteri Supeno II Street, rush hour occurs in the **evening**at 16.00 - 17.00 pm with traffic volume 866 pcu /hour.
2. The highest delay time and queue due to Pertamina's shunting activities occurred on the Abimanyu Street, with the average of length of queue 126 meters with total queue reached 70.5 pcu. The lenght of the delay time occurred in the existing conditions on the Abimanyu Street which was 582 seconds/pcu or 9.69 minutes/pcu with the number of vehicles that stopped was 286 pcu/hour.
3. **Alternative I**is a condition that reflects existing conditions according to the results written in conclusion number 2 above. **Alternative II**, the highest average queue length occurred on the Abimanyu Street which was 71 meters with average queue 35.3 pcu while the value of delay time was 4.85 minutes/pcu with the number of vehicles that stopped was 143 pcu/hour. Whereas the lowest queue value occurs on the Menteri Supeno II Street, the average queue length was 9 meters with average queue 5.4 pcu while the delay value was 3.07 minutes/pcu with the number of vehicles that stopped 16 pcu/hour. **Alternative III**, the average queue length for the highest on the Abimanyu Street was 31 meters with average queue 17.6 pcu while the value of delay time was 2.42 minutes/pcu with the number of vehicles that stopped was 71 pcu/hour while the lowest value was on the Menteri Supeno II Street with the average queue length was 5 meters with average queue 2.7 pcu while the delay time was 1.54 minutes/pcu with the number of vehicles that stopped was 8 pcu/hour. From the three alternatives mentioned above, it can be seen that Alternative I has the highest queue and delay values, while Alternative III has the lowest queue and delay values ​​while for the value of queue and delay time for Alternative II was in the middle which is between Alternative I and Alternative III.

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