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Feasibility study on intersection in North Sumatera

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Abstract. Traffic congestion is one of the problems faced by big cities, One of them is Binjai city and Medan city in North Sumatera. One of the causes of congestion is intersection of roads with highway and roads with railroads. To ensure the smooth movement of vehicles, technical handling at the intersection is needed. Therefore, it is necessary to pre-study the feasibility of level crossing in Binjai and Medan to be able to assess the investment needs and the level of importance of road development in the region. The development of transportation infrastructure and facilities is based on the thought of improving the transportation network system. The necessity of systemical integrated transportation system handling is needed in creating a transportation efficiency. The purpose of this study is to identify and prioritize the needs of the railway crossings. The objective which we want to be achieved is to obtain a document that contains technical, economic and environmental ability indicators as a reference in the feasibility and planning studies. The methodology used is collecting the primary data, secondary data, introduction of study area as the initial analysis of the problem. From the study it can be concluded that the existence of railway interchange will move the movement through traffic so it will not interfere the movement of traffic within urban areas and it keeps the national road network performance is still good.

1. Introduction

1.1Basic Legal Reviews
The development of transportation infrastructure and facilities is based on the thought of improving the transportation network system. The transportation system evolves to provide a balance between demand and supply. The need for integrated transportation system handling systemically is needed in creating a transportation efficiency [1]. Normative reference in the preparation of this study is the law of each sub-sector of transportation, especially the land Transport sub-sector.

1.2 Level Crossing Concept
Based on the Regulation of the General Director of Land Transportation Number SK.770 / KA.401 / DRJD / 2005 about Technical Guidelines for intersection between Roads and Railways, the concept of intersection and interchange is as follows:

a. The intersection of roads and railways, consisting of:
    1. Intersection with barrier/crossing gate
        a) Automatic;
        b) Not automatic either mechanical or electrical
    2. Intersection without barrier/crossing gate

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b. Intersection as referred in a letter a) item 1 if it exceeds the provisions concerning:
   1. The number of trains crossing to the location is at least 25 train/day and at most 50 trains/day;
   2. The average daily traffic volume is 1,000 to 1,500 vehicles on city roads and 300 to 500 vehicles on the road outside the city; or
   3. The multiplication result between the average daily traffic volume and the train frequency is between 12,500 to 35,000. Then it should be upgraded into an interchange.

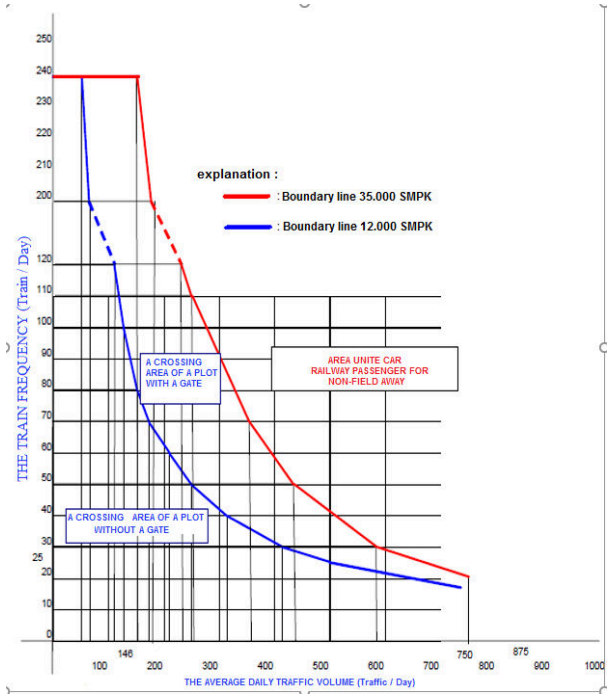


Figure 1. Graph of intersection area according to train traffic per day and average daily traffic volume

1.3 Delay

When the train passes through the interline, all vehicles must stop, this is because the train crossing gate is closed so travel time increases longer than the normal condition (delay occurs).

The delay occurring at the intersection of the highway and the railroad consists of two parts:
A. The delay that occurred when the closing of the crossing gate (see Figure 2.2).
B. The geometric delay as a result of crossing by rail when the crossing gate is opened.

So the delay experienced by any vehicle passing through the railway crossing can be stated as follows:
Delay = (delay when the railway crossing gate is closed) + (geometric delay, delay when the railway crossing gate is closed)

Meanwhile, Robertson (1994), defined the delay as follows:

- Delay is the time lost when driving due to things beyond the ability of the driver.
- Waiting time is a part of the delay process where the vehicle can not run or run slower than planned speed.
- The traffic delay occurs because of the difference between the actual travel time and the travel time based on the vehicle crossing the road segment that is used as the study field with the average speed representing the condition of the non-saturated traffic flow in the study section.

In the case of analytical calculations, the delay on the traffic light is measured on the stop line by assuming deceleration and acceleration. The delay time is identified by the length of time of a vehicle

from the time when it stops until it accelerates and reaches its average speed again. This can be explained in Figure 2.2 which shows the curve of the time line trajectory of a vehicle conducting a process of stopping by slowing the vehicle from a constant average travel speed to a halt then accelerating the vehicle until it reaches its average speed again, and maintains zero speed (stop) for a certain time between slowing motion and acceleration (the slope of the time line trajectory represents the speed of the vehicle).

From the above it can be explained that the delay occurred to the vehicle, in this case, the change between the disrupted and undisturbed travel time, can be measured on each stop line with the average value of deceleration and acceleration assumed.

The parameters shown in Figure 2:

Vc	= travel speed (km / h)
L	= mileage
Tc	= 1 / Vc
	= travel time without interference (s)
D	= delay time (s)
T	= tc + d
	= travel time with interference (s)
Ta, tb	= deceleration time and acceleration time (s)
La, lb	= deceleration distance and acceleration distance (meters)
Ds	= stopped delay time(s)

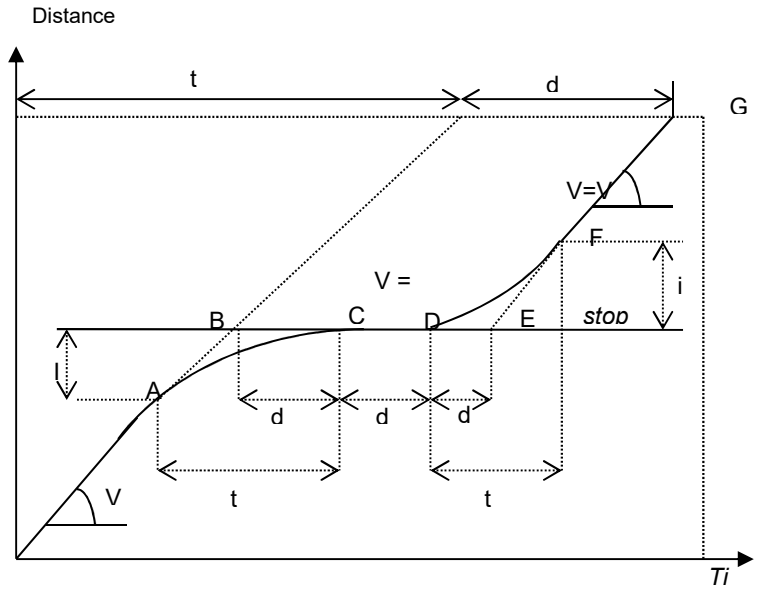


Figure 2. Trajectory of Time Ranges From A Vehicle That Made The Stop Process Due to Delay (AKCELIK 1981)

1.4 Crosses Flow

In calculating the number of currents and the length of the queue on the railway crosses with the road, there are some times that need to be considered, i.e.:

a. When the train begin to be seen by the driver
b. When the vehicle is slowing down
c. When the traffic flows start running the vehicle again
d. When traffic flows back to normal where the influence of the railway crossing gate is gone

By the time a train passes an intersection between railway and road without crossing gate, the driver can only detect by hearing first and then eyesight. When the train starts to be detected, the

driver slows down the vehicle speed. As the train begins to pass through the crossings, the vehicle begins to stay motionless. This situation is prevailing during the time of rail traffic. For an intersection with a crossing gate, the train is detected with a automatic signal and then the driver sees the door of the train that began to close. After the train passed the crossing, the vehicle begins to move through the intersection, causing currents to change gradually until a certain time. After passing through the crossing, the speed will gradually rise so that the flow will return to normal conditions. The condition can be shown in Figure 3. The shaded part of Figure 3 is the amount of delay due to the closing of the railway crossing.

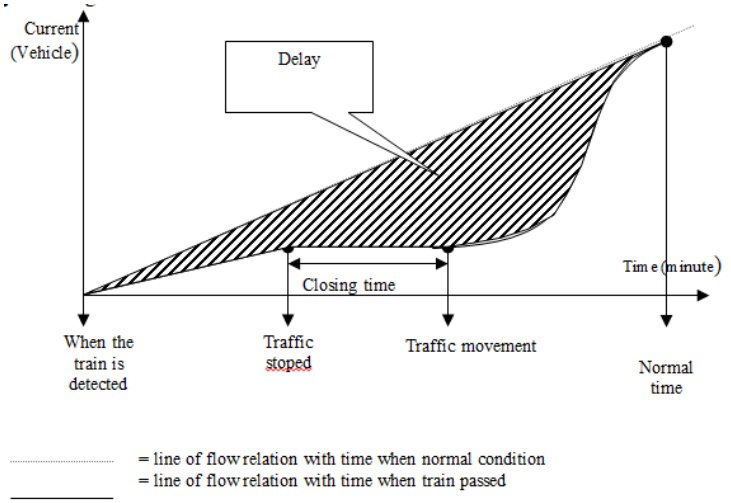


Figure 3. Graph between vehicle flows and crossing time

2. Research Method

2.1 Preparation

a. Consolidating the Methodology, planning detailed implementation phases, collecting relevant agency data, introducing study areas, establishing modelling and analysis, developing technical analysis structures and survey plans.
b. The Literature Study, by reviewing implementation methods, maximizing data usage, and analytical methods.
c. Read the relevant Regulations, by preparing the pre-feasibility study concept, knowing the layout plan and developing some assessment indicators.
d. Identify initial conditions and problems on an intersection with the road network system and the impact on the overall road network system

2.2 Collecting Primary and Secondary Data

Secondary data includes socio-economic, document related to research and road network database. While the primary data are road network survey, condition and soil structure survey, topographic survey, and traffic counting.

2.3 Stages of analysis

Analyzes conducted in this study include:

- Conditions for existing traffic conditions (delay), creating a handling scenario and putting the analytical prediction basis in the planned "time horizon."
- Do Nothing Conditions, predicting traffic performance without changes in network conditions, and then the analysis results will be used as a benchmark for the benefits of various handling scenarios.

- Do something condition, traffic performance prediction performed with changing the network conditions (FO / UP) and the benefits reviewed is a benefit to users and society.

The environmental analysis examines the implementation feasibility of the environment, including estimation of the benefits of air pollution reduction caused by vehicle emissions due to reduced congestion, assessing the hydrological side of the study area and the possible social impacts.

Project Cost Analysis is a calculation of all components of project costs incurred for the project, in this case, carried out on: land acquisition, construction, and maintenance.

The Project Benefit Analysis is a cost calculation that will be a benefit if the upgrading project is built, in this carried out on BOK and time value.

3. Research Result

The survey result of the condition of intersection based on its use of the land can be seen in Table 1.

Table 1. Recapitulation of crossing condition

No		Intersection	District	Land use		Land condition
				Left	Right	
1		JLN. LINGKAR LUAR BINJAI	BINJAI CITY	Industry	Industriy	- - -
2		JLN. ASRAMA (MEDAN)	MEDAN CITY	Commercial	Commercial	-
3		JLN. YOS SUDARSO (MEDAN)	MEDAN CITY	Plantation	Commercial	+
4	a	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM	DELI SERDANG DISTRICT	Commercial	Commercial	-
	b	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (2)	DELI SERDANG DISTRICT	Vacant land	Vacant land	+ + +
	c	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (3)	DELI SERDANG DISTRICT	Commercial	Commercial	-

Table 2. Recapitulation of Topographic Survey

No		Intersection	District	Topography conditions
1		JLN. LINGKAR LUAR BINJAI	BINJAI CITY	Flat
2		JLN. ASRAMA (MEDAN)	MEDAN CITY	Flat
3		JLN. YOS SUDARSO (MEDAN)	MEDAN CITY	Flat
4	a	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM	DELI SERDANG DISTRICT	Flat
	b	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (2)	DELI SERDANG DISTRICT	Flat
	c	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (3)	DELI SERDANG DISTRICT	Flat

Table 3. Recapitulation of Traffic Counting Survey Results

No		Intersection	District / City	JVP	k	Av. traffic	The frequency of trains	SMPK	delay (m)	Average Delay (second)
1		JLN. LINGKAR LUAR BINJAI	BINJAI CITY	816	9%	9067	24	217 608	99	65
2		JLN. ASRAMA (MEDAN)	MEDAN CITY	1246	9%	13845	24	332 280	135	110
3		JLN. YOS SUDARSO (MEDAN)	MEDAN CITY	971	9%	10789	24	258 936	64	45
4	a	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM	DELI SERDANG DISTRICT	653	12 %	5442	38	206 796	24	40
	b	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (2)	DELI SERDANG DISTRICT	702	12 %	5850	38	222 300	21	30

c	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (3)	DELI SERDANG DISTRICT	821	12 %	6842	26	177 892	14	32

The result of transportation modelling obtained from ATTN data in 2011 is calibrated and estimated into 2016 data with Furness method to obtain Ei and Ed value equal to 1 with an accuracy of 3 decimal digits.

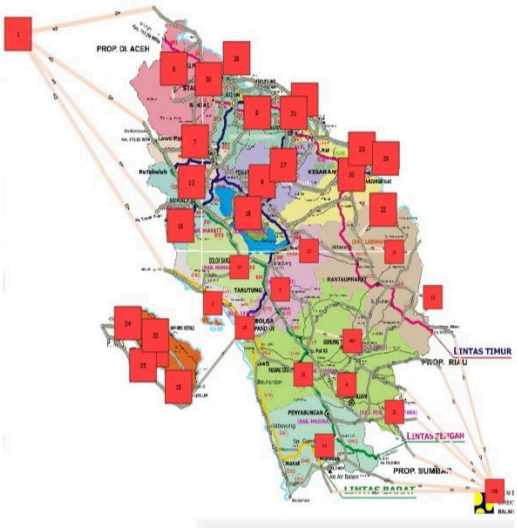


Figure 4. Zoning area in North Sumatera

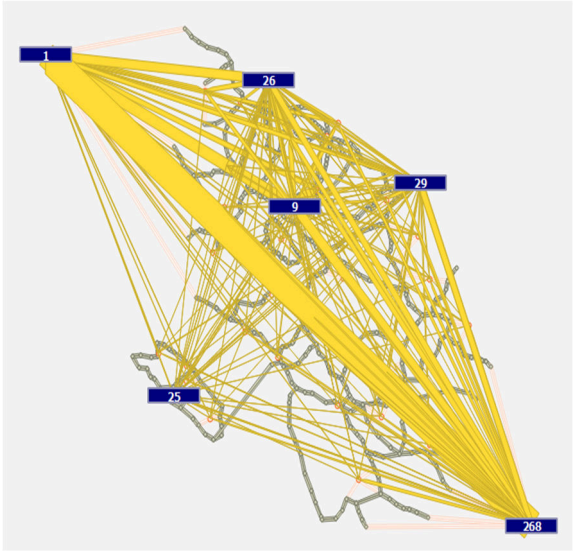


Figure 5. Desire Line in North Sumatera 2016

For modelling, the comparison of the result of the run (estimated) and TC (target) is being done. The result of modelling comparison and survey can be seen in Table 4.

Table 4. Comparison of traffic survey volume and modelling

No		Intersection	TC Volume	Model Volume
1		JLN. LINGKAR LUAR BINJAI	816	1450
			801	1334
2		JLN. ASRAMA (MEDAN)	1246	1450
			1093	1334
3		JLN. YOS SUDARSO (MEDAN)	943	1433
			971	1203
4	a	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM	628	787
			653	957
	b	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (2)	702	787
			646	957
	c	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (3)	510	787
			821	957

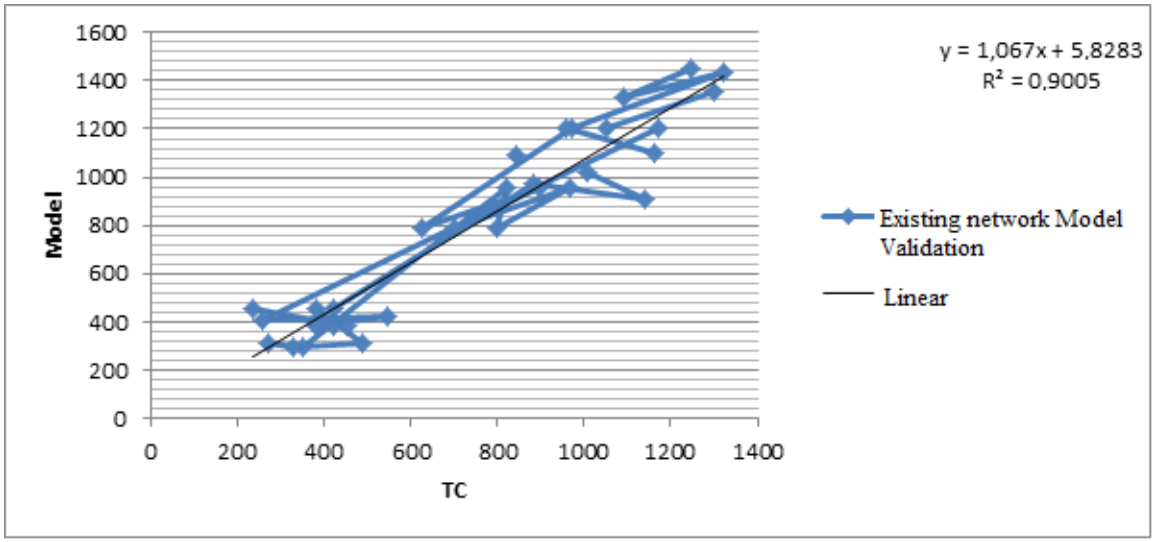


Figure 6. Graph of Existing Network Model Validations

The R2 value is 0.9005; this is indicating that the MAT model estimation results are can be represent more than 90.05% of the traffic flow in the study area. It can be said that this MAT estimation model is good enough to describe the pattern of vehicle travel demand in the study area, so it can be used as a basis for predicting MAT in North Sumatera Province and surrounding areas in the future.

Table 5. Priority-based on Analyze Results

No	Intersection	JVP (amp/hour)	K (%)	Average daily traffic (amp/day)	The frequency of passing trains	SMPK	Delay (m)	Average Delay (second)	Priority
1	JLN. LINGKAR LUAR BINJAI	816	9	9067	24	217608	99	65	2
2	JLN. ASRAMA (MEDAN)	1246	9	13845	24	332280	135	110	1
3	JLN. YOS SUDARSO (MEDAN)	971	9	10789	24	258936	64	45	3
4 a	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM	653	12	5442	38	206796	24	40	4
b	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (2)	702	12	5850	38	222300	21	30	5
c	BTS. KOTA MEDAN – TEMBUNG – LUBUK PAKAM (3)	821	12	6842	26	177892	14	32	6

Based on validation and traffic survey data of the construction of the intersection on Asrama street, Medan, the average delay obtained from the primary data is 110 seconds. The average delay obtained for outer ring of Binjai is 65 seconds, Yos Sudarso street is 45 seconds, and the border of Medan-Tembung is 40 seconds.

4. Conclusion

From the results of the analysis in the previous chapters it can be drawn some conclusions as follows:

- The existence of railway interchange will move the movement through traffic, so it does not interfere with the movement of traffic in urban areas, and this is keeping the national road network performance remains good.

- The construction of railway interchange would benefit the movement of passengers and goods and assist in the development plan of the regions which is passed by those railway interchanges.
- The order of interchange contruction in the study area: Jl. Asrama, Jl. Lingkar Luar Binjai, Jl. Yos Sudarso, Medan – Tembung – Lubuk Pakam (a), Kota Medan – Tembung Lubuk Pakam (b), Medan – Tembung – Lubuk Pakam (c)
- From the analysis of transportation needs, it can be seen that the railway interlined already needed to be built, but it still must be adjusted to the order of priority.

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