Traffic impact analysis PT. Eastern Pearl Flour Mills – City Side Jl. Nusantara, Makassar

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ABSTRACT

PT. Eastern Pearl Flour Mills – City Side Makassar affects land use changes that have an impact on changes in traffic movement, so traffic impacts analysis is needed. The purpose of this study is to identify the performance of affected roads and intersections in the present and in the next 5 years, to handle traffic problems and conflicts by simulating models without handling (Do Nothing) and with handling (Do Something), analyzing time delays on the U-turns and modeling the origin-destination matrix using the Furness Method. This study uses qualitative and quantitative analysis methods that refer to the Manual Kapasitas Jalan Indonesia (MKJI, 1997) and The Furness method. The results of the analysis of the level of service on the Jl. The archipelago is in fairly good condition with LoS values A to B and DS 0.11 – 0.40 with a speed of 26.60 – 50.00 km/hour, the road performance that has the worst impact occurs at the Tol Reformasi – Jl. Nusantara with a projection for the next 5 years in 2027, where road performance has a LoS E and DS value of 0.88 with a delay time of 19 seconds/pcu. U-turn facility on Jl. Nusantara has an average delay time of 6.16 – 7.82 seconds for one rotating vehicle with a value of < 1 so that there is no queue. The results of the trip distribution analysis using The Furness model obtained the same value of generation and attraction in the second iteration, which means that it is still close to ideal conditions.

Key word: traffic; impact; PT. Eastern Pearl Flour Mills; MKJI 1997; furness.

INTRODUCTION

The development of urban center areas, superblock areas, and several other activity centers that are currently being carried out must have a direct impact on traffic movement on the existing road network system around the area. Development will inevitably cause traffic generation and attraction caused by activities carried out in the area (Ofyar Z Tamin, 2000) [1]. Changes in a land use will have an influence on the surrounding traffic (Josef Sumarjouw, et al, 2013) [2]. This is also described in the Kajian Dampak Lalu Lintas Terhadap Kinerja Jalan by Taufik Akbar, et al (2018) [3] so that land use development will affect activities in the vicinity. Traffic impact analysis is a special study that assesses the effects caused by traffic generated by an area development on the surrounding transportation network (Hayu Rahayu, et al) [4]. Traffic impact analysis is used to predict whether transportation infrastructure in the area affects the development so that it can serve existing (existing) traffic with generated or pulled traffic by development (Momon, 2013) [5]. Through traffic impact evaluation, it can be calculated how much new trip generation requires traffic engineering and traffic management to overcome these impacts (Aldiansyah, 2022) [6]. Every development plan that can cause disturbances in security, safety, order, and smooth traffic must be carried out with a traffic impact analysis (Undang-Undang No. 22 Tahun 2009 Tentang Lalu Lintas dan Angkutan Jalan, 2009) [7], to anticipate traffic impacts. Due to the large amount of traffic on the transportation network around the development, it is necessary to conduct a traffic impact analysis study (Muhammad Yusuf, 2021) [8]. This study will conduct a study of the existing transportation conditions, predict the impact that may arise on the performance of transportation equipment and recommendations for solving transportation problems (Adriyanto Sudrajat, et al, 2020) [9]. The detailed explanation in the Peraturan Menteri Perhubungan No. 17 Tahun 2021 Tentang Penyelenggaraan Analisis Dampak Lalu Lintas [10].

PT. Eastern Pearl Flour Mills - City Side is one of the leading wheat flour producers in Indonesia which has a building area of 7,973.46 m^2 (PT. Eastern Pearl Flour Mills) [11] and is located on Jl.

Nusantara, Ujung Tanah Village, Ujung Tanah District, Makassar City, South Sulawesi Province, which is the city center area based on the Makassar City RTRW revised 2015-2034 [12]. Based on the Regulation of the Minister of Transportation of the Republic of Indonesia No. PM 17 of 2021 [10], PT. Eastern Pearl Flour Mills - City Side is included in the criteria for industrial buildings with moderate generation category, there are activities at PT. Eastern Pearl Flour Mills - City Side Makassar which is currently operating will result in additional traffic loading by two-wheeled vehicles, four-wheeled vehicles and trucks passing through the activity center. Direct traffic loading will have an impact on decreasing the performance of the road network around the building site, so a Traffic Impact Analysis is needed to minimize this impact.

RESEARCH METHODS

The type of research conducted by the author is a combination of quantitative and qualitative research using primary data and secondary data. Primary data are obtained directly through traffic counting activities on roads and intersections as well as on U-turns, road geometric measurements, as well as speed and travel time surveys. As for the secondary data needed in this study, namely Makassar City BPS data in 2022 [13], Makassar City in figures for 2022 [14] and maps of locations and affected road segments. This research was conducted in August 2022 for two weeks and used data on the peak volume of vehicles on weekdays and holidays, while the determination of the road segment to be studied was as follows:

1. Jl. Nusantara, road type 4/2 D;

2. Tol Reformasi Intersection – Jl. Nusantara (Segment 1);

3. Intersection Jl. Nusantara – Jl. Moh. Hatta (Segment 2).
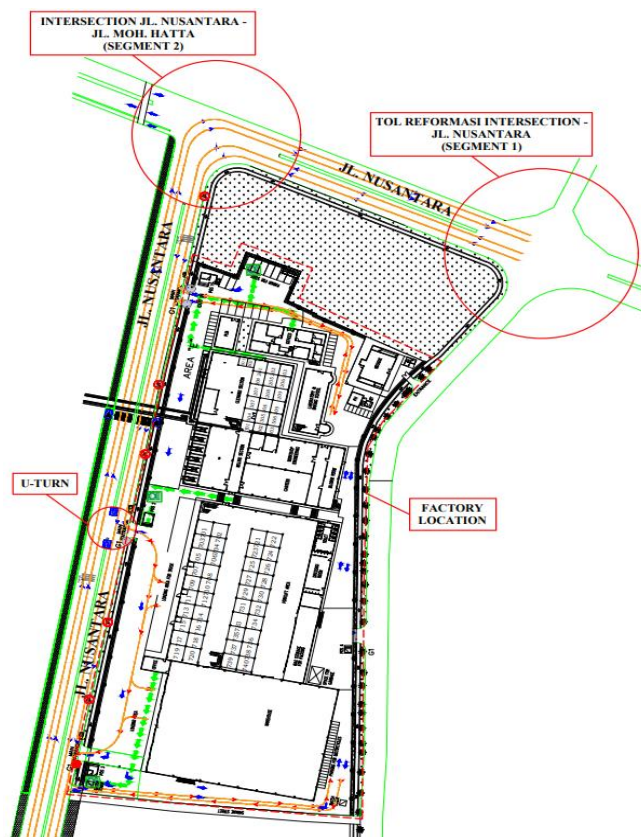
For more details, see Figure 1 below.

Figure 1. Affected Road Segment

The workings of this research are explained based on the stages that have been designed in the research flow chart shown in Figure 2.
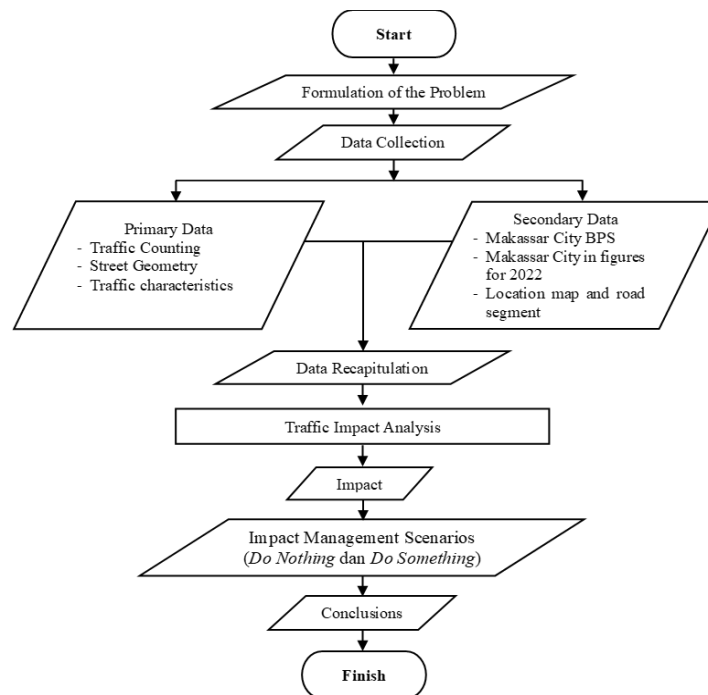

Figure 2. Research Flowchart

Data Analysis

After the data have been obtained, then the data analysis is carried out with the following analytical methods:

Capacity

Road capacity is the ability of a road segment to accommodate the ideal traffic volume per unit time, expressed in vehicles per hour or units of passenger cars per hour (PP No. 32, 2011) [15]. Capacity is defined as the maximum current through a point on the road that can be maintained per unit hour under certain conditions. For two-lane two-way roads, capacity is determined for two-way flows, but for multi-lane roads, flows are separated per direction and capacity is determined per lane (MKJI 1997) [16]. The capacity description is presented in a mathematical model and tabulated reference as follows:

$$C = Co \times FCw \times FCSP \times FCSF \times FCCS \text{ (pcu/hour)}$$

Where: C = Capacity
Co = Basic capacity (pcu/hour)
FCw = Traffic lane width adjustment factor
$FCSP$ = Directional separator adjustment factor
$FCSF$ = Side resistance adjustment factor
$FCCS$ = City size adjustment factor

Degree of Saturation

According to MKJI 1997 [16], the degree of saturation (DS) is defined as the ratio to capacity, used as the main factor in determining the performance level of intersections and road segments.

$$DS = Q/C$$

Where: Q =   Traffic volume (pcu/hour)
C =   Capacity (pcu/hour)

Growth Rate

The geometric formula for the growth rate in predicting the amount of volume in the future:

$P_t = P_0 (1+r)^t$ or $r = (P_t / P_0)^{1/t} - 1$

Where:
- P_t = Number of vehicles in year t
- P_0 = Number of vehicles in the base year
- t = Time period
- r = Vehicle growth rate

Analysis of the U-turns facility

The waiting time when the vehicle is about to turn around is significantly affected by the traffic flow/volume in the rightmost lane on the opposing lane (Heddy R. Agah, 2007) [17], and is stated as follows:

Road types 4/2 D: $y = 2E\text{-}06\ x^2 + 0,0019\ x + 5,4597$
Road types 6/2 D: $y = 6E\text{-}6\ x^2 - 0,0027\ x + 5,6477$

Trip Distribution Model (Furness Method)

In this model, the distribution of future movements is obtained by multiplying the distribution of current movements by the growth rate of the origin zone or destination zone which is carried out alternately (Ofyar Z Tamin, 2000) [1]. Systematically, The Furness method can be stated as follows:

$T_{id} = t_{id}\ x\ E_i$

Where: T_{id} = The number of movements from the zone i to zone d in the future;

t_{id} = The number of movements from the zone i to zone d at the present time.

RESULT AND DISCUSSION
Condition of Roads and Intersections

Jl. Nusantara has a road body width of 16.6 m, a median width of 1 m, and has sidewalks on the left and right sides of the road where the width of the left shoulder is 3.8 m while the right is 2.8 m and has high side barriers (Figure 1). In addition to roads, PT. Eastern Pearl Flour Mills - City Side also has an impact on the existing intersections around the study location, namely the Tol Reformasi – Jl. Nusantara (Segment 1) and the intersection of Jl. Nusantara – Jl. Moh. Hatta (Segment 2), can be seen in Figures 3 and 4.

Figure 3. Tol Reformasi Intersection – Jl. Nusantara (Segment 1)

Figure 4. Intersection Jl. Nusantara – Jl. Moh. Hatta (Segment 2)

Performance of Roads and Intersections

Results of performance analysis Jl. Nusantara can be seen in table 1.

Table 1. Performance of the Jl. Nusantara

Working Days									
		Simulation							
Time Street Name	**Time**	**Existing 2022**		**Do Nothing (2022)**		**Do Something (2022)**		**5 Years Post Surgery (2027)**	
		DS	LoS	DS	LoS	DS	LoS	DS	LoS
Jl. North-South Nusantara (Front Location)	Morning	0.20	**A**	0.20	**B**	0.22	**B**	0.28	**B**
	Noon	0.21	**B**	0.22	**B**	0.24	**B**	0.31	**B**
	Afternoon	0.23	**B**	0.24	**B**	0.26	**B**	0.33	**B**
Jl. Nusantara South-North (Front Location)	Morning	0.25	**B**	0.26	**B**	0.28	**B**	0.36	**B**
	Noon	0.22	**B**	0.24	**B**	0.25	**B**	0.32	**B**
	Afternoon	0.28	**B**	0.29	**B**	0.32	**B**	0.40	**B**
Holiday									
		Simulation							
Time Street Name	**Time**	**Existing 2022**		**Do Nothing (2022)**		**Do Something (2022)**		**5 Years Post Surgery (2027)**	
		DS	LoS	DS	LoS	DS	LoS	DS	LoS
Jl. North-South Nusantara (Front Location)	Morning	0.21	**B**	0.22	**B**	0.22	**B**	0.28	**B**
	Noon	0.24	**B**	0.25	**B**	0.25	**B**	0.32	**B**
	Afternoon	0.25	**B**	0.26	**B**	0.26	**B**	0.33	**B**
Jl. Nusantara South-North (Front Location)	Morning	0.11	**A**	0.11	**A**	0.11	**A**	0.14	**A**
	Noon	0.13	**A**	0.14	**A**	0.14	**A**	0.17	**A**
	Afternoon	0.15	**A**	0.15	**A**	0.15	**A**	0.19	**A**

Source: Analysis Results

The results of the analysis in table 1 show that the level of service for the Jl. Nusantara segment on weekdays and holidays, the existing condition of 2022 has peak hours on weekdays from the south - north, namely in the afternoon with a DS value of 0.28 and LoS B, the level of road service Nusantara in the do nothing condition 2022 has peak hours on weekdays from the south - north, namely in the afternoon with a DS value of 0.29 and LoS B, the service level of Jl.Nusantara in the do something 2022 condition has peak hours on weekdays from the south - north, namely in the afternoon with a DS value of 0.32 and LoS B, for the growth rate of the next 5 years, namely in 2027, it shows that the service level of the Jl. Nusantara segment has peak hours on weekdays from the south - north, namely in the afternoon with a DS value 0.40 and LoS B, where the flow is generally low and the traffic speed of free vehicles is less interference than other vehicles, so that congestion does not occur.

The results of the analysis of the performance of the intersection Tol Reformasi - Jl. Nusantara and the intersection of Jl. Nusantara - Jl. Moh. Hatta can be seen in table 2.

Table 2. Performance of Impacted Intersection

Working Days													
		Simulation											
Name of the intersection	Time	Existing 2022			Do Nothing (2022)			Do Something (2022)			5 Years Post Surgery (2027)		
		DS	LoS	Delay	DS	LoS	Delay	DS	LoS	Delay	DS	LoS	Delay
Tol Reformasi - Jl.Nusantara	Morning	0.33	B	15	0.34	B	15	0.40	B	15	0.46	C	16
	Noon	0.49	C	16	0.52	C	16	0.60	C	17	0.69	C	18
	Afternoon	0.63	C	17	0.66	C	17	0.77	D	18	0.88	E	19
Jl. Nusantara - Jl. Moh. Hatta	Morning	0.40	B	15	0.42	B	16	0.36	B	15	0.42	B	16
	Noon	0.42	B	16	0.44	C	16	0.38	B	15	0.44	C	16
	Afternoon	0.65	C	17	0.68	C	18	0.59	C	17	0.68	C	18
Holiday													
		Simulation											
Name of the intersection	Time	Existing 2022			Do Nothing (2022)			Do Something (2022)			5 Years Post Surgery (2027)		
		DS	LoS	Delay	DS	LoS	Delay	DS	LoS	Delay	DS	LoS	Delay
Tol Reformasi - Jl.Nusantara	Morning	0.19	A	13	0.20	B	13	0.25	B	14	0.28	B	14
	Noon	0.28	B	14	0.29	B	14	0.35	B	15	0.41	B	15
	Afternoon	0.32	B	14	0.34	B	15	0.41	B	15	0.47	C	16
Jl. Nusantara - Jl. Moh. Hatta	Morning	0.25	B	14	0.26	B	14	0.23	B	13	0.26	B	14
	Noon	0.30	B	14	0.32	B	14	0.27	B	14	0.31	B	14
	Afternoon	0.35	B	15	0.37	B	15	0.32	B	14	0.36	B	15

Source: Analysis Results

The results of the analysis in table 2 show the peak hours at the intersection of Tol Reformasi – Jl. Nusantara on weekdays and holidays, the existing condition of 2022 occurs in the afternoon on weekdays which has a DS value of 0.63 with a LoS C and a delay of 14 seconds/pcu, in the do nothing condition has peak hours in the afternoon on weekdays with a value of DS 0.66 with LoS C and a delay time of 17 seconds/pcu, in the do something condition it has a peak hour in the afternoon on weekdays with a DS value of 0.77 with LoS D and a delay time of 15 seconds/pcu, for a growth rate of 5 years in the future, namely in 2027 it has peak hours in the afternoon on weekdays with a DS value of 0.88 with LoS E and a delay of 19 seconds/pcu where the current is unstable with conditions that often stop. Peak hours at the intersection of Jl. Nusantara – Moh. Hatta in the existing condition of 2022 occurs in the afternoon on weekdays which has a DS value of 0.65 with a LoS C and a delay of 17 seconds/pcu, in the do nothing condition has peak hours in the afternoon on weekdays with a DS value of 0.68 with LoS C and delay time of 18 seconds/pcu, in the do something condition it has a peak hour in the afternoon on weekdays with a DS value of 0.59 with LoS C and a delay time of 17 seconds/pcu, for the growth rate of the next 5 years, namely in 2027 has peak

hours in the afternoon on weekdays with a DS value of 0.68 with LoS C and a delay time of 18 seconds/pcu, where the driver is limited in choosing his speed.

Analysis of the U-turns facility

Jl. Nusantara with a 4/2 D road type in front of the building has a U-turns facility, which can be seen in Figure 3.

Figure 3. Facility U-turns

The analysis of the time delay on the existing 2022 U-turns facility and the projection for the next 5 years, namely in 2027 can be seen in tables 3 and 4.

Table 3. Turning Vehicle Delay Time (North – North)

	Working Days					
	Simulation					
	Existing 2022			**5 Years Post Surgery (2027)**		
Time	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**
Morning	603	7.33	0.024	769	8.10	0.032
Noon	459	6.75	0.024	585	7.26	0.032
Afternoon	603	7.33	0.020	770	8.11	0.026
Average		7.14	0.023	**Average**	7.82	0.030
	Holiday					
	Simulation					
	Existing 2022			**5 Years Post Surgery (2027)**		
Time	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**

Mornin g	287	6.17	0.002	366	6.42	0.002
Noon	326	6.29	0.009	415	6.59	0.011
Afterno on	377	6.46	0.013	481	6.83	0.016
Average		6.31	0.008	**Average**	6.62	0.010

Source: Analysis Results

Table 4. Turning Vehicle Delay Time (South - South)

	Working Days					
	Simulation					
	Existing 2022			**5 Years Post Surgery (2027)**		
Time	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**
Mornin g	385	6.49	0.016	491	6.88	0.021
Noon	414	6.59	0.016	528	7.02	0.021
Afterno on	468	6.79	0.015	597	7.31	0.019
Average		6.62	0.016	**Average**	7.07	0.021
	Holiday					
	Simulation					
	Existing 2022			**5 Years Post Surgery (2027)**		
Time	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**	**Average traffic volume per lane on the opposing lane (vehicles/hour)**	**Delay due to 1 vehicle turning (seconds)**	**ρ**
Mornin g	259	6.08	0.007	330	6.30	0.009
Noon	286	6.17	0.012	364	6.42	0.015
Afterno on	309	6.24	0.012	394	6.52	0.016
Average		6.16	0.010	**Average**	6.41	0.013

Source: Analysis Results

The results of the analysis of the delay time on the U-Turn facility obtained that the peak volume of vehicles on the opposite lane of weekdays and holidays from the north - north and from the south - south, the existing condition of 2022 occurs on weekdays in the north - north direction with the volume of vehicles as many as 603 vehicles/hour with a delay time for 1 (one) vehicle is 7.33 seconds, the volume of vehicles on the opposing lane during the day is 459 vehicles/hour with a delay time for 1 (one) vehicle is 6.75 seconds and the volume of vehicles on the opposite lane of the day is 603 vehicles/hour with a delay time for 1 (one) vehicle is 7.33 seconds, while the peak post-operation volume in 2027 is 769 vehicles/hour with a delay time for 1 (one) vehicle is 8.10 seconds, the volume of vehicles on the opposing lane during the day is 585 vehicles/hour. Hours with a delay time for 1 (one) vehicle is 7.26 seconds and the volume of vehicles on the opposite lane of the day is 770 vehicles/hour with the delay time for 1 (one) vehicle is 8.11 seconds. Based on the queuing theory, if > 1 then the queue is declared at the U-turns, while in the table the results of the analysis that have been carried out in table 4 obtained < 1 so it is stated that there is no queue at the U-turns.

Trip Distribution Model (Furness Method)

Trip distribution is the amount of traffic flow between zones in the study area. In the process of implementing this distribution analysis, the distribution of vehicles is carried out based on the proportion of vehicles, for more details on the distribution of trips between zones can be seen in table 5.

Table 5. O/D Matrix (Iteration 2)

Working Days							
Morning				Afternoon			
OD	1	2	Oi	OD	1	2	Oi
1	13	109	122	1	23	181	204
2	42	367	409	2	88	692	780
Dd	55	476		Dd	111	873	
Holiday							
Morning				Afternoon			
OD	1	2	Oi	OD	1	2	Oi
1	13	109	122	1	23	181	204
2	42	367	409	2	88	692	780
Dd	55	476		Dd	111	873	

Source: Analysis Results

Based on the results of the analysis in table 5, the total distribution of trips to the origin zone in zone 1 is 122 pcu and the total distribution of trips to zone 2 is 409 pcu, while the total distribution of trips to the destination zone in zone 1 is 55 pcu and the total distribution of trips to zone 2 is as much as 479 junior high school and after calculating the distribution of trips, it can be seen that the same value of generation and attraction is completed in the second iteration matrix, which means that it is close to ideal conditions in the field.

CONCLUSION

The level of service for the Jl. Nusantara in front of PT. Eastern Pearl Flour Mills – City Side is in fairly good condition with LoS values A to B and DS values 0.11 – 0.40 with a travel speed of 26.60 – 50.00 km/hour both in the existing conditions of 2022 and in the projection 5 next year in 2027. Road performance that has a bad impact due to development is at the Tol Reformasi – Jl. In the archipelago on weekdays, there is a LoS C value with a DS value of 0.63 and a delay time of 17 seconds/pcu in the existing condition of 2022, the driver is limited in choosing the speed. Road performance will have the worst impact due to development occurring at the intersection Tol Reformasi – Nusantara with a projection of the next 5 years in 2027, there is a road performance that has a LoS E value with a DS value of 0.88 unstable flow with conditions that often stop with a delay of 19 seconds/pcu. The delay time at the U-Turn facility uses Heddy R. Agah's theory. The average delay time is 6.16 – 7.82 seconds for one vehicle turning. The calculation of the trip distribution using matrix analysis (OD) of the furness iteration model is known that the same generation and pull values completed in the second iteration, which means that they are close to ideal conditions in the field. Handling traffic impacts that can be done by reducing side barriers on roads and intersections so as to facilitate traffic flow.

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