

Original Article

Impact of RSJ Prof. Dr. V.L. Ratumbusang Psychiatric Hospital's Construction in Collector Road Performance - A Traffic Management Analysis

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Abstract - Land use development will affect the performance of roads. The development of new land use will cause movement generation and attraction (trip generation) during the operational period of further land use on the collector road. The development of new land uses to become activity centres will cause an increase in traffic generation and attraction. The construction of the psychiatric hospital, Prof. Dr. V.L. Ratumbusang Manado, North Sulawesi Province, caused a rise in traffic movements. The traffic generation resulting from this infrastructure development is classified as moderate traffic generation, totalling 525 pcu/day. The performance of the Kalasey - Sea collector road section is in the existing condition of service level A and a speed of 30 km/hour. Increased traffic flow in the future will cause the service level of the Kalasey - Sea collector road to decrease to service level B. The research's novelty lies in simulating the performance of road sections without construction and with development. The existence of development will reduce the level of road service.

Keywords - Land use, Trip generation, Level of service, Psychiatric hospital, Traffic flow.

1. Introduction

1.1. Background

The construction of an activity centre that attracts or generates traffic at a specific location on the side of the road will affect the surrounding traffic. The comparison between traffic volume and road capacity measures road performance. The operation of a psychiatric hospital will increase the traffic attracted to and arising from the hospital.

Research on the impact of the construction of RSJ Prof. Dr. V.L. Ratumbusang psychiatric hospital, in collector road performance - traffic management analysis, analyzes how the construction of psychiatric hospital affects the performance of roads.

Predict whether the transportation infrastructure in the development impact area can serve existing traffic. The structure and operation of a psychiatric hospital activity centre will increase the volume of traffic flow while the road capacity remains at its original condition.

Every construction and development of an activity centre will impact the surroundings, including traffic. The structure and evolution of activity centres pay little attention to the impact on road traffic, resulting in a decrease in the level of road service during the operational period of

construction and operation of the Prof. Dr. V.L. Ratumbusang psychiatric hospital, which is located on the Kalasey Dua Collector Road, Kalasey Dua Village, Mandolang District, Minahasa Regency, Manado North Sulawesi Province, is expected to attract traffic movements, which will affect the performance of the roads around the location.

Therefore, this research will estimate the effect of hospital construction on the performance of existing roads. The gap between this research and previous research is in analysing the magnitude of trip generation and trip attraction.

The previous study examined generation and attraction using simple linear regression analysis, while research into the impact of the construction of a psychiatric hospital by Prof. Dr. V.L. Ratumbusang in collector road performance - traffic management analysis, using the growth rate method of movement generation for the 5 next to 10 years.

Previous research was conducted on arterial roads, while this research was on collector roads. The research's novelty lies in simulating the performance of road sections without construction and with development. The existence of development will reduce the level of road service.



1.2. Problems

The problems of this research are:

- What is the value of movement generation and attraction (trip generation) for the operation of the psychiatric hospital Prof. Dr. V.L. Ratumbusang Manado?
- What is the influence of the construction of the psychiatric hospital, Prof. Dr. V.L. Ratumbusang Manado, on the performance of collector roads?

1.3. Research Objectives

The research objectives are as follows:

- Analyzing trip generation values for the operation of the psychiatric hospital Prof. Dr. V.L. Ratumbusang Manado.
- Analyze the influence of the construction of the psychiatric hospital Prof. Dr. V.L. Ratumbusang Manado's on-road performance.

1.4. Benefits of Research

The benefits of research are as follows:

- Providing information to the government and builders regarding how to increase traffic volume.
- Become a reference for research on road performance due to land use development.

2. Basic Theory

2.1. Trip Generation

Movement or trip generation is part of the transportation modelling stage, which estimates the number of movements originating from a zone or land use or the number of movements attracted to land use or zone. Traffic movement is a land use function that produces traffic movement. Traffic generation includes traffic leaving a location and traffic heading to or arriving at a location (Tamin, 2000). Movement generators consist of 2: 1) Trip production: the number of trips generated by a zone, and 2) Trip attraction: the number of trips attracted by a zone. Figure 1 shows trip production and trip attraction.

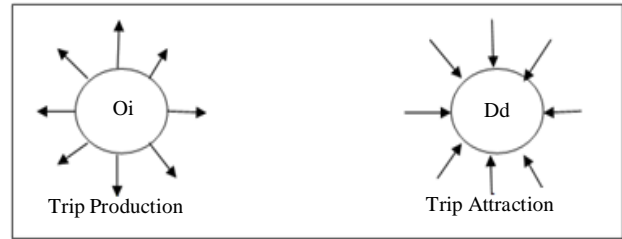


Fig. 1 Trip production and trip attraction

2.2. Traffic Flow Characteristics

2.2.1. Traffic Volume

According to IHCM 1997, traffic flow is the number of motorized vehicles passing a point on a section of road per unit time. Traffic volume units are expressed in vehicles/hour (Qveh) or Average Daily Traffic (ADT).

2.2.2. Traffic Speed

IHCM 1997 explains that speed is the average of all vehicles passing a point or lane in a specific period in units of km/hour. Speed, which is the ratio between distance and travel time, is calculated using the following formula:

$$V = \frac{s}{t} \tag{1}$$

V = speed, s = distance, and t = Travel time.

2.2.3. Traffic Density

Density is a comparison between the volume and speed of traffic flow expressed in units of pcu/km. Density shows the performance of a road section; the higher the density value of a section, the poorer the performance.

2.2.4. VC Ratio

VC Ratio is one aspect of measuring road performance parameters, where the existing traffic flow is compared with the road capacity.

2.2.5. Road Level of Service

The level of service road is the value of the degree of saturation, which is a comparison of volume and capacity. Table 1 shows the level of service characteristics.

Table 1. Service level characteristics

Level of Service	Traffic Flow Characteristics	Degree of Saturation
A	Free flow conditions with high speeds and low traffic volume. The driver can choose the desired speed without any obstacles.	0,00 – 0,19
B	In the steady current zone, the driver has sufficient freedom to choose his speed.	0,20 – 0,44
C	In the steady current zone. Drivers are limited in choosing their speed.	0,45 – 0,74
D	Approaching unstable currents where almost all drivers will be restricted. Service volume is related to acceptable capacity.	0,75 – 0,85
E	Traffic volume is approaching or at capacity. The current is unstable, with frequent stops.	0,85 – 1,00
F	Forced or stuck flow at low speeds. The queues were long, and there were big obstacles.	≥ 1,00

Source: Abubakar. I, 1995

2.3. State of the Art

State of the art is a research design that is detailed and unique compared to previous research. The state of the art can be used as a basis for research that explains the differences between previous research and the research being carried out.

Morlocks. K.E (1995) states that land use dramatically influences the transportation system in the surrounding environment. Land use for hospital construction will generate several movements of people and vehicles whose numbers need to be analyzed. The need for traffic management positively impacts the construction of hospitals and other land uses.

Traffic generation and attraction is an essential part of traffic impact analysis. According to the Ministry of Transportation regulation number 17 of 2021 concerning the implementation of traffic impact analysis, traffic generation is categorized into three categories: high traffic generation, medium traffic generation, and low traffic generation. Traffic generation for hospitals is analyzed based on the number of beds. Low traffic generation is 75 to 200 beds; medium traffic generation is 201 to 700 beds; high traffic generation is more significant than 700 beds.

Nurdin R. D. et al. (2022) stated that the development of hospitals will have several impacts on roads, such as decreased road capacity, increased side obstacles, and increased parking requirements.

Sumajouw J. et al. (2013) stated that changes in land use due to development, both changes in category and intensity, will generate new traffic. Traffic generation affects traffic. To anticipate the significant impact of traffic on the transportation network around the development, it is necessary to carry out a traffic impact analysis.

Fakhri K and Mudiyo R. (2020) stated the influence of vehicle entry and exit on the Al-Mawaddah IT Elementary School building construction project will affect the performance of the road section. The Al-Mawaddah IT Elementary School building construction project significantly impacts traffic circulation in the study area. This study predicts an increase in students in the next ten years.

Zuhdy, Basuki, Purwanto (2013): The construction of the Puncak Kertajaya apartments in the future will cause traffic problems. The large number of new residents will create a significant traffic burden. Studies regarding traffic impact analysis for apartment construction are necessary to predict traffic loads and the impact on traffic. The research results will produce recommendations on how to anticipate the effects on traffic that will occur in the future.

Muchlisin (2016): The construction of the Jogja One Park mix used plan causes the attraction of 1 bus and truck per hour, cars 73 vehicles/per hour, motorbikes 41 vehicles/per hour. The number of vehicles generated is one bus and truck per hour, 56 cars/hour, and 29 motorbikes/hour.

Prayoga L. H. et al. (2021): Rapid economic growth in Bali has led to accelerated development in activity centres, resulting in increased travel. The number of trips generated affects the performance of roads, especially national roads. An additional trip generation will cause a negative impact on roads due to increased traffic flow.

Joseph. M (2021): Construction of the PT factory. Indonesian Pharmaceutical Biotech causes traffic disruption due to the impact of development. The research aims to determine the traffic impacts caused by factory construction. The research results provide recommendations for appropriate handling to minimize traffic impacts. The data analysis method is the Indonesian Highway Capacity Manual (IHCM 1997), and transportation planning uses a 4 (four) step model. The results show that the construction of the PT factory. Biotek Pharmaceutical Indonesia is estimated to generate new generation and attraction during the construction period of 22 pcu/day and during the operational period for attraction of 94.0 pcu/day and generation of 71.6 pcu/day. Increased generation causes traffic impacts on roads in the surrounding area, and mitigation measures to minimize the resulting traffic impacts.

Wahab W, Prices A. P, Roza A. (2020): The oldest engineering campus in West Sumatra Province is the Institute of Technology Padang (ITP) is located in two locations, namely on Jalan Gajah Mada (Campus I) and on Jalan DPR (Campus II). Constructing Campus II on an area of ± 1.5 HA can potentially increase traffic volume. Increasing traffic volume will affect road performance.

The research results show that the performance of the DPR road section in pre-construction conditions and during the construction period was at level B (good performance); however, in the post-construction period, it was at level C (adequate performance). The development will decrease road performance due to increased traffic flow on the DPR road (Tamin, 2000). The generation and attraction of movement are the leading causes of traffic movement on the road. New land use development or development will cause traffic disruption. Traffic disruptions will have an impact on movement patterns.

2.4. Growth Rate

The population growth rate model is the basis for predicting the growth of vehicle movements in the future:

$$P_{t+q} = P_t (1 + q)^t \quad (2)$$

Where,

- Pt+q = number of residents or movements in the year (t+q)
- Pt = number of residents or movements in year t
- R = average increase in population or movement each year
- Q = difference between the projection year and the base year

- Analyze the age and appeal of psychiatric hospital traffic.
- Analyze the performance of existing and future roads.

3. Materials and Methods

Research methods are the primary methods used in research to achieve goals and determine answers to the problems posed (Nasir, 2008). This research method was carried out based on the flow chart shown in Figure 2.

The research methodology is explained as follows:

1. Land use conditions at the construction site for the Prof. Dr. V.L. Ratumbusang psychiatric hospital with a land area of 20,000 m². Development consists of 2 stages. This research is for stage 1 development.
2. Kalasey Dua Collector Road, Minahasa Regency, is the hospital's location.
3. Estimated transportation used:
Traffic Generation and Attraction (Trip Generation)
The estimated traffic generation and attraction due to development will burden the surrounding road network. The things to do are:

4. Determination of the base year as the basis for analysis. The basic year in planning analysis for traffic engineering and road transportation management for Prof. Dr. V.L. Ratumbusang psychiatric hospital's construction is 2023. The year 2023 is the existing condition of development.
5. Analysis Periods: The analysis period in the analysis of traffic engineering management and road transportation for the construction of the Prof. Dr. V.L. Ratumbusang psychiatric hospital is five years to 10 after the construction.
6. Collecting Traffic Data Needs.
Traffic Data Requirements include:
 - Traffic volume during the one-week survey period (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday). Carrying out a traffic flow survey at 06.00 – 18.00 WITA. Data collection in traffic flow surveys to obtain.
 - ADT data and peak hour data (busy times)
 - Average vehicle speed
 - Traffic flow density
7. Simulation of traffic flow without development and with development.

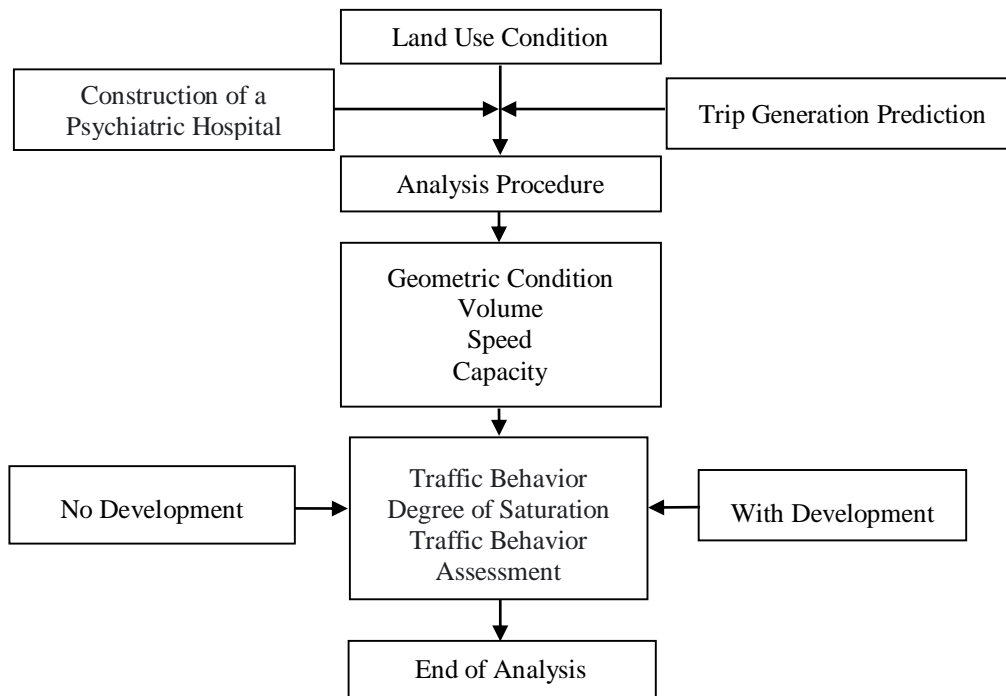


Fig. 2 Research flow chart

4. Result and Discussion

4.1. Existing Conditions in the Covered Area (Catchment Area)

The construction location of the psychiatric hospital, Prof. Dr. V.L. Ratumbusang, is located on Kalasey – Sea road, Mandolang District, Minahasa Regency, North Sulawesi Province, with a land area of 20,000m². The area of influence of the construction of Prof. Dr. V.L. Ratumbusang’s psychiatric hospital’s traffic analysis shows a radius of 1 km from the construction location, as explained in Figure 3.

The main road section is Kalasey Dua Road in Kalasey Dua Village, which is a collector road with a provincial road status.

4.2. Kalasey Dua Road Section

4.2.1. Kalasey - Sea Road Section Survey Results

The Kalasey Dua Road Section is a 2/2 UD-type road. Carrying out a traffic flow survey on Monday, 13 March 2023, to 19 March 2023, with a time interval of 06.00 - 18.00 WITA. The busy time during the study occurred on Monday, 13 March 2023, as shown in Table 2.

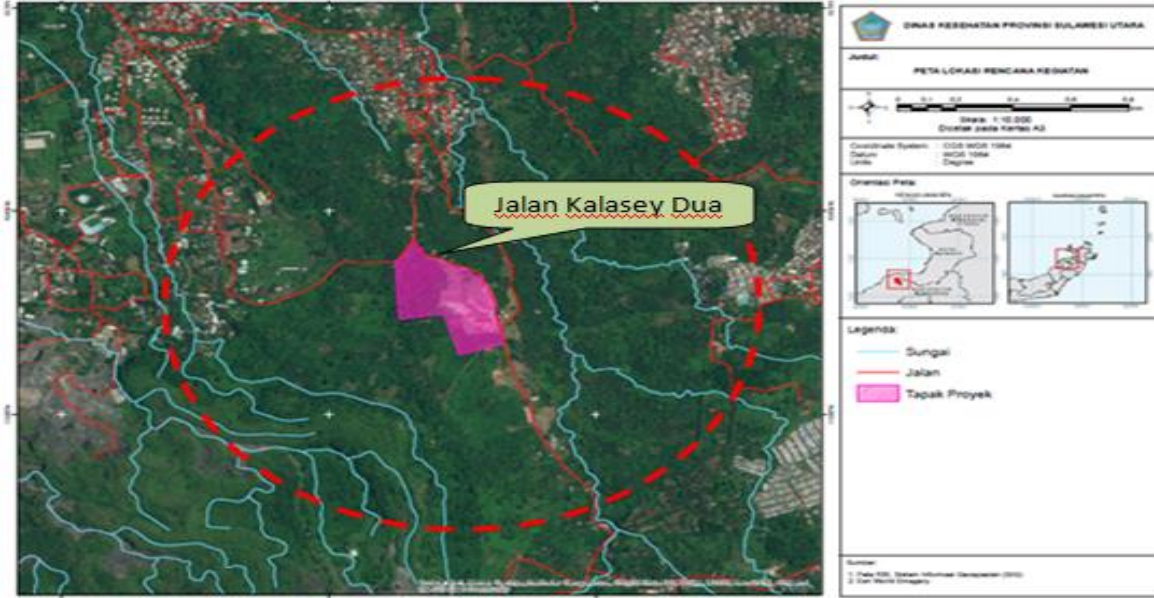


Fig. 3 Research study location area

Table 2. Traffic flow data Kalasey Dua road per hour on Monday, 13 March 2023

Hour	Vehicle				Total pcu/hour
	HV	LV	MC	UM	
06.00-07.00	5	36	172	0	131
07.00-08.00	5	72	163	0	162
08.00-09.00	12	54	152	0	151
09.00-10.00	18	37	84	0	110
10.00-11.00	13	27	67	0	83
11.00-12.00	13	32	97	0	103
12.00-13.00	12	36	90	0	102
13.00-14.00	15	43	89	0	113
14.00-15.00	9	39	71	0	90
15.00-16.00	12	53	94	0	121
16.00-17.00	11	34	84	0	95
17.00-18.00	7	24	58	0	65

Source: Survey Results 2023

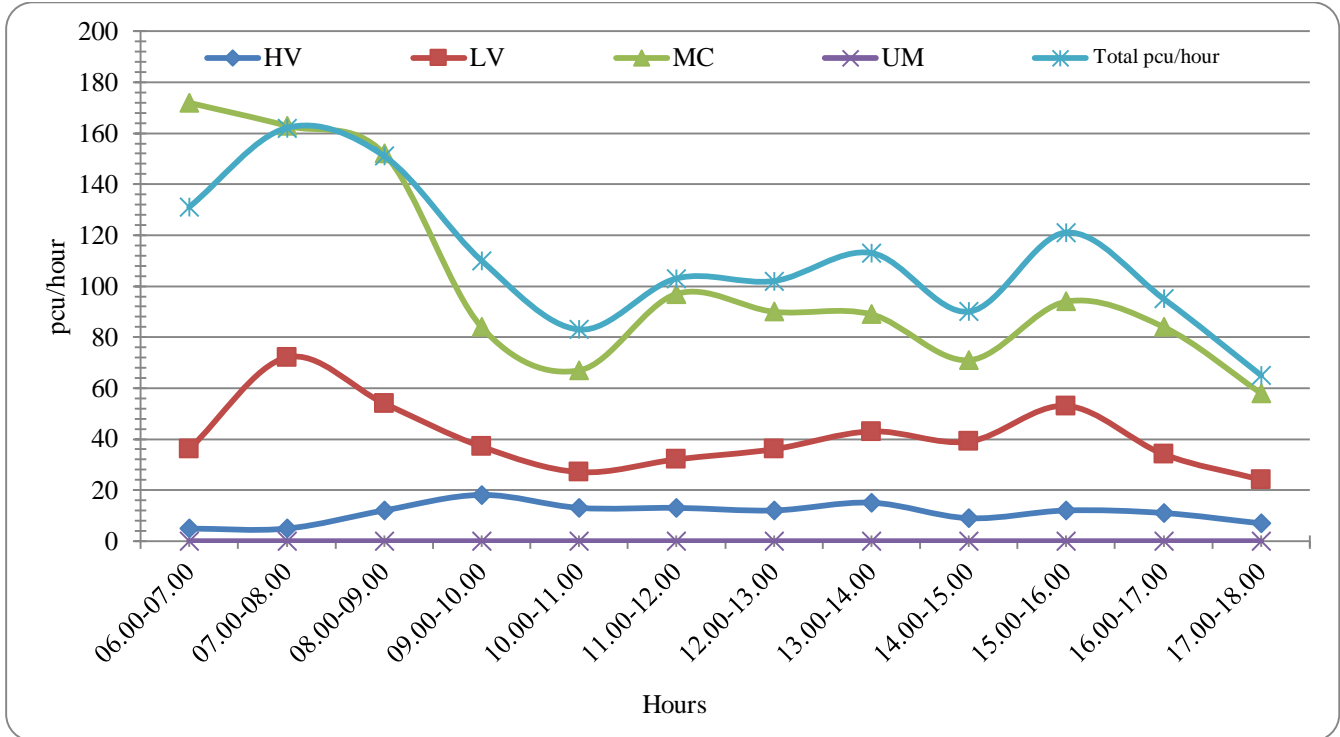


Fig. 4 Traffic flow fluctuation on Kalasey Dua Road on Monday, 13 March 2023

The results of the traffic flow analysis on Monday showed that the busy times occurred in the morning rush at 07.00 - 08.00 WITA with several vehicles of 162 pcu/hour and the afternoon rush at 15.00 - 16.00 WITA with several cars of 121 pcu/hour.

The results of this analysis are described in the form of traffic flow fluctuations, as shown in Figure 4. The analysis shows that rush hour occurs at 07.00 – 08.00 WITA with a total traffic flow of 162 pcu/hour.

4.2.2. Road Capacity Analysis

Road capacity is the maximum flow of vehicles passing a point on the road per hour under certain conditions. Capacity is expressed in units of passenger cars/hour (pcu/hour). The basic equation for determining the capacity of a road section is stated as follows:

$$C = C_0 \times FC_w \times FC_{sp} \times FC_{sf} \times FC_{cs} \tag{3}$$

Based on the road inventory survey results for the Kalasey Dua Road section in Kalasey Dua Village, the road type is 2/2 UD or two lanes, with two directions undivided.

- Road Function : Collector Road
- Road Status : Provincial Road
- Road Type : 2/2 UD
- Road Width : 5.50 m
- Median : None
- Number of Lanes : 2
- Number of Lanes : 2
- Left Sidewalk : None
- Right Sidewalk : None
- Road Condition : Good
- Pavement Type : Flexible
- Side friction : Low

The geometric of the Kalasey Dua Road Section, Kalasey Dua Village, is shown in Figure 5.

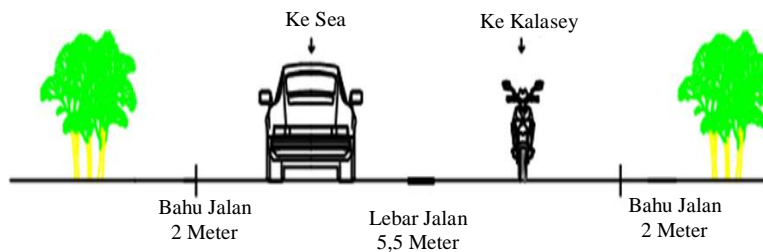


Fig. 5 Geometrics of the Kalasey Dua – Sea road, Kalasey Dua village

Table 3. The capacity of Kalasey Dua road

Road Name	Correction Factor					Total Capacity (pcu/hour)
	Co (pcu/hour)	FCw	FCsp	FCsf	FCcs	
Kalasey Dua	2.900 Total Two-Lanes	0,91	1,00	0,94	0,86	2.134

Source: Analysis results, 2023

The road capacity calculated based on IHCM 1997 for the Jalan Kalasey Dua section is shown in Table 3.

Kalasey Dua Road Level of Service

The service level value is measured based on the road section’s degree of saturation flow value. The degree of saturation is a ratio between the volume and capacity of a road section, so

$$DS=Q/C \tag{4}$$

Where DS = Degree of Saturation
 Q = Traffic Flow (pcu/hour)
 C = Road Capacity (pcu/hour)

Then $DS=162/2.134 = 0.076$

The degree of saturation value of 0.076 indicates the road level of service index; hence, the level of service is A.

4.3. Trip Generation

The transportation system and development or land development are interconnected (Tamin, 2000). Planning a transportation system aims to provide facilities for moving passengers and goods from one place to another or from various land uses. The generation and attraction of movement is the most essential part of this research.

The trip generation calculation for the Prof. Dr. V.L. Ratumbusang psychiatric hospital was analyzed based on the number of inpatients at the psychiatric hospital. Prof. Dr. V.L. Ratumbusang psychiatric hospital currently has 170 people and 110 outpatients.

The current number of rooms is 24 rooms and 200 beds. The number of doctors, nurses, and other workers is 372. Psychiatric hospital patients are different from general hospital patients whose families often visit, so the forms of movement arousal and movement are also different. Many movements occur in outpatients and general polyclinics. The survey results show that the movement generation is as follows:

- In 170 psychiatric hospital patients, the number of seizures was 25% = 43 pcu/day.

- Outpatients and general polyclinics 110 people = 110 pcu/day
- Doctors, nurses, other workers 372 people = 372 pcu/day

The total movement generation is 525 pcu/day, with peak hours occurring in the morning from 09.00 – 12.00 WITA. According to the regulation of the minister of transportation of the Republic of Indonesia number PM 17 of 2021 concerning the implementation of traffic impact analysis for constructing activity centres/settlements/other infrastructure where the activity is carried out.

It is calculated to have generated 201 vehicle trips (new vehicles during peak hours and created an average of 700 new vehicle trips every day on the roads affected (new buildings), so the traffic generation category is medium. Based on this analysis, the results of the estimated traffic generation for Prof. Dr. V.L. Ratumbusang’s psychiatric hospital in 2023, 2028, and 2033 results are shown in Table 4.

4.4. Road Segment Performance Analysis

The performance of the Kalasey Dua road section is being analyzed both with and without the planned construction of a psychiatric hospital by Prof. Dr. V.L. Ratumbusang in Manado. The analysis considers the expected traffic flow conditions for the upcoming 5 to 10 years.

The construction of the psychiatric hospital is scheduled to take place between 2023 and 2028. During this period, the traffic flow will be compared with the conditions before the construction took place. Traffic flow analysis will compare traffic conditions with and without development. The construction period is 2023, and construction will be completed in 2028.

The results of traffic flow simulations on the Kalasey Dua Road Section without any construction and with construction show an increase in traffic flow, which causes a decrease in the level of road service. The construction and operation of a psychiatric hospital by Prof. Dr. V.L. Ratumbusang Manado will increase the number of traffic movements due to the generation and attraction at the psychiatric hospital.

Table 4. Estimated traffic generation in 2023, 2028, 2033

Year	Light Vehicle LV (pcu/day)	Motor Cycle (mc/day)	pcu/day
2023	300	450	525
2028	317	476	793
2033	335	503	838

Source: Analysis Results, 2023

Table 5. Results of performance analysis of the Kalasey Dua - Sea road during peak hours (without construction and with construction)

Condition	Year	Q (pcu/hour)	Capacity (pcu/hour)	DS=Q/C	LOS
Without Construction	2023	162	2.134	0,076	A
	2028	183	2.134	0,086	A
	2033	204	2.134	0,096	A
With Construction	2023	210	2.134	0,098	A
	2028	440	2.134	0,206	B
	2033	732	2.134	0,343	B

Source: Analysis Results, 2023

5. Conclusion

The conclusions of this research are as follows:

- The trip generation value is moderate, 525 pcu/day in 2023.
- The effect of building a psychiatric hospital is that it will increase traffic flow on collector roads and the performance of the road from the level of service A to the level of service B.

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