International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Traffic Engineering Management of Nickel Mining Industry Development

Adris Ade Putra[1*], Edward Ngii[2], Ridwan Syah Nuhun[3], La Welendo[4], Muhammad Nashir[5]

Submitted: 24/04/2023 **Revised**: 25/06/2023 **Accepted**: 04/07/2023

Abstract*:* The development of nickel mining industry areas will cause a large traffic generation or attraction and impact traffic. To minimize traffic problems, traffic management of the road network system at the construction site is needed. The analysis includes an analysis of travel demand originating from the industry (the number of vehicles entering and exiting) and a supply analysis, which is an analysis of the condition of the existing road network. The method used is the Indonesian Road Capacity Manual. Based on the analysis results, industrial development activities impact road traffic at the construction and operational stages. The impacts that can be caused include disruption of security, safety, order, smooth traffic, and road transportation. The level of road service influences the form of an increase in the value of the V/C ratio, which means a decrease in section performance (negative impact), so it can be concluded that the influence of traffic impact is quite significant in affecting the performance of road sections.

Keywords: *development, industry, construction, road network, impact, traffic management*.

1. Introduction

Nickel is an important commodity in the mining quarter in Southeast Sulawesi Province. The possibility of nickel mineral sources in Southeast Sulawesi Province is pretty large, amounting to 97.4 billion heaps over 480 thousand hectares. The period 2008-2013 has been carried out nickel mineral mining as much as 56.9 million tons, so the available resources are currently 97.3 billion tons of nickel minerals. The ratio between nickel ore products and Ferronickel (FeNi) products is 377: 1. This indicates that in that period, the awareness to increase the added value of mining products through processing and refining was still very minimal.

Nickel mineral wealth in Southeast Sulawesi Province is not supported by infrastructure to increase its added value. The lack of transportation infrastructure and limited energy supply are the main problems that must be solved. Therefore, optimizing mineral utilization through mineral processing and refining (smelter) can be an industrial strength for Southeast Sulawesi Province. The nickel mineral processing and refining industry (smelter) development must be realized immediately to advance Southeast Sulawesi Province's economy, especially and encourage the national economy.

The construction of industrial centers with mining activities will certainly cause a large traffic generation or pull. It will put significant pressure on existing road infrastructure to serve and accommodate additional traffic loads caused by the construction and activity of mining product vehicles. To minimize traffic problems, the thing that must be done is to analyze the impact of traffic on the construction of the activity center, especially those that are estimated to have an important impact on the existing road network system around the construction site. In its development, development activities in the South Konawe Regency of Southeast Sulawesi Province are faced with various problems, both social, economic, and transportation problems. One of the problems related to transportation is the provision of road network access for vehicles transporting mining products to industrial estate locations. Using mining product transportation will certainly increase the traffic burden on the road network. Based on the description above, developing the Industrial Estate of South Konawe Regency, Southeast Sulawesi Province, requires traffic engineering management.

2. Literature Review

2.1. Traffic Management

Roundabout is one type of intersection controller commonly used in traffic schemes. The traffic scheme at the roundabout is that online site traffic that already exists comes first, so vehicles that will enter the roundabout must give the opportunity to motorists who are already there first. The function of the roundabout is to reduce traffic

[1*]*Department of Civil Engineering, Halu Oleo University, Kendari, Indonesia. Corresponding author: putra_adris@yahoo.com: Orcid Id : 0000-0002-8516-2126*
[2]*Department of Civil Engineering, Halu Oleo University, Kendari, Indonesia, Email: dwrd.ngii@gmail.com*
[3]*Department of Civil Engineering, Halu Oleo University, Kendari, Indonesia, Email: ridwansyahnuhun@yahoo.com*
[4]*Department of Civil Engineering, Halu Oleo University, Kendari, Indonesia, Email: wlawel@yahoo.com*
[5]*Department of Civil Engineering, Muhammadiyah University, Pare pare, Indonesia Email: nashirt75@gmail.com*

congestion on road sections. The greater the volume of vehicles at an intersection, the greater the roundabout rate limiting the density of road users.

Urban Infrastructure improvement will directly improve traffic congestion and embrace more concrete measures for congestion problems [1]. The crucial issue of Traffic Impact Analysis (TIA). Since the demand for transportation comes mainly from the need to achieve tourism place, assessing the travel speed, mostly, is a partial calculation of the transportation results of the society. A complete evaluation should be based on "people's capacity to reach a purpose," or accessibility, a function of travel and proximity to the tourist place [2]. Nevertheless, even this improvement in the Traffic Management process can face crucial obstacles. Small jurisdictions often require more technical guidance and expertise to instigate change, even when motivated. At the same time, larger jurisdictions that have adopted some modifications to Traffic Management processes often cite public opposition due to local concerns over traffic congestion [3].

With the rapid increase in private automobile ownership, transportation infrastructure is rarely supplied. Site visitor congestion has become extra severe, affecting people's travel and limiting the city's economic secure improvement [4][5]. Alongside the research in the field of technical aspects of AVs, there are many research efforts in the area of influence of the technology on a variety of other elements like general influence on the urban traffic network. [6], environmental factors [7], ethical aspects [8], and legislative [9]. Transportation and land use regulatory systems are collectively centered on accessibility and mitigating traffic congestion and cannot focus on access to goods, services, and jobs. As a growing number of scholars argue, a misplaced emphasis on mobility is at the root of the issue, and only with a shift to an accessibility framework can the means and ends of the mobility framework be altered [10][11][12][13].

Regrettably, even a shift to a land use development evaluation focused on accessibility may not be possible to take over local opposition to new development. While accessibility analysis can undermine traffic power in the anti-development narrative, it can consider and block many other parts of the development approval process from preserving locally unwanted land use from their environment [14][15]. Therefore, many researchers have studied ways to improve the analysis of travel generation by estimating the generation rate of travel from the characteristics of urban forms at the environmental level and social demography at the household level, based on the theory of travel demand and travel behavior [16][17][18][19][20].

Traffic impact analysis is the analysis of reports and notes on the situation, things to do on the impact of motorist administration on major development, and changes in transportation machinery affect land use change [21]. Furthermore, it makes sense to calculate how many trips a new visitor administration and understanding of engineering technology will require to cope with the impact [22]. Road website traffic engineering and administration is a method of web page traffic planning used except to prolong the power of thought and is usually short-term. This will include web page visitor prerequisites and support vehicles, both short-term and long-term. [23].

Traffic engineering management in regional infrastructure development has been carried out a lot of research, including [24][25][26]. Specifically, [24] predicted the influence of the construction. The analytical approach is carried out by calculating traffic loading and road section performance by calculating the degree of saturation/DS), and movement circulation. The study results show that traffic's impact arises of enormous value, so special solutions and handling are needed through traffic regulation to minimize flow disturbances on Jl. Majapahit [24]. Traffic engineering management to determine and prepare countermeasures for traffic impacts from infrastructure development. The location of the industry development significantly followed the expansion of the urban transport system, so it was necessary to plan and control developments more carefully. Otherwise, traffic jams or critical areas will continue to appear, even if new facilities are provided. Traffic engineering management to determine and prepare countermeasures for traffic impacts from infrastructure development. The location of the industry development significantly followed the expansion of the urban transport system, so it was necessary to plan and control developments more carefully. Otherwise, traffic jams or critical areas will continue to appear, even if new facilities are provided. [27], Cooperation between various stakeholders is required to implement the Traffic engineering management process successfully. According to [28], five parties must play an important role in implementing Traffic Engineering Management: the government, developers, consultants, academic personnel, and the community or civil society

2.2. Intersection

Transportation is a means that can help the success of the development of a city or country, often in supporting the community's economy [29]. The provision of transport can adorn the resources and mobility options of the population that can inform monetary growth. In addition, the gust of visitors of existing web riders displays order and obedience in road driving. But in reality, the development of a city is often accompanied by the emergence of transportation problems, one of which is traffic congestion [30]. Traffic jams occur because the volume of vehicles is no longer proportional to the area of the section. The number of motorists who are irregularly added with useful human resources prefer to use private cars, and the lack of sufficient infrastructure will exacerbate congestion in the city [31].

Traffic conditions at intersections without signals in various cities in Indonesia, especially on the prerequisites of every location. For example, an intersection entering an altitude clock will cause a waft conflict of site traffic. Therefore, the stagnation phase will start once extra due to delays and queues, reducing vehicle volume to make intersection conditions more controllable [32].

Much of the analysis comes from the number of website visitors, requiring builders to obtain entry permits from the local government. Affiliate consulting with licensed professionals consists of website visitors outside the web page influencing research. Accredited road traffic management companies must approve traffic results that impact the analysis. Other guidelines related to typical traffic performance influence the contrast set through actionable authority policies [33]. In regulation No. 32/2011 on Management and Engineering, Impact Analysis and Traffic Demand Management, Traffic affects analysis is the order of searches for things to do related to the influence of website visitors from the development of practice centers, settlements, and infrastructure, the consequence of which is as a site visitor affects the analysis. Investors analyze the appearance of website visitors to determine the impact of website visitors on residential buildings, training centers, and infrastructure that impacts the security, order, and safety of road website visitors.

2.3. Traffic Congestion

A crash can be interpreted as a laptop that cannot work properly, crashes, or is not smooth. Traffic congestion is a problem that occurs in neighborhoods due to population growth and density, so vehicles become very slow. As a result, congestion of online website visitors always occurs, making City visitors very uncomfortable for motorists. Another problem that creates congestion is the range of public transportation or online bicycle taxis regularly disturbed by motorists who carelessly supply, enter and exit the parking area, which blocks traffic lights. In the past, this problem was almost unraveled through the presence of every community that voluntarily managed the streets to keep the vehicles in order. However, in reality, it no longer greatly affects the disruption of congestion at that location.

Traffic jams can cause the economy to be hampered and waste time. In dealing with this problem, one of the steps that can be taken is to be aware of road users and expand the capacity of website traffic volume and saturation levels. Of course, unique methods are used to pay attention to the road so that the consequences are large, accurate, precise, and pleasant to the environment [34]. Special public roads used for public website web page traffic with residents around the neighborhood prepare road boundaries such as unloading, regulate speed bumps on the road, and have many time delays on the road that impact the effectiveness of road repairs [35].

3. Research Methods

In general, the outline of this method refers to the form of traffic engineering management analysis. The resulting recommendations are in the form of efforts that must be made to the existing traffic system and infrastructure to deal with the traffic load on the area to be developed. In general, this method can be seen in Figure 1.

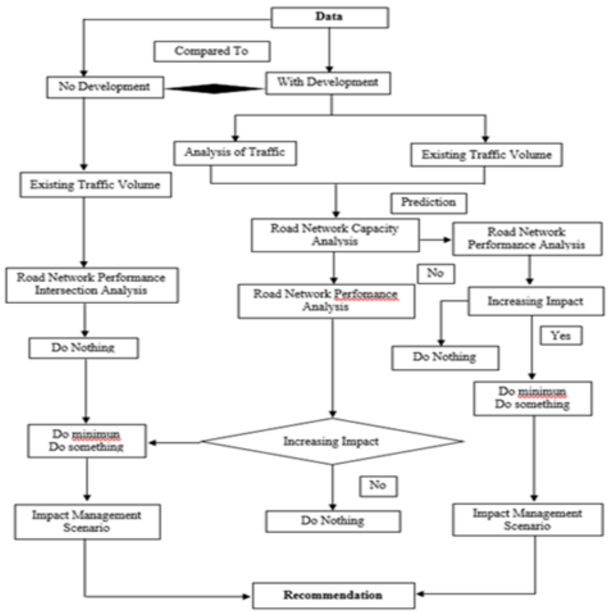

Fig 1. Flow chart of research methodology

3.1. Methodology Solidification Stage

At this stage, what is done is to plan in more detail the next stages of activity implementation, to efficiently use time and resources, and determine methods and analysis that will be used to evaluate and determine solutions to traffic problems that occur, especially during peak hours. At this stage, coordination is also carried out with the initiator regarding the description of development plans or development, as well as coordination with related agencies, especially the transportation office, regarding the scope of the study area

3.2. Data Collection Stage

At the data collection stage, consultants carry out secondary data collection processes, including the use of data that has been collected in similar studies, and conduct primary data collection, including land use data around the development area, road infrastructure power, and supporting facilities, carrying capacity of public transportation services, regional transportation problems, and reviews of the potential for generation and travel attraction caused

3.2.1. Secondary Data Collection

The compiled comprehensive methodology begins with the data collection stage, secondary data. The data collected in this stage is in the form of the identification of 2 (two) main problems, namely:

1. Land use data and existing road networks;
2. Grand *design* data industrial estate development activities

3.2.3. Primary Data Collection

To support the secondary data obtained and to get an overview of the condition of road services around the development site, primary data collection will be carried out directly to obtain important information related to land use and existing traffic performance. Before the primary survey, the survey preparation stage is first carried out, which essentially utilizes secondary information acquisition resources for the maturity of the primary survey implementation. At this stage, all information related to field problems in the study area is translated into survey forms, survey work plans, field organizations, and detailed maps.

As befits in the process of structuring studies, assessments, and other data analysis, the principles of GIGO (Garbage *In Garbage Out*) will also be applied in this study, where the determination and accuracy of the data and information obtained is the main key to obtaining appropriate and accurate analysis and recommendation results. Conversely, suppose the data and information used do not meet the accuracy and accuracy criteria standards. In that case, the resulting analysis and recommendations will also be far from accuracy and accurate. The survey time is carried out during peak hour traffic conditions. The explanation of technique and time of primary data collection will be explained below:

3.3. Inventory Survey Of Roads And Intersections

An inventory survey of roads/intersections is carried out on roads around the location of Industrial Estate Development Activities, which are predicted to be necessary for management and traffic engineering actions by developing at that location. Things that need to be noted in the survey are road geometry, speed of movement, traffic volume based on vehicle groups, and direction of movement. This inventory data will estimate the capacity of road sections and traffic management patterns.

a. Land use, information about the type of land use building, barriers to free visibility, and objects that block the smooth flow of vehicular or pedestrian traffic, such as stalls, street vendors, etc.
b. Geometric design, data relating to the geometric design of roads and intersections that need to be inventoried include detailed cross-sections covering the width of the road and the area belonging to the road; the number and width of traffic lanes, service roads, medians, hardened road shoulders, sidewalks, curb provision, and height, and others.
c. Traffic control information on traffic control devices that need to be inventoried includes traffic signs and road markings, which include location, type and size, and types of control.

3.4. Existing Traffic Survey

The section traffic enumeration survey was conducted to obtain data on volume, vehicle composition, distribution of traffic movements, and traffic volume during workday hours which are predicted to have a major impact due to operations. Traffic enumeration is done separately for each direction of traffic. In this survey, vehicles are grouped into 5 (five) classes as follows (and pedestrians):

a. Light vehicles (LV): these include sedans, station wagons, jeeps, and other personal passenger vehicles. Pick-ups and delivery cars are four-wheeled motor vehicles that are not trucks used for freight transportation with a maximum total weight of 2.5 tons.
b. Heavy vehicle (HV): namely, a motor vehicle for the transportation of people and goods with an amount with a minimum tonnage of 2.5 tons.
c. Public transport: vehicles used to serve people en masse, including public passenger cars (MPU) (including sedans, station wagons, and small-door buses) and buses (including medium buses and large buses).
d. Motorcycle (motorcycle/MC): a two-wheeled motor vehicle with a driving engine.
e. Un-motorized bicycles: two-wheeled or more motorized
f. Pedestrian

4. Results and Discussion

4.1. Capacity and V/C Ratio of Torobulu-Tinanggea Road

1. V/C Ratio Monday, January 11, 2023 Segment 1

Based on the results of the analysis that has been done, the V/c ratio in segment 1 can be seen in Table 1.

Table 1. Traffic volume data and v/c ratio of segment 1 of torobulu-tinanggea axis road

Time	Number Of Vehicles (kend/jam)	Number Of Vehicles (smp/jam)	Capacity	V/C Ratio	LoS
07.00 – 08.00	51	40	3035,5	0,01	A
08.00 – 09.00	63	47	3035,5	0,02	A
09.00 – 10.00	65	51	3035,5	0,02	A

10.00 – 11.00	64	49	3035,5	0,02	A
11.00 – 12.00	61	50	3035,5	0,02	A
12.00 – 13.00	57	45	3035,5	0,01	A
13.00 – 14.00	41	34	3035,5	0,01	A
14.00 – 15.00	33	25	3035,5	0,01	A
15.00 – 16.00	45	37	3035,5	0,01	A
16.00 – 17.00	52	42	3035,5	0,01	A
17.00 – 18.00	52	43	3035,5	0,01	A
18.00 – 19.00	46	37	3035,5	0,01	A

Based on Table 1 shows that the lowest V/c ratio value at 07.00-08.00 wita is 0.01 or is at the level of service (LoS) A, at noon at 12.00-13.00 wita the V/c ratio value of 0.01 is at the level of service (LoS) A, while in the afternoon V/c peak hour ratio of 0.01 is at the level *of service* (LoS) A. The V/c ratio graph can be seen in Figure 2.

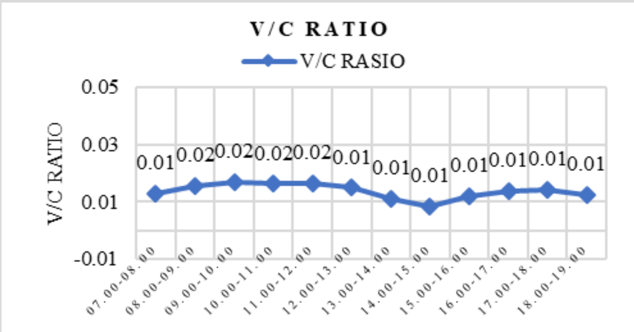

Fig 2. V/C Ratio segment 2 tuesday, january 11, 2023

Figure 2 shows the highest V/c ratio value in the afternoon and evening of 0.01 or the road service level or level of service (LoS) A category

2. V/C Ratio Monday, January 11, 2023 Segment 2

Based on the results of the analysis that has been done, the V/c ratio in segment 3 can be seen in Table 2.

Table 2. Traffic volume data and v/c ratio of segment 2 torobulu-tinanggea axis road

Time	Number of Vehicles (kend/jam)	Number of Vehicles (smp/jam)	Capacity	V/C Ratio	LoS
07.00 – 08.00	46	35	3035,5	0,01	A
08.00 – 09.00	57	43	3035,5	0,01	A
09.00 – 10.00	60	47	3035,5	0,02	A
10.00 – 11.00	60	46	3035,5	0,02	A
11.00 – 12.00	60	50	3035,5	0,02	A
12.00 – 13.00	57	45	3035,5	0,01	A
13.00 – 14.00	40	33	3035,5	0,01	A
14.00 – 15.00	31	23	3035,5	0,01	A
15.00 – 16.00	42	34	3035,5	0,01	A
16.00 – 17.00	47	37	3035,5	0,01	A
17.00 – 18.00	47	38	3035,5	0,01	A
18.00 – 19.00	42	34	3035,5	0,01	A

Based on Table 2 shows that the lowest V/c ratio value at 07.00-08.00 wita is 0.01 or is at *level* of service (LoS) A, during the day at 11.00-12.00 wita the V/c ratio value of 0.02 is at the level of service (LoS) A, while in the afternoon V/c peak hour ratio of 0.01 is at the level *of service* (LoS) A. The V/c ratio graph can be seen in the figure below.

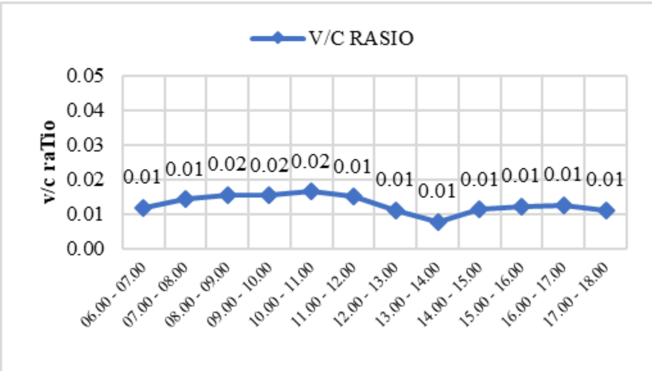

Fig 3. V/C ratio segment 2 monday, january 11, 2023

Based on Figure 3, the highest V/c ratio value in the afternoon and evening is 0.01 or in the road service level (LoS) A category

4.2. Pedestrian Analysis

Pedestrian volume data collection was carried out in two directions before the access road to the location. The results of the volume calculation can be seen in Table 3.

Table 3. Determination of PV 2 crossing facility type

Time	Pedestrian (P) (person/hour)	Vehicle (V) (V/hour)	PV²	4 Largest PV²
1	2	3	4	5
07.00 - 08.00	4	35	4900	19600
08.00 - 09.00	3	54	8748	34992
12.00 - 13.00	2	109	23762	95048
13.00 - 14.00	1	110	12100	48400
16.00 - 17.00	5	146	106580	426320
17.00 - 18.00	4	154	94864	379456
AVERAGE P		3		
AVERAGE V		101		
PV²		32517		
PV²		< 10⁸		

Based on the calculation results, the determination of the crossing facility with the results of the analysis of PV^2 values of 32,517 or $< 10^8$ with recommendations that there is no need for crossing facilities. However, zebra crossing facilities for pedestrians are needed in front of the Industrial Area.

4.3. Average Vehicle Speed

The average vehicle speed using the *Speed Gun* measuring instrument at the front location of the industrial plan at *do nothing* conditions at peak hours at 17.00-18.00 WITA can be seen in Figure 4.

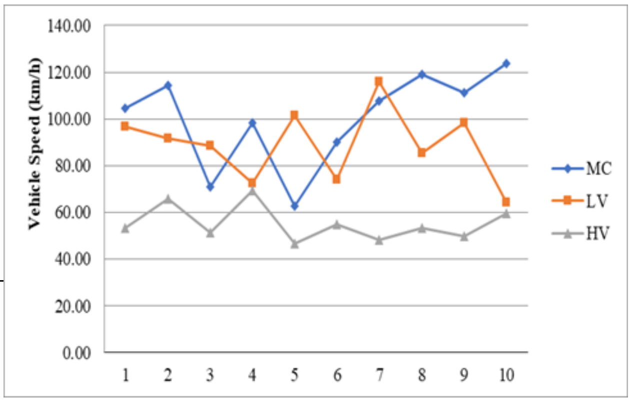

Fig 4. Speed graph from the west

Based on Figure 4 provides an overview of vehicle speed fluctuations that occur on the Torobulu-Tinanggea Road in front of the industrial estate construction site at speed the highest with the type of motorcycle vehicle is 100.26 km /h for the top speed of light vehicles of 88.84 kend/h and heavy vehicles with a top speed of 55.20 km/hour.

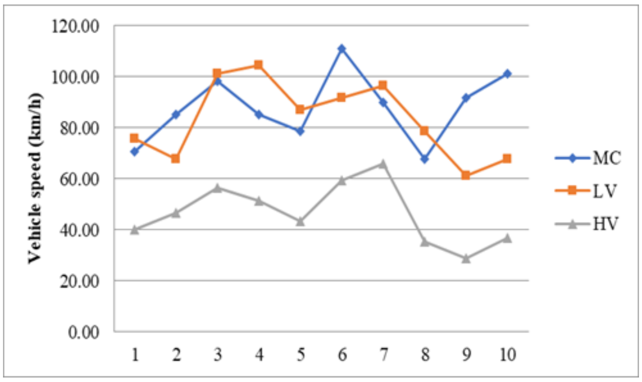

Fig 5. Speed graph from the east

Based on Figure 5 provides an overview of vehicle speed fluctuations from the east that occur on the Torobulu-Tinanggea Road with the highest speed with the type of motorcycle vehicle of 88.03 km /h. The top speed of light vehicles of 83.20 kend/h, and heavy vehicles with a top speed of 46.51 km/h.

4.4. Parking Needs Analysis

The minimum parking requirement in industrial estates is based on the Decree of the Director General of Land Transportation Number 272/HK.105/DRJD/96. To calculate the adequacy of parking space against parking needs, it can be calculated in Table 4.

No.	Land Allotment Parking	Parking Space	Number of Vehicles. Plan The Parking Lot (SRP)	Land Area Needed
1.	Passenger Cars Group I	2.3 x 5 = 11.5 m²	175	2.012,5

2.	Passenger Cars Group II	x 5 = 1 2.5 m^2	126	1.575
3.	Passenger CarsGroup III	3 x 5 = 15 m^2	126	1.890
4.	Bus/Truck	3.4 x 12.5 = 42.5 m^2	76	3.230
5.	Motorbike	0.75 x 2 = 1.5 m^2	2017	3.025,5
Number of parking spaces required			2.521	11,733 m^2
Available parking space				12,620.85 m^2
Percentage of parking needs against available land area				92.97%

Based on the calculation above, the total need for parking space with 2,521SRP is 11,733 m^2. This overall has filled the available parking area of 12,620.85m^2. Based on the above results, it can be concluded that the industrial estate has a parking lot plan that meets the minimum needs of parking space r 92.97% of the available parking area. There is still parking space available, as much as 7.03% of the available land or 887.25 m^2.

The comparison location used is a type of activity that is almost the same as industrial estate activities. The data related to the location of the comparison can be seen in Table 5:

Table 5. Peer location data

Name of Activity	Trip Generation	Trip Attraction	Area	SRP
PT. VDNI	2548	2012	1776000	1397
PT. OSS	2987	2562	2657126	1726

Data processing uses the help of SPSS 16 software with the Enter method to produce regression equations. The results of linear regression can be seen in the following figure 6

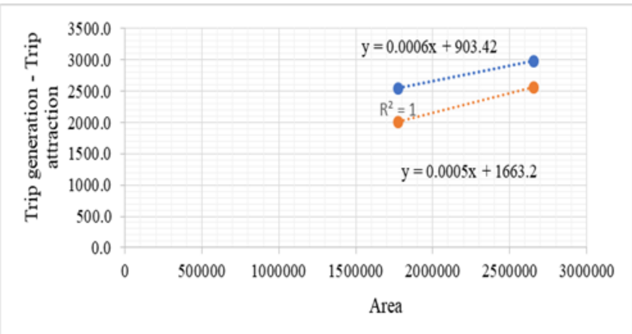

Fig 6. Generation-pull modeling of land area

Vehicle parking needs for industrial estates can be calculated based on the equation model above with the following data:

Y_{rise} = 0.0006x + 903.42

Y_{rise} = 0.0006x (4,000,000) + 903.2

= 3,303 vehicles

Y_{pull} = 0.0005x + 1663.2

Y_{pull} = 0.0005 x (4,000,000) +1663.2

= 3,663 vehicles

The generation of vehicles from the Industrial area was 3,303, and the vehicle pulls to 3,663. Based on the calculation results using the comparison location equation model, the need for the largest parking is 3,663 SRP.

4.5. Impact Management Recommendations

Handling the impacts that occur due to Industrial Estate Development is carried out clearly, and is responsible for all solutions recommended in this document. Impact handling is divided into 2 important parts: handling impacts during construction and operations. During the construction period, more emphasis was placed on mobilizing construction vehicles and material vehicles, maintaining traffic safety, and minimizing the possibility of delays in maneuvering (geometric) vehicles in and out of the construction site. Meanwhile, during the operational period, internal and external area management of Industrial Estates is carried out.

1. **Pre Construction**

In the pre construction period, from the results of the analysis that has been carried out, it is known that traffic performance has not had an impact due to the Industrial Estate Development plan because the activities carried out at this time are development preparation activities such as observations, measurements, and others so that the impact caused by the development on traffic performance does not yet exist.

2. **Implementation of Impact Management During Construction**

The analysis of conditions during the construction period results in the circulation of freight vehicles that load building materials (materials) from the *quary* to the construction site. However, this has not affected the traffic performance of the Torobulu-Tinanggea axis road because, generally, the volume of goods traffic containing building materials can still be controlled. What needs to be considered at this time is the fall of building/excavated materials, such as soil and sand, transported by vehicles on the road, which causes inconvenience to other road users. To anticipate some of the above, it is necessary to carry out security and supervision by the initiator of the circulation of goods traffic in and out of the construction site so that security, smoothness, and safety of traffic crossing the surrounding roads can be maintained without accidents. Recommendations for constructing Industrial Estates at the construction stage can be explained in Table 6.

Table 6. Mitigation recommendations for handling the impact of masa construction

No.	Handling	Information
1.	Conducting socialization to the surrounding community-related implementation of the construction of the South Konawe Regency Industrial Estate	Pre Construction
2.	Create a delivery line to transport materials according to the proposed drawings.	Access
3.	Make special entry and exit access for project vehicles during construction with a minimum width of 10 M.	Access
4.	Fencing around the construction site.	Security
5.	Installing road safety facilities in the form of: a. Careful signs with additional boards "Exit MasukProject Vehicles" as many as 2 units; b. *Warning lights* in front of access in and out as many as 5 units; c. Parking prohibition signs around the entrance and exit access as many as 2 units.	Management and Engineering
6.	Provide *a car wash* location for washing vehicles before leaving the construction site.	Location within the industrial estate
7.	Provide the location of the *stockpile* or land to forge building materials and equipment that will be used for construction within the construction site.	Location within the industrial estate
8.	Provide parking locations for transport trucks inside the construction site to prevent illegal parking on the roadside.	Location within the industrial estate
9.	Close the vehicle tightly during material transportation using tarpaulins and fasten well to avoid splattering soil and dust on the road.	The company is obliged to carry out.
10.	The delivery of materials and other materials such as sand, gravel, cement, and others using small trucks was carried out at 09.00-15.00.	Scheduling
11.	I am cleaning roads due to scattered materials on the road (especially soil material) during construction.	Specially prepared officers

Based on the Regulation of the Minister of Transportation Number 60 of 2019 concerning the Implementation of Goods Transportation by Motor Vehicles on the Road, the transportation of non-dangerous goods in the form of Bulk Goods by companies must meet the following requirements:

1. Use loading and unloading facilities that meet the requirements;
2. Have a pay case cover and emergency safety equipment that meets the requirements;
3. Loading and unloading in a place that does not interfere with security, safety, smoothness, and order of traffic and the surrounding community;
4. Placing goods in the cargo space of the freight car by the carrying capacity stated in the evidence passed the test and arranged properly so that the load is proportionally distributed on the axis of the freight car; and
5. Carried out by Vehicle Crew

3. Post Construction Impact Management

Increased Capacity of Sections and Crossroads

Increasing the capacity of the Torobulu-Tinanggea axis road, especially in front of the location of the industrial estate construction plan, is carried out in several steps as follows:

a. Leveling the roadside with existing road pavement.
b. To maintain the capacity of the road section by existing conditions, it is very necessary to prohibit parking signs around the entrance and exit of the location so that parking does not occur on the road body.

4.5. Traffic Management and Engineering on Road Sections

Traffic management and engineering is a collection of organizations and activities that involve planning, procurement, installation, arrangement, and maintenance of road gear services to realize, aid, and hold security, safety, order, and easy traffic. Related to visitors administration and engineering efforts on the traffic influence design for the development of industrial estates, the matters carried out are as follows:

a. The first step in traffic management is to make the capacity of road sections and intersections as effective as possible to smooth the movement of traffic vehicles. Some capacity management applications, such as geometric road improvements, are adapted to field conditions.
b. Parking management, where a parking park is created in the industrial area.
c. On the roadside in front of the industrial area location, it is forbidden to park on the road body *(off-street parking).*
d. Separation of vehicles on road sections by applying yellow lines separating road sections.

e. Separation of vehicle directions on the entrance and access roads
f. Priority management for non-motorized vehicles, such as dedicated bicycle lanes, is provided within the internal area.
g. Priority lanes for pedestrians on the sidewalk leading into the internal area.

5. Conclusion

Based on the results of the traffic impact analysis of regional development can be concluded as follows:

1. Industrial estate development activities impact road traffic at the construction and operational stages. The impacts that can be caused include disruption of security, safety, order, smooth traffic, and road transportation.
2. The level of road service to the value of the V/C ratio that occurs with the operation of regional industries influences the form of an increase in the value of the V/C ratio, which means a decrease in segment performance (negative impact), the V/C ratio due to the increase is still quite significant to the V/C value of the existing condition ratio, so it can be interpreted that the influence is quite significant for the performance of road sections in industrial estate locations.
3. Based on the calculation results, the determination of the crossing facility with the results of the analysis of PV^2 values of 32,517 or < 10^8 with recommendations that there is no need for crossing facilities. However, zebra crossing facilities for pedestrians are needed in front of the Industrial Area.
4. Based on the calculation of parking space needs analysis, the total need for parking space with 2,521 SRP is 11,733 m^2. This overall has filled the available parking area of 12,620.85 m^2.
5. The entry and exit access openings in segment 2 in front of the industrial estate location are 72.75 meters and have a turning radius of R12.5.

Acknowledgements

The author would like to thank the Dean of the Faculty of Engineering at Halu Oleo University through the Scientific Research and Innovation Support Fund. In addition, I would also like to thank the Southeast Sulawesi Provincial Transportation Office for providing data in this study.

Author contributions

Adris Ade Putra: Conceptualization, Methodology, Software, Field study, Writing-Original draft preparation **Edward Ngii:** Data curation, Software, Validation **Ridwan Syah Nuhun:** Field study, Visualization **La Welendo:** Investigation, Validation **Muhammad Nashir:** Writing-Reviewing and Editing.

Conflicts of interest

The authors declare no conflicts of interest.

References

[1] J. M. B. Volker, A. E. Lee, and D. T. Fitch, “Streamlining the development approval process in a post–level of service Los Angeles,” J. Am. Plan. Assoc., vol. 85, no. 2, pp. 114–132, 2019.

[2] J. Levine, J. Grengs, and L. A. Merlin, From mobility to accessibility: Transforming urban transportation and land-use planning. Cornell University Press, 2019.

[3] T. S. Combs and N. C. McDonald, “Driving change,” J. Transp. Land Use, vol. 14, no. 1, pp. 47–64, 2021.

[4] F. Wen, G. Zhang, L. Sun, X. Wang, and X. Xu, “A hybrid temporal association rules mining method for traffic congestion prediction,” Comput. Ind. Eng., vol. 130, pp. 779–787, 2019.

[5] R. Zhou, H. Chen, H. Chen, E. Liu, and S. Jiang, “Research on traffic situation analysis for urban road network through spatiotemporal data mining: a case study of Xi’an, China,” IEEE Access, vol. 9, pp. 75553–75567, 2021.

[6] S. Reed, A. M. Campbell, and B. W. Thomas, “The value of autonomous vehicles for last-mile deliveries in urban environments,” Manage. Sci., vol. 68, no. 1, pp. 280–299, 2022.

[7] F. Vrbanić, M. Miletić, L. Tišljarić, and E. Ivanjko, “Influence of variable speed limit control on fuel and electric energy consumption, and exhaust gas emissions in mixed traffic flows,” Sustainability, vol. 14, no. 2, p. 932, 2022.

[8] H. Wang, A. Khajepour, D. Cao, and T. Liu, “Ethical decision making in autonomous vehicles: Challenges and research progress,” IEEE Intell. Transp. Syst. Mag., vol. 14, no. 1, pp. 6–17, 2020.

[9] R. A. Acheampong, F. Cugurullo, M. Gueriau, and I. Dusparic, “Can autonomous vehicles enable sustainable mobility in future cities? Insights and policy challenges from user preferences over different urban transport options,” Cities, vol. 112, p. 103134, 2021.

[10] A. Mondschein and B. D. Taylor, “Is traffic congestion overrated? Examining the highly variable effects of congestion on travel and accessibility,” J. Transp. Geogr., vol. 64, pp. 65–76, 2017.

[11] E. J. Miller, “Accessibility: measurement and application in transportation planning,” Transp. Rev., vol. 38, no. 5, pp. 551–555, 2018.

[12] S. Handy, “Is accessibility an idea whose time has finally come?,” Transp. Res. Part D Transp. Environ., vol. 83, p. 102319, 2020.

[13] [13] D. Levinson and H. Wu, “Towards a general theory of access,” J. Transp. Land Use, vol. 13, no. 1, pp. 129–158, 2020.

[14] K. L. Einstein, D. M. Glick, and M. Palmer, “Neighborhood defenders: Participatory politics and America’s housing crisis,” Polit. Sci. Q., vol. 135, no. 2, pp. 281–312, 2020.
[15] P. Monkkonen, M. Lens, and M. Manville, “Built-out cities? How California cities restrict housing production through prohibition and process,” Monkkonen, Paavo, Michael Lens, Michael Manv., 2020.
[16] R. Ewing, G. Tian, T. Lyons, and K. Terzano, “Trip and parking generation at transit-oriented developments: Five US case studies,” Landsc. Urban Plan., vol. 160, pp. 69–78, 2017.
[17] A. Howell, K. M. Currans, S. Gehrke, G. Norton, and K. J. Clifton, “Transportation impacts of affordable housing,” J. Transp. Land Use, vol. 11, no. 1, pp. 103–118, 2018.
[18] G. Tian, K. Park, and R. Ewing, “Trip and parking generation rates for different housing types: Effects of compact development,” Urban Stud., vol. 56, no. 8, pp. 1554–1575, 2019.
[19] K. M. Currans, G. Abou-Zeid, K. J. Clifton, A. Howell, and R. Schneider, “Improving transportation impact analyses for subsidized affordable housing developments: A data collection and analysis of motorized vehicle and person trip generation,” Cities, vol. 103, p. 102774, 2020.
[20] G. Tian, K. Park, R. Ewing, M. Watten, and J. Walters, “Traffic generated by mixed-use developments—A follow-up 31-region study,” Transp. Res. Part D Transp. Environ., vol. 78, p. 102205, 2020.
[21] R. Safiullin, V. Fedotov, and A. Marusin, “Method to evaluate the performance of measurement equipment in automated vehicle traffic control systems,” Transp. Res. Procedia, vol. 50, pp. 20–27, 2020.
[22] A. M. Sidiq, A. I. Rifai, M. Isradi, and W. B. Dermawan, “Identification of Traffic Accident Problem Levels on Motorcycle Rider Behavior Using Traffic Conflict Technique (TCT) Method Case Study: Cileungsi Road,” ADRI Int. J. Civ. Eng., vol. 7, no. 1, pp. 172–179, 2022.
[23] J. D. Vreeswijk, M. K. M. Mahmod, and B. van Arem, “Energy efficient traffic management and control-the eCoMove approach and expected benefits,” in 13th International IEEE Conference on Intelligent Transportation Systems, 2010, pp. 955–961.
[24] W. Y. Jamani, H. Hasyim, and R. Rohani, “Analisis Dampak Lalu Lintas (Andalalin) Akibat Pembangunan Rumah Sakit Graha Ultima Medika: Traffic Impact Analysis Result the Construction of Graha Ultima Medika Health Care Centre,” Spektrum Sipil, vol. 3, no. 1, pp. 81–91, 2016.
[25] A. Rahman, M. Machsus, A. F. Mawardi, and R. Basuki, “Analisis Dampak Lalu Lintas Akibat Pembangunan Apartemen Puncak Dharmahusada Surabaya,” J. Apl. Tek. Sipil, vol. 16, no. 2, pp. 69–76, 2018.
[26] T. Rantung, B. F. Sompie, and F. Jansen, “Analisa Dampak Lalu Lintas (Andalalin) Kawasan Lippo Plaza Kairagi Manado,” J. Ilm. Media Eng., vol. 5, no. 1, 2015.
[27] N. Azra and S. Hoque, “Implementation of traffic impact assessment in developing countries: a case study of Bangladesh,” in International Conference on Future Trends in Civil and Structural Engineering, FTCSE, 2014.
[28] K. Limapornwanitch, C. M. Montalbo Jr, K. Hokao, and A. Fukuda, “The implementation of traffic impact assessment in Southeast Asian cities: Thailand and the Philippines case studies,” J. East. Asia Soc. Transp. Stud., vol. 6, pp. 4208–4223, 2005.
[29] M. Isradi, N. D. Nareswari, A. I. Rifai, and J. Prasetijo, “Performance Analysis of Road Section and Unsignalized Intersections to Prevent Traffic Jams on Jl H. Djole–Jl. Pasar Lama,” Int. J. Civ. Eng., vol. 6, no. 1, pp. 56–67, 2021.
[30] A. Rokhman, D. Putri, and S. D. Siswoyo, “Analisis Ruas Jalan Nasional Klari Kabupaten Karawang Menggunakan Metode MKJI 1997,” in FORUM MEKANIKA, 2022, vol. 11, no. 1, pp. 1–10.
[31] A. Wadu, R. Kusumawardhani, and I. Suherminingsih, “Manajemen Lalu Lintas di Jalan Lingkar Kampus Universitas Brawijaya,” JUTEKS J. Tek. Sipil, vol. 3, no. 2, pp. 266–272, 2018.
[32] R. E. Wibisono, D. P. Nurcahaya, A. Susanti, and A. Widayanti, “Evaluasi Kinerja Lalu Lintas Simpang Tak Bersinyal Berdasarkan Pertumbuhan Kendaraan Data Survei di Jalan Raya Babat–Jalan Kalen Kabupaten Lamongan,” Ge-STRAM J. Perenc. dan Rekayasa Sipil, vol. 5, no. 1, pp. 23–28, 2022.
[33] V. Shepelev, S. Aliukov, K. Nikolskaya, and S. Shabiev, “The capacity of the road network: Data collection and statistical analysis of traffic characteristics,” Energies, vol. 13, no. 7, p. 1765, 2020.
[34] V. Gorodokin, V. Shepelev, P. Buyvol, and E. Shepeleva, “Method of non-stop passage of signal-controlled intersections using dynamic signs and computer vision,” Transp. Res. procedia, vol. 50, pp. 174–181, 2020.
[35] A. N. Azizah, A. Budiharjo, and S. Maimunah, “Kajian Manajemen Lalu Lintas di Kawasan Pasar Bogor,” Techno (Jurnal Fak. Tek. Univ. Muhammadiyah Purwokerto), vol. 23, no. 1, pp. 1–8, 2022.
[36] Dr. Antino Marelino. (2014). Customer Satisfaction Analysis based on Customer Relationship Management. International Journal of New Practices in Management and Engineering, 3(01), 07 - 12. Retrieved from

http://ijnpme.org/index.php/IJNPME/article/view/26

[37] Anandpwar, W. ., Barhate, S. ., Limkar, S. ., Vyawahare, M. ., Ajani, S. N. ., & Borkar, P. . (2023). Significance of Artificial Intelligence in the Production of Effective Output in Power Electronics. International Journal on Recent and Innovation Trends in Computing and Communication, 11(3s), 30–36. https://doi.org/10.17762/ijritcc.v11i3s.6152