Planning for alternative road development connecting East Balikpapan - North Balikpapan

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Abstract Balikpapan City is one of the largest cities in the East Kalimantan region and a city that is developing quite rapidly. These developments include a high population number accompanied by a large number of new activity growths which create a considerable traffic pull around the city center. According to the 2012-2032 City Spatial Plan for Balikpapan City, the priority plan for road development is on Outer Ring Road III and other alternative roads which will become new activity centers in Karang Joang and Manggar sub-districts in Balikpapan City.

The road network currently has the highest volume of 4288 pcu / hour with an average speed of 42 km / h and reaches a VCR of 0.8 which has 35 existing roads and 17 intersections. This study intends to improve traffic performance and aims to plan an alternative road network connecting East Balikpapan with North Balikpapan.

Simulation analysis uses Visum software to produce the best conditions for handling traffic in Balikpapan City arteries, collectors and local roads where the current condition of the traveler has to go through the East, South, Central and North Balikpapan District network. The method used is the calculation of existing traffic performance and simulation to determine network volume, network speed, total distance and total travel time. The simulation results with the Visum model are the best conditions of traffic performance with an average volume of 762 pcu / hour, an average network speed of 42 km / hour, a total distance of 148487 km, and a total travel time of 3369 hours.

Keywords: distance and travel time, network, speed, volume

1. Preliminary

The development of a certain area and / or location has an influence on the traffic around it. The transportation planning system is used to predict whether the transportation infrastructure is affected by this development and whether it can serve the existing traffic, plus the traffic that the development generates or attracts. If the existing infrastructure cannot support the traffic, a study on the handling of the infrastructure or the regulation of the traffic must be carried out, particularly those that are thought to have a significant impact on the road network system in the area. [1]

Balikpapan City is one of the big cities that continues to carry out development according to its position in the National Spatial Plan (RTRWN) as a National Activity Center (PKN) which functions or has the potential to be a National Marine Transportation Node, National Air Transportation Node, Mainstay Area, and Development Area. Integrated Economy (KAPET) which is equipped with the development of a highway network from Balikpapan - Samarinda (RTRW Kota Balikpapan, 2012). Meanwhile, the position of the City of Balikpapan in the Provincial Spatial Planning (RTRWP) of East Kalimantan is as the Primary Service Center, better known as the gateway to the Province of East Kalimantan.
Based on the analysis, the Balikpapan City Field Work Practice Team can find out from the results of traffic loading on the primary arterial roads around the road network development plan that has a V / C ratio $> 0.58$, so that there will be a surge in travel demand which of course will generate traffic and increase the traffic load on these roads which are alternative routes.

2. Literature Review

2.1 Transportation System

Transportation planning as a process can also be said to be the existence of processing activities (processing) of one or more inputs / inputs to obtain one or several outputs. As in other planning sectors, in transportation sector planning we use a general planning approach, where we analyze all the factors related to the existing problems, the general approach in the transportation sector can be said to be a 'systems' approach to transportation. [6]

Activity systems, network systems, and movement systems in their interactions will be interconnected. Changes in the activity system will affect the network system through changes in service levels in the movement system. Likewise, changes to the network system will be able to affect the activity system through increased mobility and accessibility of the movement system, so that these three micro systems interact with each other in the macro transportation system. [6]

2.2 PTV Visum Application

PTV Visum (Visum) is a leading software program used for [4]:

- Analysis and forecasts for traffic and transportation systems.
- Model private transport and public transportation in one integrated model.
- Allows management of GIS data for private and public transport so that it can be managed consistently with a network editor.
- Accommodate vehicle restrictions to optimize vehicle use and to analyze costs and revenues.
- Support planning to develop policy measures and determine the impact of those policy measures.
- Equipped with a microscopic traffic simulation system from PTV VISSIM (VISSIM).
- Planning of public transport networks and services that are demand-based and service-oriented.
- Easy-to-interpret graphical display covering strategic and operational processes throughout public transportation planning.
- Model transportation demand and load onto the network. The principle of PTV VISUM modeling is a 4-step model (Four Step Modeling), namely: TG: Trip Generation (production & attraction); MS: Split Capital; TD: Trip Distribution ; TA: Trip Assignment.

2.3 Performance assessment

- Road Section Performance Indicators [2]
  Road performance indicators consist of road capacity, volume, $v / c$ ratio (traffic volume / capacity), and speed.
- Road network performance indicators [2]
  The Road Section Performance Indicator consists of the average network volume, the speed of the road network, the average total mileage and the total average travel time.
3. General Description
According to the 2012-2032 Regional Spatial Plan (RTRW), the corridor planned for the third Balikpapan outer ring road will connect the East Balikpapan District, namely Manggar towards the north, namely Soekarno Hatta Street, and then further connect the City of Balikpapan with Kutai Kartanegara Regency. Stretching from north to south, the total length of the Balikpapan-Samarinda outer ring road (III) is approximately 12 km from the Manggar TPA (Final Disposal Site) junction to the end of the new Balikpapan-Samarinda road (Highway) (Km 12.9). [5]

4. Research Methodology
This research was carried out based on the research methodology from the initial stages of problem identification, problem formulation, primary data collection and secondary data, data processing and analysis, traffic modeling during the morning and evening rush hour using PTV Visum Student Version 2020 software, model validation using the method (Chisquare) and (Mape), predicting the size of the upcoming trip in 2019-2024 and 2019-2029, until the final stage of problem solving alternatives with 8 traffic handling proposals or recommendations to anticipate the continuation of traffic performance.

5. Analysis and Problem Solving
5.1 Research Coverage Area
In general, the Balikpapan City Alternative Road Network area is a sub-center for service activities, which consists of 35 roads and 17 interconnected intersections (Figure 1).

Figure 1 Codification of the existing alternative Road Network area in 2019
Source: analysis results, 2020

5.2 Zoning of Existing Travel
Before conducting the research, what was done was dividing the study area into several traffic zones. This zone is created based on the flow of traffic in and out of Balikpapan City Alternative Road Network areawhich is used to identify the number of trips from one zone to another to get attraction and trip generation. The following table is the zone grouping contained in Balikpapan City Alternative Road Network area (Table 1).
Table 1 Balikpapan City Alternative Road Network area zone

| Zone | Access                                      | ADMINISTRATION     |
|------|---------------------------------------------|--------------------|
| 1    | JL MULAWARMAN 3                            | Manggar Baru       |
| 2    | JL TOLL BALIKPAPAN – SAMARINDA              | Manggar            |
| 3    | JL SEPINGGAN BARI 2                         | Sepinggan          |
| 4    | JL MARSMA R. ISWAHYUDI 3                    | Sepinggan Raya     |
| 5    | JL RUHUI RAHAYU 2                           | Sepinggan Baru     |
| 6    | JL LETKOL POL. HM ASNAWI ARBAIN 1           | Gunung Bahagia     |
| 7    | JL RUHUI RAHAYU JL MT HARYONO 3             | Damai Baru         |
| 8    | JL INDRAKILA 1                              | Gunung Samarinda Baru |
| 9    | JL SOEKARNO HATTA 5                         | Batu Ampar         |
| 10   | JL KM 5.5 KARIANGAU 1                       | Graha Indah        |
| 11   | JL SOEKARNO HATTA 11                        | Karang Joang       |

Source: analysis results, 2020

5.3 Trip Generation
Trip generation is the number of trips generated by the study area (Table 2). Ofyar Z. Tamin states that to estimate the number of generator trips that will come, a model is needed [6]. Based on volume of morning rush hour and evening rush hour.

Table 2 Trip Generate – Trip Attraction Traffic Volume 2019

| Zone       | Access                                      | Generate (Morning) | Attraction (Morning) | Generate (Afternoon) | Attraction (Afternoon) |
|------------|---------------------------------------------|--------------------|----------------------|-----------------------|------------------------|
| 1          | JL MULAWARMAN 3                            | 1818               | 3575                 | 1907                  | 2496                   |
| 2          | JL TOLL BALIKPAPAN – SAMARINDA              | 1887               | 736                  | 470                   | 381                    |
| 3          | JL SEPINGGAN BARI 2                         | 1102               | 996                  | 975                   | 1343                   |
| 4          | JL MARSMA R. ISWAHYUDI 3                    | 3126               | 2810                 | 2103                  | 2520                   |
| 5          | JL RUHUI RAHAYU 2                           | 1469               | 1565                 | 1525                  | 1485                   |
| 6          | JL LETKOL POL. HM ASNAWI ARBAIN 1           | 1016               | 1019                 | 2058                  | 1241                   |
| 7          | JL RUHUI RAHAYU JL MT HARYONO 3             | 1464               | 1965                 | 1799                  | 2004                   |
| 8          | JL INDRAKILA 1                              | 1705               | 1325                 | 1689                  | 2037                   |
| 9          | JL SOEKARNO HATTA 5                         | 1378               | 996                  | 1500                  | 1584                   |
| 10         | JL KM 5.5 KARIANGAU 1                       | 2198               | 2515                 | 2089                  | 2223                   |
| 11         | JL SOEKARNO HATTA 11                        | 2284               | 2173                 | 1582                  | 1714                   |

Source: analysis results, 2020

5.4 Trip Distribution
The distribution of travel transport is the stage where trips between zones are calculated based on the study of the origin and destination of trips from each zone in a study area. At this stage, consider determining the interaction relationship between the number of zones based on the size of the trip generation and the trip attractions that have been carried out in the previous stage.
The trip distribution is carried out with the aim of predicting the number of trips that will be distributed in the planned year, namely (2019-2024) and (2019-2029). This loading estimate is carried out using the model used in transportation planning. In analyzing the spread of this trip, information is needed about the origin and destination matrix of the current state (Figure 2).

5.5 Modal Split

the process of changing units of vehicle / hour into units of pcu / hour. In this study, the process begins with a trip generation / attraction through the existing traffic volume taken during the morning and evening rush hours so that the travel distribution matrix using the vehicle / hour is obtained, then to get the proportion of the mode used to change the origin destination matrix in times the percentage of use. Each mode in order to obtain a matrix of origin and destination units of vehicles / hour for each road transport mode. Furthermore, the traffic performance is indicated by the volume of traffic in passenger car units (pcu / hour), then the matrix of origin of destination for each mode is multiplied by units of emp for each road transport mode (Figure 3).

5.6 Trip assignment

The loads carried out in this analysis are as follows:

a. The present traffic assignment on the existing road network system.
b. Traffic assignment for the future (forecast) with a fixed road network system (without any changes to the road network).
c. Traffic assignment for the future (forecast) on the proposed road network system.

The loading model used in this study is the "Equilibrium Assignment" method. To make it easier to analyze this traffic assignment process, the author uses the Visum 2020 software, which is a computer application program for transportation planning that has the ability to forecast travel demand modeling (Demand Transport Forecasting Model).

The following is a visualization of traffic assignments at 07.00 -08.00 WITA and 16.00-17.00 can be seen in the following loading image (Figure 4).
Figure 4 Visualization of 2019 traffic assignments

Table 3 Existing Road Network Performance 2019

| No. | Parameter                  | Morning performance | Evening performance |
|-----|----------------------------|---------------------|---------------------|
| 1   | Volume (pcu / hour)        | 762                 | 661                 |
| 2   | Network Speed (km / h)     | 42                  | 42                  |
| 3   | Total Travel Distance (km) | 1063                | 991                 |
| 4   | Total Travel Time (hours)  | 23.3                | 22.4                |

Source: analysis results, 2020

5.7 Road Network Model Validation
The stages of traffic assignment are carried out using the PTV Vissum 2020 software, where the results obtained are road performance and road network and are equipped with visualizations. Traffic assignment is obtained from the results in the field (survey) which will later be compared with the model.

Model validation is carried out to prove whether the model that will be used to forecast trips in the planning year can be used or not. The validation used is by using the Chi square and MAPE test (Figure 5).

Figure 5 Hypothesis table The validation test uses the Chi Square method

Source: analysis results, 2020

From the table above it can be seen that H0: is accepted because X^2 count <49.80, which has a value of 45.47 and 18.27, so the data from the model is accepted and can be used further for data analysis.
The smaller the MAPE value, the smaller the error of the estimation results, on the contrary the greater the MAPE value, the greater the error of the estimation results. The results of a prediction method have very good forecasting ability if the MAPE value is <10% and have good predictive ability if the MAPE value is between 10% and 20%.

Based on the validation test using the MAPE method in the morning, it can be seen that the total is 2.29 and 1.71. this shows that the MAPE validation test requirements for data from the model is received and can be used further for data analysis.

5.8 Transportation Forecasting

Performance forecasting in the planning year is needed to analyze traffic engineering management that will be or has been implemented in order to find out whether an engineering management that has been made can still be applied in the planning year. In forecasting the number of vehicles in the planning year, secondary data is used on the number of vehicles in the last 5 years to determine the growth rate. The formula used to predict the variables affecting trips in the coming year is as follows:

\[ P_t = P_o \times (1+i)^n \]  \hspace{1cm} (1)

Information:
- \( P_t \) = Variable number of plan year (YAD volume)
- \( P_o \) = Number of base year variables (existing volume)
- \( i \) = Traffic growth rate
- \( n \) = Number of years

In forecasting the volume of planned vehicles, data on the volume of the current year and the rate of traffic growth are needed. To find out the volume of vehicles used the formula for the traffic growth rate.

The following table is the road network data for the Balikpapan City Alternative Road Network area in the planned year, namely in 2024 and 2029 which is located in the alternative road network area of Balikpapan City at 07.00 - 08.00 WITA and 16.00 - 17.00 WITA (Table 4).

| No. | Parameter               | Morning performance 2024 | 2024 afternoon performance | Morning performance 2029 | 2029 afternoon performance |
|-----|-------------------------|---------------------------|----------------------------|---------------------------|---------------------------|
| 1   | Volume (pcu / hour)     | 944                       | 820                        | 1199                      | 1044                      |
| 2   | Network Speed (km / h)  | 39                        | 41                         | 37                        | 39                        |
| 3   | Total Travel Distance (km) | 1448                    | 1261                       | 1850                      | 1614                      |
| 4   | Total Travel Time (hours) | 32                     | 28.5                       | 41                        | 36.6                      |

Source: analysis results, 2020

Based on the comparative data above, there is a significant difference in the loading of traffic carried out during the peak hours of the morning so that there is an increase in the volume in the area, travel distance and travel time compared to the loading that is carried out during the peak hours of the afternoon.
5.9 Traffic Handling Proposal Recommendations

Recommendations are needed in solving a transportation problem in an urban area, one alternative problem that can be done is by optimizing the existing facilities and infrastructure. Some of the problems that exist in the area of the Balikpapan City Alternative Road Network need to be improved in order to provide a service to the community in the form of convenience which is also to improve the performance of sections and road networks. Several scenarios that can be done, among others.

The best scenario selection is based on the road network performance comparison in each scenario. Comparison of the performance of each scenario in 2019-2024 and 2019-2029 the development of the Balikpapan City Activity Service Sub Center at 07.00 - 08.00 WITA and 16.00 - 17.00 WITA can be seen in the Figure 6 and Figure 7.

![Figure 6](Source: analysis results, 2020)

![Figure 7](Source: analysis results, 2020)

From several comparison tables above, a ranking of several existing conditions will be carried out and the selection of the best scenario in 2019-2024 for the development of the Balikpapan City Activity Service Sub Center.

After analyzing the eight scenarios above, the best scenario can be selected, namely the application of scenario 8, namely increasing road capacity in the form of road widening on problematic sections and the construction of alternative roads (manggar-sepinggan - ksatrian) in Balikpapan City, which is marked by a drastic reduction in problematic roads. With an av / e ratio above 0.7 with an average speed of 38.64 km / hr. This is in accordance with the plan of the Balikpapan City Government to make it easier for people to move, especially those that have not been reached by the road network and equitable development in the City of Balikpapan.

6. Conclusion

Based on the analysis and problem solving described in the previous section, it can be concluded that:
1. In 2019 the traffic conditions in the alternative road network area in East Balikpapan sub-district and North Balikpapan sub-district had 3 sections that could potentially be a traffic problem with a VC ratio above 0.7. Jalan Mulawarman V / C the ratio is 0.76, Jalan Syarifudin Yoes V / C ratio is 0.83, Jl Soekarno Hatta V / C is 0.82.

2. The design of transportation modeling for the development of the sub-center area of Balikpapan City service activities uses modeling using the PTV Vissum Student Version 2020 software. The results of volume-based traffic assignment at peak hours of the morning and peak hours of the evening. Modeling results obtained Traffic Network Performance as follows:

   **Morning 07.00 - 08.00 2019**
   - a. Volume : 762 pcu / hour
   - b. Network Speed : 42 Km / hour
   - c. Total Travel distance : 1063 km
   - d. Total Travel Time : 23 hours

   **Afternoon 16.00 - 17.00 2019**
   - a. Volume : 661 pcu / hour
   - b. Network Speed : 42 Km / hour
   - c. Total Travel distance : 991 km
   - d. Total Travel Time : 22 hours

3. Forecasting the demand for transportation every year has a trend of increasing traffic volume and the impact on traffic is the highest in the morning on Jalan Syarifudin Yoes V / C ratio of 0.94 and the highest in the afternoon on Jalan Mulawarman V / C with a ratio of 0.87 with the condition 5 years (2019-2024) when the development of the sub-center for Balikpapan City activities services. The highest is in the morning on Jalan Mulawarman V / C with the ratio of 0.98 and the highest in the afternoon is on Jalan Syarifudin Yoes V / C, the ratio is 0.93 to 10 years (2019-2029) after the development of the Balikpapan City activity service sub-center area.

4. Traffic network performance in Balikpapan City in the planned year With the optimization of infrastructure and road network development in the morning and evening simulations, the best assessment is in scenario 8, namely increasing the capacity of problematic roads and adding alternative road networks (manggar-sepinggan -ksatrian). The modeling results obtained from the Traffic Network Performance as follows:

   **Morning 07.00 - 08.00 in 2024**
   - a. Volume : 660 pcu / hour
   - b. Network Speed : 43 Km / hour
   - c. Total Travel distance : 1012 km
   - d. Total Travel Time : 22 hours

   **Afternoon 16.00 - 17.00 2024**
   - a. Volume : 780 pcu / hour
   - b. Network Speed : 44 Km / hour
   - c. Total Travel distance : 1180 km
   - d. Total Travel Time : 26 hours

**7. Suggestion**
In accordance with the results of the analysis that has been done, the authors can propose the following suggestions:

1. anticipating traffic problems that occur in the planning year, when the development of the Balikpapan City sub-activity center area is implemented (2019-2024), and after the
development of the Balikpapan City sub-center activity area (2019-2029) by building alternative roads (manggar-sepinggan) and additional capacity for problematic roads (JL Mulawarman - JL Marsma R iswahyudi - JL syarifudin yoes - JL MT Haryono - JL Soekarno Hatta (scenario 8))

2. The application of these eight scenarios needs to be considered from the legal aspect regarding land acquisition for the widening of several roads and the construction of a ring road in the sub-district of Balikpapan Timur - Balikpapan Utara.

3. It is necessary to carry out further analysis regarding the feasibility of the project, financial analysis, as well as from an economic point of view, it can provide positive results and impacts for the 10-year plan.

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