System Dynamics Modelling in Determining Scenario of Oil Distribution Balikpapan – Samarinda

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Abstract. East Kalimantan will be designated as the Ibu Kota Negara (IKN) of Indonesia. Energy consumption is predicted to increase, but based on Badan Perencanaan Pembangunan Nasional (Bappenas), fuel consumption will slowly be converted to gas. Previously, the process of fulfilling fuel needs in East Kalimantan was fulfilled using tankers, but with the issue of IKN, the government will build oil pipe Balikpapan – Samarinda that distribute fuel from TBBM Tanjung Batu to TBBM Samarinda and TBBM Palaran. This research is for determine which scenario are efficient to distribute the fuel using forecasting methods with trend analysis, exponential smoothing, and moving average, while Powersim Studio 8 software is used for system dynamics modelling. With the help of this application, 6 alternative scenarios are made based on the tank capacity of each TBBM to find out the least amount of pigging. From the simulation, it was found that the second alternative is the most efficient for the process of distributing fuel. Where the results of the simulation process obtained pigging of 58 times/year with the capacity of gasoil TBBM Palaran 10000 kl, gasoil TBBM Samarinda 12306 kl and the gasoline is 14562 kl.

1. Introduction

In Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020-2024), President of the Republic Indonesia, Joko Widodo, plans to relocate the Ibu Kota Negara (IKN) or Capital City of Indonesia to Kalimantan. The transfer of IKN carried out by Indonesia aims to distribute development and build a bureaucratic system that reaches all parts of Indonesia. The East Kalimantan region is famous for its abundant natural resources such as oil, gas, and coal. With the transfer of IKN, the need for natural resources, one of which is oil, in this region will increase in line with infrastructure and economic growth. In response to this, it is necessary to conduct a fuel oil market analysis to find out whether the needs in the region can be met with its own natural resources or not.

Previously, the distribution of fuel oil in the Kalimantan region used tankers which were then transported by land using trucks so that it took a long time. In the development of IKN, there will be conversion in fuel oil consumption into gas consumption according to RPJMN 2020-2024 in Phase 2 [1].

Based on the table below, it is known that the production of gasoline and diesel is always decreasing every year. This is in accordance with the 2020-2024 RPJMN policy where there will be a conversion from BBM to BBG in Phase II (2025-2035). However, the government is collaborating with relevant stakeholders to build the Balikpapan - Samarinda oil distribution pipeline to meet the needs in the region.
Table 1. Energy Demand in Transportation Sector [1]

| Year | Electricity (Million Mega Joule) | Natural Gas (Million Mega Joule) | Gasoline (Million Mega Joule) | Diesel (Million Mega Joule) |
|------|---------------------------------|---------------------------------|-----------------------------|--------------------------|
| 2025 | -                               | -                               | 4493.8                      | 1352.4                   |
| 2026 | 192.9                           | 450.2                           | 2229.3                      | 1339.0                   |
| 2027 | 424.5                           | 990.5                           | 4350.8                      | 1309.0                   |
| 2028 | 700.5                           | 1634.5                          | 4188.0                      | 1260.4                   |
| 2029 | 1027.5                          | 2397.5                          | 3949.1                      | 1188.4                   |
| 2030 | 1412.9                          | 3296.9                          | 3620.3                      | 1089.5                   |
| 2031 | 1865.3                          | 4352.3                          | 3186.2                      | 958.9                    |
| 2032 | 2394.0                          | 5585.9                          | 2628.8                      | 791.1                    |
| 2033 | 3009.8                          | 7022.9                          | 1928.0                      | 580.2                    |
| 2034 | 3725.0                          | 8691.7                          | 1060.0                      | 319.1                    |
| 2035 | 4553.2                          | 10624.1                         | -                           | -                        |

Table 2. Energy Demand in Industry Sector [1]

| Year | Electricity (Million Mega Joule) | Natural Gas (Million Mega Joule) | Gasoline (Million Mega Joule) | Diesel (Million Mega Joule) |
|------|---------------------------------|---------------------------------|-----------------------------|--------------------------|
| 2025 | 152                             | 15.9                            | 500.4                       | 18.2                     |
| 2026 | 162.2                           | 71.8                            | 475.1                       | 17.1                     |
| 2027 | 173                             | 133.6                           | 445.5                       | 15.8                     |
| 2028 | 184.2                           | 202.1                           | 411.3                       | 14.4                     |
| 2029 | 195.9                           | 277.6                           | 371.9                       | 12.9                     |
| 2030 | 208.2                           | 360.7                           | 327                         | 11.2                     |
| 2031 | 221                             | 452.2                           | 276                         | 9.3                      |
| 2032 | 234.5                           | 552.5                           | 218.4                       | 7.3                      |
| 2033 | 248.5                           | 662.4                           | 153.6                       | 5.1                      |
| 2034 | 263.3                           | 782.8                           | 81                          | 2.6                      |
| 2035 | 278.7                           | 914.3                           | -                           | -                        |

System dynamics is a method for making policies that can be used to solve complex problems [2]. This research has been widely used to address several problems, for example in studies describing production capacity and demand [3]. In previous years, several studies have been carried out, one of which is to design demand and supply to solve fertilizer shortages in the East Java region [4] and research on gas distribution in East Java using system dynamics [5]. In this study, system dynamics will be used to determine the scenario of oil distribution in Balikpapan – Samarinda.

2. Methodology

System dynamics modelling in this research was carried out in workflow of methodology is shown in Figure 1. The first phase, forecasting demand with data in previous year. The second phase, making alternative scenarios. The third phase is, system dynamics modelling. In last phase, from the simulation can be shown which alternative will be chosen.
2.1. Literature Studies

From the flowchart above, the literature study is from several reference sources related to forecasting as well as oil distribution pipelines using system.

2.1.1. Petroleum

Petroleum is a natural resource in the form of liquids originating from the earth that can be used as industrial raw materials or as fuel [6]. Chemically petroleum consists of complex compounds composed of Hydrogen (H) and Carbon (C) atoms commonly called hydrocarbon compounds (CxHy). The content in petroleum is carbon 83-87%, Hydrogen 10-14%, Nitrogen 0.1 - 2%, Oxygen 0.05 - 1.5%, Sulphur 0.005 - 6%.

2.1.2. Balikpapan – Samarinda Pipe

The construction of this pipeline is planned to be built from the fuel distribution point, namely TBBM Tanjung Batu to TBBM Samarinda and TBBM Palaran with a length of ±120 km with a diameter of 12 inches pipes and a flowrate of 470 kL/h. Where the type of fuel transported is gasoil (diesel) and gasoline (premium and pertamax).

2.1.3. Storage Tank

Storage tanks are one of the facilities that are widely owned by the industry as a storage place for oil and gas mining products [7]. The following is data related to storage tank on each TBBM.
Table 3. Tank Capacity

| TBBM              | Tank Types | Gasoil (kl) | Gasoline (kl) |
|-------------------|------------|-------------|---------------|
| TBBM Tanjung Batu| (3 tank)   | 20,000      | 40,000        |
|                   | (5 tank)   |             |               |
| TBBM Samarinda    | (5 tank)   | 12,306      | 9,362         |
|                   | (5 tank)   |             |               |
| TBBM Palaran      | (1 tank)   | 10,000      | -             |

2.1.4. *Forecasting Method: Moving Average*

A forecasting method that uses a group of existing values and then searches for the average value for the coming period [8]. One of the characteristics of moving averages is that the longer the period of moving averages, the predicted forecasting results will look more smooth. Here is a mathematical equation of a single moving average:

\[ M_t = F_{t+1} \]

Where:
- \( M_t \) = Moving Average for \( t \) Period
- \( F_{t+1} \) = Forecasting for \( t+1 \) period
- \( Y_t \) = Real value for \( t \) period
- \( n \) = Moving average limit

2.1.5. *Forecasting Method: Trend Analysis*

Trend is the average change in the long term which is usually with a period of time per year. There are 2 types of trends, namely linear trend and non-linear trend. Non-linear trends are further divided into quadratic and exponential trends.

- Trend Linier: \( Y = a + bX \) (2)
- Trend Quadratic: \( Y = a + bX + cX^2 \) (3)
- Trend Exponential: \( Y = a + b^X \) (4)

2.1.6. *Forecasting Method: Exponential Smoothing*

This method assumes that the existing data will be around a fixed mean value [9]. This method gives an effect of the use of smoothing constants, where these constants range from 0 – 1. The value 1 indicates a greater effect on the current value and the value 0 gives effect at the previous point [10].

\[ S_t = \alpha x X_t + (1 - \alpha)x S_{t-1} \] (5)

Where:
- \( S_t \) = Forecasting for \( t \) period
- \( X_t + (1 - \alpha) \) = Actual data time series
- \( F_{t-1} \) = Forecasting in time \( t-1 \)
- \( \alpha \) = Constanta (0-1)

2.1.7. *Forecasting Error*

In doing a forecasting need to be done the calculation of the error rate of forecasting to know the measure of accuracy and size to compare other alternative forecasting methods. According to [9], the level of
bias forecasting error is calculated by Mean Absolute Deviation (MAD) and Mean Square Error (MSE). MAD is the absolute ab means of forecasting errors that ignore positive and negative signs.

\[ \text{MAD} = \Sigma |A_t - F_t| \]  

Where:
- \( \Sigma \) = Total
- \( A_t \) = Data actual in t period
- \( F_t \) = Forecasting in t period

MSE is Mean Square Error, differences between the predicted value and the observed value. When compared to MAD, this MSE will strengthen the influence of error figures.

\[ \text{MSE} = \Sigma [(A_t - F_t)^2] \]  

Where:
- \( \Sigma \) = Total
- \( A_t \) = Data actual in t period
- \( F_t \) = Forecasting in t period

The last forecasting error is MAPE (Mean Absolute Percentage Error), where this method is useful for seeing the difference between the initial data and the forecasted data.

\[ \text{MAPE} = \sum_{t=1}^{n} \left( \frac{\left| A_t - F_t \right| \times 100}{n} \right) \]  

Where:
- \( X_t \) = Data actual in t period
- \( F_t \) = Forecasting in t period
- \( n \) = amount data
- \( t \) = t period

2.1.8. System Dynamics
The dynamics of a system will be more complex as feedback interactions between existing components become more and more. The model presents a form of representation of the actual state in which a dynamic perspective is always changing against the unit of time. System dynamics are representations and inventions of a moving feedback process with the stock and structure of the time flow, delay of a system [2].

2.1.9. Causal Loop Diagram
It is a representation of the conceptualization of the system dynamics model to be built. Through CLD system dynamics model to be developed explained by showing a causal relationship between variables inserted into the model before entering the model development stage. the relationship between the two variables is represented by an arrow that marks the relationship between the two variables. In addition, there are also positive signs (+) and negative signs (−) that indicate how the two variables are related. A positive sign shows us a positive effect, meaning that if there is a change in a particular variable it will affect other variables associated with the positive arrow and will change in the direction. On the other hand, negative signs indicate a negative influence where if there is a change a particular variable will affect other variables but in a different direction of change [11].

2.1.10. Stock Flow Diagram
It is a concept of a system dynamics model that serves to represent the supply and flow of a system. SFD can be described as a tub that holds the flow of water that enters through the valve and the volume of water can be reduced by opening the valve under the tub. The bathtub represents as 'inventory' in the
inventory flow diagram while the flow of water flowing either in or out of the tube distorted by the valve is the 'flow' in the inventory flow diagram.

![Image](253x603 to 357x691)

**Figure 2.** Types of Variable in System Dynamics Modelling

2.2. *Collecting Data*
Primary and secondary data collection is used to perform forecasting methods as well as system modelling and simulation.

2.3. *Trend Demand Analysis*
At this stage, forecasting of demand data has been obtained for petroleum needs projections from 2023-2043.

2.4. *Alternative Scenarios*
In this study, several operational alternative scenarios were created to support the process of analysis of the oil market as a result of the construction of the Balikpapan – Samarinda pipeline.

2.5. *System Modelling and Simulation*
Modelling will be done using the Powersim 8 app help. This stage starts from the creation of CLD and SFD. With the help of the software, the modelling and simulation process can be done. Once this stage is complete, validation is required. Validation is a stage to determine whether the model is already representing the actual model.

3. *Result and Discussion*

3.1. *Collecting Data*
Based on the National Medium Term Development Plan (RPJMN) 2020-2024, the IKN development policy will be divided into 3 phases, namely the development phase (2020-2025), the establishment phase of IKN (2025-2035), and the development phase (2035-2045). Where it is mentioned that phase 2, namely the establishment phase of IKN fuel consumption will be converted into natural gas gradually. According to PERDA 19 Year 2019 in East Kalimantan about RUED, the energy mix in East Kalimantan is as follows:

| Energy Source | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---------------|------|------|------|------|------|------|------|------|
| Coal          | 5.16%| 13.59%| 12.24%| 10.80%| 10.68%| 11.05%| 11.64%| 12.31%|
| Gas           | 24.00%| 23.89%| 25.22%| 26.10%| 26.88%| 27.63%| 28.39%| 29.45%|
| Oil           | 67.71%| 55.66%| 50.15%| 45.36%| 40.54%| 36.70%| 33.17%| 29.52%|
| Renewable     | 3.13%| 6.87%| 12.39%| 17.73%| 21.91%| 24.61%| 26.80%| 28.72%|
| Energy        |      |      |      |      |      |      |      |      |
| Total         | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Based on the data in Table 4, it is known that the energy mix will decrease annually by -0.0237 or 2.37%. So the forecasting process will be conducted from 2020-2025 while demand starting in 2026 will decrease due to the conversion of fuel to natural gas.
3.2. Forecasting Method

Actual data from previous year are as follows in Table 5.

| Year | TBBM Palaran (kl/day) | TBBM Samarinda (kl/day) | Total |
|------|----------------------|-------------------------|-------|
|      | Gasoil               | Gasoil                  | Gasoline |
| 2015 | 767.26               | 3694.12                 | 1042.36 | 5503.73 |
| 2016 | 778.74               | 3706.05                 | 1070.87 | 5555.66 |
| 2017 | 790.23               | 3717.99                 | 1099.38 | 5607.59 |
| 2018 | 801.71               | 3729.92                 | 1127.89 | 5659.52 |
| 2019 | 813.20               | 3741.86                 | 1156.40 | 5711.45 |

Based on the data above, the forecasting process can be done, this process is assisted by Microsoft Excel which will be done by 3 methods.

3.2.1. Trend Analysis

With the help of Microsoft excel, the linear trend equals for each consumption are as follows:

Retail Gasoline Consumption:
\[ y = 27.663x - 54709 \]

Maritime Industry Gasoline Consumption:
\[ y = 0.8474x - 1697.1 \]

Retail Gasoil Consumption:
\[ y = 22.447x - 44918 \]

Maritime Industry Gasoil Consumption:
\[ y = 85.501x - 171266 \]

Potential:
\[ y = 179.55x - 361661 \]

While for the demand in TBBM Palaran obtained \( y = 11.484x - 22373 \). In this trend analysis, the forecasting is for 2020-2025, and for 2026-2043 fuel consumption will decrease by 2.37%.

3.2.2. Moving Average

This method used the moving average of as many as 3 pieces to get a smoother result. This method uses calculations obtained from actual data that are then averaged by issuing old period data by entering new period data. This forecasting method is carried out until 2025, then for 2026-2043 consumption will decrease by 2.37%.

3.2.3. Exponential Smoothing

Exponential smoothing method has a value of \( 0 < \alpha < 1 \), whereas in this calculation is determined the value \( \alpha = 0.1 \).

Based on the three forecasting methods above, the results of each method when summarized in Table 6. After the calculation, then the next step needs to calculate the error of each method that has been done to know which method is the best. The following is the result of the errors of each method summarized in Table 7. MAPE error rates have the following accuracy criteria [12]:

- MAPE < 5% : Extremely correct
5% < MAPE < 10% : Correct
MAPE > 10% : Not correct

Table 6. Forecasting Result All Methods

| Year | TBBM Samarinda | TBBM Palaran |
|------|----------------|--------------|
|      | Gasoline (kl/day) | Gasoil (kl/day) | Gasoil (kl/day) |
| Trend | MO | ES | Trend | MO | ES | Trend | MO | ES |
| 2020  | 1184.91 | 1066.30 | 1059.32 | 3753.79 | 3708.55 | 3678.16 | 816.60 | 783.85 | 776.87 |
| 2021  | 1213.42 | 1065.13 | 1064.77 | 3765.72 | 3693.87 | 3622.92 | 828.08 | 781.72 | 770.09 |
| 2022  | 1241.93 | 1065.20 | 1059.87 | 3777.66 | 3697.13 | 3667.00 | 839.56 | 782.71 | 776.20 |
| 2023  | 1270.44 | 1065.54 | 1064.28 | 3789.59 | 3693.92 | 3621.69 | 851.04 | 782.76 | 770.70 |
| 2024  | 1298.95 | 1171.82 | 1166.34 | 3801.53 | 3834.01 | 3798.29 | 862.52 | 782.40 | 775.65 |
| 2025  | 1327.46 | 1210.94 | 1181.93 | 3813.46 | 3871.59 | 3773.15 | 874.00 | 782.62 | 771.20 |

Mo = Moving Average
ES = Exponential Smoothing

Based on these criteria, the trend analysis method will be determined with MAPE values of 7.03%, 0.39% and 1%. From year 2020-2025 use result from forecasting, but in 2026-2043 the consumption slowly decreases 2.37% from consumption in previous year. From the calculation this research using trend analysis for forecasting methods. The result seen in Table 7. In MAD and MSE no needs International Unit to be written in the result.

Table 7. Forecasting Error Results All Methods

| Forecasting Methods | TBBM Samarinda | TBBM Palaran |
|---------------------|----------------|--------------|
|                     | Gasoline       | Gasoil        | Gasoil       |
| Trend               | MAD | MSE | MAPE | MAD | MSE | MAPE | MAD | MSE | MAPE |
| Trend               | 74.78 | 5872.03 | 7.03% | 3698.39 | 13678252.17 | 0.39% | 8.07 | 65.18948 | 1% |
| MO                  | 84.31 | 7706.77 | 7.92% | 3721.01 | 13845841.42 | 9% | 33.92948 | 1249.773 | 4% |
| ES                  | 75.03 | 5961.44 | 7.10% | 3695.43 | 13656312.48 | 1.67% | 26.80 | 732.68 | 3% |

3.3. System Dynamics Modelling

Making causal loop diagram (CLD) using Vensim software. This CLD description shows a cause-and-effect relationship between variables related to the distribution of oil to Palaran TBBM and Samarinda TBBM. The next stage is the creation of Stock Flow Diagram (SFD) that will make it easier to model the scenario that has been determined.
3.4. Alternative Scenario Operational

The preparation of this operational scenario alternative will be based on the capacity of the tank to be installed on each TBBM, where there will be 6 alternative scenarios.
Table 8. Tank Capacity and Code

| TBBM Palaran | Tank Type       | Tank Code | Capacity (kl) |
|--------------|-----------------|-----------|---------------|
|              | Gasoil (existing)| A1        | 10000         |
|              | B1              | 2405      |
|              | B2              | 3280      |
|              | Gasoline (existing) | B3 | 1597        |
|              | B4              | 1039      |
|              | B5              | 1041      |
|              | B6              | 2043      |
|              | B7              | 2673      |
|              | Gasoil (existing) | B8 | 2683        |
|              | B9              | 2458      |
|              | B10             | 2449      |
|              | New Tank        | B11       | 3200         |
|              | B12             | 2000      |

3.4.1. Alternative 1

Alternative scenario 1 is the original scenario, where the pump capacity that has been set in the construction of the Balikpapan – Samarinda pipeline is 470 kl / hour. Where the distribution of gasoil will be done simultaneously to TBBM Samarinda and also TBBM Palaran so that the pump capacity will be divided into two for gasoil distribution of 235 kl / hour. In this alternative, the capacity of the palaran TBBM tank is 10000 kl (tank A1), While for the gasoil TBBM Samarinda tank is a B6-B10 tank with a capacity of 12306 kl, while the gasoline tank is a B1-B5 tank with a total capacity of 9362 kl.

3.4.2. Alternative 2

In alternative scenario 2. The difference in this alternative is the tank capacity of each TBBM. Where the capacity of the Palaran TBBM tank is 10000 kl (tank A1), while for gasoil tank TBBM Samarinda is Tank B6-B10 with a capacity of 12306 kl, while the gasoline tank is a B1-B5 tank with a capacity of 9362 kl coupled with a new tank B11, B12 which has a capacity of 5200 kl, so that the capacity of TBBM Samarinda gasoline tank is 14562 kl.

3.4.3. Alternative 3

In Alternative Scenario 3, the gasoil and gasoline distribution scheme is the same as in alternative 1. The difference in this alternative is the tank capacity on each TBBM some tanks will be intended. Where the capacity of the Palaran TBBM tank is 10000 kl (tank A1), while for gasoil tank TBBM Samarinda is Tank B10 with a capacity of 2449 kl, while the gasoline tank is a B1-B9 tank with a capacity of 19219 kl.

3.4.4. Alternative 4

In Alternative scenario 4, the gasoil and gasoline distribution scheme are the same as in alternative 1. The difference in this alternative is the tank capacity on each TBBM some tanks will be earmarked and the addition of new tanks. Where the capacity of Palaran TBBM tank is 10000 kl (tank A1), while for gasoil tank TBBM Samarinda is Tank B10 which has a capacity of 2449 kl, while the gasoline tank is B1-B9 and B11-12 tanks with a total capacity of 24419 kl.

3.4.5. Alternative 5

In alternative scenario 5, the gasoil and gasoline distribution scheme is the same as in alternative 1. The difference in this alternative is the tank capacity on each TBBM some tanks will be intended. Where the capacity of the Palaran TBBM tank is 10000 kl (tank A1), While for the gasoil TBBM Samarinda tank is a B4-B10 tank with a capacity of 14386 kl, while the gasoline tank is a B1-B3 tank with a capacity of 7287 kl.
3.4.6. Alternative 6

In alternative scenario 6, the gasoil and gasoline distribution scheme are the same as in alternative 1. The difference in this alternative is the tank capacity on each TBBM some tanks will be intended and the addition of new tanks. Where the capacity of Palaran TBBM tank is 10000 kl (tank A1), while for gasoil tank TBBM Samarinda is Tank B4-B10 as well as the addition of new tank B11-B12 so that the total capacity to 19586 kl, while the gasoline tank is A1-B3 tank with a total of 7282 kl.

3.5. Model Verification and Validation

In the Powersim 8 application, the verification process is carried out automatically by seeing if there are warning signs such as a red question mark, if this red question mark appears then the simulation cannot be run. Then if found signs of yellow fence, then there are several variables that are connected but the formula is entered is not related or otherwise.

Validation in this research using structural scoring test and extreme condition test. In this structure test, the researcher uses the reference of previous research or discusses with the supervisor. Where the system structure is the relationship between the components that make up the system so it needs to be adjusted to the reference structure from previous research. While the extreme condition test is to test the model by inserting extreme values in order to find out how these variables can affect the model that has been made. Extreme condition test is showing in Figure 5.
3.6. Result

3.6.1. Alternative 1
Alternative 1 is an existing condition scenario contained in TBBM Palaran and TBBM Samarinda. Wherefrom the results of the process of simulating system dynamics obtained the following results:

| Total Pigging | Tank Deficit (kl) |
|---------------|-------------------|
|               | Gasoil Palaran    | Gasoil Samarinda | Gasoline Samarinda |
| 1573          | -                 | -               | -                 |

The results in the Table 9 are an accumulation of the operating period of the pipeline starting from 2023-2043 or for a total of 21 years. If simplified, the average total pigging in alternative 1 amounted to 75 times/year, wherein in this simulation there was no deficit for Palaran and Samarinda tanks.

3.6.2. Alternative 2
Alternative 2 is an existing condition scenario but there is the addition of a new tank to the Samarinda gasoil tank. Wherefrom the results of the process of simulating system dynamics obtained the following results:

| Total Pigging | Tank Deficit (kl) |
|---------------|-------------------|
|               | Gasoil Palaran    | Gasoil Samarinda | Gasoline Samarinda |
| 1216          | -                 | -               | -                 |

The results in the table above are an accumulation of the operating period of the pipeline starting from 2023-2043 or for a total of 21 years. When simplified, the average total pigging in alternative scenario 2 amounts to 58 times/year, where in this simulation there is no deficit.

3.6.3. Alternative 3
Alternative 3 is a scenario where Samarinda gasoil tanks are intended so that some Samarinda gasoil tanks are converted into Samarinda gasoline tanks. Wherefrom the results of the process of simulating system dynamics obtained the following results:
Table 11. Simulation Result Alternative 3

| Total Pigging | Tank Deficit (kl) |   |   |
|----------------|------------------|---|---|
|                | Gasoil Palaran | Gasoil Samarinda | Gasoline Samarinda |
| 1130           | -               | 27599143.77      | -               |

The results in the table above are the accumulation of the operational period of the pipeline, starting from 2023-2043 or a total of 21 years. If simplified, the average total pigging in alternative scenario 3 is 54 times/year, where in this simulation there is no deficit for the gasoil tanks of Palaran and Samarinda. However, the deficit occurred in the Samarinda gasoline tank where the average daily deficit was 3600.67 kl/day, which when presented as a percentage of 94.42% of the required demand. This deficit occurs because the capacity of the gasoil tank at TBBM Samarinda cannot meet the existing daily demand, because the installed capacity of the gasoil tank is only 2449 kl while the daily demand in 2023 is 3789.59 kl/day, so alternative 3 has certainly not been selected because of the capacity the installed tank cannot meet the daily gasoil demand for the required Samarinda TBBM.

3.6.4. Alternative 4

Alternative 4 is a scenario where Samarinda gasoil tanks are intended so that Samarinda gasoil tanks are converted into Samarinda gasoline tanks and there is the addition of new Samarinda gasoline tanks.

Table 12. Simulation Result Alternative 4

| Total Pigging | Tank Deficit (kl) |   |   |
|----------------|------------------|---|---|
|                | Gasoil Palaran | Gasoil Samarinda | Gasoline Samarinda |
| 1200           | -               | 28797451.95      | -               |

The results in the table above are the accumulation of the operational period of the pipeline, starting from 2023-2043 or a total of 21 years. If simplified, the average total pigging in alternative scenario 4 is 57 times/year, where in this simulation there is no deficit for the gasoil tanks of Palaran and Samarinda. However, the deficit occurred in the Samarinda gasoline tank where the average daily deficit was 3757.01 kl/day, which when presented as a percentage of 98.52% of the required demand. This deficit occurs because the capacity of the gasoil tank at TBBM Samarinda cannot meet the existing daily demand, because the installed capacity of the gasoil tank is only 2449 kl while the daily demand in 2023 is 3789.59 kl/day, so alternative 3 has certainly not been selected because of the capacity the installed tank cannot meet the daily gasoil demand for the required Samarinda TBBM.

3.6.5. Alternative 5

Alternative 5 is a scenario where Samarinda gasoil tanks are intended so that some Samarinda gasoline tanks are converted into Samarinda gasoil tanks. Wherefrom the results of the process of simulating system dynamics obtained the following results:

Table 13. Simulation Result Alternative 5

| Total Pigging | Tank Deficit (kl) |   |   |
|----------------|------------------|---|---|
|                | Gasoil Palaran | Gasoil Samarinda | Gasoline Samarinda |
| 1797           | -               | -               | -               |

The results in the table above are an accumulation of the operating period of the pipeline starting from 2023-2043 or for a total of 21 years. If simplified, the average total pigging in alternative scenarios of 5 amounted to 86 times/year, wherein in this simulation there was no deficit for Palaran and Samarinda tanks.
3.6.6. Alternative 6

Alternative 6 is a scenario where Samarinda gasoil tanks are intended so that some Samarinda gasoline tanks are converted into Samarinda gasoil tanks and there is the addition of new gasoil tanks in TBBM Samarinda. Wherefrom the results of the process of simulating system dynamics obtained the following results:

| Table 14. Simulation Result Alternative 6 |
|------------------------------------------|
| Total Pigging | Gasoil Palaran | Gasoil Samarinda | Gasoline Samarinda |
| 1478          | -             | -               | -                |

The results in the table above are an accumulation of the operating period of the pipeline starting from 2023-2043 or for a total of 21 years. If simplified, the average total pigging in alternative scenarios 6 amounted to 70 times/year, where in this simulation there was no deficit for Palaran and Samarinda tank.

4. Conclusion

Based on the results of the analysis for determine the operational scenario distribution of oil in Balikpapan-Samarinda. Many factors affecting the distribution of oil in East Kalimantan are related to the operational policies issued, where this policy covers the capacity of the tanks installed in each TBBM. And another factor is the demand in East Kalimantan.

While conduct the scenario, it based on the capacity of the existing tank and by carrying out several tank designations and the construction of a new tank at TBBM Samarinda. From the simulation, scenario 2 will be selected for the distribution because the amount of pigging is 58 times/year with no deficit in every tank, so the demand will be fulfilled.

This research can be further developed by knowing the operating costs of the pump so that from several scenarios it can be compared which operational costs are the smallest and in the process of determining the operational scenario, it is necessary to consider whether by making some changes to the capacity of the existing tank the demand can be met or not.

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