Suggested normal production operable day for Kasim oil refinery in Indonesia

A Prima* and B Satiyawira

Petroleum Engineering Department, Faculty of Earth Science and Energy, Universitas Trisakti, Jakarta, Indonesia

*andry.prma@trisakti.ac.id

Abstract. Last several years, a number of mainstream mass media often reported several recurring refinery unplanned shutdown in Indonesia, one of which is Kasim refinery. As a result, the disruption of fuel production was unavoidable. This particular study aims at finding qualitative correlation between the prior working performance and the current performance of a refinery. In general, unplanned shutdown should be explained as to the optimized refinery utilization occurred in Indonesia. The study also compares the result of the result with that of the previous study by Matthew Chesnes. The method being applied in this study is qualitative approach using a non-linear multivariable regression. As the result, a non-linear multivariable regression that incorporates multivariable in an effort to help discover the presumably overlooked information of the past performance as means of management control and to monitor the current refinery utilization performance. In the end, recommendation for improvement as far as the refinery utilization can possibly be achieved in the near future. The conclusion of this particular study is the recommendation for refinery decision maker to improve the scheduling of refinery turnaround and optimize the utilization as well within the recommended range of refinery operation.

1. Introduction

Last several years, a number of mainstream mass media in Indonesia often reported several recurring refinery unplanned shutdown one of which is Kasim refinery. The said refinery is reported to operate at 120 operable days. As a result, the disruption of fuel production was unavoidable. This study further wants to find out the ideal refinery operable day then compared with the Kasim’s operable day.

Matthew Chesnes, several couple of years ago, brought up a study using simple probit regression predicting the probability of a planned outage. Later, he ran separate models for all outages, atmospheric distillation outages, and outages at major downstream refining units. In addition, controlling for month effects is crucial because it is well known that plants take annual maintenance, in the low-demand periods (usually early spring and again in the fall) and Matthew Chesnes’s goal is to estimate the effect of the crack spread changing throughout the year.

This particular study aims at finding qualitative correlation between the prior working performance and the current performance of a refinery by comparing with Matthew Chesnes’s study. In general, unplanned shutdown should be explained as to the optimized refinery utilization occurred in Indonesia. Question arose over whether the technology installed in the refinery had reached the end of its usage lifetime, or perhaps the management lacked of details in terms of management planning that later fueled the unwanted incidents.
2. Methods
The method being applied in this study is qualitative approach using a non-linear multivariable regression. In addition, a non-linear multivariable regression that incorporates multivariable in an effort to help discover the presumably overlooked information of the past performance as means of management control and to monitor the current refinery utilization performance.

Data used in this study is derived from secondary resources of data due to the limited accessibility of primary data available with Genspace. Therefore, general approach is applied since two or more identical refineries have never been existent in the industry. Therefore, regional approach should be adopted to generate the global picture of refinery performance.

3. Discussion
Previous study by Matthew Chesnes was to estimate a simple probit regression predicting the probability of a planned outage. Later, he ran separate models for all outages, atmospheric distillation outages, and outages at major downstream refining units. In addition, controlling for month effects is crucial because it is well known that plants take annual maintenance in the low-demand periods (usually early spring and again in the fall) and Matthew Cheses’s goal is to estimate the effect of the crack spread changing throughout the year. The following equation summarized his study [1]:

\[ Pr(Planned Outage_{jm}) = \beta_0 + \beta_1 (CrackSpread_m) + \mu_m + \varepsilon_{jm} \]

The summary of regression of Matthew Cheses’s Study shown in the following day [1]:

| Dependent Variable | Any Planned Outages |
|--------------------|---------------------|
| Variable           | Coeff               |
| Constant           | -0.686xxx           |
| Crack ($/Gal)      | -0456xxx            |
| Month FE           | Yes                 |
| Observations       | 13,807              |
| McFadden R²        | 0.04                |

Referring to the study by Genspace related to the Refinery Utilization, the data is collected from several oil refineries; Verero Refinery with a production capacity of 245,000 bpd in Texas City, TX, a Flint Hills production with capacity of 2,000,000 bpd in Corpus Christi, TX, and Placid with capacity of 59,000 bpd in Port Allen, TX. The following figure 1 shows the production performance of the plants mentioned above.

3.1. Data used for analysis
For the purpose of this study, data is taken from week 9 - 17 because within this period of time, the data generates a trend line in the form of downward sloping curve representing the refineries were at state of offline or shutdown [3]. In other words, the refineries must undergo service and maintenance. In brief, any point on the lower range of the curve are visualizations of the time records where the shutdown refinery and the refinery turnarounds have occurred.
All data then picked and arranged based on several columns (as can be seen in the table 2). Next, data populated Table 2 computed to find the average processing (lower range) day. The result turns out to be 0.90, the number 0.9 or 90% reveals that the average operable day of a refinery is 90% of 365 days that is equal to 328 operable or processing days. Thus, the remaining 37 days should be allocated for refinery shut down.

**Table 2.** Processing day (lower range) (2014-2017).

| Section | Process (2016) | Process (2017) | Average Process (2014-2017) |
|---------|----------------|----------------|-----------------------------|
| 1       | 0.84           | 0.92           | 0.92                        |
| 2       | 0.86           | 0.95           | 0.93                        |
| 3       | 0.83           | 0.95           | 0.86                        |
| 4       | 0.90           | 0.93           | 0.87                        |
| 5       | 0.90           | 0.92           | 0.91                        |
| 6       | 0.91           | 0.87           | 0.92                        |

Similarly, as to how populate the table 2, spanning from week 41-49, a number of points can be selected to represent the higher range of utilization.

**Table 3.** Processing day (higher range) (2014-2017).

| Section | Process (2016) | Process (2017) | Average Process (2014-2017) |
|---------|----------------|----------------|-----------------------------|
| 1       | 0.97           | 0.97           | 0.95                        |
| 2       | 0.98           | 0.94           | 0.96                        |
| 3       | 0.96           | 0.96           | 0.96                        |
| 4       | 0.97           | 0.97           | 0.97                        |
| 5       | 0.94           | 0.98           | 0.94                        |
| 6       | 0.95           | 0.96           | 0.95                        |

From table 3, after computing the numbers, the average processing (higher range) days is 0.96 (96%) from 365 days or on is on par with to 350 processing days. Slightly different than that of the table 2, the
set of data populated in table 3 reveals the allocated time for refinery shutdown should be or less than 15 days.

3.2. Regression analysis
More in-depth analysis can be done through the Regression approach. From the first table tabulation above, the Non Linear pattern should be used, with the basic equation pattern being:

\[ y = m_1x_1 + m_2x_2 + \ldots + b \]

In this particular study, XL Stat application is used to run the non-regression linear. The study further aims at finding out whether or not variables such as the processing days of previous year along with the average of last 3-year processing day has a significant impact on the current refinery processing or operable days. The results of the regression shown in the following table 4.

| Table 4. Regression. |
|----------------------|
| R^2                  | 0.941 |
| Observations         | 3.3, 6,000 |
| DF                   | 3.4, 1,000 |

From the summary above, it can be seen that R^2 is 0.941, the interpretation is that previous and average processing days has an effect of 94.10% on the current processing days, the rest (100% - 94.10% = 5.90%) is influenced by other factors.

In comparison with Matthew’s previous study, it incorporates fix operation day, whereas our model accommodates the previous years of performance. as far as the result, model built in this study returns R^2 as ideal as Matthew’s. Therefore, the model generated in this study can definitely be applied.

After running the regression application, the formed regression equation is:

Current Process = -25.43 + 69,766. Previous process – 7,79. Average 3year Process – 40,31. Previous process^2 + 3,98. Average 3year Process^2.

The data run in application also produces the following figure 2.

![Figure 2](image-url)

**Figure 2.** Distribution between real and predictive data.

The analysis results from the table above, shown in the graph below suggests that the distribution data of the variables are still close to the predictive line, confirming that this regression model is suitable for the conditions being observed.

Based on the plotting from table 2 above, minimum range is at 90% (0.90) and the higher range is at any point over 96% (0.96) of the refinery’s operation. Thus, its midpoint is 93% or equivalent with 339 days. Therefore, any refinery in the state of operating at minimum 90% of its operable days is considered as acceptable i.e. tolerable. Furthermore, the allocation of time should be made available to accommodate refinery shut downs.

In the light of tolerable refinery operable day, any refinery in the world should plan approximately 26 days for refinery shutdown. By doing so, maintenance, including tests, measurements, adjustments,
parts replacement, and cleaning, performed specifically to prevent unplanned shutdown from occurring [2].

Previous work by Andry Prima, Bayu Satiyawira, Cahaya Rosyidan and Samsol [6] summarizes:

Table 5. Processing day (higher range) (2014-2017).

| 80%–90% Normal | 90%≥ Excellent |
|----------------|----------------|
| Realization is in accord with planning | Technical and non-technical innovations |
| Planning refers to the success of the previous year. | Planning refers to the success of the beyond targeted plan during previous year |
| The average 3-year performance consistently achieves the targeted operable day | Exceed the average 3-year performance consistently achieves the targeted operable day |

As for the refinery performance of Kasim in Indonesia, the average operation performance is 60 days. Hence, by referring the table 5 above, the Kasim refinery definitely falls under the category of poor performance. The Kasim refinery needs immediate improvement in order to bring it to the new level of production performance.

4. Conclusions

In this study, a model based on a non-linear multivariable regression developed to prove the acceptable or ideal refinery operable day. Furthermore, the average 3-year performance has profound impact on the current performance. If the last 3 years the refinery performs poorly, the current performance can be foreseen to fall below the target. However, should the average 3-year performance be always in consistent with target plan, the current performance can be straightforwardly achieved. The performance of current production can possibly excel as new innovations and technology applied. With regard to performance summary (table 5), the Kasim refinery in Indonesia falls under the category of poor performance due to the fact that its operable day is at the level of 120 working days. In the end, recommendation for improvement as far as the refinery utilization can possibly be achieved in the near future. The conclusion of this particular study is the recommendation for refinery decision maker to improve the scheduling of refinery turnaround and optimize the utilization as well within the recommended range of refinery operation.

References

[1] Agus P 2017 Pertamina Refinery Improve Operational Performance, Media Monitoring Oil and Gas [Online]. Retrieved from: http://www.monitoringoil.com/2017/01/pertamina-refinery-improve-operational.html

[2] Matthew C 2014 The Impact of Outages on Prices and Investment in the US Oil Refining Industry Bureau Of Economics Federal Trade Commission Washington, Dc 20580

[3] Ron J and Andy G 2016 An Analysis Of Common Causes Of Major Losses In The Onshore Oil, Gas & Petrochemical Industries; Implications For Insurance Risk Engineering Surveys Lloyd’s Market Association OG&P IGRES

[4] Amanda F D 2018, Maintenance Plans Foreshadow Strong U.S. Refinery Turnaround Seasons in Genspace

[5] Andry P, Bayu S, Cahaya R and Samsol S 2018 Kajian Rentang Batas Kewajaran Utilisasi Produksi Kilang Minyak Indonesia Jurnal Petro VII(3)