Scientific Contributions Oil & Gas, Vol. 49. No. 1, March: 453 - 466

SCIENTIFIC CONTRIBUTIONS OIL AND GAS

Testing Center for Oil and Gas
LEMIGAS

Journal Homepage:http://journal.lemigas.esdm.go.id
ISSN: 2089-3361, e-ISSN: 2541-0520

Evaluating Global Oil Data Reporting Consistency and Stability: Insights from Indonesia

Taufik Roni Sahroni[1], Lulut Alfaris[2], Ruben Cornelius Siagian[4], Andri Wahyudi[2], Anas Noor Firdaus[4], and Ukta Indra Nyuswantoro[3]

[1]Industrial Engineering Department, Universitas Bina Nusantara,
K.H. Syahdan Street No. 9, Kemanggisan, Palmerah, West Jakarta 11480, Indonesia.

[2]Department of Marine Technology, Politeknik Kelautan dan Perikanan Pangandaran,
Babakan Highway KM 2, Babakan, Pangandaran District, Pangandaran Regency, West Java 46396, Indonesia.

[3]Department of Structural Engineering, Asiatek Energi Mitratama,
Pakuwon Tower Unit 10F, Tebet, Jakarta Selatan 12870, Indonesia.

[4]Pusat Riset Cendekiawan dan Peneliti Muda Indonesia (CITA),
Padang Bulan, Medan Baru District, Medan City, North Sumatra 20222, Indonesia.

Corresponding author: Ruben Cornelius Siagian (rubensiagian17april@gmail.com)

Manuscript received: February 12th, 2026; Revised: March 03th, 2026
Approved: March 06th, 2026; Available online: March 26th, 2026; Published: March 27th, 2026.

ABSTRACT - Transparent and consistent oil data reporting is a critical component of global energy governance and market stability. This study evaluates the consistency, stability, and overall quality of global oil data reporting from 2002 to 2025 using the dataset of the Joint Organizations Data Initiative (JODI), with Indonesia employed as a regional reference case. The principal indicators applied include the Index of Reporting Consistency (IRC), the Reporting Volatility Index (RVI), and the Oil Data Availability Index (ODAI). Countries are classified according to market role (producer or importer), economic grouping, and geographical region. The analysis further incorporates K-means clustering and structural change detection to assess temporal stability and responsiveness to major global shocks. The findings reveal substantial variation in reporting performance across countries. Nations exhibiting high IRC values and low RVI scores generally possess more mature institutional and statistical capacities, whereas those with low IRC scores tend to face governance or data management constraints. Oil-producing countries typically demonstrate higher ODAI values but display greater vulnerability to systemic crises, while importing countries show relatively more stable reporting patterns. Major global shocks in 2008, 2014, 2020, and 2022 exerted asymmetric impacts on producers and importers, highlighting structural vulnerabilities within the global energy reporting system. Indonesia demonstrates consistently strong reporting performance, with an ODAI value of 0.944, exceeding the averages of ASEAN (0.889) and OPEC (0.829). The country records a non-reporting rate of only 5.6% and a maximum non-reporting duration of ten months. This study addresses a

gap in long-term, shock-sensitive analyses and introduces an integrated framework combining IRC, RVI, and ODAI as a novel approach for assessing oil data reporting quality. The findings provide a foundation for strengthening institutional capacity, enhancing regional coordination, and developing crisis-resilient reporting systems, while positioning ODAI as a practical indicator for evaluating energy governance and policy transparency.

Keywords: oil data reporting, data consistency, reporting volatility, oil data availability index (ODAI),

How to cite this article:

Taufik Roni Sahroni, Lulut Alfaris, Andri Wahyudi, Anas Noor Firdaus, Ukta Indra Nyuswantoro, and Ruben Cornelius Siagian, 2026, Evaluating Global Oil Data Reporting Consistency and Stability with Insights from Indonesia, Scientific Contributions Oil and Gas, 49 (1) pp. 125-133. DOI org/10.29017/scog.v49i1.2010.

INTRODUCTION

The availability and quality of petroleum data constitute critical factors that support decision-making processes at both national and international levels (Batubara et al., 2016; Janssen et al., 2017). Complete and consistent data are crucial for supporting comprehensive analyses of energy markets, optimizing production planning, formulating effective import policies, and monitoring the dynamics of global oil prices (Rafieisakhaei et al., 2016). However, in practice, the data collection process often faces several challenges, including limited institutional capacity, inconsistencies in reporting mechanisms, and the influence of global economic and geopolitical fluctuations (Noch 2024; Noy & Dabamona 2024). JODI seeks to address these challenges by promoting transparent, consistent, and standardized energy data reporting, which is conducted regularly by participating member countries (Hassani & Christodoulides 2021; Johnsson et al., 2025).

Although the JODI provides a standardized platform for collecting oil and gas data across countries, differences in technical capacity, national priorities, and economic conditions continue to generate variations in reporting practices. These disparities are further influenced by the roles of countries within the global energy system, particularly whether they function primarily as producers or importers, which may shape their strategic and operational reporting behavior. Consequently, inconsistencies in the availability and reliability of oil data may affect national decision-making processes as well as the stability of the global energy market. The uneven distribution of energy data highlights the importance of examining patterns of data availability, reporting consistency, and data volatility across countries. Such analysis is essential for assessing the overall quality of energy governance and for supporting the integration of global energy information systems.

Comparative assessments among countries and major economic groupings, such as the Organisation for Economic Co-operation and Development (OECD) and the Group of Twenty (G20), can help identify gaps in data governance while also revealing opportunities to strengthen institutional capacity and improve the reliability of reporting mechanisms. Accordingly, this study aims to examine the availability of global oil data, evaluate the consistency of reporting practices, and analyze differences in reporting patterns across countries and regions. The findings are expected to provide a scientific basis for strengthening energy governance and promoting more transparent, reliable, and stable energy reporting systems at the global level.

This study analyzes global oil data reporting from 2002 to 2025 using data from the joint organisations data initiative (JODI). Reporting consistency is assessed through the index of reporting consistency (IRC), temporal fluctuations are measured using the reporting volatility index (RVI), and overall data availability is evaluated via the oil data availability index (ODAI) at national, regional, and global levels. Countries are categorized according to their reporting patterns using K-means clustering, while long-term trends and structural breaks are identified employing the Bai–Perron method. The study further investigates the effects of major global shocks, including the 2008 global financial crisis, the 2014 oil price decline, the 2020 COVID-19 pandemic, and the 2022 geopolitical crisis on oil data availability. Indonesia's reporting performance is compared with that of ASEAN, OPEC, and G20 member countries, highlighting differences between oil-producing and oil-importing nations, as well as between OECD and non-OECD countries. Additionally, oil data availability is employed as a proxy indicator for evaluating the quality of energy governance. The findings are expected to offer strategic insights for enhancing energy data reporting systems, supporting evidence-based policymaking, improving transparency, and positioning Indonesia as a regional benchmark for stable and reliable oil data reporting.

This study has several limitations concerning data sources, measurement approaches, and the analytical scope. First, the analysis relies solely on global oil reporting data from the JODI covering the period 2002–2025, thereby excluding non-member countries and potentially limiting the generalizability of the findings. Second, the key variables; availability, IRC, RVI, and ODAI are quantified using exclusively numerical methods, which do not capture qualitative aspects such as the underlying reasons for non-reporting, administrative challenges, or institutional constraints. Moreover, the analysis depends on the consistency of national reporting practices, meaning that errors, delays, or inconsistencies in reporting may influence the results. External factors beyond global crises, including policy reforms, geopolitical conflicts, or domestic regulatory changes, are not explicitly incorporated into the modeling framework. The use of monthly data and fixed K-means clustering (k=3) may oversimplify complex temporal dynamics, while the structural break analysis assumes linear relationships that may not fully reflect real-world patterns. Additionally, cross-country comparisons are conducted without explicitly controlling for heterogeneity in country size, institutional capacity, or levels of oil dependency, which may affect reporting performance. The study's exclusive focus on oil reporting constrains its ability to assess broader aspects of energy governance, transparency, and overall policy effectiveness.

This study posits that global oil data reporting through the JODI exhibits overall consistency and stability, with variations largely determined by the institutional capacity of participating countries. Countries with well-established and mature energy institutions are expected to display low reporting volatility, whereas those with less developed institutional frameworks are likely to experience greater fluctuations. Oil-producing countries are anticipated to have higher levels of data availability but are also more susceptible to global economic and geopolitical shocks. In contrast, oil-importing countries are expected to maintain relatively stable reporting patterns. Major global events, such as the 2008 financial crisis, the 2014 oil price collapse, the COVID-19 pandemic in 2020, and the 2022 geopolitical crisis are projected to impact oil-producing countries more strongly than importers. Indonesia is expected to sustain a high and stable reporting performance relative to ASEAN and OPEC members, though slightly below that of G20 countries. OECD members and major oil-consuming countries are anticipated to demonstrate higher reporting consistency. Regionally, the Asia-Pacific is projected to show increasing reporting availability, the Middle East is expected to maintain stable performance, and Africa is likely to exhibit relatively lower reporting levels with gradual improvement.

Previous research on global oil data reporting has primarily examined the availability of aggregate data, the effects of global events on energy statistics, and comparative analyses across individual countries or country groups. Notably, several studies, such as (Watts & Zalik 2020; Wu et al., 2013; and (Alazzani & Wan-Hussin 2013), existing literature predominantly examines reporting consistency using the Index of Reporting Consistency (IRC), reporting volatility via the reporting volatility index (RVI), and data availability through the oil data availability index (ODAI) at the global level..

However, these studies exhibit several notable limitations. Temporal analyses that distinguish the responses of oil-producing and oil-importing countries to major global shocks such as the 2008 global financial crisis, the 2014 oil price decline, the COVID-19 pandemic, and the 2022 geopolitical crisis remain limited. Furthermore, the integration of the index of reporting consistency (IRC) and the Reporting Volatility Index (RVI) to systematically classify countries based on reporting consistency and stability has not been widely applied, resulting in a lack of comprehensive characterization of homogeneous and heterogeneous reporting patterns. Quantitative evaluations of Indonesia's position within regional and global reporting frameworks are also relatively scarce. In addition, the use of structural break analysis to assess the long-term impacts of global shocks on reporting systems has received limited attention. Regional disparities, as well as the relationship between oil data availability and the quality of energy governance at both national and regional levels, remain underexplored, thereby constraining a holistic understanding of the vulnerability of reporting systems to institutional, economic, and geopolitical factors.

This study builds on and extends previous research on the management and utilization of oil and gas data in Indonesia. Earlier studies have emphasized the substantial contribution of the upstream oil and gas sector to the national economy, particularly through the application of input–output analytical methods (Notonegoro et al., 2025), Energy system modeling for projecting household-level oil and gas demand (Jumardi et al., 2025), as well as an analysis of structural and institutional factors influencing the development of CCS/CCUS technology (Yusgiantoro et al., 2025) and the mapping of CO_2 source–sink potential in the oil and gas industry (Al Hakim et al., 2025). Previous studies have primarily focused on economic analyses, demand forecasting, and technical or institutional evaluations of oil and gas data at national or regional scales, often with limited temporal coverage.

Several previous studies have investigated various aspects of oil and gas data, reserves, and energy policy; however, they have not specifically assessed the consistency and stability of quantitative data reporting (Pasarai et al., 2019) discusses petroleum regulations and characteristics, providing governance context, although it does not focus on indices or data consistency. Research (Caryana 2017) referring to fuel reserves and supply, indirectly related to supply stability and energy data. Article (Sugiantoro 2014) displaying historical production data, which most closely resembles trend analysis and data consistency, but remains focused on production rather than global reporting. Meanwhile (Yuliarita et al., 2020) only touching on operational energy usage data, not reporting or indices.

This study addresses a gap in the literature on global oil data by examining the differential responses of oil-producing and oil-importing countries during major crises (2008, 2014, 2020, and 2022), highlighting that producing countries generally exhibit higher vulnerability. By integrating the IRC and the RVI with K-means clustering, the study classifies countries according to reporting stability, thereby uncovering heterogeneity in global energy governance. Indonesia is quantitatively positioned within the ASEAN, G20, and OPEC contexts, demonstrating relatively high and stable reporting performance. Structural break analysis indicates that crisis-induced shocks temporarily alter reporting patterns without causing long-term structural changes. Moreover, regional and economic classifications offer broader insights into global energy governance and the quality of reporting practices.

METHODOLOGY

This study utilizes global oil reporting availability data from the JODI, spanning the period from January 2002 to 2025. JODI is an international initiative coordinated by the International Energy Forum (IEF) and supported by major global organizations, including the Asia-Pacific Economic Cooperation (APEC), Eurostat, the Gas Exporting Countries Forum (GECF), the International Energy Agency (IEA), the Latin American Energy Organization (OLADE), the Organization of the Petroleum Exporting Countries (OPEC), and the United Nations Statistics Division (UNSD).

Data and variables

In this study, the primary variables examined are Availability and the IRC. Availability is operationalized as a binary variable (1 = reported, 0 = not reported), indicating whether a country reported oil data in a given month. The IRC is calculated as the proportion of months with reported data relative to the total number of observed months, serving as a measure of each country's reporting consistency throughout the study period (Quagli et al., 2021). To evaluate fluctuations in reporting patterns, the RVI was used to quantify the average month-to-month changes in reporting status (Sridharan 2015). Furthermore, the overall data availability is evaluated using the ODAI, which represents the average data availability for each country or group of countries throughout the entire observation period (Dang et al., 2024). The analysis further incorporates a classification of countries based on their roles in the global oil market, distinguishing between producer and importer economies, as well as their memberships in major economic groups and geographical regions. Specifically, these classifications encompass ASEAN, OPEC, the G20, OECD and non-OECD countries, major oil producers and consumers, and the Asia-Pacific, Middle East, and Africa regions. This structured framework facilitates a comprehensive assessment of the availability and quality of oil data reporting across global, regional, and national levels.

Quantitative analysis

Quantitative analyses were performed using multiple complementary approaches to assess the availability and quality of oil data reporting at both national and regional levels. Reporting consistency and temporal stability were evaluated using the IRC and the RVI, respectively. For each country i, the IRC was calculated as the proportion of months with available reports relative to the total number of observed months during the study period:

$$\mathrm{IRC}_i = \frac{\sum_{t=1}^{T} A_{i,t}}{T}, \text{ where } A_{i,t} = \begin{cases} 1, & \text{if data is available for the month } t \\ 0, & \text{if the data is not available} \end{cases} \quad (1)$$

Here, (T) denotes the total number of months in the observation period, and $(A_{i,t})$ represents the data availability indicator for country (i) in month (t). The RVI quantifies the average change in reporting status between consecutive months, thereby capturing the temporal variability in a country's reporting behavior. The RVI for country (i) is computed as follows:

$$\mathrm{RVI}i = \frac{1}{T-1}\sum t = 2^{T}|A_{i,t} - A_{i,t-1}| \quad (2)$$

A low RVI value signifies a stable reporting pattern, whereas a high RVI value indicates substantial fluctuations between periods of data availability and unavailability. Subsequently, the IRC and RVI metrics are used as feature vectors $(\mathrm{IRC}_i, \mathrm{RVI}_i)$ in a K-means clustering algorithm with (k = 3), aiming to classify countries based on their reporting patterns. The K-means algorithm determines optimal cluster assignments by minimizing the Within-Cluster Sum of Squares (WCSS) objective function:

$$\mathrm{WCSS} = \sum_{c=1}^{k} \sum_{i \in C_c} |(\mathrm{IRC}_i, \mathrm{RVI}_i) - \mu_c|^2 \quad (3)$$

where (μ_c) denotes the centroid of cluster (c), and (C_c) represents the set of countries belonging to that cluster. Subsequently, a temporal analysis is performed by converting the monthly data into a

time-series format to calculate the Oil Data Availability Index (ODAI). The ODAI for country (i) in month (t) is defined as follows:

$$\text{ODAI}i,t = \frac{\sum t = 1^{T} A_{i,t}}{T} \quad (4)$$

to assess long-term trends and detect potential shifts in reporting regimes, a structural break analysis was conducted using the Bai–Perron method, modeling ODAI as a linear regression with allowance for (m) structural break points $(T_1, T_2, \dots, T_m)$.

$$\text{ODAI}t = X_t\beta_j + \epsilon_t, Tj-1 < t \le T_j, j = 1, \dots, m+1 \quad (5)$$

where (β_j) represents the regression coefficient for segment (j), and (ϵ_t) denotes the error term. This analytical framework allows for the detection of significant changes in reporting patterns associated with major global shocks, including the 2008 financial crisis, the 2014 oil price decline, the COVID-19 pandemic, and the 2022 geopolitical crisis. These impacts are further evaluated using a before–after shock analysis, in which the mean ODAI values prior to and following each event are systematically compared:

$$\Delta\text{ODAI} = \text{ODAIafter} - \text{ODAIbefore} \quad (6)$$

Third, comparative analyses across countries and groups were performed to evaluate Indonesia's position relative to ASEAN, OPEC, and the G20. Reporting continuity was assessed using two indicators: the NO streak, defined as the number of consecutive months without reporting, and the NO share, defined as the proportion of non-reporting months relative to the total number of observed months:

$$\text{NO Share}i = \frac{\sum t = 1^{T}(1 - A_{i,t})}{T} \quad (7)$$

to evaluate the statistical significance of differences in Oil Data Availability Index (ODAI) values across country groups, this study employs an independent two-sample t-test (Manfei et al., 2017). This test aims to assess whether a statistically significant difference exists in the mean ODAI between two groups of countries, such as OECD and non-OECD countries, or between major producer and major consumer groups. The t-test statistic is computed using the following Equation 8:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (8)$$

here, $(X_1)$and (X_2)represent the mean ODAI values for the first and second groups, respectively; (s^2_1) and (s^2_2) denote the variances of each group; and (n_1) and (n_2) indicate the number of countries in each group.

In applying the two-sample t-test, this study carefully considers the statistical assumptions that underpin the validity of the test. First, ODAI data across countries are assumed to be independent, meaning that the ODAI value of one country does not affect that of another. Second, the distribution of ODAI values within each group is assumed to approximate normality. This assumption is deemed reasonable, as the sample sizes in most groups are sufficiently large to satisfy the conditions of the Central Limit Theorem, which states that the sampling distribution of the mean tends to approximate a normal distribution as sample size increases (Islam 2018).

Prior to conducting the independent samples t-test, the homogeneity of variances between groups was assessed using Levene's test (Mishra et al., 2019). If the test results indicate that the variances of the two groups do not differ significantly, a t-test assuming equal variances (pooled-variance t-test) is applied (Abidoye et al., 2021). Conversely, when the variances between two groups differ significantly, an independent samples t-test assuming unequal variances, commonly known as Welch's t-test should be employed, as it adjusts the degrees of freedom to provide estimates that are more robust to variance heterogeneity (Derrick et al., 2016).

This methodological approach ensures that the selection of statistical techniques is properly aligned with the characteristics of the data, thereby

enhancing the validity of inferences when testing for differences in ODAI across country groups.

Fourth, a regional analysis was performed by calculating annual ODAI trends for each geographical region (Asia-Pacific, Middle East, and Africa) to evaluate disparities in data availability at the regional level. The regional ODAI value was determined as the mean ODAI across all member countries within each respective region:

$$\text{ODAIregion}, t = \frac{1}{N\text{region}} \sum_{i \in \text{region}} \text{ODAI}_{i,t} \quad (9)$$

This quantitative approach allows for a thorough evaluation of the consistency, stability, and quality of global oil data reporting, while also providing insight into Indonesia's position within regional and international contexts.

Software

All analyses were performed in the R statistical environment. Data preprocessing and visualization were conducted using the readxl, dplyr, tidyr, lubridate, and ggplot2 packages. Cluster analyses were carried out with the cluster and factoextra packages, while structural break detection and extraction of statistical test results were conducted using the strucchange and broom packages.

This approach enables a comprehensive assessment of the consistency, stability, and quality of oil data reporting at global, regional, and national levels, while contextualizing Indonesia within the broader framework of international reporting practices.

RESULT AND DISCUSSION

Results

Global oil data reporting consistency

Based on the analysis of JODI data over the observation period, the global oil data availability rate exhibited a relatively high level of coverage, with an average rate of 77.9%. This suggests that nearly four-fifths of member countries consistently reported their oil data in each reporting cycle. However, this performance was not uniform across time, as evidenced by a minimum availability rate of 41.0%, indicating periods when country participation in data reporting was limited. Such fluctuations were particularly apparent during the early stages of the reporting system's implementation or amid disruptions in institutional and statistical capacities in several countries. Conversely, a maximum availability rate of 89.7% reflects a marked improvement in member countries' compliance and reporting capabilities, confirming that the JODI system has become increasingly established as a reliable global instrument for oil data provision.

Figure 1. Global oil data reporting availability (2002–2025)

Figure 1 illustrates the global oil data reporting levels to JODI from 2002 to 2025, revealing an overall upward trend despite fluctuations in the early years. The proportion of countries consistently providing data increased from a relatively low baseline at the start of the observation period.

The analysis reveals notable variations in the consistency of oil data reporting among countries included in the JODI database during the observation period. The Index of Reporting Consistency (IRC), defined as the ratio of reported months to the total observation months, shows that the majority of countries maintain a high level of reporting compliance. Specifically, 75 countries were classified as highly consistent, with IRC values ≥ 0.80, indicating near-continuous reporting throughout the study period. In contrast, 15 countries were categorized as moderately consistent, with IRC values between 0.50 and 0.79. While this group exhibits generally adequate reporting patterns, intermittent gaps suggest potential administrative limitations, policy transitions, or technical disruptions within the reporting systems. Meanwhile, 27 countries fall into the low-consistency category, with IRC values below 0.50, reflecting highly sporadic or limited reporting. The low consistency in this group likely stems from more pronounced structural challenges, such as constrained institutional capacity, economic or political instability, and a lower prioritization of energy statistics reporting.

Based on the calculation of the Reporting Volatility Index (RVI) and clustering via the k-means method, this study identifies distinct patterns in the consistency and stability of oil data reporting among JODI member countries. The RVI, defined as the average change in reporting status across observation periods, captures temporal volatility and differentiates countries that report data consistently from those exhibiting intermittent reporting patterns. By integrating the RVI with the Index of Reporting Consistency (IRC) and the total number of reporting months, a more comprehensive characterization of each country's reporting behavior is achieved, encompassing both the frequency and the sustainability of reporting over time.

The clustering analysis, based on three optimal clusters, reveals that the majority of countries (n = 73) form a large group characterized by relatively high reporting consistency, extended reporting duration, and low reporting volatility. This cluster comprises countries with well-established institutional capacity and robust energy statistical systems, enabling continuous oil data reporting with minimal disruption. In contrast, 30 countries are grouped into the second cluster, which displays moderate reporting consistency and stability, though reporting gaps are still observed during certain periods. This pattern indicates an ongoing process of strengthening reporting capacity, wherein these countries demonstrate active participation but have yet to achieve full stability in maintaining continuous reporting.

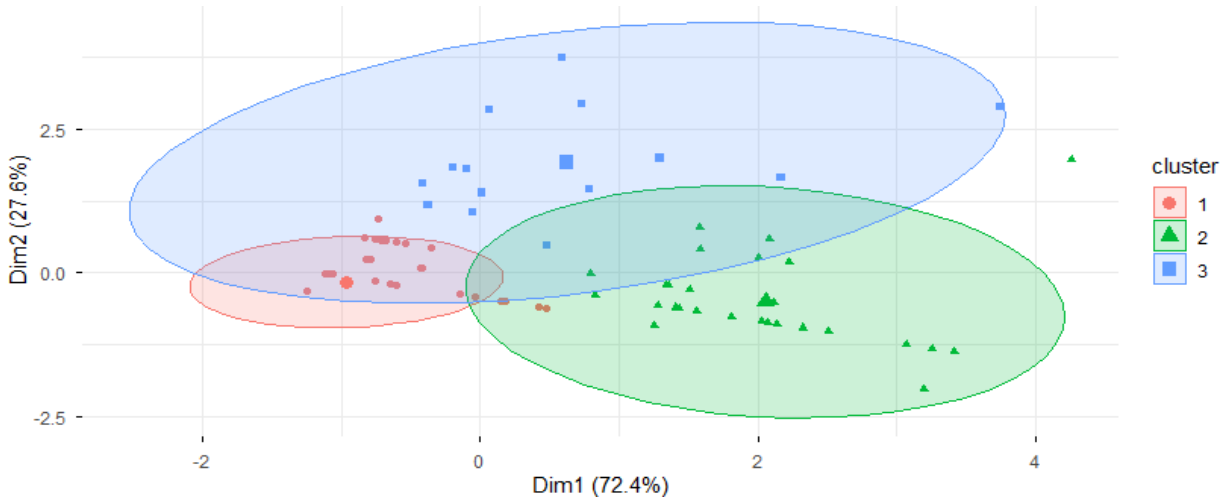

Figure 2. Clusters of oil data reporting consistency

Meanwhile, the third cluster, consisting of only 14 countries, represents the group with the lowest levels of reporting consistency and stability. Countries in this cluster exhibit low IRC values, a limited number of reporting months, and relatively high reporting volatility, reflecting sporadic and unsustainable reporting patterns.

Figure 2 illustrates the clustering of JODI reporting countries based on the consistency and stability of their oil data reporting, using the K-means method (k = 3). Each point represents a country, with the distance between points reflecting the similarity of their reporting patterns. Three distinct clusters emerged; (i) countries exhibiting highly consistent and stable reporting, (ii) countries with moderate consistency and partially sustainable reporting, and (iii) countries showing low and sporadic reporting. These results underscore structural differences in the capacity and governance of energy data reporting among countries.

The analysis indicates substantial variations in the consistency of oil data reporting among countries participating in the JODI system over the observation period. Countries exhibiting the highest consistency, namely; Australia, Austria, Belgium, Brunei Darussalam, Canada, China, and Estonia achieved an Index of Reporting Consistency (IRC) of 1. This signifies that these countries provided complete and uninterrupted data across 286 months, without any instances of non-reporting. Moreover, a Reporting Volatility Index (RVI) of zero indicates highly stable reporting, with no temporal gaps or fluctuations. These findings suggest the existence of mature institutional capacity in energy statistics, robust data management systems, and a strong commitment to transparency and compliance with international energy data governance standards.

In contrast, countries with the lowest consistency levels exhibited severely limited and unsustainable reporting patterns. Syria did not submit any data throughout the entire observation period, as reflected by an IRC value of zero and a reporting duration of zero months, indicating a complete lack of effective participation in the JODI system. Other countries, including Bangladesh and Nepal, reported data for only two months over the entire period, resulting in extremely low IRC values of approximately 0.7%. Gambia, Grenada, and Bermuda showed slightly improved reporting, yet their patterns remained sporadic and inconsistent. Although some countries in this group display relatively low RVI values, these figures largely reflect the prevalence of persistent non-reporting rather than genuine reporting stability.

Temporal stability of oil data reporting

Based on the analysis of JODI Oil Data Availability by country, nations can be classified into two primary groups: oil-producing countries and oil-importing countries. This classification follows the list of major global oil producers, which includes 19 countries such as the United States, Saudi Arabia, Russia, Canada, and Indonesia. The distinction highlights differences in data reporting practices between countries directly engaged in oil production and those primarily dependent on oil imports.

Initial results suggest that the availability of oil-related data is unevenly distributed both across countries and over time. In general, oil-producing countries tend to exhibit higher levels of data availability compared to oil-importing countries, reflecting greater institutional capacity and a stronger strategic interest in international energy data reporting systems. Nevertheless, this pattern is not entirely stable, as temporal fluctuations indicate that oil data availability is dynamic and influenced by specific contextual factors.

The findings suggest that, although oil-producing countries generally demonstrate higher levels of data provision, challenges related to consistency persist, particularly under evolving global conditions. In other words, the existence of oil production capacity does not inherently guarantee long-term stability in data reporting. This highlights that the availability of oil-related data is shaped not only by technical capabilities and production capacity but also by institutional structures, policy frameworks, and external factors influencing the national energy statistics system.

The analysis of the oil data availability index highlights significant differences between oil-producing and oil-importing countries. On average, oil-producing countries exhibit higher data availability, with a mean value of 0.882, compared to 0.759 for oil-importing countries. This indicates that producing countries generally maintain more consistent reporting of oil data to the JODI system, likely driven by stronger domestic needs for operational and market-related information. Nevertheless, data availability among oil-producing countries shows greater variability, with a standard deviation of 0.120 almost twice that observed in oil-importing countries (0.063). This increased variability suggests that, although data reporting in producing countries is typically more comprehensive, its consistency is more sensitive to temporal fluctuations and external influences, such as market disruptions or geopolitical pressures.

This pattern is further evidenced by the wider range of index values observed among oil-producing countries, which vary from a minimum of 0.474 to a maximum of 1.000, reflecting periods of both highly comprehensive reporting and notable declines in data availability. In contrast, oil-importing countries display a narrower range, from 0.398 to 0.888, indicating a relatively more stable reporting pattern, albeit with a lower overall level of data availability. These results suggest that the quality and stability of oil data reporting are influenced not only by a country's role in oil production but also by the strength and responsiveness of its national energy statistics system in the context of global oil market dynamics.

The structural break analysis, performed using the Bai–Perron method, reveals that the dynamics of oil data availability, both for producing and importing countries, did not experience any permanent structural regime changes over the observation period. The determination of the optimal number of breaks, based on the Bayesian Information Criterion (BIC), indicated a value of zero for both groups, suggesting that a model without structural breaks most appropriately explains the variations in the oil data availability index. These findings imply that, from a statistical standpoint, there is no evidence of a persistent long-term shift in global oil data reporting patterns.

Nevertheless, the estimation of potential break points highlights several periods of temporary instability in data reporting. Within the group of oil-producing countries, candidate break points were identified at various intervals, roughly aligning with periods of significant stress in the global oil market. A similar pattern emerged among oil-importing countries, although with a slightly higher number of break points, suggesting episodic fluctuations in reporting. However, as these points were not supported by model selection criteria as optimal breaks, the observed variations are more appropriately interpreted as short-term responses to external conditions rather than as structural changes in the data reporting system.

Substantively, these findings indicate that the availability of oil data in the JODI database has remained relatively stable over the long term for both producing and importing countries. Observed temporal disruptions during certain periods likely reflect short-term impacts of global economic fluctuations, market dynamics, or geopolitical events, which may affect countries' capacity or incentives to report data accurately.

Based on the analysis of pre- and post-global shock data, the impact of crises on oil data availability was asymmetrical between oil-importing and oil-producing countries and exhibited temporal variation. During the 2008 global financial crisis, oil-importing countries experienced an increase in data availability, with the average index rising from 0.720 before the crisis to 0.773 afterward. This trend suggests that, in the initial phase of global economic instability, importing countries tend to strengthen their energy reporting systems to accommodate the heightened demand for information relevant to domestic energy policy and demand management. Conversely, oil-producing countries showed a decline in data availability over the same period, with the index decreasing from 0.937 to 0.863, reflecting a reduction in reporting consistency amid intensified market pressures and price uncertainty.

A similar pattern was observed during the 2014 oil price shock. Following a sharp decline in global oil prices, the availability of data in oil-importing

countries showed only a marginal improvement, with the index rising slightly from 0.748 to 0.771. In contrast, oil-producing countries experienced a pronounced decline in their data availability index, dropping from 0.951 to 0.811. This pattern indicates a heightened sensitivity of oil data reporting in producing countries to market fluctuations, particularly during periods of abrupt price corrections and strategic adjustments in production policies.

Entering the COVID-19 pandemic in 2020, this pattern underwent a fundamental transformation. Both oil-importing and oil-producing countries experienced a decline in data availability. In oil-importing countries, the index fell from 0.776 before the pandemic to 0.709 afterward, whereas in oil-producing countries, the decrease was substantially sharper, dropping from 0.939 to 0.707. These findings indicate that a global systemic crisis; disrupting supply chains, mobility, and institutional capacity has a direct negative impact on energy data reporting systems, particularly in countries heavily dependent on the oil and gas sector.

This negative impact was further exacerbated by the geopolitical upheavals of 2022. In the wake of the crisis and the ensuing disruptions in the global energy market, the data availability index in importing countries fell from 0.773 to 0.686, while in oil-producing countries, the decline was even more pronounced, dropping from 0.924 to 0.664. This persistent and substantial reduction underscores that, during the current energy crisis, the transparency and continuity of oil data reporting have become increasingly vulnerable, particularly in producing countries facing geopolitical pressures, strategic production considerations, and uncertainties in international markets.

Table 1. Impact of oil market shock years on ODAI by country group

Shock year	Country group	Before	After	Δ (After – Before)	Direction
2008	Oil importer	0.72	0.773	0.052	Improves
2008	Oil producer	0.937	0.863	−0.074	Deteriorates
2014	Oil importer	0.748	0.771	0.023	Improves
2014	Oil producer	0.951	0.811	−0.140	Deteriorates
2020	Oil importer	0.776	0.709	−0.067	Deteriorates
2020	Oil producer	0.939	0.707	−0.232	Deteriorates
2022	Oil importer	0.773	0.686	−0.087	Deteriorates
2022	Oil producer	0.924	0.664	−0.260	Deteriorates

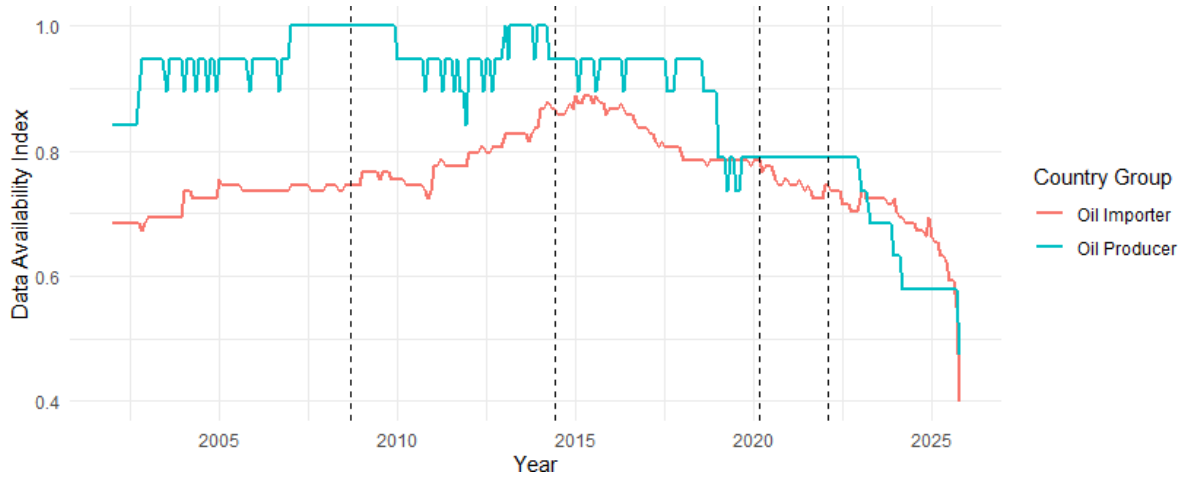

Figure 3. Differences in oil data availability patterns between producing and importing countries and responses to the global crisis

Table 1 illustrates that global shocks exert varying impacts on oil data availability across producing and importing countries. Producing countries generally maintain higher baseline data availability but are more vulnerable to reductions during crises. Conversely, importing countries tend to exhibit greater stability and may even experience slight increases in data availability during the initial stages of shocks, although notable declines occur during systemic crises.

As shown in Figure 3, the oil data availability index exhibits distinct patterns between producing and importing countries. Producing countries generally demonstrate higher levels of data availability but also greater variability, particularly during periods of global shocks, as indicated by the dotted lines in 2008, 2014, 2020, and 2022. In contrast, importing countries display a more stable trajectory, with moderate increases during early shocks and notable declines during large-scale crises. These findings suggest that the stability of oil data reporting in producing countries is more sensitive to market pressures and global disruptions than in importing countries.

Indonesia in the global context

Based on the analysis, Indonesia demonstrates a relatively high level of oil data availability, with an Oil Data Availability Index (ODAI) of 0.944, indicating that its oil and gas data reporting has been relatively consistent throughout the 2002–2025 period. Among regional and international

Table 2. Comparison of oil data availability patterns between producing and importing countries

Group / Country	Mean ODAI	Min ODAI	Max ODAI	SD ODAI
Indonesia	0.944	0.944	0.944	NA
ASEAN	0.889	0.406	1	0.238
G20	0.969	0.78	1	0.063
OPEC	0.829	0.5	1	0.185

Table 3. Comparison of Indonesia's oil data availability index (ODAI) with ASEAN, G20, and OPEC countries

Group	Mean ODAI	Min ODAI	Max ODAI	SD ODAI	Gap vs Indonesia
Indonesia	0.944	0.944	0.944	NA	0
ASEAN	0.889	0.406	1	0.238	-0.055
G20	0.969	0.78	1	0.063	0.025
OPEC	0.829	0.5	1	0.185	-0.115

Table 4. Streak of non-reporting and percentage of NO (Non-Reporting) per country

Country	Longest NO streak (month)	NO share (%)
Vietnam	135	59.4
Libya	139	50
Iran (Islamic Rep.)	87	32.5
Qatar	82	28.7
United Arab Emirates	82	28.7
Iraq	60	28
Argentina	63	22
Brazil	34	11.9
Russian Federation	31	10.8
South Africa	12	7.7
Philippines	8	5.9
Indonesia	10	5.6
Algeria	2	2.1

groups, ASEAN countries exhibit an average ODAI of 0.889, with considerable variability (minimum: 0.406; maximum: 1.0; SD: 0.238), reflecting substantial disparities in data reporting practices among member states. The G20 countries present the highest average ODAI of 0.969, accompanied by limited variation (minimum: 0.780; maximum: 1.0; SD: 0.063), suggesting that most members maintain highly consistent data reporting. In contrast, OPEC countries show an average ODAI of 0.829, with a relatively wide range (0.5–1.0; SD: 0.185), indicating fluctuations in data availability among major oil-producing nations. Indonesia's performance is comparatively strong, surpassing the ASEAN and OPEC averages but slightly below the G20 mean, suggesting that the country maintains relatively stable oil and gas data reporting and could serve as a benchmark for enhancing regional energy data reporting systems.

Table 2 presents a comparative analysis of oil data availability patterns using the Oil Data Availability Index (ODAI) across several country groups, including Indonesia. For each group, the table reports the mean, minimum, maximum, and standard deviation (SD) of ODAI. The analyzed country groups comprise Indonesia, ASEAN countries, G20 countries, and OPEC member countries. These descriptive statistics offer an overview of the distribution and variability of oil data availability within each group over the observation period.

Table 3 provides a comparative analysis of the Oil Data Availability Index (ODAI) across Indonesia and selected country groups, including ASEAN, G20, and OPEC. It reports the mean ODAI, minimum and maximum values, standard deviation, and the difference in ODAI between each group and Indonesia.

Table 4 summarizes the durations during which countries did not submit oil data (non-reporting periods). The indicators include Longest NO Streak, which represents the maximum number of consecutive months a country failed to provide oil data, and NO Share, which reflects the proportion of the total non-reporting period relative to the entire observation period. This table facilitates a comparison among the participating countries, highlighting variations in data reporting continuity based on these two metrics.

As illustrated in Figure 4, Indonesia demonstrates a high and stable ODAI, surpassing the average levels of both ASEAN and OPEC countries, yet remaining slightly below the G20 average. The dotted line denotes Indonesia's position as a reference point. Moreover, the variation in ODAI among countries is more pronounced within the ASEAN and OPEC groups than within the G20.

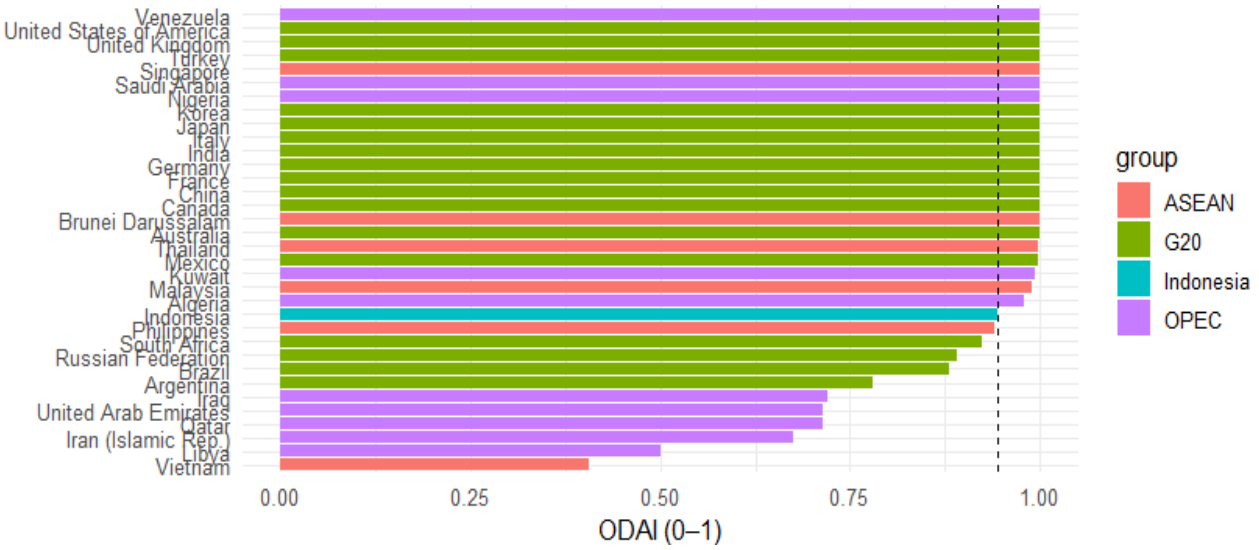

Figure 4. Indonesia's position in the oil data availability index (ODAI) compared to ASEAN, OPEC, and G20

Assessing oil data availability as a proxy for energy governance quality

A comparative analysis between groups reveals that OECD countries exhibit a markedly higher average Oil Data Availability Index (ODAI) of 0.988, with a median of 1 and low variability (SD = 0.058). In contrast, non-OECD countries show a substantially lower average ODAI of 0.683, a median of 0.767, and greater variability (SD = 0.313). The results of the t-test indicate that this difference is statistically significant ($t = -8.41$, $p < 0.001$), confirming that oil data availability is not only higher but also more consistent in OECD countries than in non-OECD countries.

From the perspective of production and consumption status, countries classified as major consumers exhibit a perfect ODAI of 1, with no observed variation, whereas major producers show an average ODAI of 0.906 with a standard deviation of 0.130. Results of the t-test indicate that this difference is statistically significant ($t = 2.50$, $p = 0.030$), suggesting that major consumer countries tend to report oil data more completely and consistently than major producer countries.

Regional patterns of oil data availability

Based on the analysis of the regional Oil Data Availability Index (ODAI), trends in oil data availability exhibit notable variation across different regions. Generally, regions with a positive slope in the linear regression model indicate an increase in data availability over time, reflecting improved consistency and completeness of reporting. In contrast, regions with a negative slope demonstrate a declining trend in data availability year by year. The statistical significance of these trends was assessed using p-values, with $p < 0.05$ indicating that the observed trend is statistically significant. The trend interpretation column provides a summary of both the direction and statistical significance of trends for each region, thereby facilitating the identification of areas experiencing either improvements or declines in oil data availability throughout the study period.

Analysis of regional disparities in data availability revealed substantial variation. The gap summary, calculated as the annual difference between the maximum and minimum ODAI values, showed an average gap of 0.403, ranging from 0.167 to 0.556. These results indicate pronounced interregional differences in data availability, with higher gap values reflecting greater variability among regions.

Figure 5 shows that the Asia-Pacific region exhibits the highest ODAI, with a consistently increasing trend over time. In contrast, the Middle East displays a moderate ODAI level with relatively minor fluctuations, whereas Africa records a comparatively lower ODAI accompanied by gradual growth. These patterns highlight the existence of regional disparities in oil data availability.

Discussion

Research shows that the availability of global oil data from 2002 to 2025 was relatively high, with an average reporting rate of 77.9%, indicating that most JODI member countries consistently

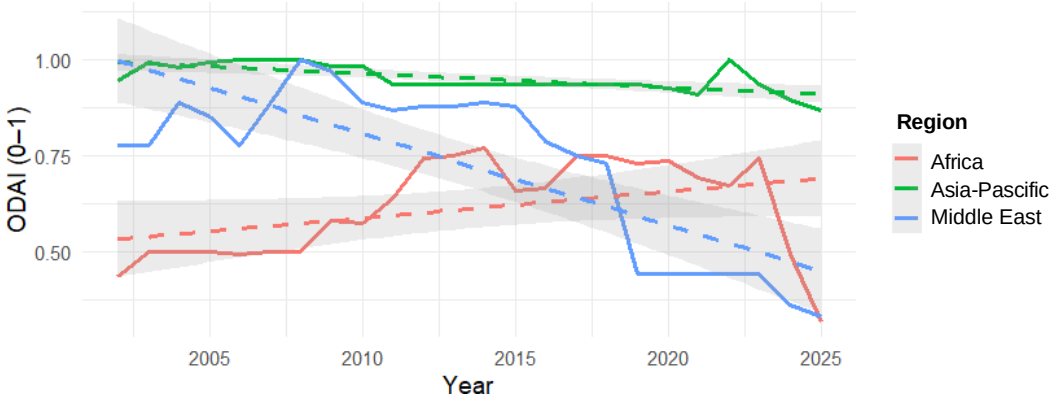

Figure 5. Annual trends in the oil data availability index (ODAI) by region

submitted their energy data. However, substantial fluctuations were observed, with reporting rates ranging from a minimum of 41.0% to a maximum of 89.7%. These variations suggest that the consistency of global energy data reporting continues to be influenced by differences in institutional capacity, technical readiness, and administrative stability among countries.

The results of the cluster analysis, based on the Index of Reporting Consistency (IRC) and the Reporting Volatility Index (RVI), reveal notable structural differences in the governance of energy statistics across countries. Countries exhibiting high consistency and low volatility, such as Australia, Canada, and China, display robust institutional capacities and a strong commitment to global energy data governance. Conversely, countries with low reporting consistency often face administrative challenges, policy transitions, or political instability, which can compromise the sustainability and reliability of energy data reporting.

These findings support institutional capacity theory, which suggests that the quality of energy data governance is shaped not only by technical capabilities but also by the stability of institutions and the effectiveness of national statistical systems (Anderson & Whitford 2017; Andrews-Speed, 2016).

Temporal analysis reveals a pronounced asymmetry between oil-producing and oil-importing countries. Oil-producing countries exhibit a higher Oil Data Availability Index (ODAI), with a mean value of 0.882, compared to 0.759 in oil-importing countries. However, oil-producing countries appear more vulnerable to reductions in data availability during periods of global shocks.

Conversely, importing countries generally exhibit greater stability in data reporting and, in some cases, even an increase in reporting during the early stages of a crisis. This pattern aligns with resource dependence and strategic reporting theories, which posit that producing countries adjust their data reporting in response to global market pressures and national strategic objectives. In contrast, importing countries tend to reinforce their domestic energy information systems to mitigate risks associated with reliance on external energy supplies (Balahurovska & Bahrii, 2025; Jiang et al., 2023.

Structural break analysis using the Bai–Perron methodology reveals that, despite temporary disruptions caused by global crises including; the 2008 financial crisis, the 2014 oil price decline, the 2020 COVID-19 pandemic, and the 2022 geopolitical tensions no evidence of a permanent structural regime shift was observed in the JODI reporting system. These results suggest that the global energy reporting framework exhibits strong long-term institutional resilience, while remaining vulnerable to short-term fluctuations induced by external shocks.

In a global context, Indonesia exhibits a relatively stable performance, with an ODAI value of 0.944. This value surpasses both the ASEAN average (0.889) and the OPEC average (0.829), while remaining slightly below the G20 average (0.969). An examination of reporting streaks further reveals that Indonesia maintains a high level of reporting consistency, with a maximum non-reporting period of only 10 months and a non-observation (NO) proportion of 5.6%. This performance is markedly superior to that observed in several other countries, including Vietnam and Libya.

These findings suggest that Indonesia demonstrates robust institutional capacity and governance in energy statistics, underpinned by strong governmental commitment and effective use of information technology. This context indicates that Indonesia holds considerable potential to serve as a best-practice model for energy data management within the ASEAN region.

The availability of oil data, as reflected by the ODAI indicator, can serve as a proxy for evaluating the quality of energy governance. Comparative analysis reveals that OECD countries achieve an average ODAI score of 0.988, significantly higher than the 0.683 observed in non-OECD countries. This difference is statistically significant. Moreover, the Major Consumers group demonstrates perfect reporting consistency, whereas the Major Producers group continues to

exhibit variability in reporting performance. However, ODAI has certain limitations, as it measures only the sustainability of data reporting, without evaluating the quality, accuracy, or methodological transparency of the reported data. Therefore, it should be complemented with additional data quality indicators to provide a more comprehensive assessment of energy governance.

Regional analysis reveals notable disparities across different regions. The Asia–Pacific region demonstrates the highest ODAI levels, exhibiting a consistent upward trend, followed by the Middle East, which experiences moderate fluctuations. In contrast, Africa shows relatively lower ODAI levels with slow growth. These variations likely reflect differences in energy market integration, the maturity of national statistical systems, and the degree of international institutional support.

These findings underscore the crucial role of capacity-building policies such as technical training, the harmonization of energy reporting standards, and enhanced regional cooperation in addressing global gaps in energy data reporting.

The findings of this study carry several important policy implications. First, enhancing institutional capacity and modernizing energy statistical systems are crucial for improving the consistency and reliability of data reporting. Second, the incorporation of information technology into energy reporting frameworks has been shown to strengthen data stability. Third, international cooperation through knowledge transfer and technical assistance should be further promoted, especially for countries with limited reporting capabilities.

Furthermore, oil-producing countries should develop reporting mechanisms that are more resilient to global market fluctuations in order to ensure the stability of international energy data.

This study makes a theoretical contribution by showing that the stability of energy data reporting is more strongly determined by governance quality and institutional capacity than by the level of energy production or consumption. Moreover, it extends the existing literature by highlighting the asymmetric effects of global crises on energy data reporting in energy-producing versus energy-importing countries. Further research is encouraged to extend the analysis by incorporating indicators of data quality, transparency in reporting methodologies, and the influence of digital transformation on energy statistics systems. Additionally, a comprehensive comparative study examining Indonesia's best practices in regional energy data management could provide valuable insights to enhance energy governance in developing regions.

CONCLUSION

The consistency and stability of global oil data reporting vary considerably across countries, shaped not only by production capacity but also by institutional capabilities, policy frameworks, and external pressures. Oil-producing countries generally exhibit more comprehensive data availability; however, they are often more susceptible to disruptions during crises. Conversely, oil-importing countries tend to demonstrate greater reporting stability, despite having relatively limited data coverage. Moreover, global crises exert asymmetric impacts on reporting performance, with the availability of oil data serving as a potential proxy for the quality of national energy governance. Indonesia exemplifies strong reporting performance, as reflected by an Oil Data Availability Index (ODAI) value of 0.944, indicating high stability and consistency. For developing countries with weaker reporting systems, enhancing institutional capacity, improving energy statistical frameworks, and establishing crisis-resilient reporting mechanisms are crucial. Consequently, ODAI can serve as a valuable indicator for assessing the effectiveness of energy transparency policies and a country's preparedness to respond to oil market volatility.

Future research should investigate the factors that influence the consistency and volatility of oil reporting, including institutional capacity, energy regulation, political stability, and national statistical infrastructure. Developing quantitative and predictive models is essential for projecting reporting responses to global or regional crises and for facilitating comparisons between oil-importing and oil-producing countries. Enhancing data

capacity in developing nations, integrating cross-country energy statistical systems, and assessing ODAI indicators are critical steps toward improving transparency and preparedness in the face of market volatility. The Indonesian case study can provide a reference for effective reporting practices, while comparative analyses and regional longitudinal studies can support the monitoring of long-term trends and the evaluation of the effectiveness of evidence-based energy policies.

ACKNOWLEDGMENT

The authors sincerely acknowledge JODI and its partner institutions, including the International Energy Forum (IEF), APEC, Eurostat, the Gas Exporting Countries Forum (GECF), the International Energy Agency (IEA), the Latin American Energy Organization (OLADE), the Organization of the Petroleum Exporting Countries (OPEC), and the United Nations Statistics Division (UNSD), for providing open access to comprehensive global oil data. The availability of this dataset, spanning 2002 to 2025, has been instrumental for this study, particularly in enabling the assessment of consistency, stability, and quality in global oil data reporting.

GLOSSARY OF TERMS AND SYMBOLS

Terms & Symbols	Definition	Unit
Availability	Binary indicator of whether oil data for a country and month is reported (1) or not (0).	
Index of reporting Consistency (IRC)	Proportion of months a country reports oil data out of the total observation period.	
Reporting volatility index (RVI)	Measures month-to-month fluctuations in reporting status, indicating temporal volatility.	
Oil data availability index (ODAI)	Average data country or group during the observation period.	
NO share	Proportion of months a country does not report oil data relative to total months.	
K-means clustering	Method to group countries with similar reporting patterns based on IRC and RVI.	
Within-cluster sum of squares (WCSS)	Metric minimized in K-means to measure cluster compactness.	
Structural break (Bai–Perron method)	Point in time series where reporting patterns significantly change.	
JODI (Joint organizations data initiative)	Global initiative for energy data transparency, coordinated by IEF and partners.	
Major producers	Countries with high oil production globally.	
Major consumers	Countries with high oil consumption globally.	
OECD / Non-OECD countries	Groups of countries based on membership in the Organization for Economic Co-operation and Development.	
ASEAN / OPEC / G20	Country groups used for regional or economic comparison in reporting performance.	
Time series analysis	Analysis of data over time to detect trends or changes.	
Δ ODAI (Delta ODAI)	Change in ODAI before and after global shocks or crises.	
Regions (Asia-Pacific, Middle East, Africa)	Geographical groups used to compare regional data availability patterns.	

REFERENCES

Abidoye, A., Lamidi, W., Alabi, M., & Popoola, J., (2021), Testing for equality of means with equal and unequal variances. Scientia Africana, 20(2), 51–60.

Al Hakim, M. F., Tony, B., Chandra, S., Nugraha, F. Y., & Nandiwardhana, D., (2025), Mapping The Potential Co2 Source-Sinks For Carbon Capture Storage From Industry In Indonesia. Scientific Contributions Oil and Gas, 48(1), 121 –133. https://doi.org/10.29017/scog.v48i1.1626.

Alazzani, A., & Wan-Hussin, W. N., (2013), Global Reporting Initiative's environmental reporting: A study of oil and gas companies. Ecological Indicators, 32, 19–24.

Anderson, D. M., & Whitford, A. B., (2017), Developing knowledge states: Technology and the enhancement of national statistical capacity. Review of Policy Research, 34(3), 400–420.

Andrews-Speed, P. (2016). Applying institutional theory to the low-carbon energy transition. Energy Research & Social Science, 13, 216–225.

Balahurovska, I. O., & Bahrii, R. R., (2025), Ukraine's cross-border energy security as a strategy for reducing energy dependence and developing renewable energy exports.

Batubara, M., Purwanto, W. W., & Fauzi, A., (2016), Proposing a decision-making process for the development of sustainable oil and gas resources using the petroleum fund: A case study of the East Natuna gas field. Resources Policy, 49, 372–384.

Caryana, Y. K., (2017), Kajian Kebijakan Cadangan Penyangga Bahan Bakar Minyak Serta Rencana Umum Pembangkit Tenaga Listrik Untuk Menjamin Kesinambungnan Penyediaan Energi Pada Program Implementasi Tol Laut (Petroleum Fuel Reserves Policy and Power Plant Construction Planning Reviews to Assure Energy Security Supply for Sea Toll Implementation Program). Lembaran Publikasi Minyak dan Gas Bumi (LPMGB), 51(1), 41–48. https://doi.org/10.29017/LPMGB.51.1.14.

Dang, H.-A., Pullinger, J., Serajuddin, U., & Stacy, B., (2024), Reviewing assessment tools for measuring country statistical capacity. IZA Discussion Papers.

Derrick, B., Toher, D., & White, P. (2016). Why Welch's test is Type I error robust. The Quantitative Methods for Psychology, 12 (1), 30–38.

Hassani, H., & Christodoulides, P., (2021), OPEC's efforts on energy data transparency: Evidence from the Organization's 60 year history. OPEC Energy Review, 45(1), 44–51.

Islam, M. R., (2018), Sample size and its role in Central Limit Theorem (CLT). Computational and Applied Mathematics Journal, 4(1), 1–7.

Janssen, M., Van Der Voort, H., & Wahyudi, A., (2017), Factors influencing big data decision-making quality. Journal of Business Research, 70, 338–345.

Jiang, H., Luo, Y., Xia, J., Hitt, M., & Shen, J., (2023), Resource dependence theory in international business: Progress and prospects. Global Strategy Journal, 13(1), 3–57.

Johnsson, S., Andrei, M., & Johansson, M., (2025), Harmonizing energy audit reporting: Addressing data loss and policy challenges in the EU member states. Energy, 319, 135040.

Jumardi, A., Yusgiantoro, P., & Siagian, U., (2025), Development of Energy System Modeling to Forecast 2060 Oil and Gas Demand in The Household Sector of East Kalimantan Using Bottom-Up Method. Scientific Contributions Oil and Gas, 48(1), 159 –177. https://doi.org/10.29017/scog.v48i1.1732.

Manfei, X., Fralick, D., Zheng, J. Z., Wang, B., Xin, M. T., & Changyong, F., (2017), The differences and similarities between two-sample t-test and paired t-test. Shanghai Archives of Psychiatry, 29(3), 184.

Mishra, Prabhaker, Singh, U., Pandey, C. M., Mishra, Priyadarshni, & Pandey, G., (2019), Application of student's t-test, analysis of variance, and covariance. Annals of Cardiac Anaesthesia, 22(4), 407–411.

Noch, M. Y., (2024), Navigating uncertainty: International accounting and financial reporting

amid geopolitical conflict. Advances: Jurnal Ekonomi & Bisnis, 2(1), 1–11.

Notonegoro, K., Setiati, R., & Mardiana, D. A., (2025), Analysis On Linkage And Multiplier Effects Of Upstream Oil And Gas Sector In Indonesia's Economy Using Input-Output Method. Scientific Contributions Oil and Gas, 48(1), 207–216. https://doi.org/10.29017/scog.v48i1.1700.

Noy, I., & Dabamona, J., (2024), War and financial statements: Assessing the impact of the russia-ukraine conflict on international accounting and reporting standards. Advances in Applied Accounting Research, 2(2), 71–82.

Pasarai, U., Hazman, H., Pribadi, E., Lucia, A., & Widarsono, B., (2019), Kajian Regulasi Pengusahaan Oil Sands Kedalaman Dangkal Dengan Metode Oil Mining. Lembaran Publikasi Minyak Dan Gas Bumi (LPMGB), 53 (1), 1–14. https://doi.org/10.29017/LPMGB.53.1.265.

Quagli, A., Lagazio, C., & Ramassa, P., (2021), From enforcement to financial reporting controls (FRCs): A country-level composite indicator. Journal of Management and Governance, 25(2), 397–427.

Rafieisakhaei, M., Barazandeh, B., & Tarrahi, M., (2016), Analysis of supply and demand dynamics to predict oil market trends: A case study of 2015 price data. D011S004R004.

Sridharan, S. A., (2015), Volatility forecasting using financial statement information. The Accounting Review, 90(5), 2079–2106.

Sugiantoro, J. J. (2014). Analisis Laju Pengurasan Produksi Minyak Lapangan-Lapangan Sumatera Selatan. Lembaran Publikasi Minyak Dan Gas Bumi (LPMGB), 48(3), 133–140. https://doi.org/10.29017/LPMGB.48.3.1219.

Watts, M., & Zalik, A., (2020), Consistently unreliable: Oil spill data and transparency discourse. The Extractive Industries and Society, 7(3), 790–795.

Wu, K., Bethel, E. W., Gu, M., Leinweber, D., & Ruebel, O., (2013), A big data approach to analyzing market volatility. Algorithmic Finance, 2(3–4), 241–267.

Yuliarita, E., Zulkifliani, Z., Atmanto, M. D., Sunarjanto, D., & Lubad, A. M., (2020), Kajian Pemanfaatan Gas DME (Dimethyl Ether) atau Uji Terap Pada Sektor Rumah Tangga Di Wilayah Sumatera Selatan. Lembaran Publikasi Minyak Dan Gas Bumi (LPMGB), 54(2), 61–67. https://doi.org/10.29017/LPMGB.54.2.499.

Yusgiantoro, L., Prabowo, T. B., & Kristanto, D., (2025), The Structural Factors in Advancing CCS/CCUS Technology in Indonesia: A Comprehensive Analysis. Scientific Contributions Oil and Gas, 48(2), 279–292. https://doi.org/10.29017/scog.v48i2.1780.