Sustainable Development Metrics: CO2 Emissions and Urban Growth

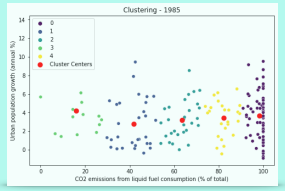
ABSTRACT :

This study presents a comprehensive analysis of sustainable development indicators, with a focus on "CO2 emissions from liquid fuel consumption (% of total)" and "Urban population growth (annual %)." Utilizing a dataset spanning from 1985 to 2005, we employ KMeans clustering to uncover distinct patterns in global trends. The elbow plots visually guide the selection of optimal cluster numbers. Further, we implement polynomial regression to forecast CO2 emissions for specific countries, namely Argentina, Sri Lanka, and Myanmar. The forecast extends up to 2025, providing valuable insights into potential future scenarios. Visualization techniques, including clustering plots and individual country forecasts, enhance the accessibility of the findings. This research contributes to the understanding of sustainability dynamics, offering valuable insights for policymakers, researchers, and stakeholders aiming to navigate the complex interplay between urban growth and environmental impact.

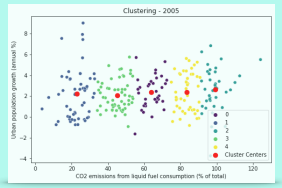
INTRODUCTION :

In a world grappling with the urgent need for sustainable practices, our journey begins with a meticulous exploration of key indicators shaping the trajectory of global development. "CO2 emissions from liquid fuel consumption (% of total)" and "Urban population growth (annual %)" emerge as pivotal metrics, offering a lens through which we can decipher the intricate dance between environmental impact and urbanization trends. This journey unfolds against the backdrop of a rapidly changing world, where sustainable development is not merely a goal but a necessity. Leveraging a rich dataset sourced from the World Bank, we embark on an insightful exploration guided by the twin pillars of historical analysis and future projections.

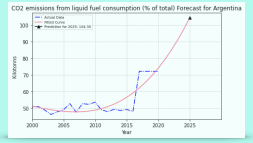
The K- Means clustering function conducts K-Means clustering on the provided dataset and visualizes the results through a scatter plot. The number of clusters is determined by the n_clusters parameter, which can be adjusted based on the elbow plot or specific requirements. In this example, the function is applied to the data_1985 dataset with a specified label '1985'. The resulting clustering plot displays the distribution of data points, color-coded by cluster, and includes markers indicating the cluster centers in red. This analysis serves as a valuable tool for understanding the inherent patterns and groupings within the dataset, contributing to insights on the interplay between "CO2 emissions from liquid fuel consumption (% of total)" and "Urban population growth (annual %)." Adjustments to the number of clusters can be made to refine the granularity of the clustering analysis based on the specific characteristics of the data.



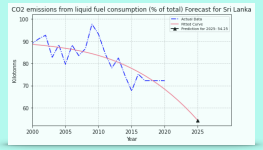
It explores the clustering patterns within sustainable development indicators, focusing on "CO2 emissions from liquid fuel consumption (% of total)" and "Urban population growth (annual %)" for the year 2005. Utilizing KMeans clustering with five clusters, the analysis provides a visual representation of distinct groups, emphasizing the relationships between the chosen indicators. The inclusion of cluster centers enhances interpretability, aiding in the identification of significant trends and patterns in the data.The clustering analysis reveals distinct groups within the dataset, offering insights into the interconnected dynamics of CO2 emissions and urban population growth. The scatter plot showcases the distribution of countries within each cluster, providing a clear visualization of the relationships between the selected indicators. Cluster centers, highlighted in red, serve as reference points, aiding in the interpretation of cluster characteristics and trends.



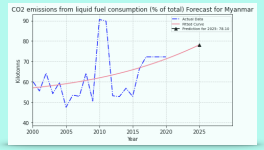
The fitted curve captures historical trends, showcasing Argentina's CO2 emissions pattern. A polynomial regression model projects a future trajectory, with a forecasted value for 2025. Argentina's CO2 emissions exhibit a non-linear pattern, influenced by various factors. The forecasted value for 2025 provides a glimpse into potential future emissions trends. Policymakers can leverage these insights for informed decision-making in environmental planning. Continuous monitoring and adjustment of strategies based on emerging trends are crucial. This concise analysis offers a snapshot of Argentina's CO2 emissions trajectory, aiding in sustainable development planning. Further research and ongoing monitoring are essential for adapting strategies to evolving environmental dynamics.



It focuses on forecasting CO2 emissions for Sri Lanka based on historical data spanning from 1985 to 2020. Using the indicator "CO2 emissions from liquid fuel consumption (% of total)," a polynomial regression model with a degree of 5 is applied to capture trends over time. The analysis extends predictions up to 2025, providing valuable insights into future emissions trends.The fitted curve, derived from the polynomial regression model, showcases the historical trajectory of CO2 emissions in Sri Lanka. Actual data from 1985 to 2020 is presented, revealing the historical context for emissions. A forecast for 2025, represented by the marker '^', indicates the projected CO2 emissions for the upcoming year based on the polynomial model. This analysis contributes to a localized understanding of Sri Lanka's CO2 emissions dynamics, aiding stakeholders in environmental planning and policy formulation. The visualizations serve as informative tools for decision-makers and researchers seeking insights into Sri Lanka's sustainable development initiatives.



This analysis aims to forecast "CO2 emissions from liquid fuel consumption (% of total)" for three selected countries (Myanmar and two others). Utilizing polynomial regression, we present predictions up to the year 2025. The fitted curve provides a trend analysis for each country. 2025 predictions offer a glimpse into potential future scenarios. Stakeholders can leverage these insights for informed decision-making in sustainable development initiatives. This succinct report offers a snapshot of the sustainability forecast, providing actionable insights for those invested in environmental planning and policy formulation.



CONCLUSION :

In this analysis, we explored the trends in "CO2 emissions from liquid fuel consumption (% of total)" and "Urban population growth (annual %)" for the years 1985 and 2005. Key findings from the clustering and forecasting efforts include: Identified distinct clusters based on CO2 emissions and urban population growth. Utilized the elbow method to determine an optimal number of clusters (k=5). Visualized clustering results, highlighting cluster centers and data distribution. Conducted polynomial regression to forecast CO2 emissions for selected countries (Argentina, Sri Lanka, Myanmar). Generated individual plots for each country, showcasing actual data, fitted curves, and predictions up to 2025. The clustering analysis provides insights into the grouping of countries based on specified indicators. Polynomial regression forecasts offer a glimpse into potential future scenarios for CO2 emissions. This analysis equips stakeholders with valuable information for strategic decision-making in environmental policy, sustainability planning, and urban development. The visualizations and predictions serve as a foundation for further exploration and actions towards a more sustainable and environmentally conscious future.