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Suicide Trends Analysis of India and Global Perspective

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Abstract:

This study analyzes suicide trends in India and globally from 2010 to 2022 using demographic, socio-economic, and regional data. The analysis uses statistical techniques such as data visualization, correlation analysis, ANOVA, and time-series modeling. The results indicate a steady increase in suicide cases in India, with the highest number recorded in 2022, while global trends show fluctuations without a consistent long-term rise. Age-wise analysis reveals that young adults (18–29) are the most affected group in India, whereas the 60+ age group records higher cases globally. Gender analysis shows that males consistently report higher suicide rates than females in both India and worldwide. Socio-economic analysis demonstrates a positive association between suicide rates and poverty, while income, literacy, and urbanization show negative relationships, suggesting that better socio-economic conditions may reduce suicide risk. Regional analysis in India reveals statistically significant differences in suicide rates across geographical regions, indicating the influence of regional factors. Time series forecasting further suggests a gradual increase in suicide cases in the coming years if current trends continue. Overall, the findings highlight the important role of demographic, socio-economic, and regional factors in shaping suicide patterns and emphasize the need for targeted prevention strategies and policy interventions.

Keywords: Data visualization, K- Means, Correlation analysis, One-way ANOVA, Tukey's HSD test, Augmented Dickey–Fuller test, ARIMA model, Time series analysis, Forecasting.

Introduction:

Suicide is a major public health concern worldwide and has significant social, economic, and psychological impacts on individuals and communities. Understanding the patterns and factors associated with suicide is essential for developing effective prevention strategies. In recent years, suicide rates have been influenced by several factors such as demographic characteristics, economic conditions, mental health issues, and social pressures.

This study analyzes suicide trends in India and globally from 2010 to 2022 using demographic, socio-economic, and regional data. The main aim of the study is to identify patterns in suicide rates, compare trends between India and the world, and examine the influence of factors such as poverty, literacy, income, and urbanization. Statistical tools including data visualization, correlation analysis, ANOVA, and time series modeling are used to understand the relationships between variables and to forecast future suicide trends.

The findings of this study help in understanding the key determinants of suicide and provide insights that may support policymakers and researchers in developing effective mental health and suicide prevention strategies.

Literature Review:

1. Trends and socio-economic determinants of suicide in India: 2001- 2013

Vikas Arya, Andrew Page, Jo River, Gregory Armstrong, Peter Mayer

Arya et al. (2018) examined suicide trends and socio-economic determinants in India from 2001 to 2013 using data from the National Crime Records Bureau and Census of India. Suicide rates were analyzed by sex, age group, and region, and a multilevel negative binomial regression model was applied to identify socio- economic factors affecting suicide rates. The study found that male suicide rates remained relatively stable at around 14 per 100,000, while female suicide rates declined from 9 to 7 per 100,000 during the study period. Higher suicide rates were associated with states having higher levels of development, agricultural employment, literacy, and unemployment. The study concluded that modernization and agricultural distress may contribute to increasing suicide risk in certain regions of India.

2. Distribution of Suicides in India: A Decadal Data Analysis (2011-2020)

A Arif - The study analyzed suicide distribution in India from 2011–2020 using data from the National Crime Records Bureau. The results showed that the 15–29 age group (35.05%) had the highest proportion of suicides, followed by the 30– 44 age group (32.61%). Family problems were the leading cause of suicides in these age groups. The study found gender differences in causes, with women more affected by marriage-related issues and dowry disputes, while men were more affected by economic factors such as unemployment, bankruptcy, and poverty. A significant rise in suicides in 2020 was observed among businesspersons, agricultural labourers, and daily wage earners, possibly due to economic stress during the COVID-19 lockdown. The study concluded that suicide in India is strongly influenced by social and economic factors, highlighting the need for targeted interventions for vulnerable groups.

3. Suicide in India: A Systematic Review

Anil Rane, Abhijit Nadkarni

This study conducted a systematic review of suicide research in India using databases such as PubMed, PsycINFO, EMBASE, and Google Scholar. A total of 36 studies were analyzed to examine suicide rates and associated risk factors. The findings indicated that suicide rates were highest among individuals aged 20–29 years, with female suicide rates higher than males below age 30, while the opposite pattern was observed above age 30. Common suicide methods included hanging and ingestion of organophosphate pesticides, while self- immolation was also reported among women. Major factors associated with suicide included low socio-economic status, alcohol misuse, mental illness, and interpersonal conflicts. The study concluded that suicide is a significant and growing public health issue in India, and official statistics from the National Crime Records Bureau may underestimate the actual suicide rates.

Purpose of the Study:

The purpose of this study is to analyse suicide trends in India and globally from 2010 to 2022 and to understand the influence of demographic, socio-economic, and regional factors on suicide rates. The study also aims to compare suicide patterns between India and the world, examine relationships with factors such as poverty, income, literacy, and urbanization, and forecast future suicide trends using statistical tools.

Source:

WHO (World Health Organization):

https://www.who.int/data/gho/data/themes/mental-health/suicide-rates

NCRB (National Crime Records Bureau):

https://www.ncrb.gov.in/

ADSI (Accidental Deaths and Suicides in India Report):

https://ncrb.gov.in /en/ accidental -deaths -suicides -india -adsiIndia: 2010 to 2022

Statistical Tools Used:

Data Visualization, Correlation Analysis, One-Way ANOVA, Tukey's HSD Test, Augmented Dickey– Fuller (ADF) Test, Time Series Analysis, ARIMA Model, Forecasting Techniques

Objectives:

1. Visualization and analyzation of comparative study of suicidal trends and related factors in India and the World (2010–2022).
2. To analyze the trend and forecast future suicidal cases in India and global level using time series modelling techniques.
3. To compare the average suicidal rates of the top 10 Indian states and analyze their trends.
4. To examine the correlation between suicide rate (per 100k) and socio- economic factors.
5. To identify regional patterns of suicidal risk by using cluster analysis based on suicidal rates and socio-economic factors.
6. To check whether low-income countries show rising trends.
7. To examine whether suicidal rates differ significantly across geographical regions using ANOVA and Tukey's test.

Methodology:

Feature Engineering:

In this study, we used secondary data from NCRB (2010-2022) and WHO (2000– 2022). The data was cleaned and analyzed by using data visualization, correlation analysis, One-Way ANOVA, Tukey's HSD test, and time series analysis (ADF test and ARIMA model) to examine trends, relationships, regional differences, and to forecast future suicide cases.

1. Visualization and analyzation of comparative study of suicidal trends and related factors in India and the World (2010–2022).

The comparative analysis of suicide trends in India and worldwide from 2010 to 2022 highlights important demographic and socio-economic differences. In India, suicide counts are consistently higher among males, which may be associated with traditional social roles and financial responsibilities. In contrast, global suicide patterns show greater variation between genders due to differences in cultural, economic, and social conditions across countries.

Marital status also shows contrasting patterns. In India, currently married individuals record higher suicide counts, possibly due to family responsibilities, financial pressure, and social expectations. Globally, higher suicide counts are often observed among single individuals, which may be linked to loneliness, social isolation, and weaker support systems.

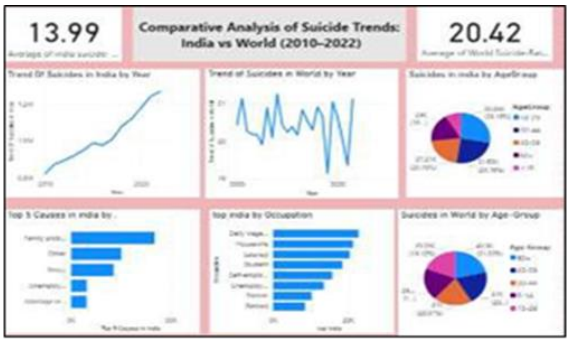
Age-group analysis indicates that in India, the 18–29 age group has the highest suicide counts, followed by the 30–44 age group, mainly due to academic stress, employment uncertainty, and financial responsibilities. At the global level, suicide counts are more evenly distributed across age groups, reflecting diverse social and economic conditions.

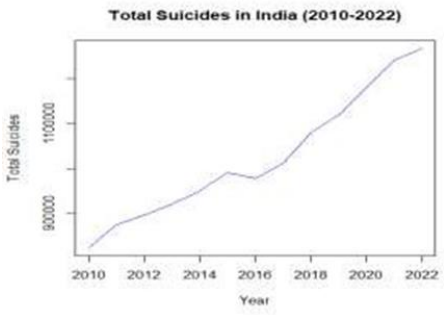
Education level also influences suicide patterns. In India, individuals with secondary education show higher suicide counts, possibly due to employment challenges and socio-economic stress. Globally, individuals with no schooling tend to have higher suicide counts, which may be related to poverty, unemployment, and limited access to resources.

2. ARIMA Model:

Purpose: The ARIMA model is used to analyze time series trends and forecast future suicide cases based on past data.

Time Series And Forecasting For India:



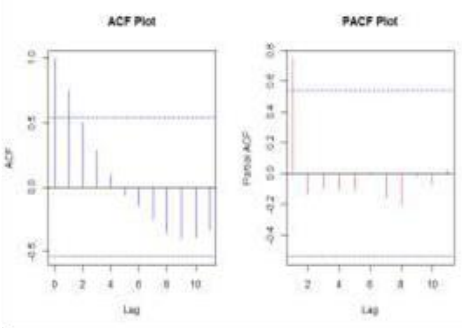


Augmented Dickey-Fuller Test:

H0: The time series is non-stationary Vs H1: The time series is stationary.

Dickey-Fuller = -0.71984, Lag order = 2, p- value = 0.9567

Since the p-value (0.9567) > 0.05, we accept H0. Therefore, the time series is non- stationary.



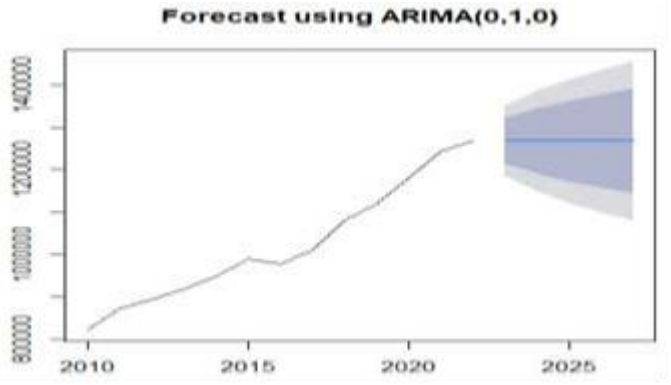
ARIMA (0,1,0) for India:

ARIMA (0,1,0) is a time series model where the data is differenced once to remove the trend and make it stable. The model helps in understanding the fluctuations and temporal patterns in suicide rates across years. The fitted model produced an estimated error variance (σ^2) of 1.827×109 with a log-likelihood value of −144.98 and an Akaike Information Criterion (AIC) value of 291.97.

Box-Lung test:

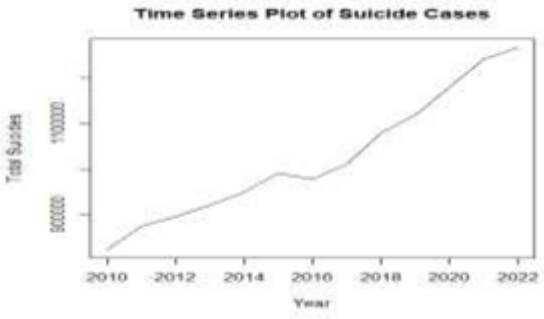
data: model Arima residuals

X-squared = 4.4821, do = 5, p-value = 0.4823 > 0.05 Model is adequate. Conclusion: p-value = 0.4823 >0.05. The model is adequate.



Year	forecasting	Lo 80	Hi 80	Lo 95	Hi 95
2023	1267329	12125	13221	11835	1351
2024	1267329	11898	13447	11488	1358
2025	1267329	11724	13622	11222	1412
2026	1267329	11577	13768	10997	1434

Time series and forecasting for the world:



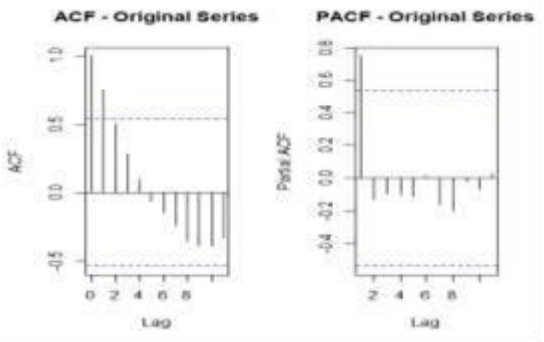
Augmented Dickey-Fuller Test

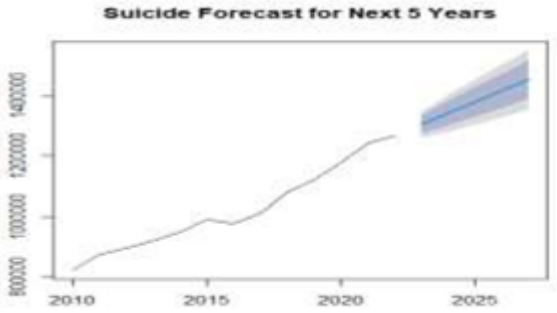
H0: The time series is non-stationary vs H1: The time series is stationary.

Dickey-Fuller = -0.71984, Lag order = 2, p- value = 0.9567

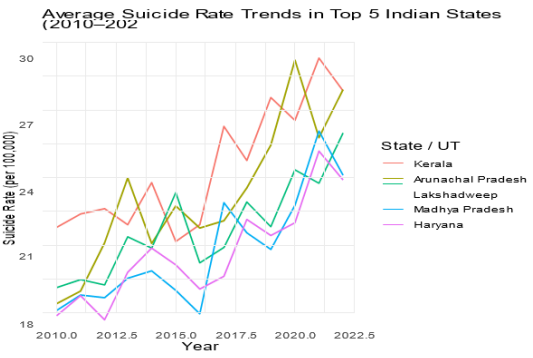
Conclusion: Since the p-value (0.9567) > 0.05, we accept H0.

Therefore, the time series is non-stationary.





3. To compare the average suicide rates of the top 10 Indian states and analyze their trends.



States	Mean suicide rate
Kerala	25.2
Arunachal Pradesh	24.0
Lakshadweep	22.5
Madhya Pradesh	21.5
Haryana	21.4
Assam	21.2
Ladak	20.9
Puducherry	20.9
Rajasthan	20.0
Himachal Pradesh	19.1

Conclusion: (for India data): Kerala has the highest mean suicide rate (25.2), followed by Arunachal Pradesh (24.0). Most of the top 10 states show rates above 20 per 100k, indicating comparatively higher suicide prevalence in these regions. Himachal Pradesh has the lowest rate (19.1) among the top 10 listed states.

Kerala shows higher suicide counts mainly due to factors such as higher literacy, unemployment among educated youth, financial stress, and higher alcohol consumption. In contrast, Arunachal Pradesh records lower suicide counts largely because of its smaller population size and possible underreporting due to limited reporting systems. Differences in socio-economic conditions and population size contribute to this variation.

Year	forecasting	Lo80	Hi80	Lo95	Hi95
2023	1304395	1275	1332	1260	1347
2024	1341461	1301	1381	1279	1403
2025	1378527	1329	1427	1303	1454
2026	1415593	1358	1472	1328	1502
2027	1452659	1388	1516	1355	1550

To compare suicide trends across countries and time.

Country	Mean suicide rate
Nepal	21.2
Sri Lanka	21.1
China	21.0
Germany	21.0
South Africa	20.8
Brazil	20.8
Bangladesh	20.8
Pakistan	20.6
Italy	20.6
Australia	20.3
USA	20.3
UK	20.3
Spain	20.2
Mexico	20.1
Japan	20.1

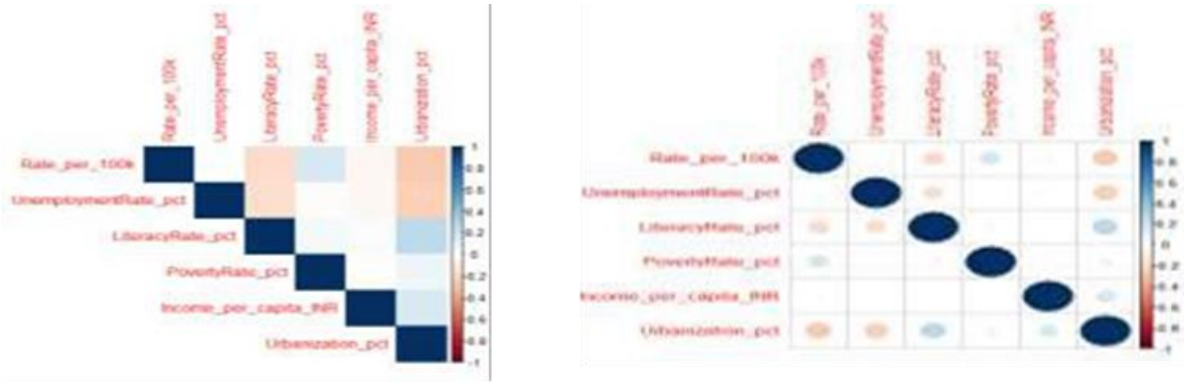
France	20.0
India	19.9
Russia	19.9
Nigeria	19.8
Canda	19.4

Conclusion: (for world data)

- Nepal has the highest average suicide rate (21.2), closely followed by Sri - Lanka and China.
- Most countries show a similar average rate around 20–21 per 100k, indicating relatively small variation among them. Canada has the lowest average rate (19.4) among the listed countries

Higher suicide rates in Nepal are mainly associated with poverty, unemployment, agricultural and financial stress, migration- related pressure, limited mental health services, social stigma, family conflicts, and substance abuse. These combined economic, social, and healthcare challenges increase psychological distress and contribute to the relatively higher suicide rates in the country.

4. Correlation Analysis

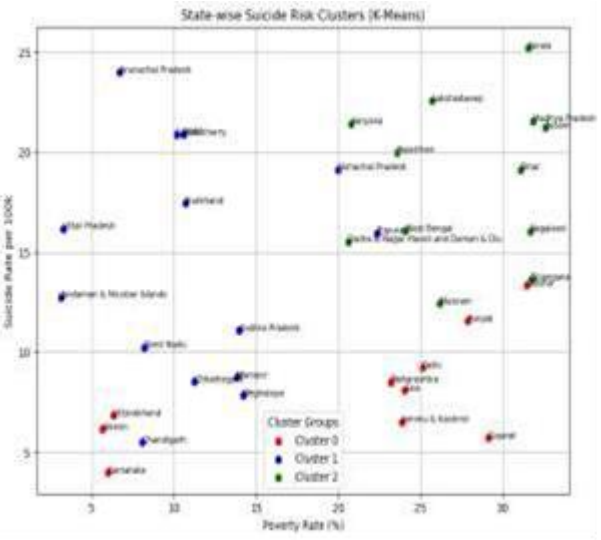


India: Suicide rates increase with poverty and decrease with higher income, literacy, and urbanization (mostly weak to moderate relationships).

World: Suicide rates are positively linked with poverty and negatively linked with literacy and urbanization, suggesting better socio-economic conditions may reduce suicide rates.

5. K- Means Clustering:

Purpose: To group of Indian states into clusters based on suicide rates and socio-economic factors to identify regional patterns of suicide risk.



Cluster	Interpretation	States
Cluster 0	These states may experience balanced socio-economic conditions but still face notable suicide risks, possibly due to a combination of economic pressure and social factors.	Delhi, Goa, Gujarat, Jammu & Kashmir, Karnataka, Maharashtra, Odisha, Punjab, Sikkim, Uttarakhand.
Cluster 1	This suggests that employment-related stress and economic insecurity may contribute to suicide risk in these regions.	Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Chandigarh, Chhattisgarh, Himachal Pradesh, Jharkhand, Ladakh, Manipur, Meghalaya, Puducherry, Tamil Nadu, Tripura, Uttar Pradesh
Cluster 2	Higher literacy and urban development may provide better access to education, healthcare, and economic opportunities, which can contribute to lower suicide risk.	Assam, Bihar, Dadra & Nagar Haveli and Daman & Diu, Haryana, Kerala, Lakshadweep, Madhya Pradesh, Mizoram, Nagaland, Rajasthan, Telangana, West Bengal.

6. To Check whether low-income countries show rising trends.

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# Groups:   Country [20]
   Country     'High Income' 'Low Income' 'Middle Income'
   <chr>              <int>        <int>           <int>
 1 Australia         458285       397462          436981
 2 Bangladesh        439983       421337          470280
 3 Brazil            443736       328274          443163
 4 Canada            439752       426633          349321
 5 China             379682       450140          399665
 6 France            398347       386556          441691
 7 Germany           415628       337185          437915
 8 India             477075       427840          436704
 9 Italy             382967       441315          400141
10 Japan             409809       445046          381861
11 Mexico            405379       446404          347120
12 Nepal             490604       467353          452116
13 Nigeria           408322       487453          472255
14 Pakistan          426016       380797          354088
15 Russia            381089       366839          390830
16 South Africa      436624       405030          451349
17 Spain             410030       450990          347645
18 Sri Lanka         404374       386139          459230
19 UK                408781       360755          408565
20 USA               438782       404156          392506
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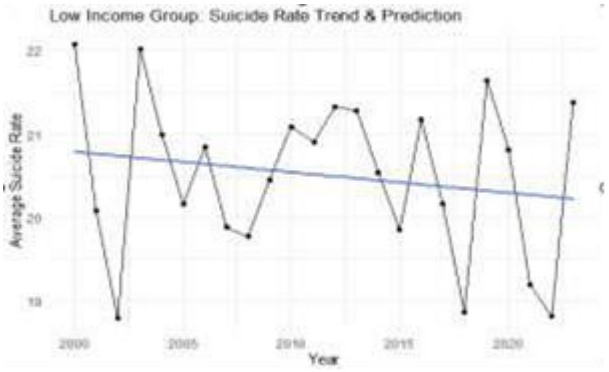

- Overall suicide rate shows a slight decreasing trend over the years.
- There are year-to-year fluctuations, but no sharp long-term increase.
- The rate was higher in the early 2000s compared to recent years.
- Overall, the suicide rate in the low- income group is gradually declining with minor variations.

Region	Mean rate	SD rate
East	17.0	9.15
Central	16.3	9.77
North	13.6	9.29
North-East	13.0	9.40
Other	14.9	10.6
South	12.8	10.1
West	10.6	8.24

7. To examine whether suicide rates differ significantly across geographical regions using ANOVA and Tukey's test:

- Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Telangana – South
- Maharashtra, Gujarat, Goa, Rajasthan – West
- Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh – Central
- Punjab, Haryana, Himachal Pradesh, Uttarakhand, Delhi – North
- West Bengal, Odisha, Jharkhand, Assam – East
- Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, Sikkim – North- East.

Conclusion:

- East (17.0) and Central (16.3) regions show the highest average suicide rates.
- West (10.6) has the lowest mean suicide rate.

Standard deviations are relatively high in all regions, indicating substantial within- region variability.

This suggests that states within the same region still differ, but regional patterns are visible.

One-Way ANOVA :

Null Hypothesis (H_0):

There is no significant difference in the mean suicide rates among the geographical regions of India (North, South, East, West, Central, and North-East).

Alternative Hypothesis (H_1):

There is a significant difference in the mean suicide rates among at least two geographical regions of India

DF Sum Sq MeanSq F value PR(>F)

6 32691 5449 58.83 <2e-16

Residuals 9353 866217 93

Since $p < 0.001$, H_0 is rejected.

Conclusion: Suicide rates differ significantly across regions. Suicide rates vary significantly by region. Region is a strong explanatory factor for suicide rate differences.

Tukey's HSD :This test is applied after a significant One-Way ANOVA to identify specific regional differences in mean suicide rates.

Hypotheses for Tukey's Test :Tukey's test checks pairwise regional differences after the ANOVA is significant.

(H_{0ij}): There is no significant difference in mean suicide rates between region I and j

(H_{1ij}): There is a significant difference in mean suicide rates between region I and j

Conclusion: The Central region differs significantly from the North, North-East, South, West, and East regions.

The West region consistently shows significantly lower mean suicide rates compared to most other regions.

The South and North-East regions also show significant differences when compared with several regions.

Overall Conclusion:

1. Suicide trends from 2010–2022 show a steady increase in India, with the highest cases recorded in 2022, whereas the World shows fluctuations without a consistent long-term rise.
2. Age-wise analysis reveals that in India, the 18–29 age group is most affected, while in the World, the 60+ age group records the highest cases, indicating different vulnerable populations. Male suicides remain significantly higher than female suicides in both India and globally.
3. In India, family problems account for 33,179 cases (19.3%), followed by illness 18,174 (10.6%) and unemployment 6,598 (3.8%), highlighting the strong impact of social and health-related factors. Hanging is the most common method of suicide in both India and the World.
4. Marital status analysis shows that married individuals record higher cases in India, whereas single individuals show higher cases globally.
5. Education analysis indicates higher cases among Secondary and Higher Secondary groups in India, while the no-schooling group records the highest cases in the World.
6. Occupational analysis in India identifies daily wage workers as the most vulnerable group.
7. Comparison of average suicide rates shows that Kerala (25.2 per 100k) and Arunachal Pradesh (24.0) have the highest mean rates among Indian states, while Nepal (21.2 per 100k) has the highest average rate globally, and Canada (19.4) has the lowest among selected countries.

8. Correlation analysis confirms that in both India and the World, suicide rates have a positive association with poverty and a negative association with income, literacy, and urbanization, indicating the protective role of socio-economic development.
9. Regional analysis in India shows significant variation, with East (17.0) and Central (16.3) regions having higher mean rates and West (10.6) having the lowest. ANOVA results ($F = 58.83$, $p < 0.001$) confirm statistically significant regional differences.
10. Time series analysis indicates non- stationarity (ADF $p = 0.9567$) for both India and the World. The ARIMA (0,1,0) model is adequate, and forecasting suggests a gradual increase in suicide cases in the coming years.

Future Scope:

Future research can include longer time- period data and additional factors such as mental health, social conditions, and policy interventions. Advanced machine learning and forecasting models can also be used to improve prediction accuracy and support better suicide prevention strategies.

Limitations:

The study is based on secondary data, so the results depend on the accuracy and reliability of the available sources. The analysis covers only the 2010–2022 period, which may not fully represent long-term suicide trends. Some important factors, such as mental health conditions, personal stress, and cultural influences, were not included due to data limitations. In addition, underreporting of suicide cases may affect the accuracy of the findings. The ARIMA forecasting model is based on past trends, so unexpected future events may influence the predicted results

Reference:

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