

1. Title Page:

- Title of the project : Assignment - I Statistical Interpretation and Exploratory Data Analysis
- Student name, ID: Saurav Tamang(250016)
- Course name: Concept and Technology of AI
- Date of submission: 10th Jan 2026

Human Development Index Analysis

Table of Contents

1. Introduction

1.1 Objectives of the Analysis

1.2 Scope of the Report

2. Issue by Issue Analysis: Problem 1A – Single Year HDI Exploration (2022)

2.1 Methods / Approach

2.2 Key Results

2.3 Visualizations and Tables

2.4 Interpretation and Discussion

3. HDI Visualization and Trend Analysis (2020–2022)

3.1 Methods / Approach

3.2 Key Results

3.3 Visualizations and Tables

3.4 Interpretation and Discussion

4. Problem 2 – Exploring Global Development Patterns More Intensively Using HDI

4.1 Methods & Approach

4.2 Key Results

4.3 Visualizations and Tables

4.4 Discussion and Interpretation

5. South Asia vs Middle East Comparative Regional Analysis

5.1 Methods / Approach

5.2 Key Results

5.3 Visualizations and Tables

5.4 Interpretation and Discussion

6. Conclusion

6.1 Summary of Findings

6.2 Insights on HDI Trends and Inequalities

6.3 Limitations

6.4 Implications and Recommendations

Human Development Index Analysis

Introduction

The Human Development Index, or HDI, is not a figure; it is a narrative of the way people live. It was developed by the United Nations to assess the development of a country in three primary categories, namely health (years people live), education (number of years in schools), and standard of living (income people earn). It serves as a reminder that the development of the country is not only about the increase of the economy, but also about providing people with the opportunity to live long, well-educated, and decent lives. The new dataset, which reflects the period between 1990 and 2022, allows not only to observe the position of countries in 2022, but also to trace the distance they have completed on the way, and the inequalities that continued to exist.

Objectives of the Analysis

The idea of this project is to dig deeper behind the simple figures and find actual trends in the way various regions of the world develop. We will:

- Find out the change of HDI in countries and time, highlighting the best and the worst performers.
- Analyse patterns and disparity among regions, particularly South Asia and the Middle East.
- Examine the relationship between HDI and other variables such as income, life expectancy, and gender development.
- Notice anomalies that are not consistent with the trend—countries that perform better or worse than the rest around or within the same level of wealth.
- Use this to give an explanation not only on what the data presents but why it is important and how development is experienced in various locations.

Scope of the Report

This report is based on HDI data 2020-2022, the time of the COVID-19 pandemic that struck the health, education, and economy of the world. We will:

- Individual year and aggregate period patterns of study.
- Make comparisons with South Asian and Middle Eastern states and find out their strong and weak sides.
- Present the information in charts such as line graphs, bar charts, scatter plots, and box plots in order to be comprehensible.
- Be descriptive and have actionable insights that can be recited in a Jupyter Notebook.

It is a blend of the technical data knowledge and people, demonstrating a picture of what development is in numbers and in real life.

Issue by Issue Analysis Problem 1A - Single Year HDI Exploration (2022)

Methods / Approach

I referred to the data of 2022 to regard how people are doing that year. I did not simply do some calculations; I attempted to narrate a story of the way we have developed over the decades and the hardship in the world. The analysis used a snapshot of the world in 2022, from which I extracted information about the whole history of the world. I sorted out the conflicting values and made the data at a glance look coherent. I sorted numeric columns and omitted data gaps in the HDI since I wanted a neat analysis, although it would have necessitated the loss of some data.

After that, I searched the data systematically:

- Description of the landscape: I computed the average, standard deviation, and median HDI of all the countries.
- Indicating extremes: I identified the nations which received the highest and lowest HDI.
- Zooming in on excellence: I examined nations that score very high on the HDI and compared their locations to the GNI per capita to determine the relationship between income and general progress.
- Classification of the development: I derived categorical development by using the official UN categories of development (Low, Medium, High, Very High) to classify each nation, and instead of the HDI score continuing as a continuous number, I made it more comprehensible as a pattern.

Key Results

The success stories and differences in the world are evident. It is important to note that the variation in development is great, as the global average is 0.723 with a standard deviation of 0.153 in 2022.

- Best and Worst Performers: Switzerland leads with a score of 0.967 on HDI due to a combination of good health, education, and income. Somalia comes last with an index of 0.380, facing great challenges.
- Wealth and Very High Development: Liechtenstein ranks first on the list of the 66 countries with HDI 0.942 and higher according to GNI per capita (~\$146,673). This depicts a correlation between wealth and welfare.
- Distribution of development: Finished goods and services are dispatched to regions like Europe and America, where they are subsequently sent to sub-regions like France and Italy.

Very High Development: 66 countries.

High Development: 59 countries.

Medium Development: 120 countries.

Low Development: 38 countries.

Thus, whereas most countries are on the high levels, still, almost 79 countries also fall under the Medium or Low categories, which means that the world is not completely developed yet.

Visualizations and Tables

Table 1: Ranked top 10 countries by GNI per Capita (Filter: HDI > 0.800)

Country	HDI	GNI per Capita (USD)
Liechtenstein	0.942	146,673
Qatar	0.875	95,944
Singapore	0.949	88,761
Ireland	0.950	87,468
Luxembourg	0.927	78,554
United Arab Emirates	0.937	74,104
Switzerland	0.967	69,433
Norway	0.966	69,190

United States 0.927 65,565

Hong Kong, China (SAR) 0.956 62,486

This table indicates that top-tier HDI not only shares high income but is also shared. Countries such as Switzerland and Norway have reached the heights of HDI with high, but not the highest, income.

STD: HDI Category Distribution (2022).

This uncomplicated tally shows the form of the world development: a large aggregate at the upper end, an extensive group in the high-middle area, and a lengthy uniform line of countries that continue to struggle through fundamental issues.

Discussion and Interpretation

In this paragraph, the results of the test have been presented in a table and discussed (Guttram, 2008). By examining 2022 data in such detail, I can have a better vision of human progress. The average HDI in the world is positive and is 0.723. However, the large number of countries with a high rate in the spread, and the 38 countries in the low category, are reminders that there are large disparities that exist.

The criticism questions the notion that money is the sole cause of progress. In spite of the fact that high incomes are observed in countries such as Liechtenstein and Qatar, they do not lead in terms of HDI. Rather, Switzerland and Norway demonstrate that good health, education, and sufficient income do not only make the best growth not only money. This holds the lesson that beyond a threshold, increasing your income does not bring much joy; better is having social structures that make people healthy and educated.

The categorization of every nation was an eye-opener. When raw data were converted to a map with four categories, the world image became more apparent. It raises the question: What policies are there in common to the 66 very high countries? Why do the 38 low countries not improve? This categorization is not mere numbers, but action-oriented and targeted assistance.

Concisely, 2022 is progressing and presenting difficulties. The data demonstrate both what is possible with balanced development, but also point towards the efforts that should be undertaken to seal gaps that continue to leave millions of people frozen. The single-year perspective precludes noticing the trend and shock on longer analysis.

HDI Visualization and Trend Analysis (2020-2022)

Methods / Approach

Data Filtering and Cleaning

Whittled the original data to years 2020-2021/2022. Extraction of clean data into a file named HDI problem1B.csv. Children: Marked and fixed bad country names, incomplete values, and duplicates as well as number values with formatting issues. Shapes: EDA or exploratory data analysis is the tool used to make shapes with the goal of revealing and discussing data patterns. Made sure that the years 2020-2022 were tracked in the filtered data. Verified the types of data of each column and found missing values. Ensured that numeric columns were correctly formatted.

Visualization Design

The second graph was the Line Chart: The HDI trends of the five chosen countries (Afghanistan, Albania, Switzerland, United States, Singapore) provided in the years 2020-2022. Bar Chart: Compared (grouping and averaging) the average HDI by region (Asia, Europe, Americas) each year.

Tools Used

- Python packages: Pandas, seaborn, matplotlib.
- Analysis and visualization of WebAMN interactive.

Key Results

Cleaned Dataset

- 610 up-to-date records after elimination of blank HDIs.
- None of the columns HDI, country, and year have any missing values.
- No duplicate rows.

HDI Trends (2020-2022)

- Switzerland was always at the top in terms of HDI (~0.96).
- The lowest HDI (~0.46-0.49) was in Afghanistan and it slightly declined.
- The HDI in the United States and Singapore were high and steady (around 0.92-0.93).
- There was a slight growth from 1.3165 to 1.3163 in Albania.

Regional Average HDI

The most average HDI was in Europe. Asia was the second at the expense of the Americas. The HDI of all the regions was changing slightly within a span of years.

Visualizations and Tables

Trend in HDI across Selected Countries (2020-2022): Line Chart

Purpose: Compare the development of five countries in terms of HDI. Conclusion: A clear inequality exists between the developed and developing countries; Afghanistan is falling.

Bar Chart: HDI Average (2020-2022) of Regional and High-Income Countries

Purpose: Compare the performance in terms of HDI by region. Findings: Europe wins; the Americas and Asia come next.

Interpretation and Discussion

- Global HDI Stability: HDI scores of the developed countries did not see a decrease regardless of the COVID-19 pandemic, which implies strong socioeconomic systems.
- Regional Inequality: Europe and the Americas had their HDI higher than Asia due to such factors as healthcare, education, and income.
- Country-Specific Insights:
 - The collapse of Afghanistan can be indicative of political and economic instability.
 - The slight improvement of Albania implies slow development advancements.
 - Switzerland, the U.S., and Singapore are good examples of high human development, and their performance has been steady.
- Limitations:
 - It contains aggregates at the regional level (e.g., "Arab States" or "Sub-Saharan Africa"), which can bias a country-level analysis.
 - The secondary columns (e.g., gender inequality, mat footprint) had no missing values, which were not imputed, which could have affected the multidimensional analysis.
- Recommendations:
 - Expand the analysis in earlier non-pandemic years to see the trend.
 - Reason is to add more measures (e.g., inequality indices, environmental factors) to make human development holistic.

Conclusion

This discussion reveals that there are stable HDI indicators in the developed countries and significant differences among geographic areas. These patterns are well conveyed in the visualizations and provide support for human development globally, which is data-driven, between the years 2020 and 2022.

Problem 2 - More Intensive Study of Global Development Patterns HDI

This aspect is more than the normal HDI. It reveals how the levels of money can influence the countries to spend on education and health of people and what are the outcomes thereof. The big question was: Are more money better health and education, and what does this relationship change with the development of countries?

Methods & Approach

Relational analytics and diagnostic analytics were used in order to answer these questions. We did not examine a single indicator of development, but we have compared the interactions between various indicators.

The initial step that we took was to cluster countries based on four development levels, as per the standard HDI index: very high, high, medium-level, and low. This grouping formed the basis of all subsequent comparisons, and as such, we ensured we did not make unfair comparisons such as those involving Nigeria and Norway.

The most fundamental approach was paired comparative analysis. We concentrated on several major relationships:

- Economic Capacity vs. Life Outcomes: We have compared GNI per capita to life expectancy and education index. This is a test that increases in national income are directly purchasing better health and education.
- Mean Years of Schooling vs. Years of Schooling: Years of schooling achieved (future outcome) is the variable we studied the relationship between the average years of schooling (investment over time) and the years of schooling spent.

In these scatter plots, correlation analysis was also included and trend lines (or linear regression lines). They were not used to provide particular predictions, but they demonstrated graphically and numerically how strong and towards which direction the relationships are in each level of the HDI.

- **Key Results**
 - The findings were that experience continues to slow down and priorities cease to vary with an increase in development.
- **The Life Expectancy Plateau**
 - The correlation between gross national income (GNI) and life expectancy is very low in countries with a High Human Development Index (HDI) or Very High Human Development Index (HDI). The rise in the level of economic growth does not necessarily result in the fact that the amount of money an individual has increases, and he/she lives longer. However, in the Low and Medium HDI countries, the correlation is high and positive, as the national income is expected to increase life expectancy.
- **The Disconnection in Education**
 - The same trend occurred with education, and it was even more evident. In the highly developed nations, GNI has hardly anything to do with the Education Index. The connection is very acute in the least developed countries. This implies that once a nation is economically developed, education is not influenced solely by the economy, but also by laws, culture, and policies.
- **The Educational Investment Achievement Gap**
 - The gap is unexpected even within education, particularly in Low HDI countries. The projected number of years the children are supposed to spend in school does not correlate with the standard average years spent by adults in school. This indicates a discrepancy in the objectives and the reality, probably due to poverty, child labor, or lack of school facilities.
- **Visualizations and Tables**
 - In order to make these findings come to life, we employed a few very obvious visual aids:
 - Multi-Panel Scatter Plot Figure
 - This focused the exploration. It also consisted of four minor scatter plots on a 2x2 grid, with each indicating some of the important relationships (GNI vs. Life Expectancy, GNI vs. Education Index, etc.). The dots were colored based on the level of the HDI of a country (Very High, High, Medium, Low). We also prepared four trend lines for each group of HDI. This enabled us to make a comparison of the appearance of a relationship in low and high levels of development at a glance, with the help of simple axes and clear colors.
 - A Summary Statistics Table

- There was a short table indicating the average GNI per capita, life expectancy, and education index in each level of HDI. This not only provided actual figures but also emphasized the extent of the difference between the high and low levels, which backs the more abstract plots.
-

Discussion and Interpretation

The results are an apparent representation of the developmental transformation. Initially, development is normally directed in a straight line. The economy of a given nation gains them the cash to fund the most fundamental health care, education, and water. The result is the definite quantifiable improvements in life expectancy and in the levels of learning ability. The latter improvements can be observed in the sharply upwards sloping trends of the Low and Medium HDI.

But the analysis also indicates clearly that development is not necessarily a linear one. The abundance of money is no longer the primary indicator of well-being in high and very high-developed countries. Life expectancies of approximately 85 years and already existing good schools have necessitated something beyond money. It requires proper management, equal allocation of resources, technology, as well as healthy social connections. When the HDI scales are higher, the trend-lines cease to flatten out and instead, it creates a change in the types of development issues.

One of the major lessons gained in this research is the significance of disconnect. The poor connection between predicted and actual years of schooling of the lowest-HDI countries is a red flag. This is to say that education through a school cannot just be made available and children fail to remain in school or learn properly. This gap and the practical barriers to education should be among the key priorities of the policy.

Concisely, in this paper, it has been demonstrated that the HDI is not just a ranking. It can be used as a diagnostic tool by dissecting its components and analyzing its connections throughout its history. It informs us that the idea of progress is evolving - now it is not only about money but about intelligent, fair, and focused investment in the potential of people.

Comparative Regional Analysis of South Asia Against the Middle East

In this assignment, I have compared the level of Human Development Index (HDI) of South Asia and the Middle East in the period between 2020 and 2022. I did not simply consider global or national perceptions but referred to regional trends, inequalities, and exceptional nations.

Methods / Approach

I divided the work in the following way:

1. I filtered the original file, which was HDI problem1B.csv, first. Then I divided the data into two piles: South Asia and the Middle East, with precise country names (as of instance, Iran (Islamic Republic of) as opposed to Iran itself). I put this data in the form of HDI SouthAsia 2020 2022.csv and HDI MiddleEast 2020 2022.csv to be used later.
2. I further made simple calculations on each area: average HDI and variation in HDI for each of the three years. The average represents the general development, whereas the variance represents the consistency or unequalness of the region.
3. I searched for the highest and lowest countries considering the average HDI for 2020-2022 of the nation and listed the three most successful and the three poorest countries in the region.
4. I made basic bar charts. In both cases, I created charts that only indicate the best and worst countries, which means that the difference between the largest and the smallest HDI is noticeable at first sight.

Key Results

Inequality in averages at the regional level: The Middle East recorded a higher average of HDI (0.7665) than South Asia (0.6396). Here, there is an apparent disparity in terms of health, education, and income between the regions.

Internal inequality: There is extensive dispersion (standard deviation of 0.1391 versus 0.0983 in South Asia). Although the mean is great, it is not evenly distributed. The scores in South Asia are closer and more similar to the average of the region.

Top and Bottom Performers

- South: Sri Lanka (0.780) is the best, followed by Maldives (0.751) and Bhutan (0.678). The lowest performers are Afghanistan (0.474), Pakistan (0.538), and Nepal (0.595).

- Middle East: UAE (0.933), followed by Israel (0.911), and then Bahrain (0.885).
The lowest performers are Yemen (0.426), Syria (0.559), and Iraq (0.667).

Visualizations and Tables

The analysis did have two primary results:

- Numerical tables: Tables presenting the top and bottom-ranked countries in every region were indicated with precise HDI figures.
- Bar charts: Four charts were created:
 1. Chart 1 - Top 3 South Asian nations (Sri Lanka, Maldives, Bhutan).
 2. Chart 2 - Bottom 3 South Asian nations (Afghanistan, Pakistan, Nepal).
 3. Chart 3 - Leading 3 countries in the Middle East (UAE, Israel, Bahrain).
 4. Chart 4 - Bottom 3 Middle Eastern nations (Yemen, Syria, Iraq).

The charts adopt a green approach when the top performers are considered and a red approach when the bottom performers are considered, with a scale of 0 to 1 to indicate the extent of difference between the two.

Discussion and Analysis

The results indicate that there are variations in the patterns of development in South Asia and the Middle East. The UAE and Qatar are some of the very rich countries in the Middle East, which increases the average HDI. The wide gap in the countries indicates that certain nations, such as Yemen and Syria, are very far behind the leaders, even though others are at the summit. High average and high inequality are indications that regional totals may conceal very serious problems in certain areas of the region.

In South Asia, the scores of countries are more clustered, and the scores tend to be lower. The distribution was also not very high but evenly spread, which means that there is a trend of a familiar but low level of development. Afghanistan is a large outlier due to serious problems. The development of the region is weakened by constant issues rather than severe problems.

Policy Implications

The Middle East requires not just institutionalized growth that provides the benefits of the most successful to the rest of the region, perhaps by integrating economies or providing specific assistance. One intervention for South Asia could be to increase the basic level of health, education, and income for everyone, perhaps through the development of regional poverty, health, and education cooperation.

Concisely, the Middle East leads in absolute HDI but has a phenomenally weak and lopsided lead. South Asia is a less developed region with a lesser base, though it can achieve more streamlined development under the condition of resolving internal differences. This analogy reveals that rankings are not the whole picture in terms of progress within and among regions.

Conclusion

Summary of Findings

I searched the changes in the Human Development Index (HDI) over time and between regions and ensured there was no suspicious value present.

The statistics demonstrate that the HDI is highly disparate across the world. Considering an example, Switzerland has a very high HDI, whereas Somalia has a very low HDI. HDI has improved over the years, and in most localities, it indicated improved health, education, and income. However, the rate of its improvement is quite different in different areas.

I had a closer glance at each area. The HDI and GNI of South Asia remained relatively constant, and all the countries of this region are similar. Yemen is an exception to this conduct in the Middle East since it has a considerably lower HDI than the others. This demonstrates that wars, politics, and economic issues may negatively affect growth.

HDI Trends and Inequalities

It is vital to underscore HDI trends and inequalities. One important fact is that there is an association between money and HDI, but it does not entirely explain such association. The higher the income per person of a country, the higher the HDI would be, but life expectancy and education are also important.

The given countries have experienced the same development pattern since the South Asia region does not include any drastic outliers, which is likely due to the fact that they share the similarity of the economy and the social context. The case of Yemen in the Middle East demonstrates how a shift in path can be converted by long-term conflict and a crisis despite having numerous countries that are rich. The differences demonstrate that development is not even, and the meanings can conceal significant information.

Limitations

The study has some limits. To start with, not all countries had data during some years, making it more difficult to compare data over longer periods. Second, HDI summarizes numerous things in a single number and thus cannot necessitate all the elements of welfare such as inequality, freedom, and the environment. Lastly, the application of outlier techniques may engage countries into two extremes and omit their history and politics.

Implications/Recommendations

According to what we have learned, planners ought to reach into activities that belong to a given country rather than make plans like the regions. In South Asia, development can be sustained and balanced by investing more in education, health care, and jobs. Yemen is in need of additional assistance in the Middle East. It requires assistance, peace operations, and long-term policies in fixing its great development issues.

More measures would help in bettering future work. Take, as an example, a version that takes into account inequality, the rate of poverty, or the indexes of conflict. This would provide the complete picture of the problem. It is demonstrated in this paper that HDI is not merely a ranking. It is an instrument that comes in handy to identify gaps and draft actual, strong policies.