UNIVERSITY OF WOLVERHAMPTON

BIRATNAGAR INTERNATIONAL COLLEGE

Concept and Technologies of AI

5CS037

Analysis of the Human Development Index (HDI): A Data - Driven Exploration of Global and Regional Development Patterns.

January 10 ,2026

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Statistical Interpretation and Exploratory Data Analysis of the Human Development Index (HDI)

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Introduction:

HDI is a measure that tells us how well countries are doing in terms of health, education, and income. It's not just about money, it's about overall human development.
In this report, we are looking at HDI data to see trends over the last few years, differences between countries and regions, and how other factors like life expectancy, gender equality, and income relate to HDI.
The main goal is to understand which countries are doing well, which are struggling, and why, so we can see patterns and insights about human development. This report covers South Asia and the Middle East mainly, with data from 2020 to 2022.

Objectives:

- To study HDI values using real-world country data and understand basic development patterns
- To compare development levels across years and regions using simple analysis techniques
- To explore how different indicators relate to HDI and highlight major differences between regions

Problem 1A – Single Year HDI Exploration (2022)

Methods / Approach:
I removed the data, removed duplicates, handled missing values, and did some basic statistics like mean, median, and standard deviation. Then we looked at which countries had the highest and lowest HDI, and grouped countries based on HDI categories.

Key Result:
Dataset of 2022 contained hdi values for larger number of countries among multiple development indicators. Most numeric columns are properly formatted, though a few missing values were present. Countries showed a wide range of HDI values, from very high development levels to very low ones. The highest HDI country in 2022 was among the developed nations, while the lowest HDI country belonged to the least developed group.

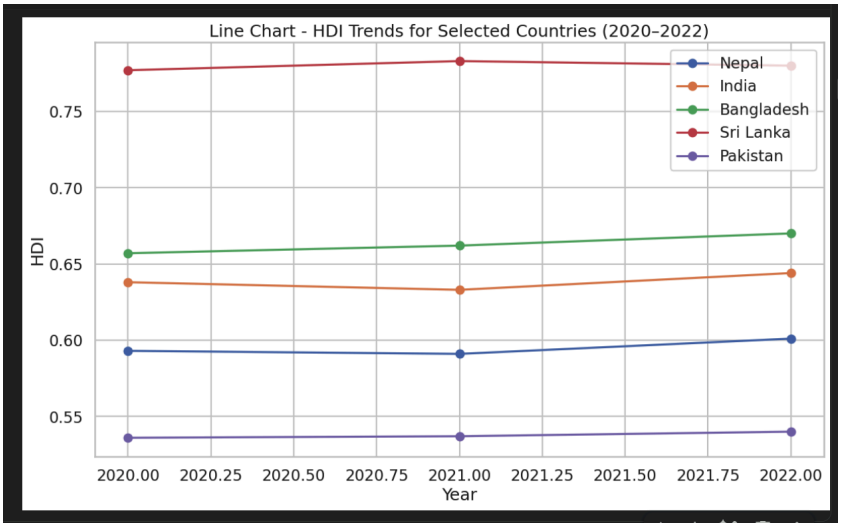
Interpretation:
Looking at just 2022 gives a clear snapshot of global development. Some countries are doing extremely well with strong health, income, and education systems, while others are still struggling on basic development indicators. The gap between high-HDI and low-HDI countries is very visible, which shows that global development is uneven. This single-year analysis helps set a baseline before moving into multi-year trends and regional comparisons.

Problem 1B-HDI Visualization and Trend Analysis (2020-2022)

Methods / Approach:
I filtered data from (2020–2022) , cleaned it, created charts to see trends for selected countries and regions. We looked at averages by region, distributions each year, and how HDI relates to income. The goal was to see patterns, improvements, and differences clearly.

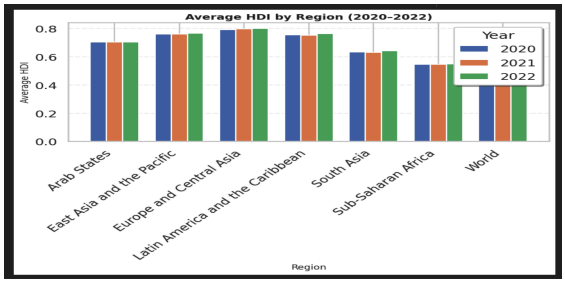
Visualizations and tables :

Figure 1: Line Chart – HDI Trends for Selected Countries (2020–2022)



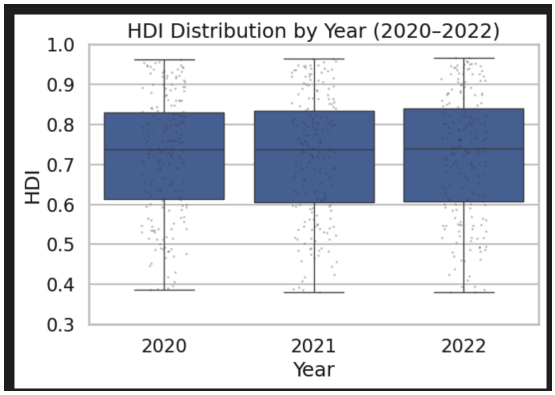
So, looking at the lines, most countries didn't change much, some got a bit better. It's slow but steady progress in human development. Small ups and downs happen, maybe because of stuff like COVID hitting some countries harder. Overall, HDI is creeping up slowly.

Figure 2: Average HDI by Region (2020–2022)



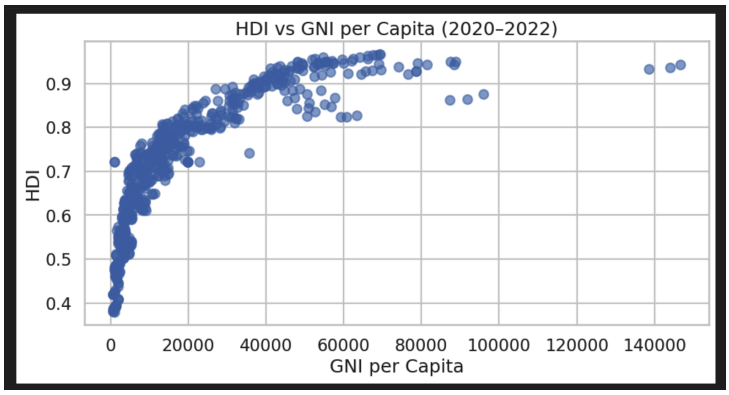
The bars show that richer regions are way ahead in HDI. Developing regions are behind, but most are inching up a little. You can see the gap is real, but at least improvement is happening. Money helps, but it's not the only thing.

Figure 3: HDI Distribution by Year (2020–2022)



The box plots tell us that medians went up a bit, so average development is improving. But the spread is wide, some countries are doing really badly. Those low-end outliers are struggling more than others. HDI inequality is still real.

Figure 4: HDI vs GNI per Capita (2020–2022)



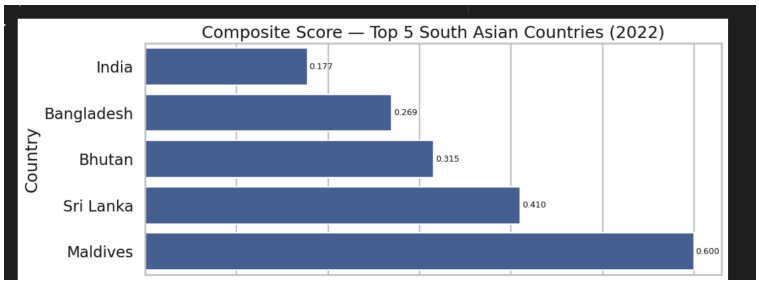
Here we can say that usually richer-developed countries has high hdi, which makes sense. As it is not perfect because some countries who has capital has low hdi. So, money helps, but you also need good health, education, and equality.

Problem 2 – Advanced HDI Exploration (South Asia)

Methods / Approach:
I looked at South Asia specifically and created a Composite Score that mixes life expectancy, GNI, and education. We did ranking, outlier detection using 1.5×IQR, and looked at how HDI relates to life expectancy and gender development. We also analyzed gaps where money and HDI don't match.

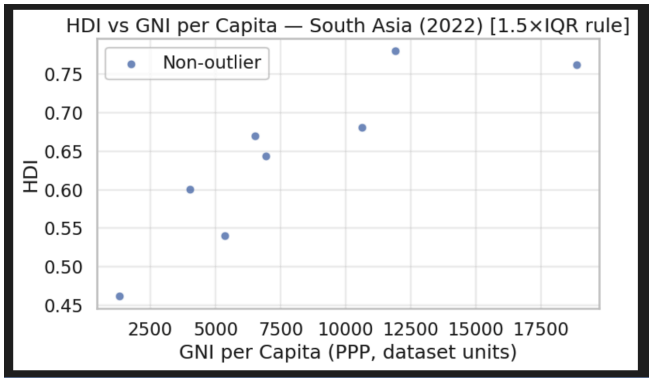
Visualizations and tables :

Figure 5: Composite Score of top 5 south asian countries (2022)



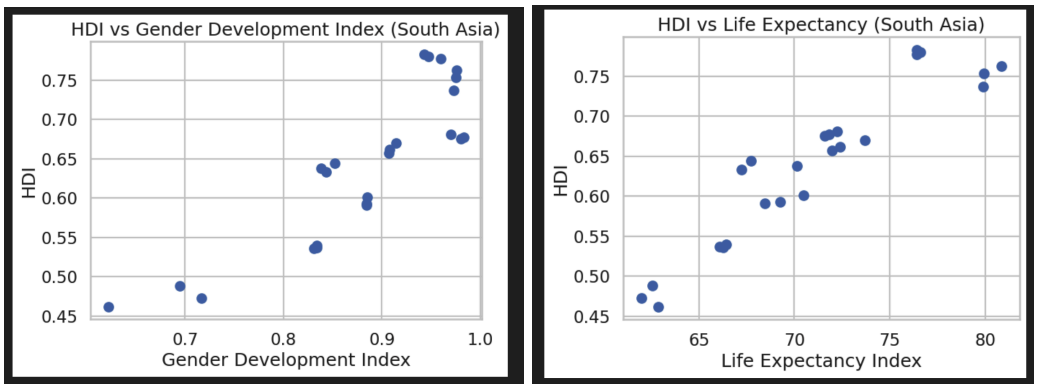
This chart ranks South Asian countries on a mix of health, income, and education. Countries doing better have strong health and decent income. It shows that balancing everything matters, not just money. The top 5 are doing it the best.

Figure 6: HDI vs GNI per Capita — South Asia (2022) [1.5×IQR Rule]



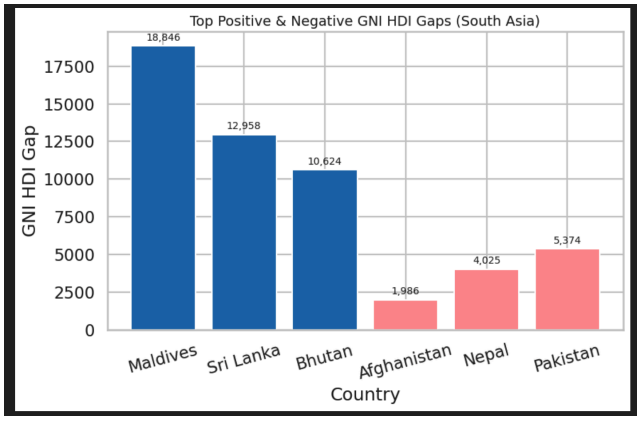
Scatter shows that more money kinda means higher HDI, but some countries don't follow the rule. The outliers are countries where cash doesn't really turn into a better life. Health, gender, and education still make a big difference.

Figure 7: HDI Relationships (South Asia)



Life expectancy and HDI go hand in hand, like super strongly. Gender development also matters, countries with more equality do better. Health is huge, equality is important, money alone isn't enough.

Figure 8: top positive & negative GNI–HDI Gaps (SA)



Positive gap means high income but low HDI, negative means good HDI even with less money. Basically, some countries aren't using money well, others are squeezing more human development out of less. Shows money isn't everything.

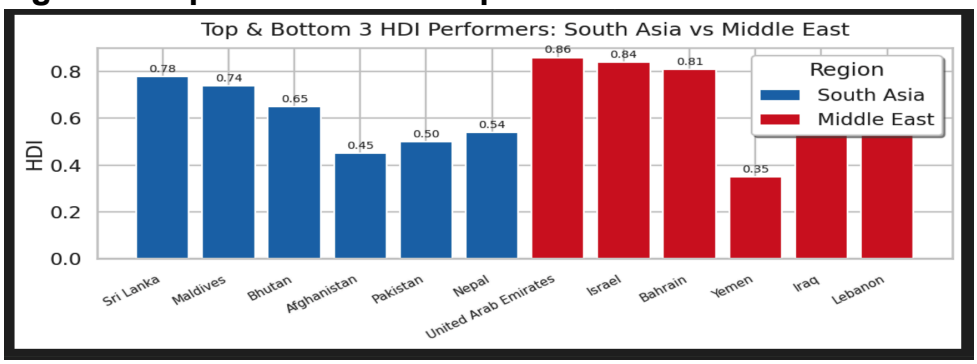
Problem3-Comparative Regional Analysis :SouthAsia vs MiddleEast

Method:

Here i use the data from 2020-2022 and compared the human development index and other metrics between south asia and middle east .I looked at the up and mid performers,metrices like expectancy of life ,gni per capita,correrelation analysis and outlier detection.

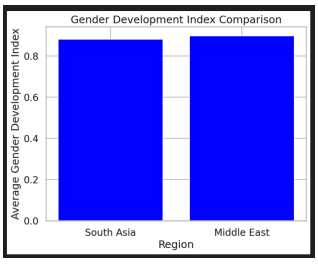
Visualizations and tables :

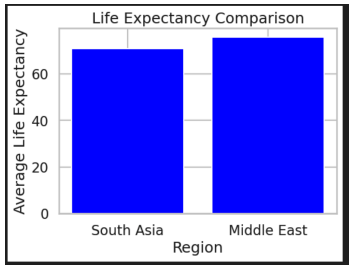
Figure 9: top & bottom 3 HDI performers –SA vs ME

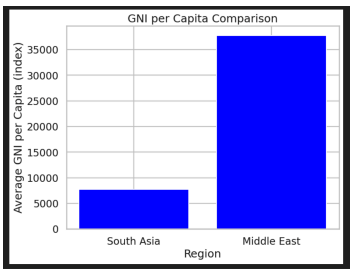


Middle East countries dominate the top spots, South Asia is mostly at the bottom. Makes sense with a better economy, healthcare, and social stuff shows clear regional differences in the Middle East.

Figure 10: Regional Metric Comparisons

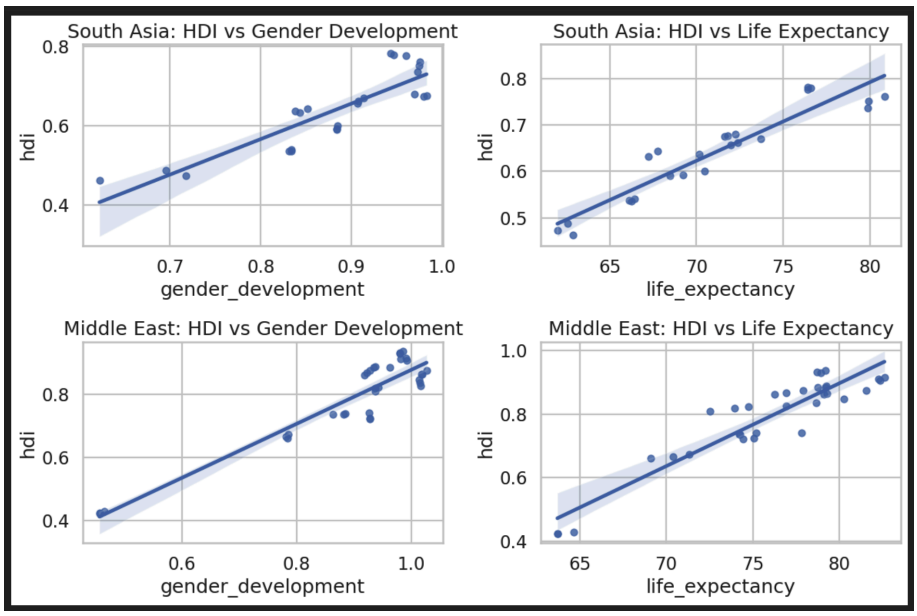






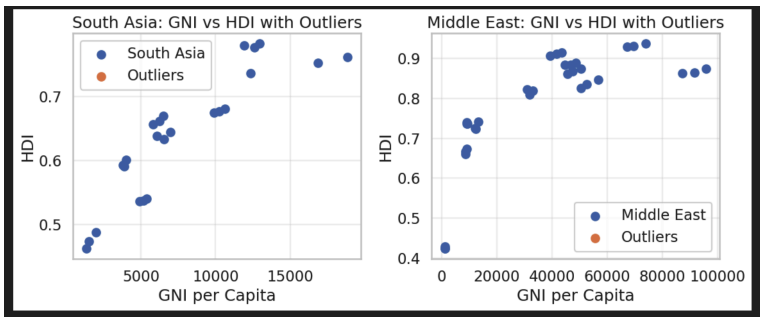
South Asia is beaten by the Middle East in income ,life expectancy and gender equality.The biggest difference is cash, but health and equality also matter. South Asia needs to catch up on all fronts, not just money.

Figure 11: Correlation Analysis Plots



Life expectancy is the strongest factor for HDI, gender equality is next. Both regions show this trend. Money helps, but health and equality drive development more.

Figure 12: Outlier Detection (GNI vs HDI)



Outliers show weird cases where money and HDI don't match. The Middle East has some super-rich countries with average HDI, South Asia has struggling countries despite income. Highlights that income alone doesn't fix everything.

Conclusion

Summary of findings:
Looking at the data, HDI shows that richer countries generally have higher development, but money alone doesn't guarantee it.The strong drivers of HDI are life expectancy and gender equality. South Asia is mostly behind the Middle East, with slow improvements from 2020–2022 but still clear inequality. Some countries are outliers — either rich but not doing well in human development, or doing well despite lower income.

Limitations:

- Short time frame (only 2020–2022)
- Some missing or estimated data in the dataset
- Outliers may affect averages slightly
- Analysis depends on available indicators; other factors like governance or social programs weren't included

Recommendations / Implications:
Income must not be the focus point for the countries as it should on health,education and equality. For South Asia, improving healthcare and gender equality is key. Middle East countries can work on ensuring income translates into better social outcomes. Policymakers should target investments that improve life expectancy and education to boost HDI overall.

References

- HDI Dataset (Latest Version) by Lucas Yukiolmafuko.
- Course materials: 5CS037 Statistical Interpretation and EDA notes.

github :[repo link]

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