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Concepts and Technologies of AI (5CS037)

Assignment - I - Statistical Interpretation and Exploratory Data Analysis.

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

Student University ID: 2501431
Student Name : Nijal Maharjan
Group: L4CG9
Module Leader: Mr. Siman Giri
Tutor: Ms. Rakhee Pandey
Date of submission: 2026-01-09

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Introduction

The main objective of the report is to analyze HDI using multiple perspectives. The first section examines HDI for a single year in all countries, then looks at trends for five countries (Nepal, India, Norway, the United States, and China) from 2020 to 2022. To illustrate how the issue of inequality is impacting development, an advanced analysis of the HDI is done using the inequality-adjusted HDI. Finally, the comparison between the Middle East and South Asia is made to emphasize the regional difference.

Figures, tables, and explanations are used in the study to examine and show trends, disparities, and patterns in human development (World Population Review, 2025).

Problem 1A – Single-Year HDI Exploration

Methods/Approach:
the majority of the recent year's HDI statistics were recorded. The mean, median, range, and other metrics were used to calculate summary statistics. The nations were categorized as having very high, high, medium, or low HDI levels of development (UNDP, 2024). Graphs were created for the HDI distribution visualization once the top and bottom nations had been identified.
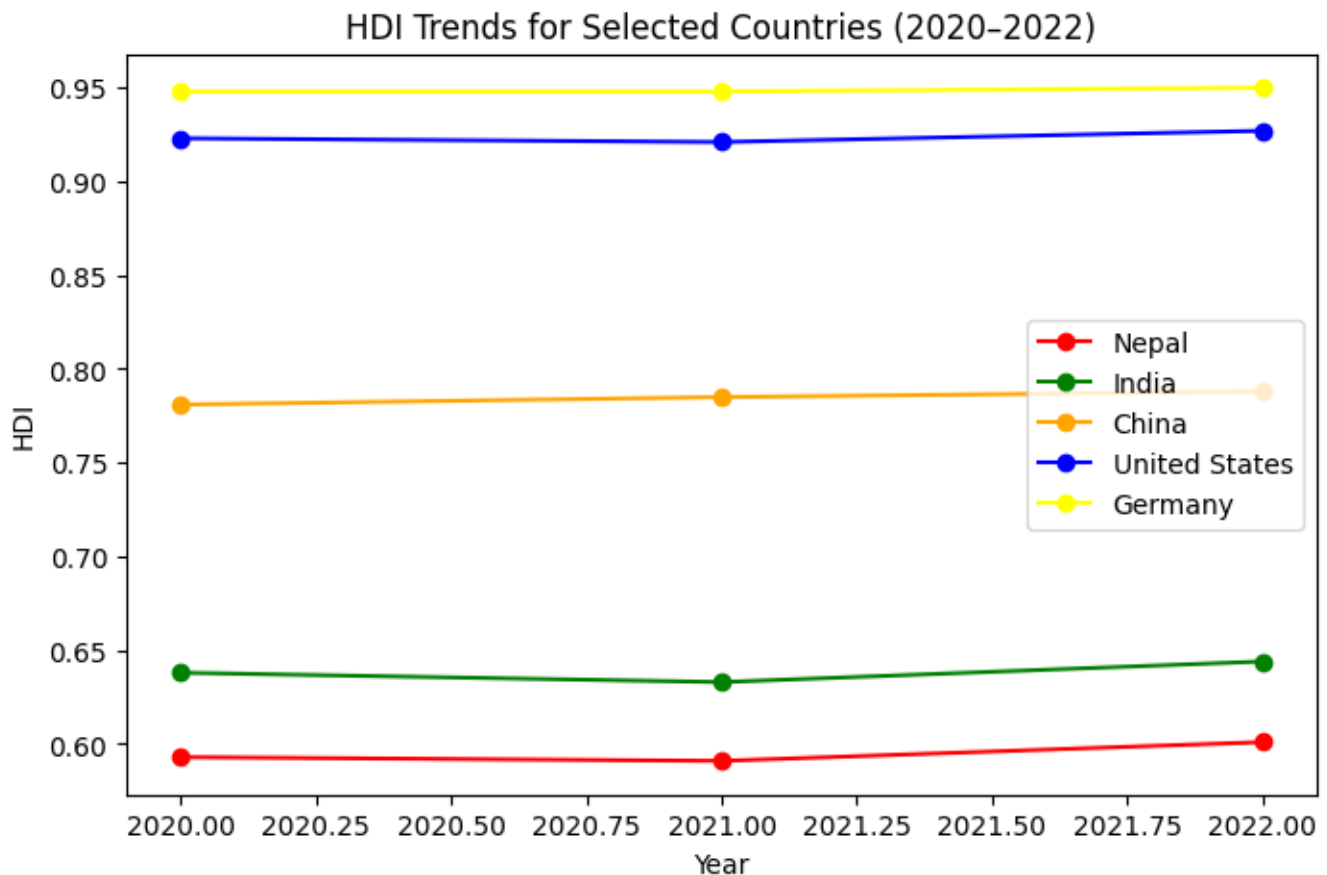
Key Findings:
There are huge global variations in HDI levels. Somalia had a far lower HDI value of about 0.38, while Switzerland had a relatively high HDI value of about 0.967 (UNDP, 2022). The HDI average was roughly 0.75 on a global scale, although the majority of nations fell short of that average. The majority of high-HDI nations were located in East Asia, North America, and Europe. However, the majority of poor HDI nations were located in southern Asia and Africa (World Population Review, 2025).

Interpretation and Discussion:
The majority of high HDI nations are often politically stable, economically sound, and have high levels of education, even though the most recent evaluation shows disparate global growth trends. For instance, low-HDI nations experience poverty, have uneven access to education, and offer subpar medical care. In other words, these disparities exist mainly within the global human framework (Miranda-Lescano et al., 2024).
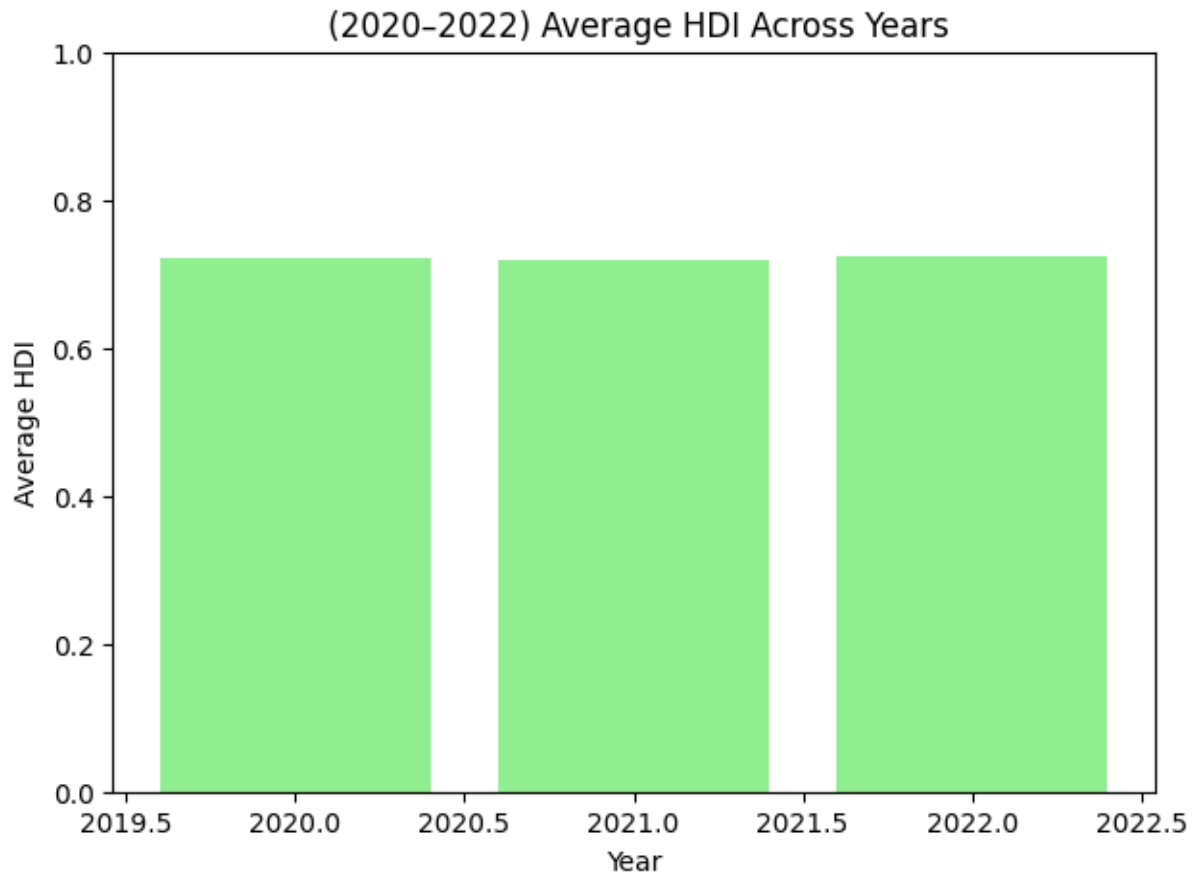
Problem 1B – HDI Trend Analysis (2020–2022)

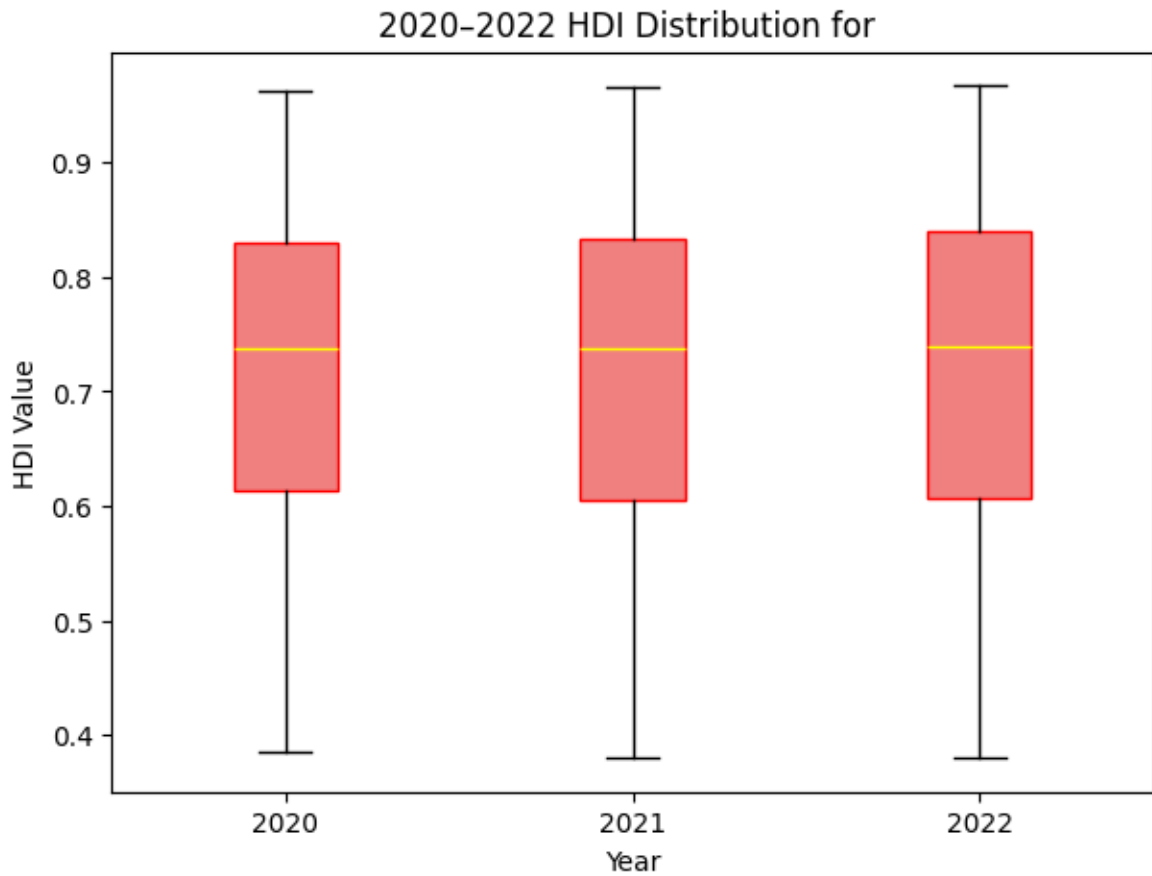Figure 1 (HDI Trend for Selected Countries(2020-2022)

The HDI trajectories for five nations from 2020 to 2022 are displayed in this graph. While developing nations like Nepal and India exhibit an exceptionally dramatic decline in 2021 and then rebound equally sharply in 2022, Norway and the USA seldom ever move within the same stable hierarchy of high HDI countries. China, on the other hand, shown a moderate and consistent rise. This immediately addresses the trend analysis since it provides visual evidence of the post-COVID recovery, with varying resilience according to developmental stage.
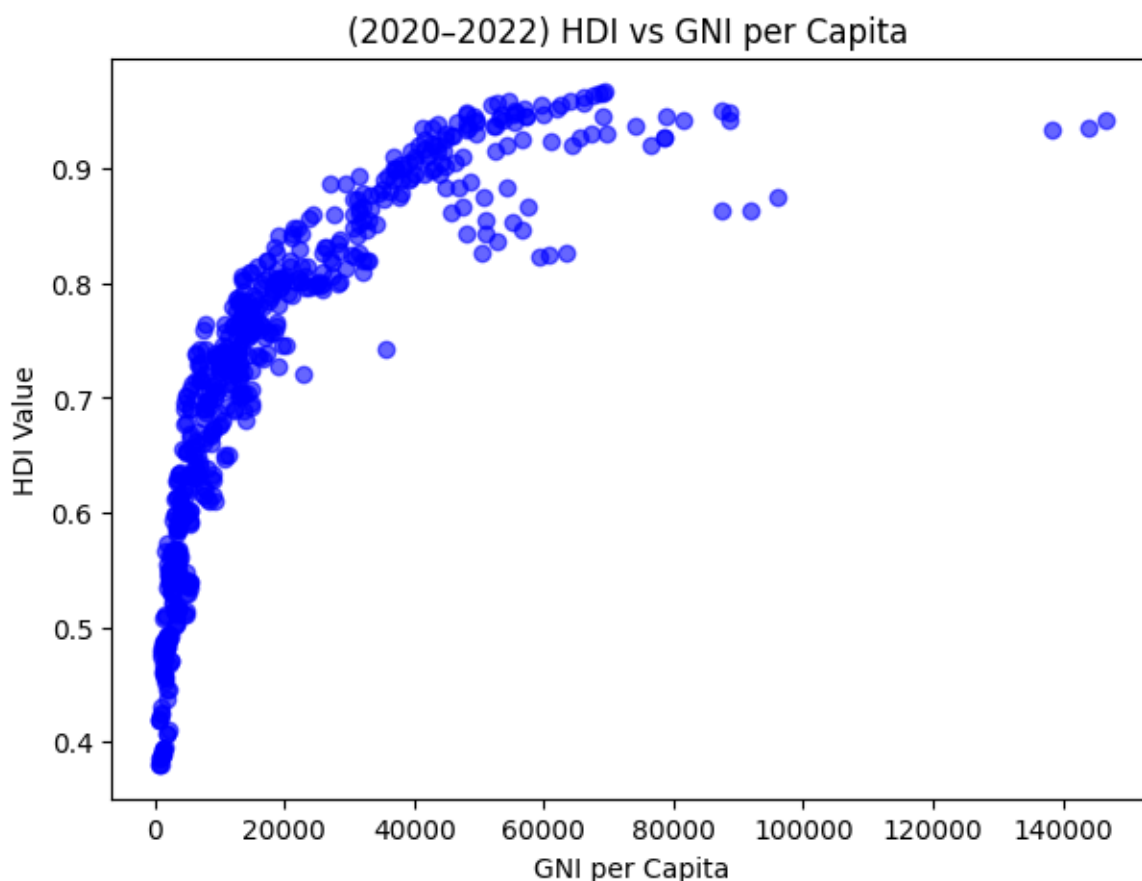
Figure 2 (Average HDI Across Years)

Between 2020 and 2022, the global average of the HDI was clearly heading upward in 2022 and decrease in 2021. This demonstrates the reality that the COVID-19 pandemic's shock waves are affecting every nation on the planet. Every nation depicted in Figure 1 has recovered from that overall downturn and subsequently from the global recovery.

Figure 3 (HDI Distribution for 2020–2022)

It displays the annual distribution of HDI values among nations. The point is that there is still a significant disparity between nations with low and high levels of development, which helps to explain why different countries recovered from the crisis in different ways due to persistent inequality.

Figure 4 (HDI vs. GNI per Capita)

(2020–2022) HDI vs GNI per Capita

The National Income shows how income and development are related. High GNI per capita nations often have greater HDI, however at very high income levels, the benefits of rising income levels develop more slowly. As evidenced by the patterns, wealthier and more developed nations were therefore better equipped to withstand and recover from the crisis.

Methods/Approach: In addition to Norway, the USA, and China overall, we examined the HDI trends for Nepal and India. Line charts were created using the HDI values from 2020 to 2022. To properly evaluate the rate of development, percentage changes were also computed.

Key Findings: By 2022, all five nations had recovered from COVID-19. In the extremely high HDI category, Norway and the US displayed more slight variations. Despite modest downturns in 2021, the economies of Nepal and India recovered fully by 2022. China has been on a steady economic trajectory for the past three years.

Interpretation and Discussion: The global health crisis caused brief drops in HDI, but recovery rates varied greatly. While the recovery rates of the poorest countries were hampered by the oscillations, the high-income countries were more robust. This demonstrates how a nation's capacity to handle a crisis is influenced by its level of development (UNDP, 2022).
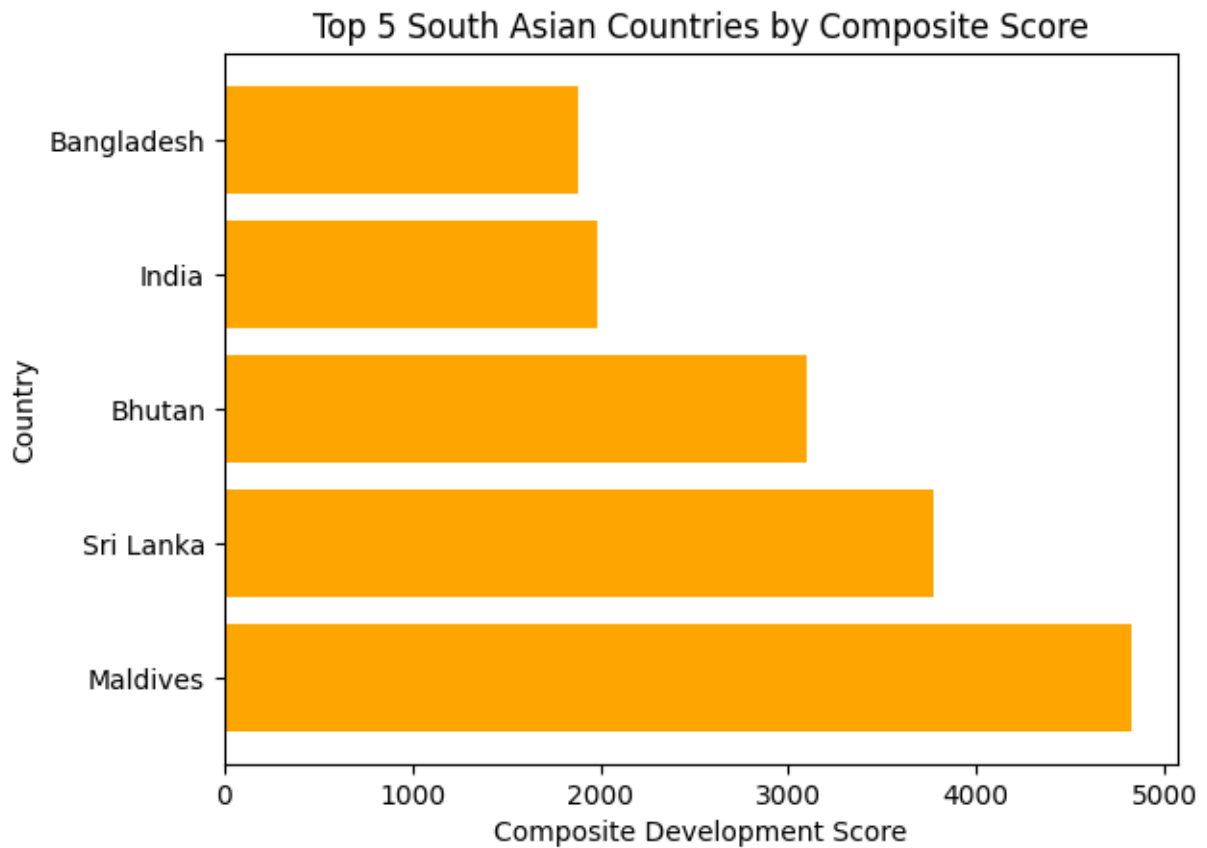
Problem 2 – Advanced HDI Exploration

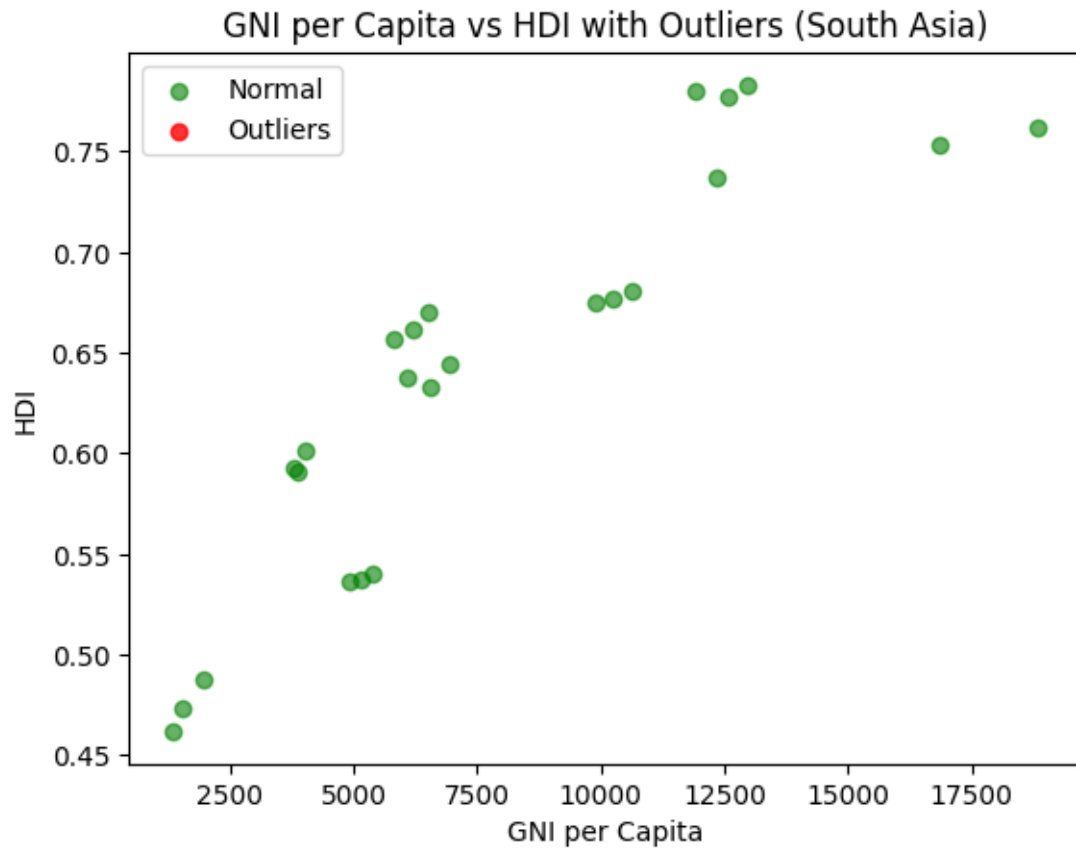|	country	Composite Score	hdi
4	Maldives	4827.657597	0.750667
7	Sri Lanka	3767.752918	0.780000
2	Bhutan	3097.787317	0.677667
3	India	1978.776712	0.638333
1	Bangladesh	1877.251264	0.663000

Figure: Composite Score Table

Five South Asian nations are shown in this composite score and HDI against development chart. Sri Lanka has the greatest HDI, indicating excellent human development in health and education, whereas the Maldives has the highest composite score. The nations receive lower ratings on both assessments; however, Bangladesh's HDI score is somewhat higher than India's, while Iceland's composite index values are nearly identical. Therefore, a high composite index score does not always indicate greater human development, and each nation might assess social and economic advancement in a somewhat different way than the other.

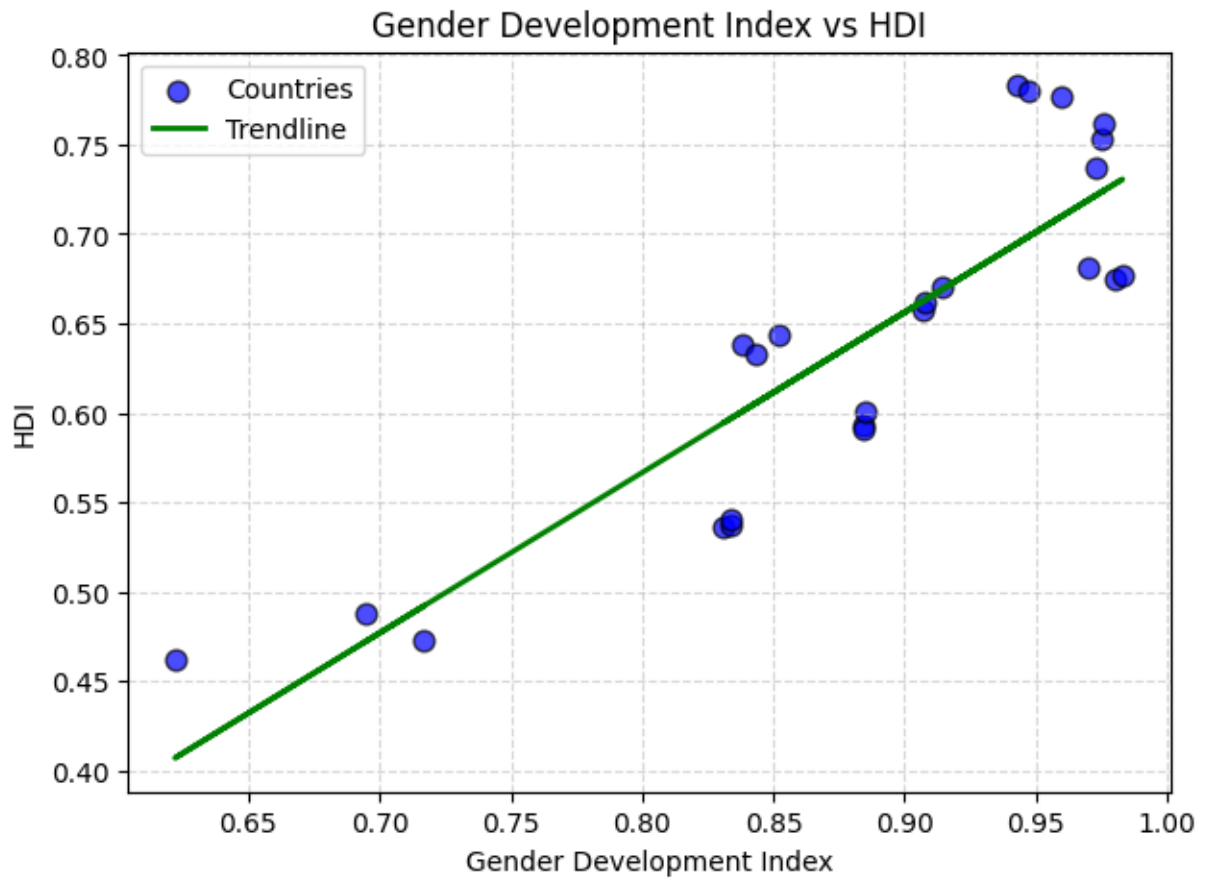# Figure 5(Top Countries by Composite Score Bar Chart)

The Maldives and Sri Lanka have the greatest composite development scores among the top five South Asian nations, closely followed by Bhutan in the center, while Bangladesh and India have the lowest values. This suggests that there are still differences in the area with relation to personal advancement.
countries.

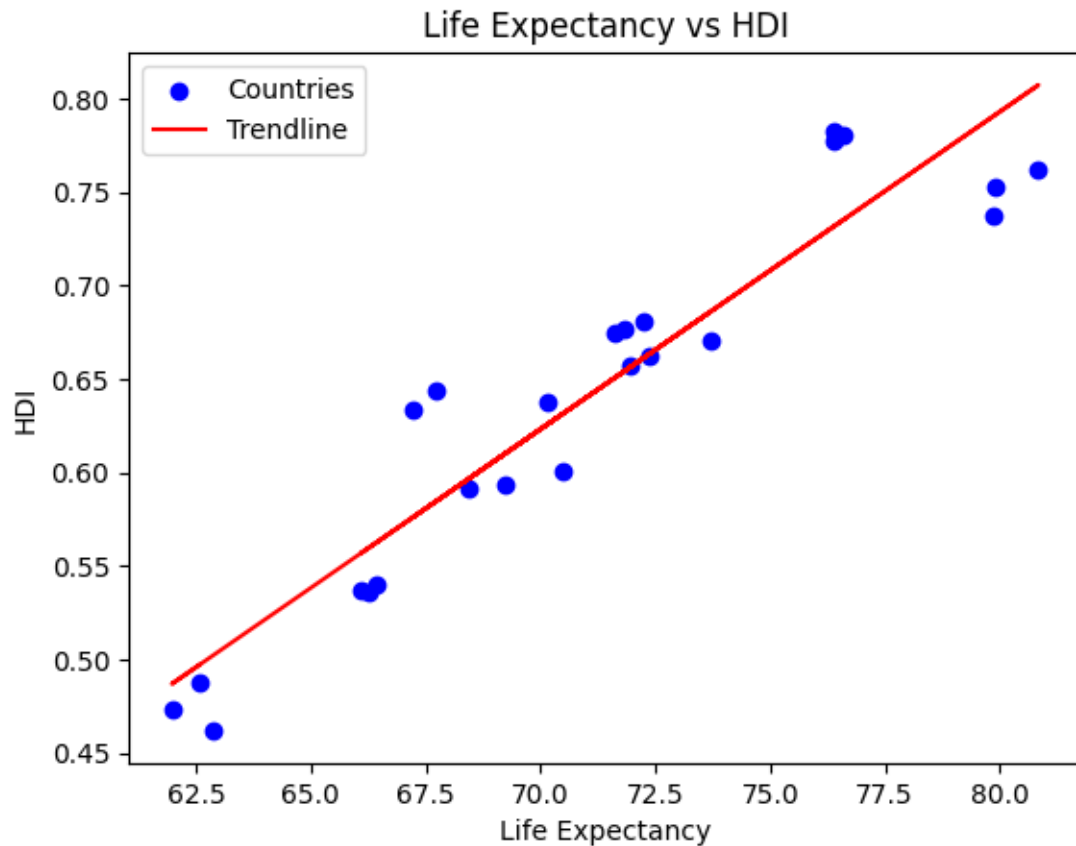# Figure 6(GNI per Capita vs HDI with Outliers)

In order to identify outliers—countries having an HDI that is either noticeably higher or lower than what would be predicted based solely on income—the graphic compares GNI per capita to HDIs for South Asian nations. These nations might be investigated to see why their development deviates from regional economic expectations, which would be helpful for the mission.

Figure 7(Gender Development Index vs HDI)

Analysis has been done on the relationship between gender equality and development. Gender outcomes are often better in nations with a higher HDI. This demonstrates how gender inequality impacts the country's HDI and validates the relationship between gender equality and general development.

Figure 8(Life Expectancy vs HDI)

It demonstrates the connection between development and health. The obvious positive correlation demonstrates that nations with longer life expectancies also typically have greater HDI. It makes the task easier to understand by placing health at the front of the list of factors.

	country	GNI_HDI_Gap
4	Maldives	16011.230657
7	Sri Lanka	12481.929060
2	Bhutan	10253.395723

Figure:Top positive gap

	country	GNI_HDI_Gap
0	Afghanistan	1618.240627
5	Nepal	3901.138692
6	Pakistan	5149.963106

Figure: Top negative gap

The current diagram shows how revenue finally translates into human development and discusses the GNI-HDI Gap for six South Asian countries. However, Afghanistan, Nepal, and Pakistan all have negative gaps since they essentially do not expect their income to be correlated with the HDI. The remaining three neighbors—Bhutan, Sri Lanka, and the Maldives—all have positive gaps and have advanced beyond their income-based human development level. This explains a significant variation in how various resources are used between nations in terms of living standards, health, and education.

Figure 9(Top 3 Positive and Negative GNI HDI Gaps Chart)

Top 3 Positive and Negative GNI HDI Gaps (South Asia)

The top three GNI-HDI disparity profiles among South Asian countries are shown in the above table. The Maldives, Sri Lanka, and Bhutan have the biggest positive gaps, indicating that their human development outcomes are higher per income level. Conversely, Afghanistan, Nepal, and Pakistan, which rank highest to lowest in that order, are shown by the negative gaps. The disparity shows that human progress falls well short of expectations based on economic status. In this way, identifying the nations that are most effective at allocating resources to health, education, and quality of life as well as those that might need more focused development policies is beneficial.
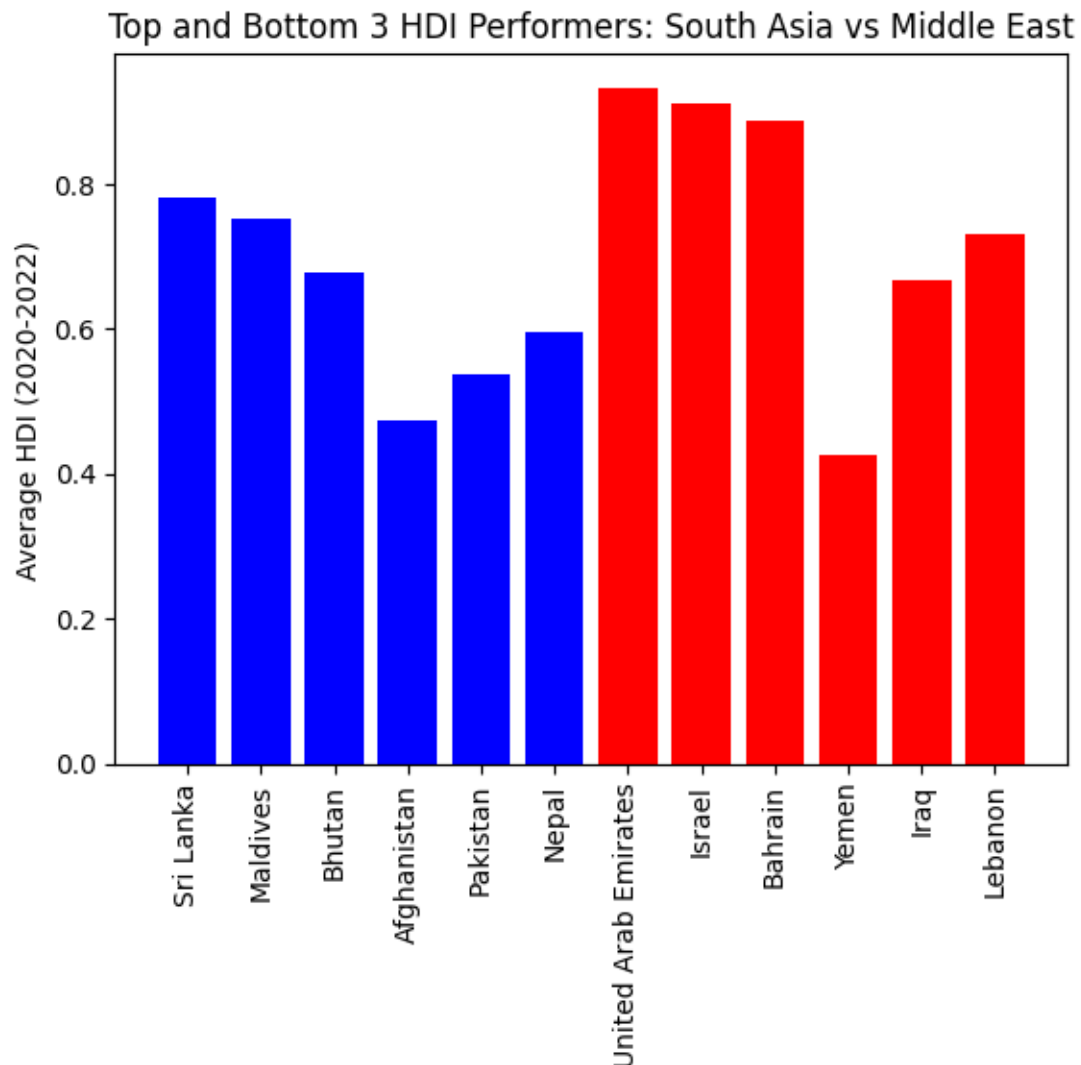
Methods/Approach: We calculated the inequality-Adjusted Human Development Index (IHDI), which modifies HDI scores to account for the frequency of internal disparities in income, education, and health. The impact of inequality on overall development is shown in the share of loss from HDI to IHDI.

Key Findings: High-income nations like the USA and Norway had slight declines in HDI as a result of inequality. However, India and Nepal lost significantly more—nearly 10–20%—which means that actual individual progress is lower than what the average HDI value indicates (Miranda-Lescano et al., 2024).

Interpretation and Discussion: Since IHDI measures inequality in addition to HDI, it may be the most accurate indicator of development. When inequality is taken into account, two nations with the same HDI may have quite different realities. Reducing disparities in wealth, health, and education can significantly enhance what is sometimes referred to as "actual human development" (UNDP, 2024).
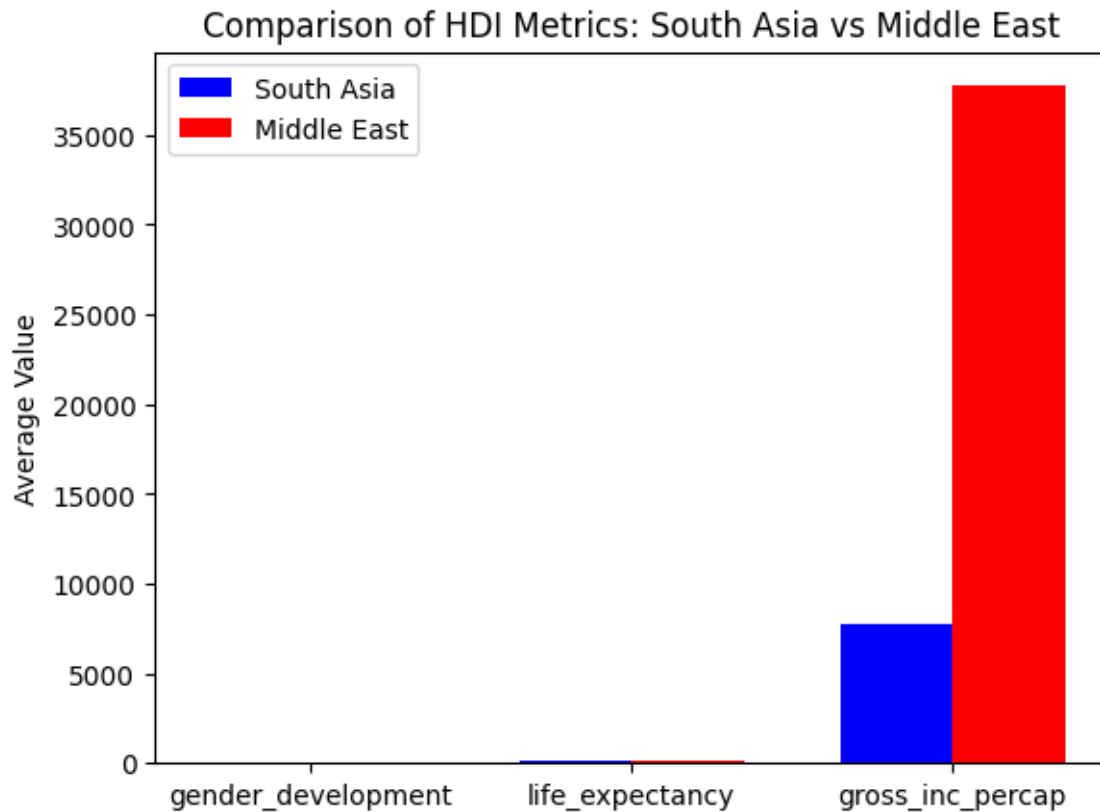
Problem 3 – Comparative Regional Analysis: South Asia vs Middle East

Figure 10(Top and Bottom HDI Performers)
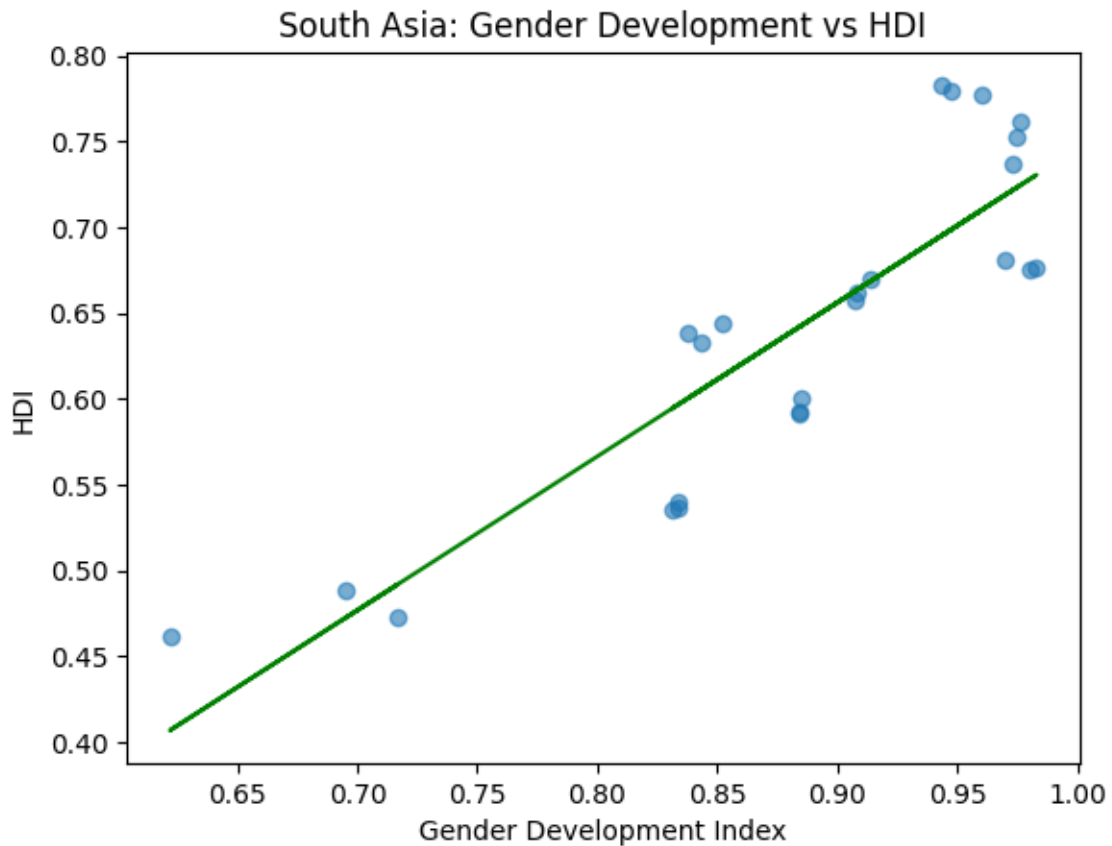

Top and Bottom 3 HDI Performers: South Asia vs Middle East

The graph contrasts the top and bottom average HDI performers in South Asia and the Middle East between 2020 and 2022. The highest performers in South Asia—Sri Lanka, the Maldives, and Bhutan—are contrasted with the lowest scorers—Afghanistan, Pakistan, and Nepal—while the highest achievers in the Middle East—the United Arab Emirates—stand in opposition to the lowest achievers, especially Yemen, Iraq, and Lebanon. Even among strong performers with highly varied HDIs, the plot illustrates the unmistakable regional split in development, with the Middle Eastern region typically showing higher averages than South Asia.

Figure 11(Comparison of HDI Metrics)

Comparison of HDI Metrics: South Asia vs Middle East
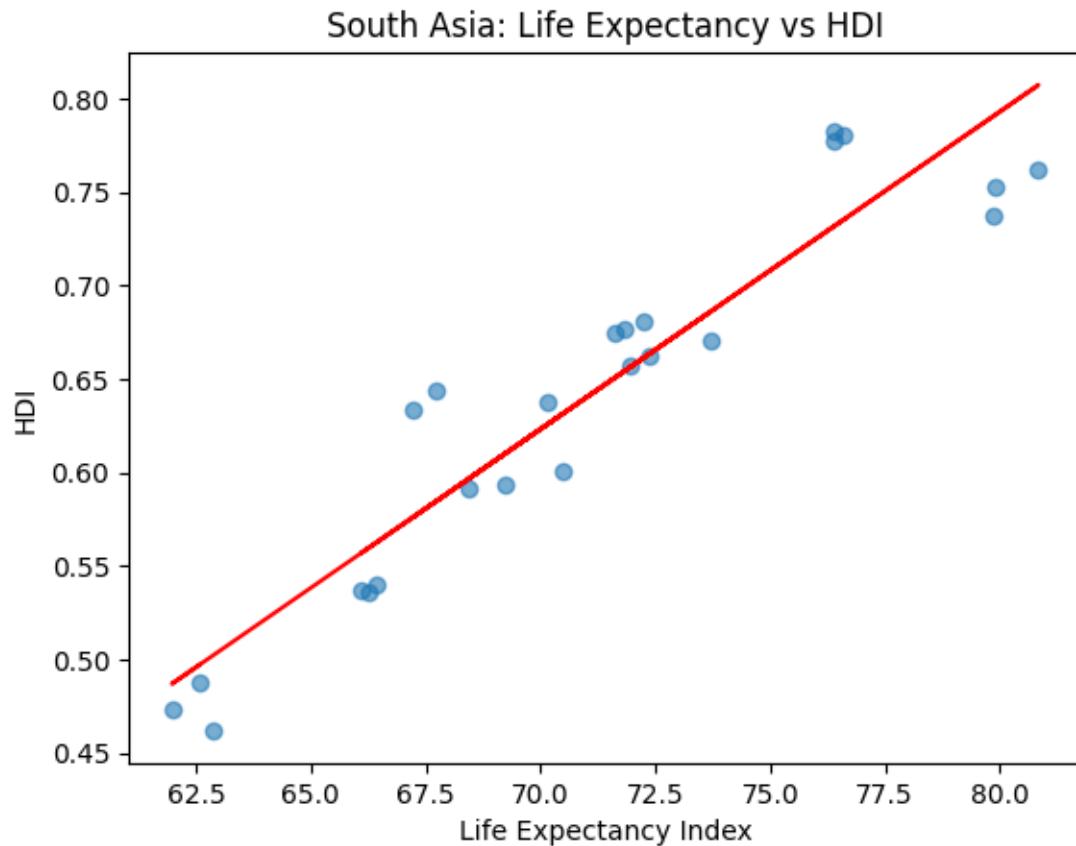
Here is a comparison of the regional averages for these three primary HDI components. The disparities in life expectancy and gender development are lower, despite the Middle East having the greatest mean income. This demonstrates that the Middle East's superior performance across the whole human development portfolio is primarily related to wealth, particularly oil-based revenue.

Figure 12(South Asia: Gender Development vs HDI)

Examined are connections between gender equality concerns and South Asia's general development. There is a clear and positive correlation: nations with higher HDI scores also typically have better gender results. This demonstrates that the advancement of gender equality is inextricably linked to general development, especially in low-HD areas.

Figure 13(South Asia: Life Expectancy vs HDI)

South Asia: Life Expectancy vs HDI

shows the state of health in relation to South Asia's overall development. A higher human development index[17] is clearly positively correlated with life expectancy. Thus, it is believed that enhancing health is the best method to advance progress in this area.

Figure 14(GNI per Capita vs HDI with Outliers)

Outliers in HDI vs GNI per Capita

The Human Development Index and GNI per capita outliers are compared to South Asia and the Middle East in this graph, which reveals some intriguing relationships. Some of these nations stand out as exceptions, even if the majority of them demonstrate that increasing income generally supports higher HDI. While some nations are unable to meet expectations, others are able to reach higher levels of human development than would be predicted given their financial levels. This plot—an overly optimistic perspective—best reveals the low-income, high-human-development nations.

Methods/Approach: The Middle East (which included the United Arab Emirates, Saudi Arabia, Israel, Qatar, and Yemen) and South Asia (which included India, Nepal, Bangladesh, Pakistan, Sri Lanka, Bhutan, Maldives, and Afghanistan) were evaluated. South Asia is treated as a single region in this analysis. Coefficients of variance, range, and average HDI were computed. To illustrate these variations, charts were used (World Population Review, 2025).

Key Findings: The majority of South Asian nations had medium to HDI scores, with the Gulf States and Israel among those with extremely high scores. Every region has experienced some variation: in the Middle East, Yemen had a low HDI, while in South Asia, Sri Lanka and the Maldives were at the top.

Interpretation and Discussion: The resource economy, which is reliant on petroleum-based ones, has a significant impact on the revenue that is produced. The Middle Eastern nations benefit from wealth and infrastructure developments. The HDI is lower in South Asia due to its bigger population and development issues. Both regions' HDI can be improved by reducing inequality (UNDP, 2022).

Conclusion

According to global HDI metrics, there are clear internal and external disparities in person development. Globally, countries' HDI values range from low to very high. There is a notable difference between countries with very high HDI and those with low HDI, since this indicates a wide disparity in access to chances for income, health, and education (UNDP, 2022). Since trend analysis from 2020 to 2022, there has been evidence of a decline in HDI levels since 2019, when the global COVID-19 pandemic struck. As is common, recovery rates will differ, although developed nations recover far more swiftly than developing ones (UNDP, 2024). Effective human development is significantly impacted by inequality.

This is especially true for South Asia, where differences in wealth, education, and health outcomes cause inequality-adjusted HDI values to be significantly muted when compared to normal HDI values (Miranda-Lescano et al., 2024). However, regional comparisons generally show that Middle Eastern nations often have higher HDI averages than South Asian nations. However, due to their stronger economies and social spending, these regions continue to have significant internal differences in development levels (World Population Review, 2025).

Insights:
The Human Development Index patterns reveal both disparity and progress at the same time. Income, education, and health should all be prioritized more closely.

Limitations: These analyses do not take into account variations between nations or environmental factors; instead, they rely on HDI statistics from publications. Three-year intervals are used to compute short-term trends.

Suggestions: In order to give everyone the opportunity to live a better life, progressive policies must now take the form of systems that lessen disparities in access to health care, education, and economic opportunities. Investments in public health could lead to a longer and healthier life, while education could boost employability and lifetime production by enabling skill focus. Public funding for high-priority projects like digital access, clean water, and sanitation should be included in this category since they are all closely related to the results of human progress. Now, policymakers have the opportunity to explore beyond the HDI or Inequality-Adjusted HDI to exchange data, investigate underlying disparities, and develop new initiatives targeted at disadvantaged groups.

Naturally, evidence-based policymaking and regional cooperation can provide inclusive and durable increases in national growth across nations (UNDP, 2022).

Melioristic policies need to change to become more progressive in order to overcome disparities in health, education, and access to economic opportunities for all groups. Investments in public health will increase life expectancy at birth and improve the general well-being of the population, while improvements in education will improve people's abilities and increase their long-term production. Since they directly affect human development results, national projects like digital access, clean water, and sanitation should receive the highest priority when it comes to financing allocations from public monies. Regular monitoring of HDI and Inequality-Adjusted HDI (IHDI) allows drug policy makers to identify underlying disparities and develop special strategies for particular vulnerable groups.

Collaboration at the regional level can be justified by evidence-based policies, which will sustain and increase inclusive national growth among these nations (UNDP, 2022).

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