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ANALYZING THE INDICATORS WHICH CONTRIBUTE TO DISPARITIES IN HUMAN DEVELOPMENT LEVELS AMONG NATIONS

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DECLARATION

I hereby declare that the work presented in this project report was carried out independently by myself and have cited the work of others and given due reference diligently.

……. ……

Salma Firoze Date

I certify that the above student carried out her project under my supervision and guidance.

……. …….

Mr. T Balakumar Date

DEDICATION

I dedicate this research project to the people from nations which still need to develop, as a guide to help their efforts in striving for a better life despite the challenges they face.

ACKNOWLEDGEMENT

I take this opportunity to convey my heartfelt gratitude to all those who helped me successfully complete this project.

I am highly indebted to our course coordinator and module lecturer Mrs. W.M.S.G.D..C Wanigasekara for providing me with valuable advice, guidance and support throughout the entire project. I am also obliged to my research supervisor Mr. T. Balakumar for providing me with useful insights, guidance and imparting constructive feedback that helped me improve my work.

I would like to acknowledge my family and friends for their unwavering support and constant encouragement.

Thank you for all your invaluable contributions to this project.

EXECUTIVE SUMMARY

This project aimed to bring forward a better understanding on the factors contributing to disparities in Human Development Levels among nations. Appropriate statistical tests were conducted to achieve the objectives of this research. The dataset used in this research is a secondary dataset obtained from Kaggle therefore analyzations were limited to the variables given in the dataset.

The multiple linear regression carried out between Human Development Index and the four contributing factors namely Life expectancy at birth, Expected years of schooling, Mean years of schooling and Gross National Income indicated that every factor has a high significance in predicting Human Development Index. The anova test conducted between Gross National Income and the levels of development imply that there is a significant difference in Gross National Income across very high, high, medium and low levels of Human Development. The results of the correlation test performed on Gross National Income with Expected years of school and Life expectancy at birth separately reveal the affect of Gross National Income on each of these indicators.

It is recommended to promote international collaboration so that countries can reach out and help out with strategies to develop globally. Respective authorities must take measures to improve health, education and income fields collectively. Stabilizing their economic growth will help them fund and facilitate improvement in education and health factors thus progressing Human Development. Future research can focus on analyzing the root causes for disparities in every contributor alone as it can help in identifying the most effective strategies for development.

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CHAPTER 1

INTRODUCTION

1.1 Background

Improving the quality of life would pave the way for the progress of any country. The United Nations Development Programme (UNDP) uses Human Development Index (HDI) as a measure to rank a country's average achievements based on three dimensions:

- Long and healthy life- indicated by life expectancy at birth.
- Knowledge- indicated by expected years of schooling and mean years of schooling.
- A decent standard of living- indicated by gross national income.

For a country to take effective decisions that make progress on the population's quality of life it is important to understand how each indicator contributes to the human development index and the relationship between these indicators. Considering this, the proposed research seeks to analyze the indicators contributing to differences in human development levels among nations and examine the impact of gross national income on human development level and the other indicators.

1.2 Research Problem

With a range of interconnected challenges such as poverty, inadequate healthcare, limited access to education, high unemployment rates and political instability commonly faced by countries with low Human Development Index it is important to give due attention to the three root dimensions and analyze their effects on each other. As this addresses a global issue knowing the relationship between human development indicators would facilitate awareness to any country or its government in need to cater to the root problem and improve human development.

1.3 Research Questions

At the end of the research answers for the following questions will be proved:

I. How do the indicators of life expectancy at birth, expected years of schooling, mean years of schooling and gross national income contribute to disparities in the Human Development Index among nations?
II. Does Gross National Income significantly affect human development?
III. What is the association between a country's Gross National Income with the life expectancy and mean years of schooling of its population?

1.4 Objectives of the Project

The research aims to achieve the following:

I. Identify the relationship between Human Development Index and its indicators.
II. Determine if there is a significant difference in Gross National Income across groups of human development.
III. Analyze whether Gross National Income affects the dimensions of knowledge and healthy life by evaluating the association between them.

1.5 Scope of the Research

The core idea of this research is to analyze the relationship between Human Development Index and its indicators while further examining the effects of Gross National Income among different levels of human development and its effect on Health and Knowledge indicators. The research focuses on all development levels grouped as very high, high, medium, and low among 192 different nations around the world.

1.6 Justification of the Research

The Human Development Index quantitatively calculates a country's development but fails to highlight in which aspect a country needs to work on to enhance its quality of life. This research aims to bridge this gap by conducting a detailed analysis of the relationship between the indicators with the Human Development Index and further evaluating the association of Gross National Income with life expectancy and mean years of schooling.

Even though Human Development Index is a global issue research has been limited to analyzing the factors of regions in a selected country which makes values less diverse. Research has also not connected the indicators to check if less development of one indicator like Gross National Income would interfere with the development of other indicators. Therefore, this research aims to enhance the current body of knowledge leading to more effective findings.

This research will also explore possible solutions to pave the way for sustainable strategies in improving quality of life after identifying the relationship between the Human Development Index and its indicators.

1.7 Limitations

Although the measurement of the Human Development Index is spread only among 3 dimensions there are other factors which contribute to its differences such as environmental sustainability, income inequality or political freedom. The dataset that will be used is a secondary dataset therefore other factors are not included which will cause limitations in this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to the Research Theme

Human development is a subject which needs global attention as it refers to the lives of humankind from all nations. The theme of the research aims to focus on the indicators that contribute to disparities in human development and explore the relationship between these indicators and the Human Development Index. The study will also evaluate the association between each of these factors to identify if either of them would influence the other.

2.2 Theoretical explanation of keywords in the topic

Key Words	Definition/Explanation	Source
Human Development	Human development is the process of improving people's freedoms and creating more opportunities to improve their well-being.	The measure of America of the Social Science Research Council
Human Development Index	The Human Development Index (HDI) is a geometric mean that measures the average achievement of human development in a country based on three dimensions a long and healthy life, being educated, and having a good income.	United Nations Development Programme
Disparities in Human Development	Extreme inequalities in opportunity that have a direct effect on human competencies. Most commonly between rich and poor and those who live in rural or urban areas.	GSDR Applied Knowledge Services

Gross National Income	Gross National Income (GNI) is the total value of money earned by a nation through people and businesses.	Investopedia
Sustainable strategies	A sustainable strategy is a set of steps that decision-makers put into action in order to improve the community or the environment. Sustainable strategies may take long to execute, but when accurately done, it would benefit everyone involved.	

Table 2.2

2.3 Findings by other researchers

This segment strives to delve into the studies carried out by other former researchers related to our theme and the conclusions they arrived at.

A study conducted on the examining human development index and the elements contributing to it in the east part of Indonesia indicated that the government spending directly on health and investments has a positive impact on human development while spending on education either directly or indirectly has no effect and spending on protection of the society has a negative effect on human development. (S.R Wafitrah, Rahmatia, N.D.S Saudi 2023)

According to a study on Reducing Poverty by studying Human Development Index patterns at Belitung Regency, it was identified that taking measures to improve the Human Development Index would reduce poverty levels which is a common issue that national governments address. (A.D Setiadi & A.Y Mafruhat 2023)

Another study suggests rebalancing the life expectancy index to 40 as all countries have a realistic expectancy above it and adding new parameters such as renewable energy consumption and gender balance index to enhance the effectiveness and relevance of the Human Development Index. (P.S Borse 2023)

By revising research conducted to examine the effect of the unemployment rate and education on the Human Development Index that can be mediated by poverty in South Sumatra province it was clear that both education and unemployment rates have a significant positive effect on the Human Development Index. It is also added that poverty acts as a mediating variable affecting both education and unemployment rates. (J Maharani & I Yuliana 2023)

Based on another study that analyzed factors affecting the human development level in Indonesia it was stated that poverty level had a negative influence on the Human Development Index as the needs of people were neglected, economic growth had a positive impact which opened opportunities to its people and health function expenses had a negative impact due to lack of health facilities while capital expenditures had no impact. (F.D.A Putri, S Suhendro & P Nauli (2022)

An interesting study which was conducted to analyze the bond between the indexes of Human Development and Global Peace implies that as wealth increases, peace decreases although developed nations have less conflict and better welfare systems. It also highlights the significance of learning more about the complex interplay between wealth and stability in the Middle East (S.A Djailani 2023)

According to a study conducted on the effect of gross national income and human development index on the population of poor, it was verified that the Human Development Index has an affirmative and significant effect on the population of underprivileged people in Minahasa district. (C.P Lapian, E.N Walewangko & L.M Yapanto 2023)

A research conducted on long term and short term factors increasing Human

Development Index in Nusa Tengara which had low a low index disclosed that long term

policies such as new job opportunities, health aid and price stability are essential to

improve the index in the long run. (R.A Pramuja 2023)

A distinctive study conducted to test the relationship of nine different factors with Human Development Index using multiple linear regression proved that four of the nine were significant. Thus, skilled labor force, R&D expenditure, tourism, export and import were the factors highlighted from countries which has very high human development index. (F.D.A Putri 2022)

According to a study conducted on the factors affecting Human Development Index in Central Java Province it was presented that Education expenditure, Health expenditure and Income expenditure indicated a positive and significant relationship. It was also disclosed that Community income variable affected the Human Development Index the most, while Education expenditure has the least influence. (Anna Nurfarkhana 2023)

2.4 The research gap

The prior researches have analyzed the factors that impact to the Human Development Index only within a selected region which makes the data less diverse. It does not analyze the effect of the indicators on each other which is yet another important result in understanding how the indicators vary. Therefore, this study aims to fill the research gap by taking these points into account moving a step ahead from the previous research studies and bringing forward an additional understanding of the relationship between each of the indicators and all three with the Human Development Index as well.

2.5 Table for variables, their definitions, and sources

Variable	Definition	Sources
HDI rank	A country's ranking is based on Human Development Index. The country with the highest index ranks first and so on.	Kaggle
Country	The country to which the data is related.	Kaggle
Human Development	The category to which the human development index belongs. Very High, High, Medium, or Low	Kaggle
Human Development Index	A composite index based on health, education and income dimensions that is used to measure the average achievement of a country.	Kaggle
Life Expectancy at Birth	The number of years a person is expected to live is predicted at the time of birth if the conditions remain unchanged throughout.	Kaggle
Expected years of schooling	The number of years a child of school age is expected to receive education if prevailing conditions remain unchanged.	Kaggle
Mean years of schooling	The average amount of years a child receives schooling education.	Kaggle
Gross National Income per capita	The collective earnings of an economy generated by its production and its ownership of factors of production, less the money which flows out to the rest of the world as payments for the use of factors of production converted to	Kaggle

	international dollars using PPP rates, divided by midyear population.	

Table 2.5

The equations used to derive the above values are given below:

1. **Life Expectancy Index (LEI)** = $\frac{LE-20}{85-20}$

LE: Life expectancy at birth

2. **Education Index (EI)** = $\frac{MYSI+EYSI}{2}$

MYSI:

Mean Years of Schooling Index = $\frac{MYS\ (Mean\ Years\ of\ Schooling)}{15}$

EYSI:

Expected Years of Schooling Index = $\frac{EYS\ (Expected\ Years\ of\ Schooling)}{18}$

3. **Income Index (II)** = $\frac{\ln(GNIpc) - \ln(100)}{\ln(75,000) - \ln(100)}$

GNIpc: Gross national income at purchasing power parity per capita

HDI = $\sqrt[3]{LEI \cdot EI \cdot II}$.

2.6 Chapter Conclusion

In conclusion, the measure of human development has a global concern as it directly implies to human life. Prior research has demonstrated how different factors affect human development levels among a selected region and the necessity to understand these factors which would in return pave the path towards improvement. It also brought to our attention how failing on these indicated topics would result in drawbacks like poverty. However, a gap still prevails as there has not been researching that studies indicators of all countries collectively nor a study that analyzes the association between two indicators. This study will focus on bridging this gap as it would add meaning to those who need to get a deeper understanding of this topic.

CHAPTER 3

METHODOLOGY

3.1 Introduction

As the motive of this research is to analyze the indicators that contribute to disparities in human development, I hope to clearly describe the process which will be followed to achieve the expected outcome. In this chapter, all particulars on the types of data to be analyzed, the data collection tool, the conceptual framework for doing the research, the hypothesis to be tested, an operationalization table with additional details about the variables and the method which will be used for data analysis will be discussed.

3.2 Population, Sample and Sampling Technique

The population of this dataset consists of randomly selected participants from various countries around the world. The average data received from each country have been used to get the measures of all the indicators using the equation which was included under topic 2.5.

As a result, the dataset includes records related to 192 countries which show varied values and belong to all levels of development very high, high, medium, and low. The whole dataset will be used for analysis therefore any sampling technique will not be used.

3.3Types of Data to be Collected and Data Source

The dataset for this research was obtained from an existing database on the website www.kaggle.com. The dataset was uploaded by Raj Kumar Pandey who is a data analyst at BSES Rajdhani Power LTD in New Delhi, India. The data source is mentioned to be from the Human Development Report content 2021-22 of the United Nations Development Programme (UNDP).

The type of data collected are as follows:

Human Development – Categorical data

Human Development Index – Numerical data

Life Expectancy at Birth – Numerical data

Expected Years of Schooling – Numerical data

Mean Years of Schooling – Numerical data

Gross National Income per capita – Numerical data

3.4Data Collection Tools and Plan

As mentioned previously the dataset was obtained from Kaggle. Anyone interested can browse this dataset by searching Human Development Index and its Components on Kaggle or use the link https://www.kaggle.com/datasets/rajkumarpandey02/human-development-index-and-components. As this dataset is already processed and published, data collection tools and plans are required.

3.5 Conceptual Framework

I. Identifying the relationship between Human Development Index and all its indicators.
   - Dependent Variable – Human Development Index
   - Independent Variable – Life Expectancy at Birth
     Expected Years of Schooling
     Mean Years of Schooling
     Gross National Income

II. Determining if there is a significant difference in Gross National Income across groups of human development.
    - Dependent Numerical – Gross National Income
    - Independent Categorical – Human Development

III. Analyzing whether Gross National Income affects the dimensions of knowledge and healthy life by evaluating the association between them.
    - Dependent Variable – Life Expectancy at birth
      Mean Years of Schooling
    - Independent Variable – Gross National Income

Each dependent variable will be tested individually with the independent variable.

3.6 Hypothesis

The assumptions for each of the objectives are as stated below.

I. Identifying the relationship between Human Development Index and all indicators.
    - Null Hypothesis - Life Expectancy at Birth, Expected Years of Schooling, Mean Years of Schooling, and Gross National Income per capita have no significant relationship with the Human Development Index.
    - Alternative Hypothesis - Life Expectancy at Birth, Expected Years of Schooling, Mean Years of Schooling, and Gross National Income per capita has a significant relationship with the Human Development Index.

II. Determine if there is a significant difference in Gross National Income across groups of human development.
    - Null Hypothesis – Gross National Income has no significant difference across groups of human development.
    - Alternative Hypothesis – Gross National Income have a significant difference across groups of human development.

III. Analyze whether Gross National Income affects the dimensions of knowledge and healthy life by evaluating the association between them.

- Null Hypothesis – Gross National Income does not affect life expectancy value/ mean years of schooling.
- Alternate Hypothesis – Gross National Income affects life expectancy value/ mean years of schooling.

3.7 Operationalization Table

Variable	Indicators	Measures
Rank	Unique ID	The country is ranked according to their Human Development Index.
Country	Country	-
Human Development	The category to which the human development index belongs.	(Categorical) Very High: 0.8 – 1 High: 0.7 – 0.799 Medium: 0.55 – 0.699 Low: 0.3 – 0.549
Human Development Index	A value between 0 and 1 indicating the level of development.	By Scores (Numerical) 1 – Highest level 0 – The lowest level
Life Expectancy at birth	Number of years of life expected	By Years (Numerical)

Expected years of schooling	The mean number of years a person is expected to school	By Years
Mean years of schooling	The mean number of years a person is has schooled	By Years
Gross National Income per capita	The mean income of an economy	By Currency Dollars

Table 3.7

3.8 Methods of Data Analysis

All the objectives stated will be tested using statistical methods and graphical representation in Python and RStudio.

I. Identifying the relationship between Human Development Index and all its indicators.
   - Multiple Linear Regression

II. Determining if there is a significant difference in Gross National Income across groups of human development.
   - Anova Test

III. Analyzing whether Gross National Income affects the dimensions of knowledge and healthy life by evaluating the association between them.
   - Correlation Test with Scatter Plot

Finally, after respective tests are performed the null and alternate hypotheses will either be accepted or rejected, and we will arrive at meaningful conclusions to understand the indicators which contribute to disparities among human development levels among nations.

CHAPTER 4

DATA ANALYSIS

4.1 Data Preprocessing

The data was preprocessed according to requirements so that it is suitable for analysing. The first step followed was to remove the unwanted columns.

	A	B	C	D	E	F	G	H	I	J
1	HDI rank	Country	HUMAN DEVEL	Human Development Index	Life expectancy at birth	Expected years of schooling	Mean years of schooling	(GNI) per capita	GNI per cap	HDI rank
2	1	Switzerland	VERY HIGH	0.962	84	16.5	13.9	66933	5	3
3	2	Norway	VERY HIGH	0.961	83.2	18.2	13	64660	6	1
4	3	Iceland	VERY HIGH	0.959	82.7	19.2	13.8	55782	11	2
5	4	Hong Kong, China (SAR)	VERY HIGH	0.952	85.5	17.3	12.2	62607	6	4
6	5	Australia	VERY HIGH	0.951	84.5	21.1	12.7	49238	18	5
7	6	Denmark	VERY HIGH	0.948	81.4	18.7	13	60365	6	5
8	7	Sweden	VERY HIGH	0.947	83	19.4	12.6	54489	9	9
9	8	Ireland	VERY HIGH	0.945	82	18.9	11.6	76169	-3	8
10	9	Germany	VERY HIGH	0.942	80.6	17	14.1	54534	6	7
11	10	Netherlands	VERY HIGH	0.941	81.7	18.7	12.6	55979	3	10

Dataset before removing unnecessary columns

The last two columns named GNI per capita and HDI rank were not involved in our analysis therefore it was removed using R-studio.

	A	B	C	D	E	F	G	H
1	HDI.rank	Country	HUMAN.DEVELOPMENT	Human.Development.Index	Life.expectancy.at.birth	Expected.years.of.schooling	Mean.years.of.schooling	Gross.national.income..
2	1	Switzerland	VERY HIGH	0.962	84	16.5	13.9	66933
3	2	Norway	VERY HIGH	0.961	83.2	18.2	13	64660
4	3	Iceland	VERY HIGH	0.959	82.7	19.2	13.8	55782
5	4	Hong Kong, China (SAR)	VERY HIGH	0.952	85.5	17.3	12.2	62607
6	5	Australia	VERY HIGH	0.951	84.5	21.1	12.7	49238
7	6	Denmark	VERY HIGH	0.948	81.4	18.7	13	60365
8	7	Sweden	VERY HIGH	0.947	83	19.4	12.6	54489
9	8	Ireland	VERY HIGH	0.945	82	18.9	11.6	76169
10	9	Germany	VERY HIGH	0.942	80.6	17	14.1	54534
11	10	Netherlands	VERY HIGH	0.941	81.7	18.7	12.6	55979

Dataset after removing columns

The dataset was the checked to see if there were null values to which the results were False that assured any records need not be removed.

Next, the data structure was checked.

```r
str(HDI1)
```

```
'data.frame':   191 obs. of  8 variables:
 $ HDI.rank                           : int  1 2 3 4 5 6 7 8 9 10 ...
 $ Country                            : chr  "Switzerland" "Norway" "Iceland" "Hong Kong, China (SAR)" ...
 $ HUMAN.DEVELOPMENT                  : chr  "VERY HIGH " "VERY HIGH " "VERY HIGH " "VERY HIGH " ...
 $ Human.Development.Index..HDI.      : num  0.962 0.961 0.959 0.952 0.951 0.948 0.947 0.945 0.942 0.941 ...
 $ Life.expectancy.at.birth           : num  84 83.2 82.7 85.5 84.5 81.4 83 82 80.6 81.7 ...
 $ Expected.years.of.schooling        : num  16.5 18.2 19.2 17.3 21.1 18.7 19.4 18.9 17 18.7 ...
 $ Mean.years.of.schooling            : num  13.9 13 13.8 12.2 12.7 13 12.6 11.6 14.1 12.6 ...
 $ Gross.national.income..GNI..per.capita: int  66933 64660 55782 62607 49238 60365 54489 76169 54534 55979 ...
```

```r
attach(HDI1)
HDI1$HUMAN.DEVELOPMENT =as.factor(HDI1$HUMAN.DEVELOPMENT)
HDI1$Gross.national.income..GNI..per.capita =as.numeric(HDI1$Gross.national.income..GNI..per.capita)
```

The structure of the variable Human Development was supposed to be changed as factor and that of Gross National Income as numeric in order to carry out the appropriate tests.

The dataset is now fit to be used for testing.

4.2 Descriptive Statistics and Data Analysis

The summary of the variables which are included in the research computed using R-Studio is presented in this section to offer significant understanding on its range, spread and central tendency.

- ✓ Human Development Index

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.3850	0.5995	0.7390	0.7206	0.8350	0.9620

- ✓ Life Expectancy at Birth

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
52.50	65.75	71.70	71.31	76.70	85.50

- ✓ Expected years of schooling

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
5.50	11.60	13.40	13.53	15.60	21.10

- ✓ Mean years of schooling

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
2.100	6.250	9.300	8.984	11.500	14.100

- ✓ Gross National Income per Capita

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
732	4593	12306	20249	30080	146830

In addition to the descriptive statistics, the graphs given below will illustrate the relationships and trends among selected variables.

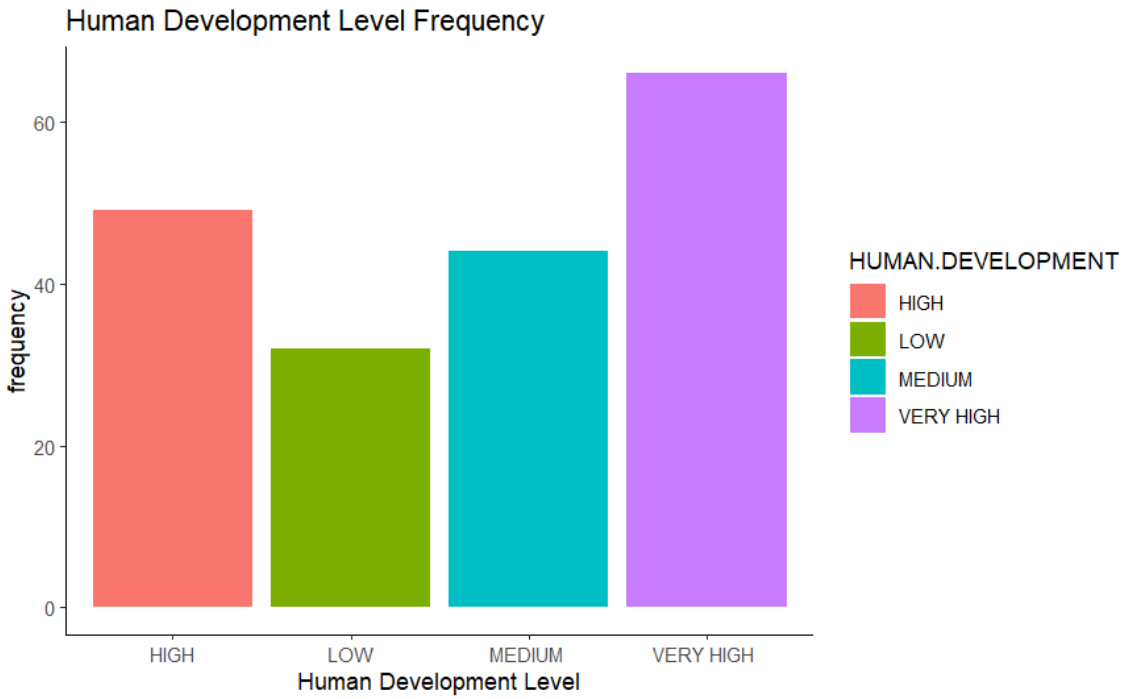


Figure 1: Bar Graph depicting Human Development Levels

According the bar graph given above we can distinguish that 66 countries show a very high human development level, whereas 49 countries show a high level of development while 44 countries show medium level of development and 32 countries belong to low human development level.

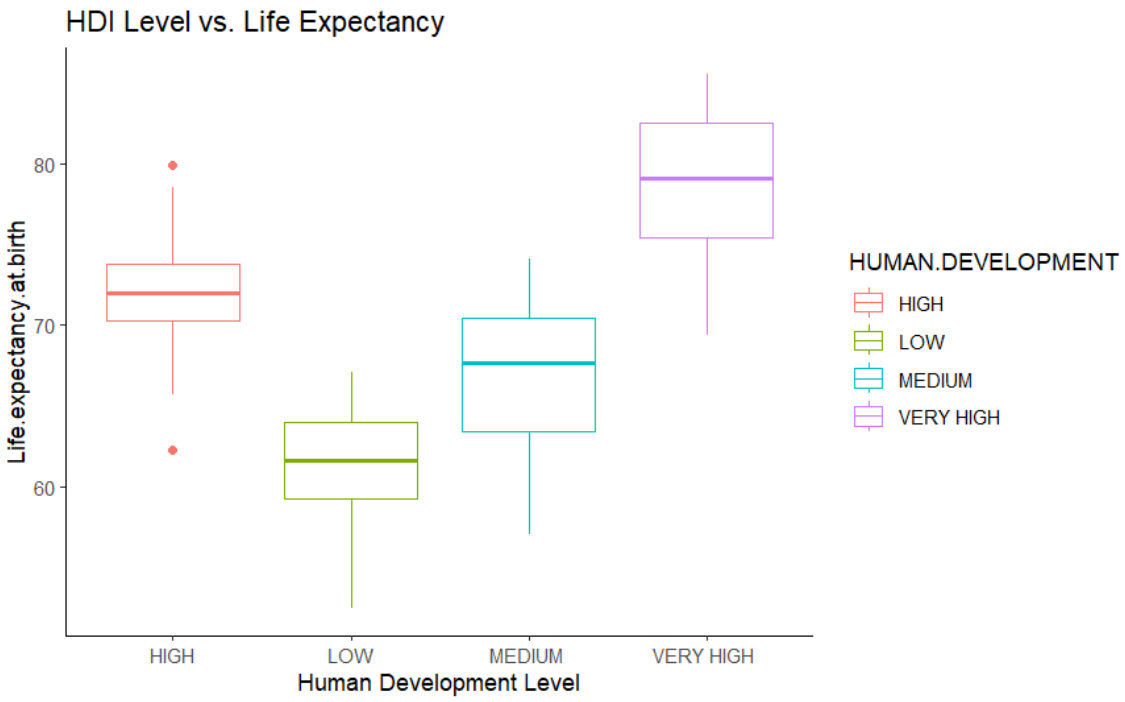


Figure 2: Box plot depicting relationship between Human Development Level and Life Expectancy at Birth

According to the box plot the median and quartiles of life expectancies of each human development levels rounded off to the nearest whole number are as follows

HDI Level	Q1	Median	Q3
Very High	75	79	82
High	70	72	74
Medium	63	68	71
Low	59	62	64

It is evident that there is an overall positive correlation between Human Development Levels and Life expectancy at birth. Countries with higher Human Development Level tend to have a higher life expectancy and vice versa.

There are a few outliers and this can have various reasons. The country with high human development level may show low life expectancy due to natural disasters or chronic diseases whereas that with low development level can possess high life expectancy if population size is small or a certain health procedure executed.

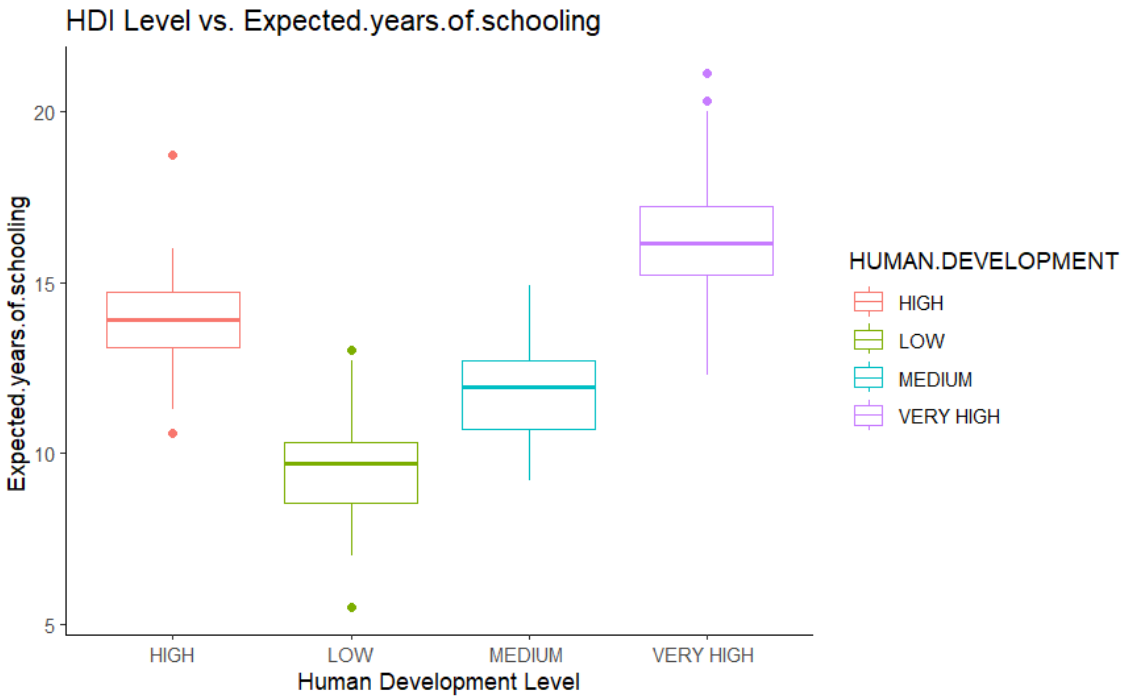


Figure 3: Box plot depicting relationship between Human Development Level and Expected years of schooling

According to the box plot the median and quartiles of expected years of schooling of each human development level rounded off to the nearest whole number are as follows

HDI Level	Q1	Median	Q3
Very High	15	16	17
High	13	14	15
Medium	11	12	13
Low	9	10	11

It is evident that there is an overall positive correlation between Human Development Levels and Expected years of schooling. Countries with higher Human Development Level tend to have a higher number of years expected to be schooled and vice versa.

There are a few outliers and this can have various reasons. The country with high human development level may show low expected years of schooling due to inequality or lack of access to education whereas that with low development level can possess high years expected procedure if population size is small or a certain education system is implemented.

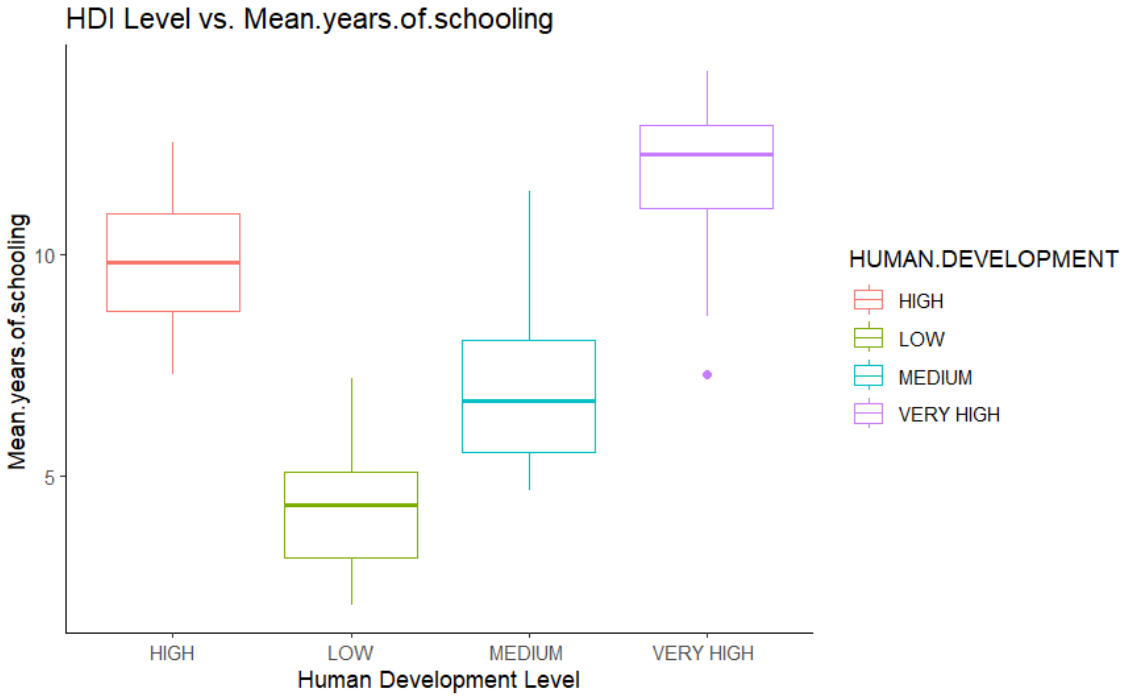


Figure 4: Box plot depicting relationship between Human Development Level and Mean years of schooling

According to the box plot the median and quartiles of mean years of schooling of each human development level rounded off to the nearest whole number are as follows

HDI Level	Q1	Median	Q3
Very High	11	12	13
High	9	10	11
Medium	6	7	8
Low	3	4	5

It is evident that there is an overall positive correlation between Human Development Levels and Mean years of schooling. Countries with higher Human Development Level tend to have a higher number of years schooled and vice versa.

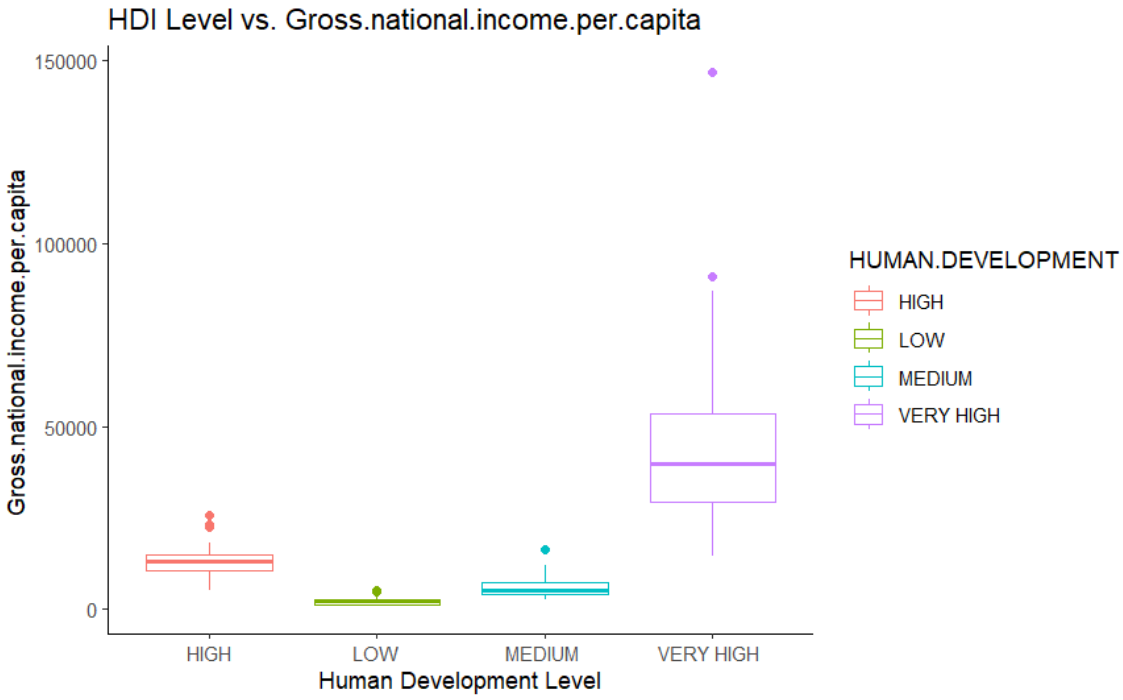


Figure 5: Box plot depicting relationship between Human Development Level and Gross National Income per Capita

According to the box plot the median and quartiles of life Gross National Income of each human development levels rounded off to the nearest whole number are as follows

HDI Level	Q1	Median	Q3
Very High	28 543	39 622	53 837
High	10 450	12 948	15 059

Medium	4 012	5 146	7 585
Low	1 327	2 126	2 691

It is evident that there is an overall positive correlation between Human Development Levels and Gross National Income. Countries with higher Human Development Level tend to have a higher Gross National Income.

There can be several reasons as to why certain countries which belong to the same Human Development Level display outlaying Gross National Income which maybe Currency Exchange Rates, an Export based economic structure if the country is rich in natural resources or due to outstanding Economic policies.

4.3 Findings and Interpretation

The data analyzed through suitable methods using R-Studio to achieve the set objectives are presented below.

I. Identifying the relationship between Human Development Index and all indicators.

```
#MULTIPLE REGRESSION
```{r}
mltp_lm<-lm(HDI1$Human.Development.Index..HDI.~HDI1$Life.expectancy.at.birth+HDI1$Expected.years.of.schooling
                +HDI1$Mean.years.of.schooling+HDI1$Gross.national.income..GNI..per.capita)
mltp_lm
```
```

```
Call:
lm(formula = HDI1$Human.Development.Index..HDI. ~ HDI1$Life.expectancy.at.birth +
    HDI1$Expected.years.of.schooling + HDI1$Mean.years.of.schooling +
    HDI1$Gross.national.income..GNI..per.capita)

Coefficients:
                                (Intercept)                HDI1$Life.expectancy.at.birth
                                  -9.631e-02                                    6.370e-03
           HDI1$Expected.years.of.schooling                 HDI1$Mean.years.of.schooling
                                   1.339e-02                                    1.808e-02
HDI1$Gross.national.income..GNI..per.capita
                                   9.408e-07
```

The call segment shows that the lm() function was used to fit a linear regression model where the dependent variable is Human Development Index and the independent variables are life expectancy at birth, expected years of schooling, mean years of schooling and Gross national income.

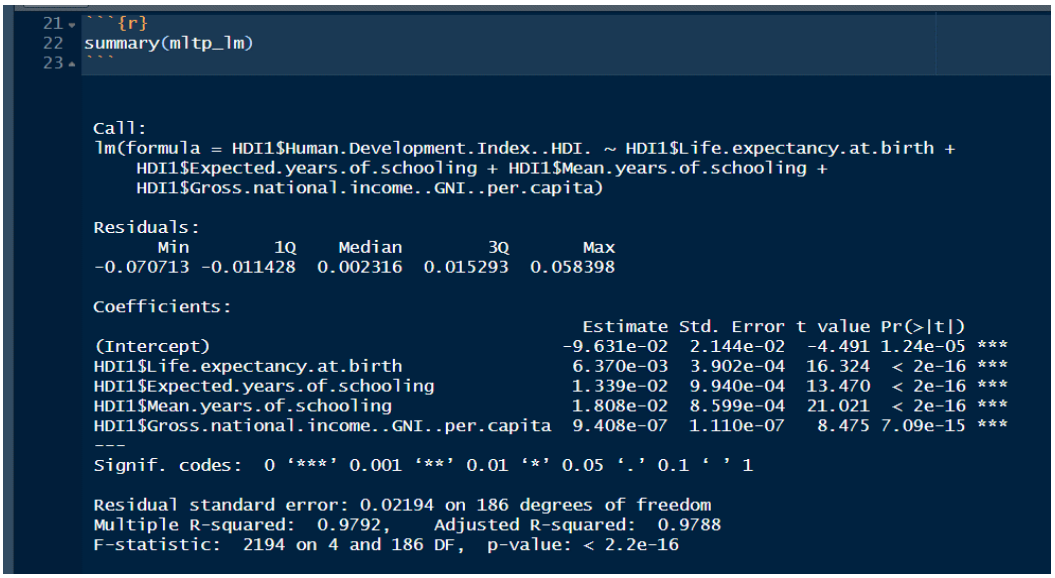
The intercept here is approximately -0.09631 which denotes the value of Human Development Index when all the independent variables are valued 0. As the Human Development Index is a decimal value between 0 and 1 according our dataset it has led to a smaller intercept.

The coefficient of life expectancy at birth is 6.370e-03, expected years of schooling is 1.339e-02, mean years of schooling is 1.808e-02 and that of Gross national income is

9.408e-07. The positive coefficients denote that for each additional unit of independent variable the Human Development Index is estimated to rise by the units of the respective coefficient retaining the other variables constant.

The equation of the regression model will be:

Y=0.09631+(0.00637*life expectancy+0.01339*expected years of schooling+0.01808*mean years of schooling+0.0000009408*gross national income)



```
21 ```{r}
22 summary(mltp_lm)
23 ```
```

```
Call:
lm(formula = HDI1$Human.Development.Index..HDI. ~ HDI1$Life.expectancy.at.birth +
    HDI1$Expected.years.of.schooling + HDI1$Mean.years.of.schooling +
    HDI1$Gross.national.income..GNI..per.capita)

Residuals:
      Min        1Q    Median        3Q       Max
-0.070713 -0.011428  0.002316  0.015293  0.058398

Coefficients:
                                          Estimate Std. Error t value Pr(>|t|)
(Intercept)                             -9.631e-02  2.144e-02  -4.491 1.24e-05 ***
HDI1$Life.expectancy.at.birth            6.370e-03  3.902e-04  16.324  < 2e-16 ***
HDI1$Expected.years.of.schooling         1.339e-02  9.940e-04  13.470  < 2e-16 ***
HDI1$Mean.years.of.schooling             1.808e-02  8.599e-04  21.021  < 2e-16 ***
HDI1$Gross.national.income..GNI..per.capita 9.408e-07  1.110e-07   8.475 7.09e-15 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02194 on 186 degrees of freedom
Multiple R-squared:  0.9792,    Adjusted R-squared:  0.9788
F-statistic:  2194 on 4 and 186 DF,  p-value: < 2.2e-16
```

When the summary function is called we get the p-value for all independent variables. As the p-values are less than 0.001 it indicates that every variable holds a high significance in predicting Human Development Index.

R-Squared (R^2 or the coefficient of determination) is a statistical measure in a regression model that determines the proportion of variance in the dependent variable that can be explained by the independent variable.

Therefore, we reject the null hypothesis and accept the alternative hypothesis as the values provide evidence for the significance of the independent variables in relationship with Human Development Index.

II. Determine if there is a significant difference in Gross National Income across groups of human development.

```
#Anova
```{r}
library(ggplot2)
library(ggpubr)
library(tidyverse)
library(broom)
library(AICcmodavg)
```

```{r}
one.way<-aov(Gross.national.income..GNI..per.capita~HUMAN.DEVELOPMENT,data=HDI1)
summary(one.way)
```
```

```
                    Df    Sum Sq   Mean Sq F value Pr(>F)
HUMAN.DEVELOPMENT    3 5.852e+10 1.951e+10   114.1 <2e-16 ***
Residuals          187 3.198e+10 1.710e+08
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The Pr(>F) value calculated here for the level of Human Development which are categorized as very high, high, low and medium is <2e-16. This is an extremely small value which is less than 0.05, which implies that we have enough verification to conclude that the Gross National Income of countries is significantly different between the 4 categories of Human Development Levels.

Therefore we can reject the null hypothesis and accept the alternative hypothesis which supports the statement that there is a significance difference in Gross National Income across groups of Human development.

III. Analyzing whether Gross National Income affects the dimensions of knowledge and healthy life by evaluating the association between them.

```
#Correaltion Test with Scatter Plot
```{r}
res1<-cor.test(HDI1$ Gross.national.income..GNI..per.capita,HDI1$Life.expectancy.at.birth,method="spearman")
res1
```

Warning: Cannot compute exact p-value with ties
        Spearman's rank correlation rho

data: HDI1$Gross.national.income..GNI..per.capita and HDI1$Life.expectancy.at.birth
S = 173697, p-value < 2.2e-16
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.8504266
```

This test measures the strength and direction of relationship between the two variables Gross National Income and Life expectancy.

The Spearman's rank correlation is estimated to be 0.85 which indicates a positive correlation between the two variables.

As the P-value indicates an extremely low value <2.2e-16 which is almost 0 it implies that the correlation is statistically significant and has not occurred in random.

```r
res2<-cor.test(HDI1$ Gross.national.income..GNI..per.capita,HDI1$Mean.years.of.schooling,method="spearman")
res2
```

```
Warning: Cannot compute exact p-value with ties
        Spearman's rank correlation rho

data:  HDI1$Gross.national.income..GNI..per.capita and HDI1$Mean.years.of.schooling
S = 199134, p-value < 2.2e-16
alternative hypothesis: true rho is not equal to 0
sample estimates:
      rho
0.8285219
```

This test measures the strength and direction of relationship between the two variables Gross National Income and Mean Years of Schooling.

The Spearman's rank correlation is estimated to be 0.83 which indicates a positive correlation between the two variables.

As the P-value indicates an extremely low value <2.2e-16 which is also almost 0 it implies that the correlation is statistically significant as well.

Relative to the values obtained above we can reject the null hypothesis and accept the alternate hypothesis as it is evident that Gross national income has an impact on the life expectancy and mean years of schooling.

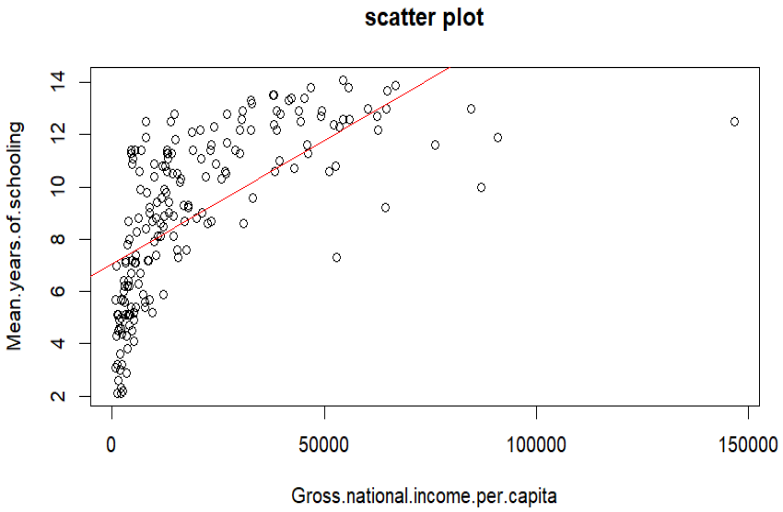


Figure 6: Scatter plot of GNI vs Mean years of schooling

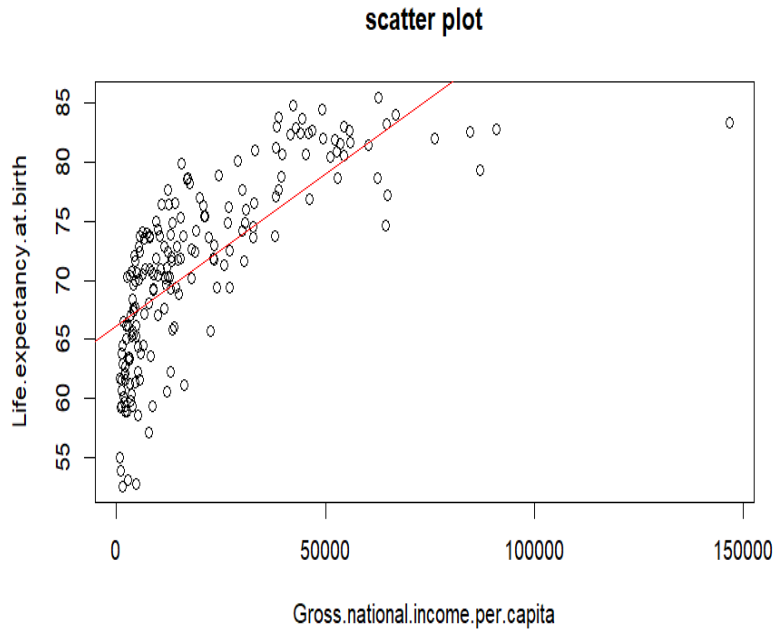


Figure 7: Scatter plot of GNI vs Life Expectancy at Birth

Observing figure 6 and 7 we can perceive that mean years of schooling and life expectancy at birth are highly correlated to Gross National Income. This emphasizes the need to maintain a high Gross National Income to have a stable human development level.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.1 Discussion

In this section a brief out on the interpretation will be discussed while narrowing down the field of study.

This study provides evidence that there is a strong relationship between Human Development Index and the 4 indicators while also indicating that there exists a significance difference in Gross National Income between the different levels of Human development. It also highlights the fact that the Gross National Income plays an important role in determining Human Development Index as it also affects the other factors of development.

Our results connect to the prevailing findings on studies related Human development Index conducted in selected regions. Studies by P.S Borse (2023) and S.R Wafitrah (2023) similarly found that spending on investments have a positive impact on Human Development as Gross National Income has a significant association with the other contributing factors of development.

There were several limitations to this study the main being that the dataset obtained was secondary therefore any other contributing factors such as unemployment rate and corruption were not assessed. Therefore only the variables already available were tested.

As all the factors of Human Development have a significant relationship with Human Development Index and thus the appropriate implication would be that the representatives of every country should focus on the improving all these areas. Gross National Income affects the other contributing factors therefore stability in this area would benefit and ease the upliftment of other sectors.

Future research should explore the underlying contributors to each of these factors alone as that would help to identify and resolve root problems which causes downfall in any of these factors and lead to better human development levels among all nations.

Collectively our study gives a detailed idea on the factors contributing to Human Development Levels among nations and proves that there is a significance difference in contributing factors among different levels. Therefore studying each level separately is necessary to identify in which ways nations can improve further.

5.2 Recommendations

By Promoting International collaboration within countries, those with higher Human Development Index can share their ideas and strategies to help the countries with lower indexes improve.

As the countries belong to different levels of Human Development the same strategies may not work for all. Therefore it is mandatary to identify the most suitable ways of improving by studying the unique challenges that each country faces.

The Government and respective authorities must give precedence to invest and improve the fields of education, health and standard of living which contribute to Human Development Index. They should also focus on getting long term goals rather than short term fixes.

To heighten Human Development Index levels it is important to tackle income inequality as Income levels directly affect the other contributing factors. Strategies which support economic stability must be promoted and new job opportunities can be encouraged.

An effective monitoring and evaluation method should be pursued to identify the effect of policies or strategies implemented on Human Development Index. Analyzing this evaluation can help make necessary changes and improve them further.

It is also equally important to raise awareness on the contributing factors of Human Development Index among the population and community as it would also be a pillar of support for government implementations when the people are understand values.

5.3 Conclusion

In conclusion, Human Development Index is a comprehensive measure which focuses on human well being of nations with regard to education, health and income.

By analyzing the indicators contributing to disparities in human development levels among nations we identified that all four factors had a significant relationship with Human development Index. Further it was also highlighted that there is a significant difference in Gross National Income across different levels of Human Development. It was also indicated that Gross National Income affects education and health fields directly and it has to be the field of topmost concern when it comes to Human Development.

In order to improve Health Development Index countries can promote international collaboration and exchange ideas and it is the responsibility of the government and

respective authorities to invest and improve the fields which contribute to the Index. It is recommended to study the other factors which contribute to Human development when it comes to future research. Focus on the root causes for variation in education, health and income fields is appreciated as it can help to decide on strategies for improvement.

APPENDICES

```r
hdi=read.csv("Human Development Index and Components.csv")
hdi
```

```r
library(tidyverse)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ─
✓ dplyr     1.1.2     ✓ readr     2.1.4
✓ forcats   1.0.0     ✓ stringr   1.5.0
✓ ggplot2   3.4.2     ✓ tibble    3.2.1
✓ lubridate 1.9.2     ✓ tidyr     1.3.0
✓ purrr     1.0.1     ── Conflicts ────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package to force all conflicts to become errors
```

```r
HDI1= hdi%>%select(-c("GNI.per.capita.rank.minus.HDI.rank","HDI.rank.1"))
HDI1
```

```{r}
write.csv(HDI1,"C:/Users/Acer/Desktop/RESEARCH PROJECT/HDI1.csv", row.names=FALSE)
```

```{r}
is.na(HDI1)
```

```{r}
summary(HDI1$Life.expectancy.at.birth)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  52.50   65.75   71.70   71.31   76.70   85.50 
```

```{r}
summary(HDI1$Expected.years.of.schooling)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
   5.50   11.60   13.40   13.53   15.60   21.10 
```

```{r}
summary(HDI1$Mean.years.of.schooling)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  2.100   6.250   9.300   8.984  11.500  14.100 
```

```{r}
summary(HDI1$Gross.national.income..GNI..per.capita)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
    732    4593   12306   20249   30080  146830 
```

```{r}
HDI1=read.csv("HDI1.csv")
HDI1
```

```{r}
library(tidyverse)
```

```{r}
ggplot(data=HDI1)+geom_bar(mapping=aes(x=HUMAN.DEVELOPMENT,fill=HUMAN.DEVELOPMENT))+labs(title="Human Development Level Frequency",x="Human Development Level",y="frequency")+theme_classic()
```

```{r}
mytable<-table(HDI1$HUMAN.DEVELOPMENT)
mytable
```

```{r}
ggplot(data=HDI1)+ geom_boxplot(mapping=aes(x=HUMAN.DEVELOPMENT,y=Life.expectancy.at.birth,color=HUMAN.DEVELOPMENT))+labs(title="HDI Level vs. Life Expectancy",x="Human Development Level",y="Life.expectancy.at.birth")+theme_classic()
```

```r
ggplot(data=HDI1)+ geom_boxplot(mapping=aes(x=HUMAN.DEVELOPMENT,y=Expected.years.of.schooling
color=HUMAN.DEVELOPMENT))+labs(title="HDI Level vs. Expected.years.of.schooling ",x="Human
evelopment Level",y="Expected.years.of.schooling ")+theme_classic()
```

```r
ggplot(data=HDI1)+ geom_boxplot(mapping=aes(x=HUMAN.DEVELOPMENT,y=Mean.years.of.schooling
,color=HUMAN.DEVELOPMENT))+labs(title="HDI Level vs. Mean.years.of.schooling ",x="Human Development
Level",y="Mean.years.of.schooling ")+theme_classic()
```

```r
ggplot(data=HDI1)+ geom_boxplot(mapping=aes(x=HUMAN.DEVELOPMENT,y=Gross.national.income..GNI..per.cap
ita  ,color=HUMAN.DEVELOPMENT))+labs(title="HDI Level vs. Gross.national.income.per.capita ",x="Human
Development Level",y="Gross.national.income.per.capita ")+theme_classic()
```

REFERENCES

- Human Development Reports (19 February 2015) “What is Human Development?” [online] available from <https://hdr.undp.org/content/what-human-development> [Accessed 19th July 2023]
- Measure Of America of the Social Science Research Council “About Human Development” [online] available from <https://measureofamerica.org/human-development/> [Accessed 19th July 2023]
- GSDRC Applied Knowledge Services (2023) “Inequality and Human Development” [online] available from <https://gsdrc.org/document-library/inequality-and-human-

development/#:~:text=Deep%20human%20development%20disparities%20persist,and%20are%20transmitted%20across%20generation> [Accessed 20th July 2023]

- The Investopedia Team (4th April 2023) "Gross National Income definition, with real-world example" [online] available from <https://www.investopedia.com/terms/g/gross-national-income-gni.asp> [Accessed 20th July 2023]
- J. Maharani (May 2023) "Effect of Unemployment Rate, Education on HDI which is Mediated by Poverty" [online] available from <https://www.researchgate.net/publication/370965078_Effect_of_Unemployment_Rate_Education_on_Human_Development_Index_which_is_Mediated_by_Poverty>
- P Nauli (November 2022) "Analysis of factors affecting the level of the HDI" [online] available from <https://www.researchgate.net/publication/365881235_Analysis_of_factors_affecting_the_level_of_the_human_development_index> [Accessed 15 July 2023]
- P.S Borse (9 June 2023) "An analysis of the HDI and modelling income distributions" [online] available from <http://cds.iisc.ac.in/faculty/murugesh/lab_html/Report_Prajakta.pdf> [Accessed 15 July 2023]
- S.R Wafitrah (8th February 2023) "Analysis of the HDI and factors affecting it in eastern Indonesia" [online] available from <https://ejournal.seaninstitute.or.id/index.php/Ekonomi/article/view/1311> [Accessed 15 July 2023].

- S.A Djailani & Surwandono (June 2023) “The Wealth-Peace Connection: Human Development Index and Global Peace Index in Middle Eastern Nations” [online] available from <https://www.researchgate.net/publication/372142969_The_Wealth-Peace_Connection_Human_Development_Index_and_Global_Peace_Index_in_Middle_Eastern_Nations> [Accessed 22nd July 2023]

- Ch. P Lapian (May 2023) “The Effect of Population, Human Development Index, and Gross Regional Domestic Product on Poor Population” [online] available from <https://www.researchgate.net/publication/371924233_The_Effect_of_Population_Human_Development_Index_and_Gross_Regional_Domestic_Product_on_Poor_Population>
[Accessed 22nd July 2023]

- A.D Setiadi & A.Y Mafruhat (May 2023) “Optimization of Poverty Reduction Through Human Development Index Schemes And Indirect Spending At Belitung Regency” [online] available from <https://www.researchgate.net/publication/370909342_Optimization_Of_Poverty_Reduction_Through_Human_Development_Index_Schemes_And_Indirect_Spending_At_Belitung_Regency> [Accessed 22nd July 2023]

- R.A Pramuja (Feb 2023) “Long and Short term analysis on Human Development in West Nus Tengara” [online] available from <https://journal.uinmataram.ac.id/index.php/jed/article/view/6764> [Accessed 10th September 2023]

- Omer Bafail (July 2023) “Human Development Index- Determining and Ranking the significant factors” [online] available from <https://www.researchgate.net/publication/372625097_Human_Development_Index_Determining_and_Ranking_the_Significant_Factors> [Accessed 10th September 2023]

- Anna Nurfarkhana (January 2023) “Human Development Index as an effort to increase economic growth”

<https://www.researchgate.net/publication/368384189_Human_Development_Index_As_An_Effort_To_Increase_Economic_Growth> [Accessed 10th September 2023]