

Final Report - Group 01

HDI and Broadband - Data Analysis

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Abstract

This report analyzes the relationship between Human Development Index (HDI) and broadband access across various countries, highlighting trends and insights from the data. Lorem ipsum dolor sit amet, consectetur adipiscing elit. In egestas lobortis porta. Phasellus tincidunt metus sed mollis imperdiet. Aliquam blandit nibh in fermentum consequat. Fusce blandit magna quis nulla ornare, non mattis enim tempor. Nulla et odio dui. Nunc ut elit venenatis, porttitor dui et, placerat tortor. Sed aliquet sodales magna, sit amet porta odio tempor in. CHANGE THIS AT THE END

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1. Motivation

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2. Review of Similar Research

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3. Research Questions

3.1. Question 1

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3.2. Question 2

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3.3. Question 3

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4. Data

We are using three files from the Gapminder dataset:
HDI, Broadband, and GDP. (*Gapminder Datasets* 2023)

4.1 Loading the files

```
hdi <- read.csv("data/hdi_human_development_index.csv")
broadband <- read.csv("data/broadband_subscribers_per_100_people.csv")
gdp <- read.csv("data/gdp_pcap.csv")
```

4.2. Data Structure

In this section we will clean the header names of each dataset and explore and describe the datasets one by one.

1. Human Development Index (HDI):

Let's explore the shape of the dataset.

Rows x Columns

```
## [1] 193 35
```

Since there are 35 columns, let's only see the first and last five columns to see more detail of column names (after cleaning).

```
## [1] "country" "x1990" "x1991" "x1992" "x1993"
```

```
## [1] "x2019" "x2020" "x2021" "x2022" "x2023"
```

The year range of this dataset is 1990 - 2023. We can also see that the column names have "x" characters that need to be cleaned further.

2. Broadband subscribers (per 100 people):

Rows x Columns

```
## [1] 206 27
```

And the first and last five column names:

```
## [1] "country" "x1998" "x1999" "x2000" "x2001"
```

```
## [1] "x2019" "x2020" "x2021" "x2022" "x2023"
```

The year range of this dataset is 1998 - 2023. Again, the column names have “x”s that aren’t helpful. Several columns have chr data type, which we will need to clean up.

3. Gross Domestic Product (GDP):

Rows x Columns

```
## [1] 193 303
```

And the first and last five column names:

```
## [1] "geo" "name" "x1800" "x1801" "x1802"
```

```
## [1] "x2096" "x2097" "x2098" "x2099" "x2100"
```

This dataset has the most number of years ranging from 1800 - 2100. The future year values might be predicted or empty which we can analyze further when standardizing and cleaning rows. The *geo* column is also interesting as after standardizing the country names, and merging the datasets, we can also map the data if needed.

4.3. Selecting the required columns

Since the dataset has values from 100+ years, we will narrow them down to the most recent decade starting from 2010 to 2023. Will also clean the years by removing the ‘x’ character before we select the columns of interest.

HDI

```
##      country 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
## 1 Afghanistan 0.474 0.484 0.492 0.497 0.496 0.495 0.496 0.498 0.507 0.501 0.486
## 2      Angola 0.545 0.557 0.567 0.577 0.603 0.609 0.610 0.611 0.611 0.610 0.609
## 3      Albania 0.781 0.790 0.793 0.797 0.797 0.797 0.798 0.801 0.805 0.794 0.794
##      2022 2023
## 1 0.495 0.496
## 2 0.615 0.616
## 3 0.806 0.810
```

Broadband

```
##      country 2011 2012 2013 2014 2015 2016 2017 2018
## 1      Aruba      NA 18.70000 18.60000 18.2000      NA      NA      NA
## 2 Afghanistan 0.00491 0.00474 0.00457 0.0209 0.0254 0.0257 0.0435
## 3      Angola 0.0653 0.08150 0.08520 0.32300 0.5450 0.2900 0.3210 0.3500
##      2019 2020 2021 2022 2023
## 1 17.700 17.700 17.7000 17.5000      NA
## 2 0.052 0.068 0.0664 0.0796 0.0801
## 3 0.368 0.363 0.3910 0.3870 0.3740
```

GDP

```
##      country      2011      2012      2013      2014      2015      2016
## 1 Afghanistan 1962.057 2123.871 2166.402 2145.500 2109.747 2102.452
## 2      Angola 7663.286 8011.050 8099.679 8183.165 7966.886 7487.925
## 3      Albania 11052.778 11227.950 11361.252 11586.817 11878.438 12291.842
##      2017      2018      2019      2020      2021      2022      2023
## 1 2097.120 2061.709 2080.941 1969.306 1517.016 1386.755 1359.020
## 2 7216.061 6878.590 6602.269 6029.692 5911.836 5906.116 5778.834
## 3 12770.992 13317.119 13653.182 13278.370 14595.944 15491.992 16209.877
```

4.4. Standardizing country names - rows

Since the datasets might have countries that are not listed in the others, we need to make sure that we standardize all the country names to match one of the datasets as our source. We will take the HDI dataset as our source, and compare the names, and check for the difference in rows/country names. If we find any difference, we will make sure to either match those rows to the source dataset country names, and also remove territories and records that are not common amongst all.

```
## [1] "Number of rows in HDI, Broadband, and GDP datasets:"
```

```
## HDI: 193 , Broadband: 206 , GDP: 193
```

```
## [1] "Countries in Broadband but NOT in HDI:"
```

```
## [1] "Aruba"          "Bermuda"          "Cayman Islands"
## [4] "Faeroe Islands" "Gibraltar"        "Greenland"
## [7] "Guam"           "Macao, China"     "Monaco"
## [10] "New Caledonia"  "Curaçao"          "French Polynesia"
## [13] "British Virgin Islands"
```

```
## [1] "Countries in GDP but NOT in HDI:"
```

```
## [1] "Monaco"          "North Korea"
```

We can see some differences in countries within each dataset. We will now standardize and filter the data to only focus on countries that are common amongst all three datasets.

After standardizing:

```
## Number of rows in HDI dataset: 191
```

```
## Number of rows in Broadband dataset: 191
```

```
## Number of rows in GDP dataset: 191
```

Now let's check for duplicates.

4.5. Handling duplicates (if any):

```
## 0 rows removed.
```

```
## 0 rows removed.
```

```
## 0 rows removed.
```

Now that we have standardized names, and checked for duplicates, let's explore the missing values.

4.6. Handling missing values - rows

```
## [1] "Empty values in HDI"
```

```
## [[1]]
## country    2011    2012    2013    2014    2015    2016    2017    2018    2019
##      0      1      1      1      1      1      1      1      1
##    2020    2021    2022    2023
##      1      1      1      0
```

```
## [1] "Empty values in Broadband"
```

```
## [[1]]
## country    2011    2012    2013    2014    2015    2016    2017    2018    2019
##      0      0      7      6      7      5      7      20      4
##    2020    2021    2022    2023
##      6      3      2     40
```

```
## [1] "Empty values in GDP"
```

```
## [[1]]
## country    2011    2012    2013    2014    2015    2016    2017    2018    2019
##      0      0      0      0      0      0      0      0      0
##    2020    2021    2022    2023
##      0      0      0      0
```

5. Methodology

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6. Results and Interpretation

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7. Discussions

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Appendix

Code

The report was created using *R* (R Core Team 2020) and *R Studio* (RStudio Team 2020) with *R Markdown* (RStudio, n.d.). The main library utilized for this purpose is *Tidyverse* (Wickham et al. 2019). Its used sub-packages include *dplyr* (Wickham et al. 2022) to enable query-like syntax, and *ggplot* (Wickham 2016) to create graphs and charts. Other packages and tools include *janitor* (Firke 2021), *knitr* (Xie 2022), *kableExtra* (Zhu 2021), and *scales* (Wickham and Seidel 2022).

References

- Firke, Sam. 2021. *Janitor: Simple Tools for Examining and Cleaning Dirty Data*. <https://CRAN.R-project.org/package=janitor>.
- Gapminder Datasets*. 2023. Gapminder. <https://www.gapminder.org/data/>.
- R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- RStudio. n.d. *Your Data Tells a Story. Tell It with r Markdown*. <https://rmarkdown.rstudio.com>.
- RStudio Team. 2020. *RStudio: Integrated Development Environment for r*. Boston, MA: RStudio, PBC. <http://www.rstudio.com/>.
- Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>.
- Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Golemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. <https://doi.org/10.21105/joss.01686>.
- Wickham, Hadley, Romain François, Lionel Henry, and Kirill Müller. 2022. *Dplyr: A Grammar of Data Manipulation*. <https://CRAN.R-project.org/package=dplyr>.
- Wickham, Hadley, and Dana Seidel. 2022. *Scales: Scale Functions for Visualization*. <https://CRAN.R-project.org/package=scales>.
- Xie, Yihui. 2022. *Knitr: A General-Purpose Package for Dynamic Report Generation in r*. <https://yihui.org/knitr/>.
- Zhu, Hao. 2021. *kableExtra: Construct Complex Table with 'Kable' and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>.