

Table of Contents

Introduction	1
Data	1
Persona and questions	2
Requirements	2
Design	3
Implementation	5
Walkthrough	10
Question 1	10
Question 2	12
Reflective Discussion	14
References	15

Introduction

1 out of 10 people in the world still lives in extreme poverty (i.e., below \$1.90 a day). (Freije-Rodríguez et al., 2022) In 2015, United Nations General Assembly set 17 interlinked Sustainable Development Goals to be achieved by 2030. "No Poverty" is one of the goals established by the United Nations to remove any form of extreme poverty from the world. So, to understand the progress made by the countries to eradicate extreme poverty, we decided to visualise it using a tableau.

Data

To visualise three datasets, i.e., the AID Effectiveness dataset from the world bank, the working poor and the Current poverty status (2021) from the International Labour Organization are used. Details on data are in the following table.

Dataset	Details	Link
AID Effectiveness	It contains information on AID and assistance provided by various countries and UN agencies, along with some development indicators between 1960 and 2020. In raw data, there were 19684 rows and 66 columns. After cleaning, the dataset was reduced to 4453 rows and ten columns.	Link
Working Poverty	It contains information on the extreme poverty rate (i.e., employed people living below \$1.90 a day). In the raw dataset, there were 4064 rows and seven columns.	Link
Current Poverty	It contains information on people living in extremely Poor, moderately poor, and near-poor in a country in 2021. There were 118 rows and five columns.	Link

Data dictionary for all the variables used are mentioned in following table.

AID Effectiveness		
Column Name	Description	Domain
Country Name	Name of country.	Text
Country Code	Code of country in ISO 3166-1 alpha-3 format.	Text
Year	Year of information related to.	Date
Net bilateral aid flows from DAC donors, United States (current US\$) **	Net disbursements of official development assistance from United State.	Number
Net bilateral aid flows from DAC donors, United Kingdom (current US\$) **	Net disbursements of official development assistance from United Kingdom.	Number
Net bilateral aid flows from DAC donors, Germany (current US\$) **	Net disbursements of official development assistance from Germany.	Number
Net bilateral aid flows from DAC donors, European Union institutions (current US\$) **	Net disbursements of official development assistance from European Union.	Number
Net bilateral aid flows from DAC donors, Total (current US\$) **	Total disbursements of official development assistance.	Number
Region	Groups of countries based on the regions used for administrative purpose by the world bank.	Text
Income group	Groups of countries classified based on the estimate of their GNI per capita for the previous calendar year.	Text
** Net bilateral aid flows is calculated by gross disbursements of grants and loans minus repayments of principal on earlier loans. ODA consists of loans made on concessional terms (with a grant element of at least 25 percent, calculated at a rate of discount of 10 percent) and grants made to promote economic development and welfare in countries and territories.		

Working Poverty		
Country	Name of country.	Text
Sex	It is a gender. There are three values in this field Male, Female and Total. Total represent the aggregated value of both male and female.	Text / Categorical
Year	Year of information related to.	Date
Poverty Rate	Rate of working people who are living below \$1.90 a day.	Number
Current Poverty		
Income Group	Groups of countries classified based on the estimate of their GNI per capita for the previous calendar year.	Text
Country	Name of country.	Text
Extremely poor	Rate of working people who are living below \$1.90 a day.	Number
Moderately poor	Rate of working people who are living below \$3.20 a day	Number
Near Poor	Rate of working people who are living between \$3.20-\$5.50 a day.	Number
Country Code	Code of country in ISO 3166-1 alpha-3 format.	Text

Persona and questions

"The UK has historically ranked highest among major donors for targeting poverty." (Rumford and Whitehead, 2022) UK AID direct is one of the organizations funded by the UK's Foreign, Commonwealth and Development Office that provides humanitarian assistance to various developing countries. So, the **fund director of UK AID** wants to understand the progress on extreme poverty reduction across developing countries. Here in this scenario, **the fund director of UK AID** is the persona. Similarly, an alternative persona could be the **executive director of UNICEF**, who is planning to launch a support program for least developed countries in the Sub-Saharan Africa region.

Both the persona have expert level domain knowledge, are highly experienced and have average technical knowledge.

From the above persona's perspective, we are answering the following two research questions through the visualization technique.

1. Which countries have the highest poverty rate, what is their current poverty status, its trends in the last decade and is there any significant relationship between the male poverty rate and the female poverty rate?
2. Which countries have the highest poverty rate, current poverty status, and trend in the flow of aid to those countries in the last decade?

Requirements

1. R1. To answer Q1, user need to know the countries with high extreme poverty rate.
 - Cluster the countries into three group based on poverty rate
 - Visualise the cluster in map with three distinct colours.
 - Plot current poverty statistics in doughnut chart
 - Plot last decade's poverty rate in line chart to understand trend.
 - To distinguish line chart by gender, distinct colours should be used.
 - Filter all view by country and line chart by date and gender.
2. R2. To answer Q2, we need to countries cluster and poverty statistics same as R1. Further we need to plot the information of AID flow.
 - Plot the flow of AID in bar graph.
 - Add new filter to filter doner countries.

Apart from the functional requirements, there are some non-functional requirements.

3. R3. Every data point must have proper tooltip.
4. R4. Screen resolution must be within 1080p
5. R5. Proper title must be given in each chart.

Design

Based on the above research questions and requirements following prototype design (Paper Landscape) has been developed.

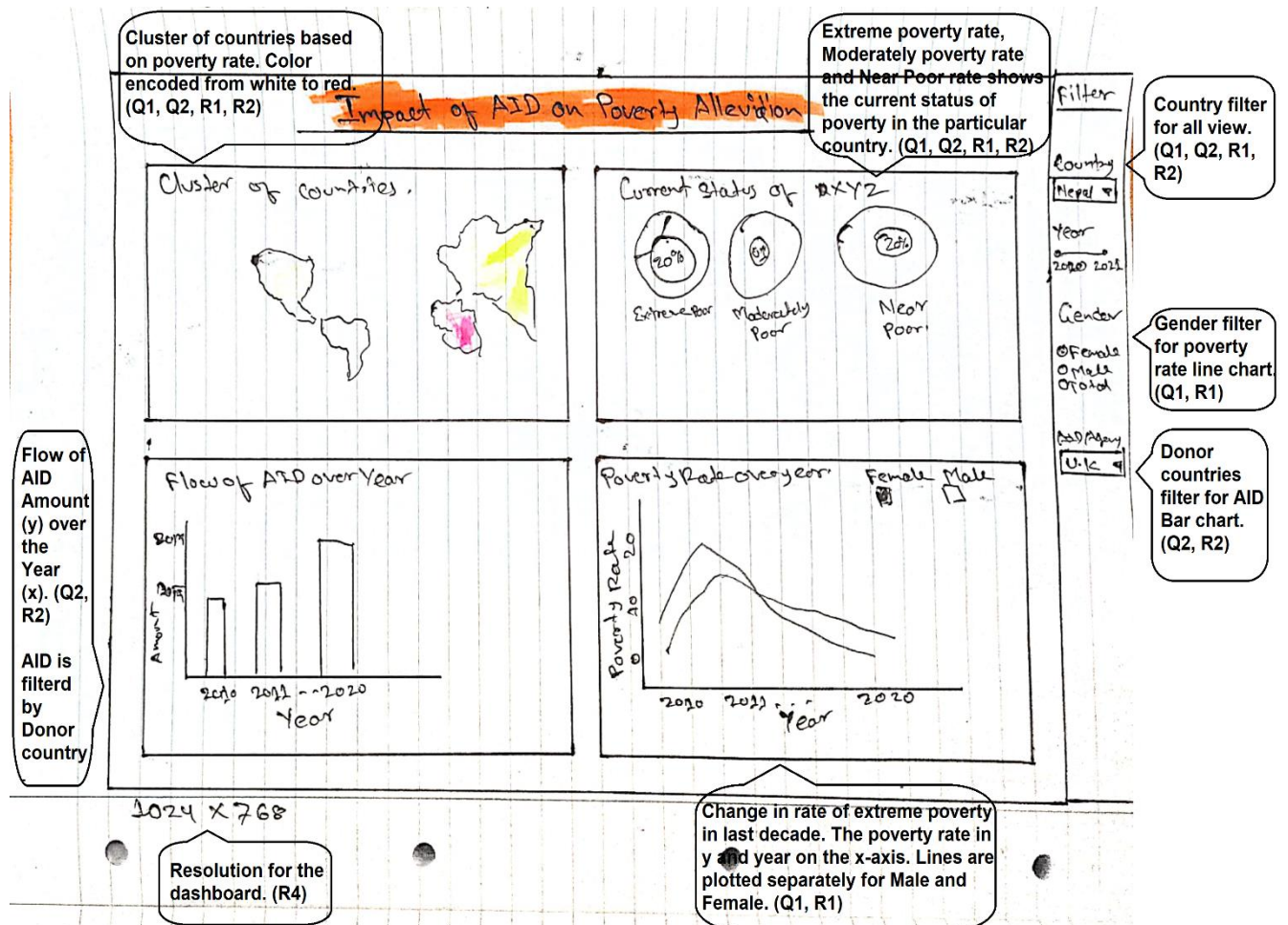
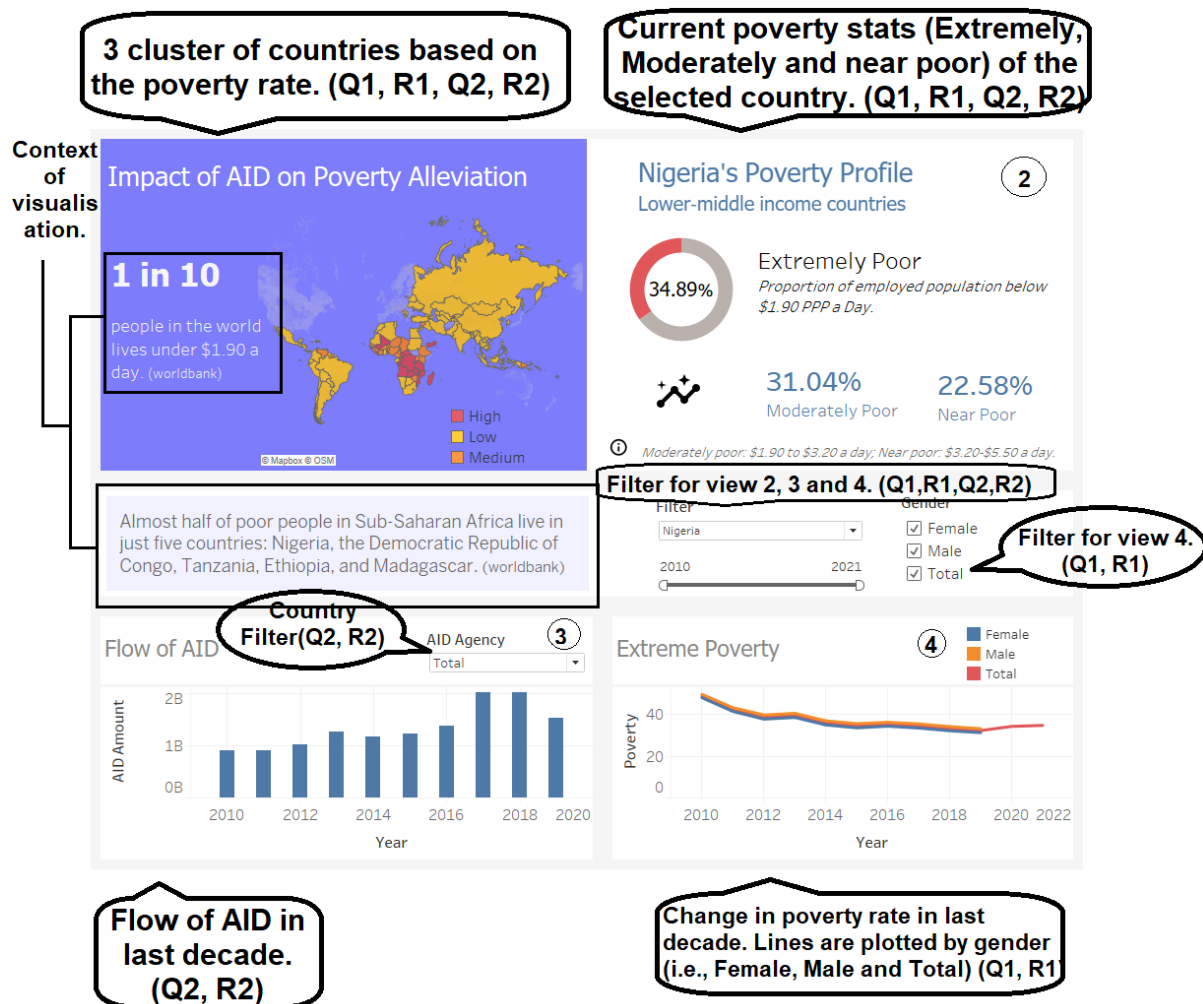


Figure 1: Annotated Paper Landscape

While implementing the above prototype in tableau, some improvements have been made to get more insight from visualization. Annotated screenshot of tableau implementation is mentioned in the following figure.



There is slight modification while implementing the prototype in the tableau. Firstly, the filter on the right sidebar of the prototype has been moved to the right column of the second row in the tableau because the sidebar occupied the whole column and made the design messy. Moreover, the AID Agency filter is moved to the Flow of AID view to utilise the space possible. Similarly, in the current statistics view (2), only the extremely poor data is shown in the doughnut chart, and moderately poor and near-poor data are presented as text with highlighted colour. Here, I am trying to emphasise extremely poor data and give more importance to the visitor's perception. This idea is based on the Gestalt principle of similarity. If we want to make some visual items stand out from the crowd, we can change that item into dissimilar. (Chapman, 2022a) "Without proper context - numbers are just numbers and colours are just colours". (Robitaille, 2013) So, the context has been added to convey more insight and background on the visualisation.

In this visualisation, we try to use colours based on the basic understanding of colour psychology. (Chapman, 2022b) explained that red colour represents danger and passion, and bright blue is affiliated with communication. Also, blue is the most universally liked colour in the world. Based on this concept, red colour is used in doughnut charts and maps to represent the extremely poor-rate and extremely poor country on the map, respectively. Furthermore, the background on the first view and statistics on the second view is brighter blue to symbolise that it is trying to communicate some information.

Implementation

The prototype, as mentioned earlier, has been implemented using tableau as a primary tool and d3.js as a secondary tool.

Eight views were used to achieve the intended visualization in a single dashboard. Let us explore each view in sequential order.

The first view is related to the cluster of countries. A cluster of Country and Extreme poverty is created by dragging the cluster from the analytics pane to view. After making the cluster, it is saved as a group with the name Extreme Poverty Cluster so that it can be used in a map with colour. A new view was created, the country was dropped to view, and the cluster group was visualized by dropping Extreme Poverty Cluster to the colour mark. Similarly, Extreme poverty was dropped to the tooltip to view the rate of extreme poverty in a particular country.

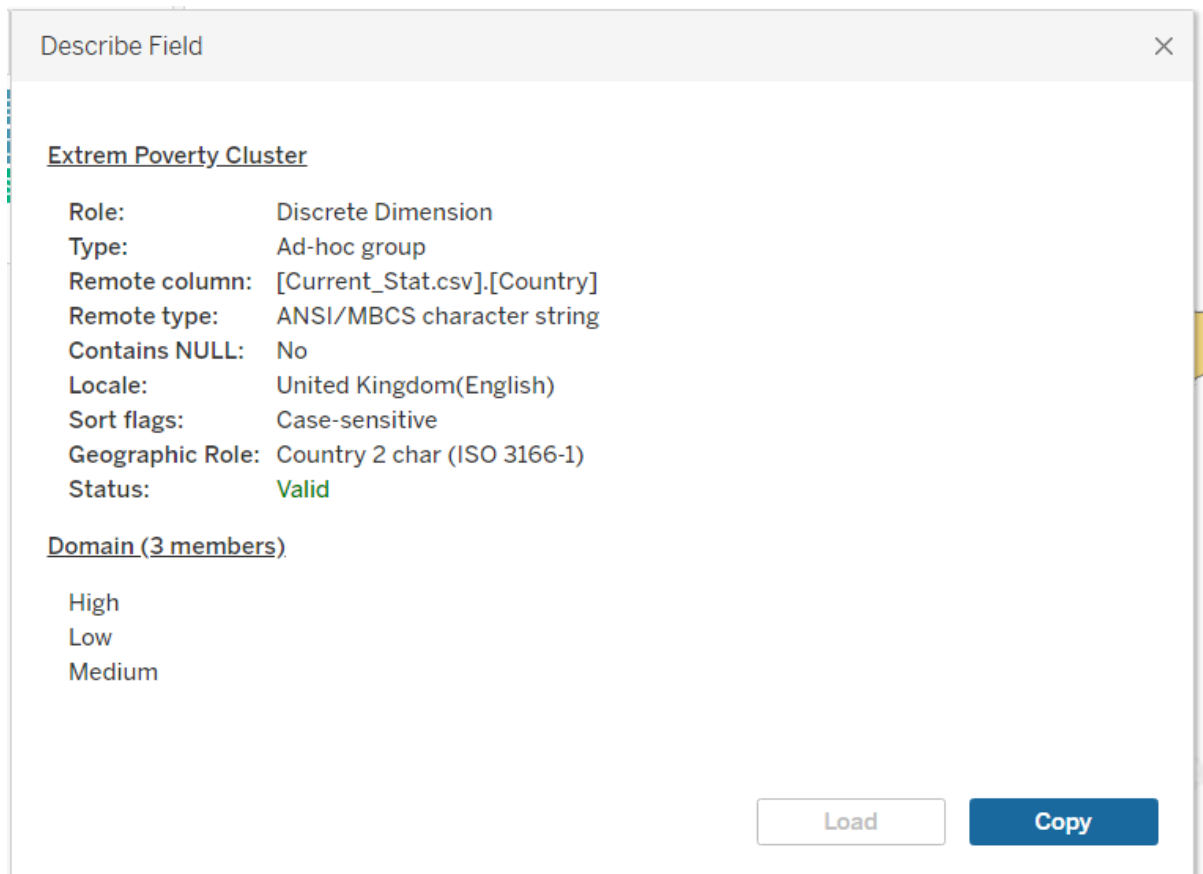


Figure 2: Extreme Poverty Cluster

The following view is a line chart showing the change in the poverty rate over the last decade. We have used Measure Name as a filter to generate this chart because three fields (Female, Male and Total) are in the chart. These fields are the calculated fields derived from the Poverty rate field. We dropped filtered

Measure values to rows and years to columns. Similarly, we dropped Measures Names to colour to distinguish each line by a different colour.



Figure 3 Extreme Poverty Rate

In the bar chart, AID Cal is plotted against the country. AID Cal is calculated based on the filter from the AID Agency parameter.

Value	Display As
EU	European Union
Germany	Germany
UK	United Kingdom
US	United State
Other	Other

Figure 4: AID Agency parameters

To generate the chart, we dropped AID Cal to rows and Year to Columns.

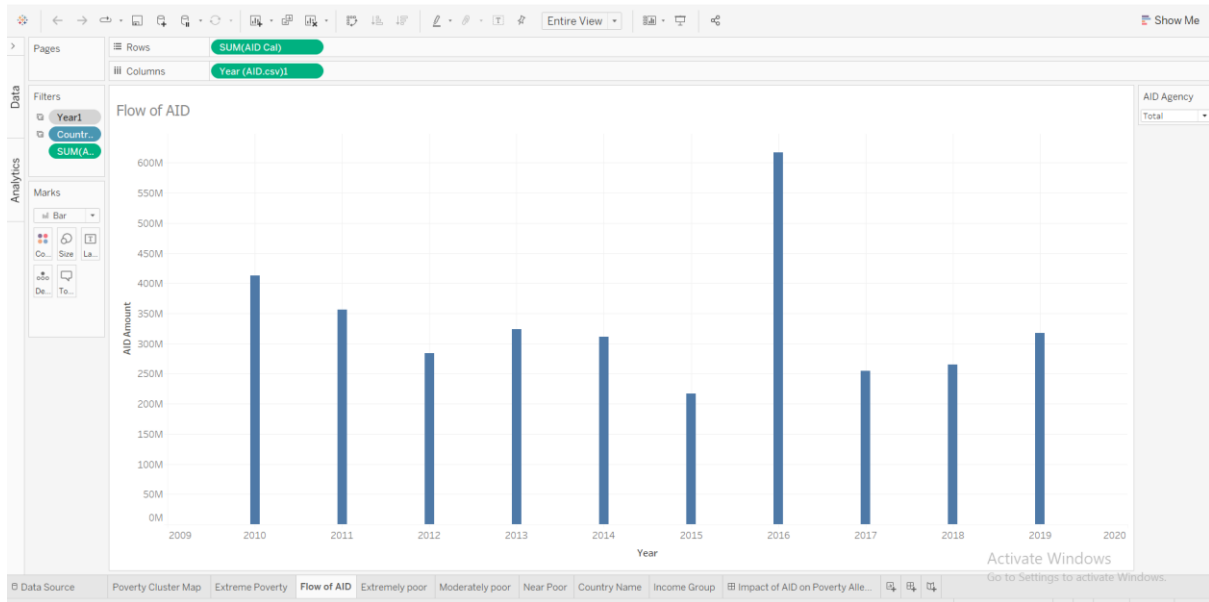


Figure 5 Flow of AID

Similarly, we have plotted an extremely poor rate of the filtered country in the doughnut chart in extremely poor view. There is no chart called doughnut in tableau, so, to achieve the doughnut chat, we have implemented two pie charts and merged them.

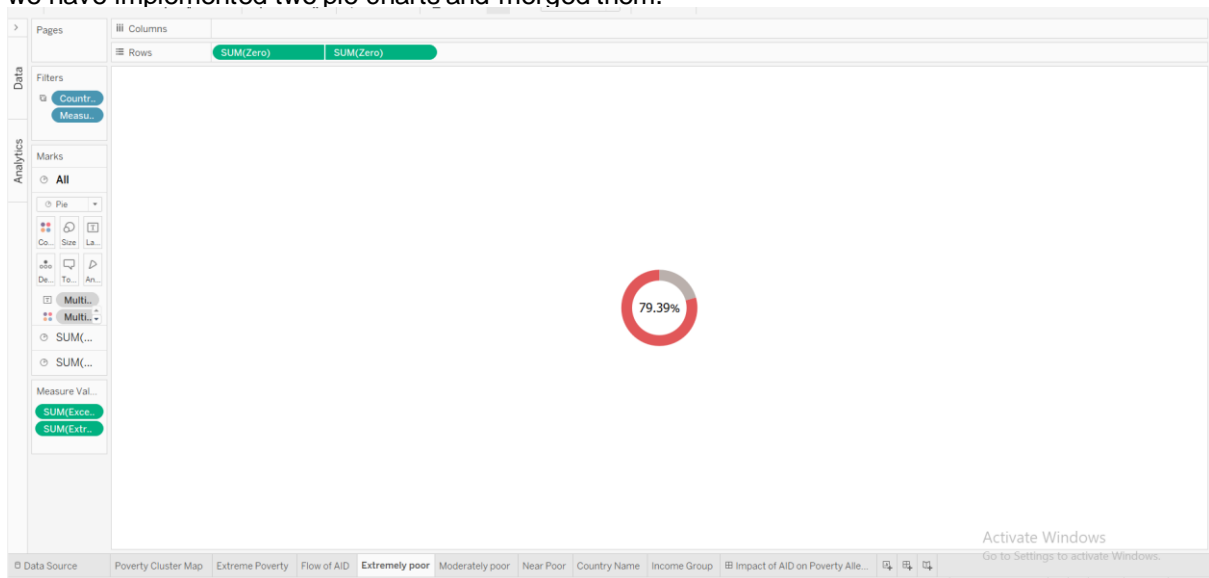


Figure 6 Doughnut chart showing extremely poor rate

Similarly, moderately poor, near-poor, country name and income group are text showing the values from moderately poor, near-poor, country, and income group fields.

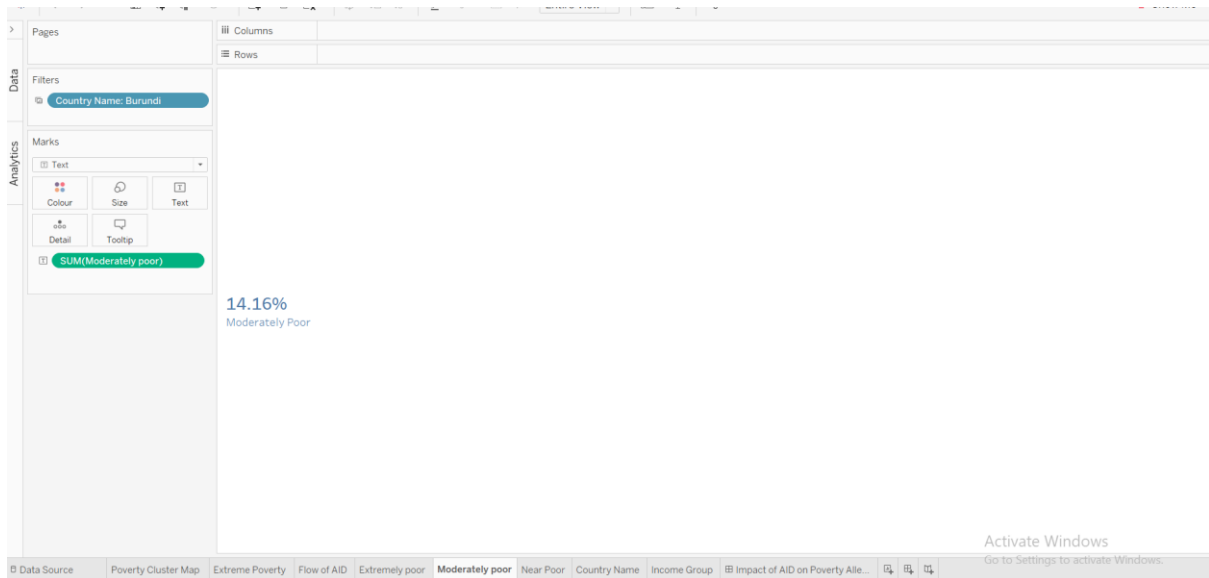


Figure 7 Current status text

For interaction and filter, country and date range has been used as global filter and Gender and AID Agency as a local filter.

While merging all these views, a tiled layout has been used, and a few objects such as text for context, icons and filters have been used as a floating layout.

While implementing the visualization on the tableau, a few issues were tackled. The most challenging issue was creating a doughnut chart because we needed to create a custom chart using existing charts. After search a solution for a couple of days, we found one of the best solutions by [Viztip](#) on youtube. The solution was simple, creating two pie charts of different sizes and merging both charts by converting the view into a dual-axis.

Similarly, for the second implementation, we have used d3.js. It is a JavaScript library for data visualization.

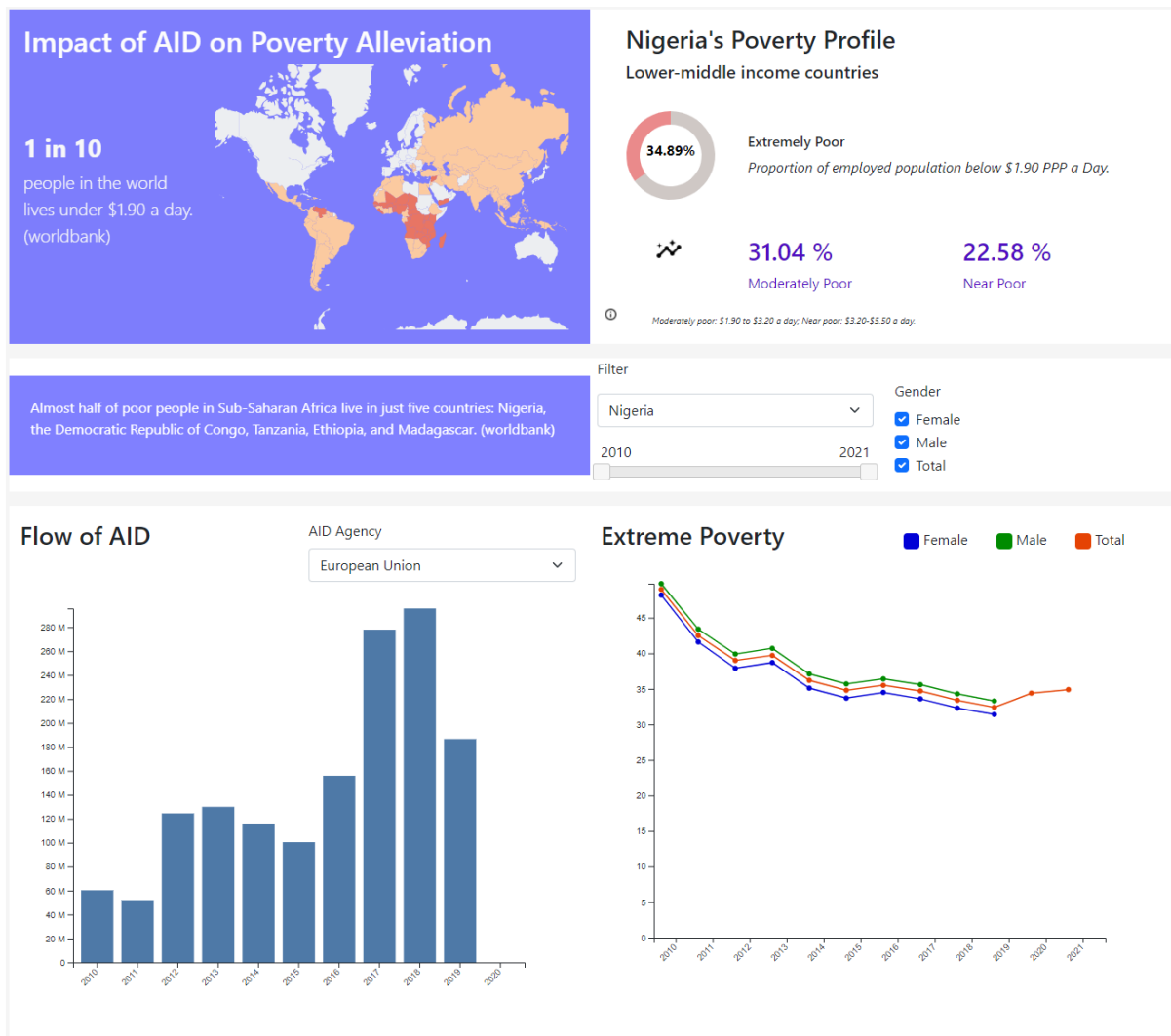


Figure 8: d3.js implementation

Since d3.js is a JavaScript library, it manipulates the DOM and uses SVG to generate charts. Apart from d3, we have used bootstrap for style, jQuery for DOM manipulation and jQuery UI for year range slider. Both tableau and d3 implementation are almost identical, but one of the significant differences in how the countries are clustered. The tableau uses K-mean clustering, but in d3, there is no implementation for it. So, we grouped the data by simply dividing extremely poor rates. Moreover, another issue with d3 is the lack of proper documentation for API and functions.

Walkthrough

From both tableau and d3 implementation, we managed to achieve the answer for both research questions Q1 and Q2.

Question 1

In the walkthrough, to achieve the answer for research question Q1 following steps should be followed:

Step1: Explore the cluster of countries on the top left view. Countries with a high extreme poverty rate are clustered under high dark red colour. Here Burundi has a very high extreme poverty rate of 79.39 % of working people. (Q1, R1, R3)

Note: You can zoom and move the map as per your requirement.

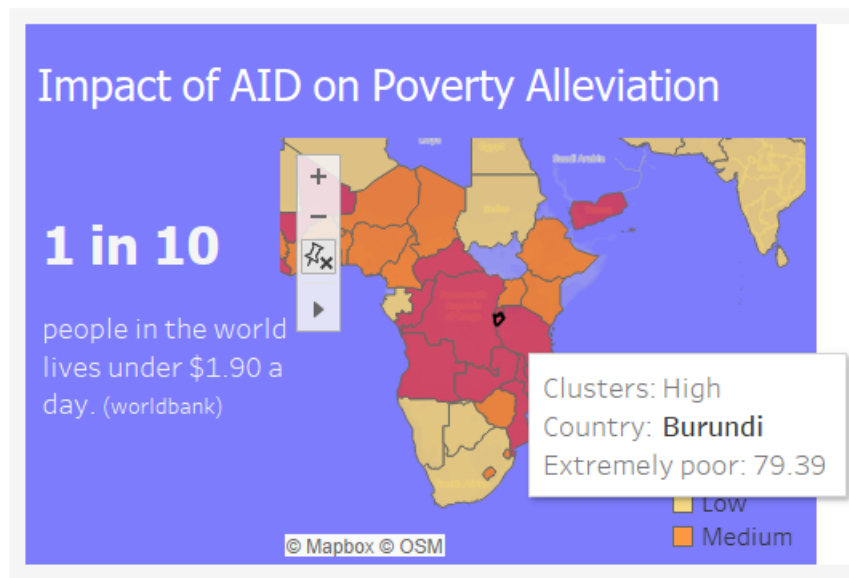


Figure 9 Countries cluster

Step 2: From step 1, we found that Burundi has the highest poverty rate. So, let us set a country filter to Burundi. Search and select Burundi from the country filter, which lies on the second column of the second row. (Q1, R1)

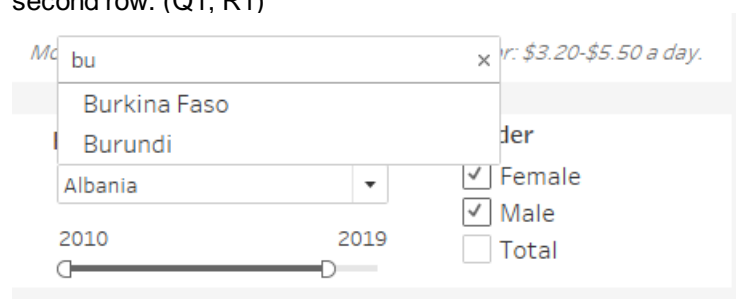


Figure 10 Country filter

Step 3: To visualise the change in the poverty rate in the last decade, we need to adjust the year range between 2010 and 2019 from the year filter. (Q1, R1)

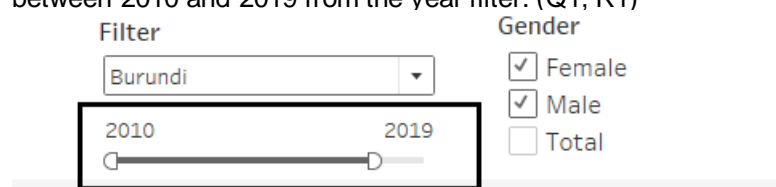


Figure 11 Year range filter

Step 4: To identify the difference between female and male poverty rate. We need to select Male and Female from gender filter. (Q1, R1)

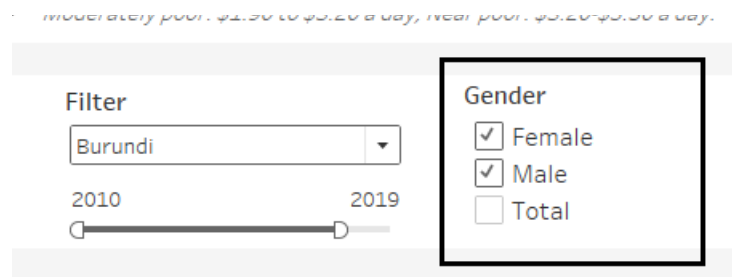


Figure 12 Gender Filter

Step 5: As a result, we got following dashboard. (Q1, R1, R4, R5)

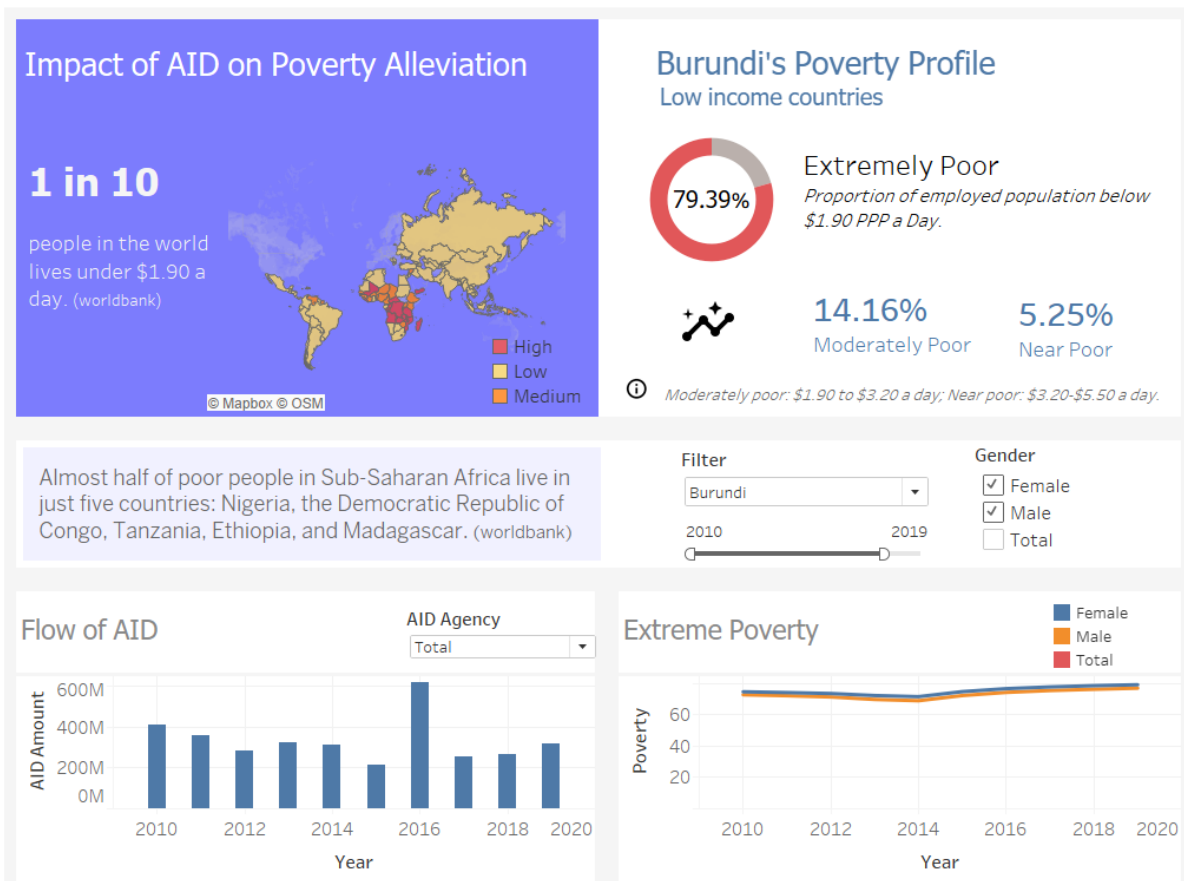


Figure 13 Final Result

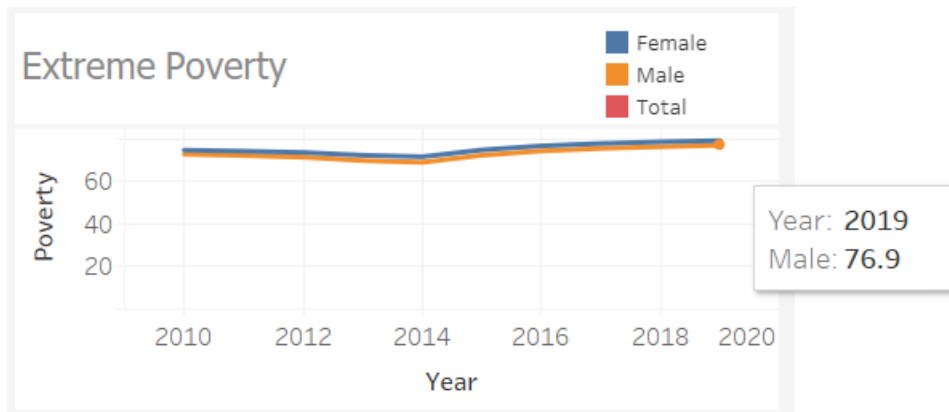


Figure 14 Male Poverty Rate

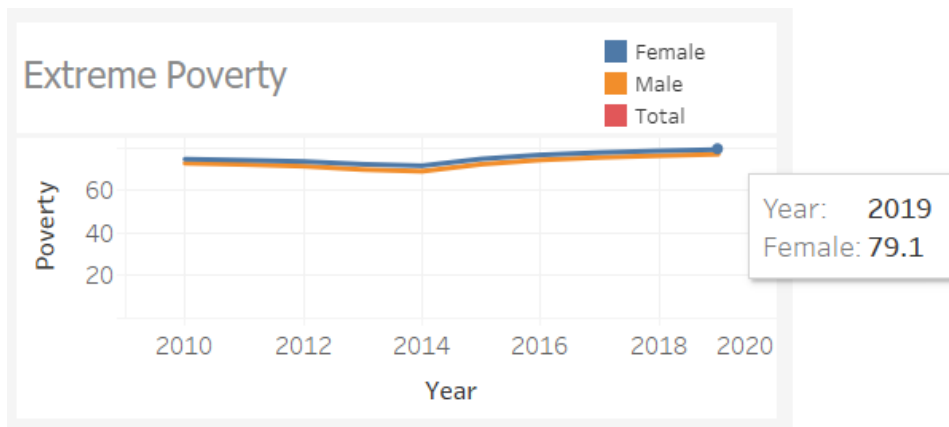


Figure 15 Female Poverty Rate

In similar fashion we can derive similar result from d3 implementation.

As an answer to Q1, Burundi is one of the countries with the highest extreme poverty rate. The current extreme poverty rate is 79.39%, the moderately poor rate is 14.16% and 5.25% near-poor. From the data of 2019 Female poverty rate is higher than the male.

Question 2

For the second research question, two views (first and second) and two filters (country and date range) are similar to the first question.

To answer the second research question, we will repeat the first three steps from the first question, so we have skipped those steps and started from step 4.

Step 4: To view the flow of development assistance in the last decade, select a donor country from the filter located in the Flow of AID view.

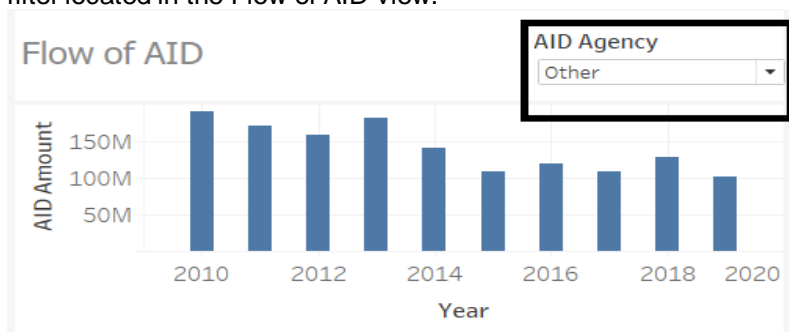
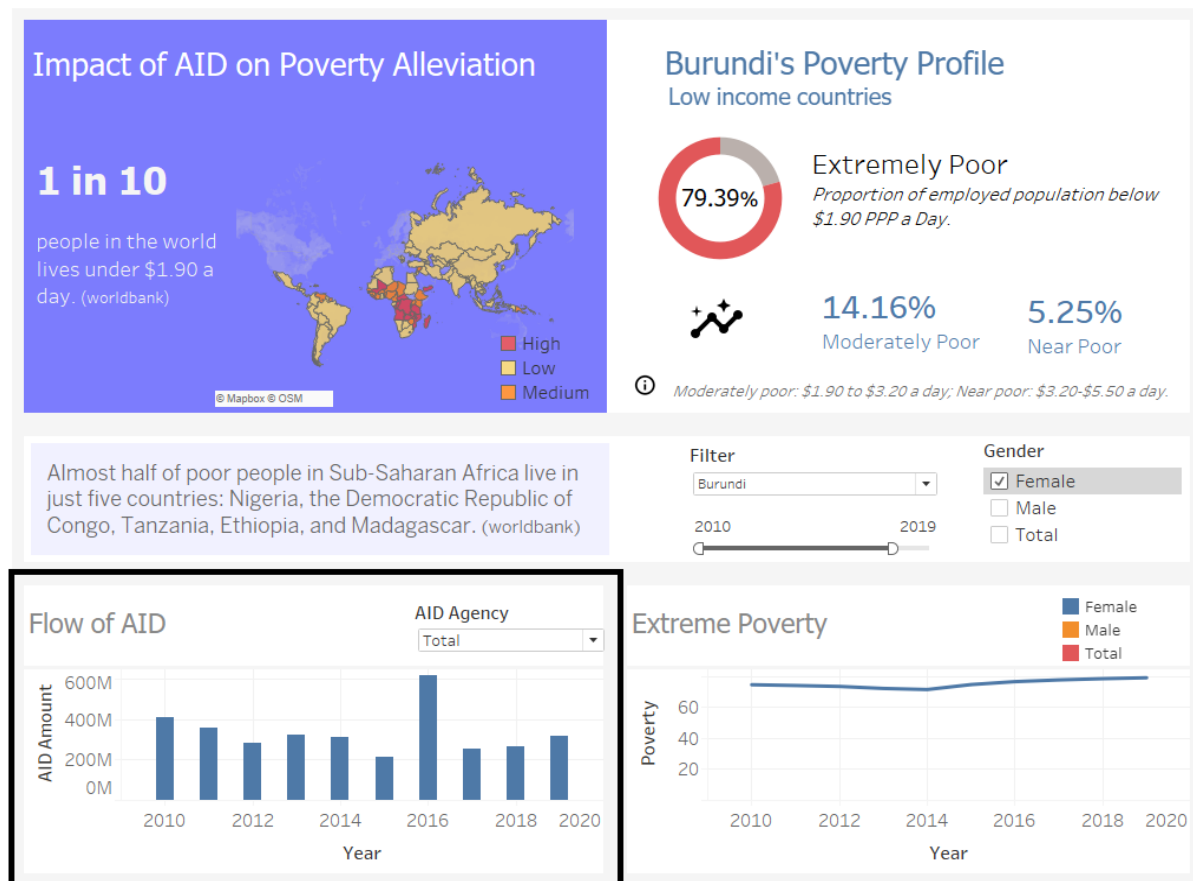


Figure 16 Country / Agency filter on Flow of AID view

Step 5: As a result, we got the following dashboard result.. (Q2, R2, R4, R5)



From this dashboard, we can quickly answer the second question. Burundi is one of the countries with the highest extreme poverty rate, and the current extreme poverty rate is 79.39%, the moderately poor rate is 14.16% and 5.25% near-poor. In 2016, Burundi received the highest AID from the donor at about 600 million USD, and in 2019 it is 317 million USD.

Both research questions Q1 and Q2 can be answered via both implementations, i.e., Tableau and D3. D3 implementation has similar control as tableau implementation, and the interface is almost similar. So, generated visualisation to answer the research question on d3 similar procedure mentioned above must be followed.

Reflective Discussion

Overall, we managed to answer both research questions using Tableau and d3. Though both tools were based on different technologies, we achieved almost similar views and controls.

Implementing the visualization project in Tableau and d3 was an excellent opportunity to practically sharpen the knowledge and skills acquired during the course. While working on this project, hands-on experience on the various components of Tableau and d3 were gained.

We have learned that Tableau is not just a visualization tool during implementation. Further, it is an analytical tool, whereas d3 is a visualization tool for the web. For example, we efficiently implemented clustering to cluster the countries based on extreme poverty in Tableau, but there was no method or API for clustering on d3. Also, the best part of Tableau is the short learning curve and a thriving community compared to d3. Visualization can be designed rapidly in Tableau, but d3 is time-consuming. For example, in this project, we had created the histogram in a few minutes by simply dragging and dropping the fields into rows and columns, but in d3, we had to write 30 lines of code to generate the bar chart. Also, we need to write a script to bind with various mouse events on charts and tooltips. So, Tableau is more efficient and worth it in terms of time efficiency. At the same time, we can have more control over the visual component in d3 rather than Tableau because almost everything in d3 needs to be created from scratch using JavaScript.

We tried to experiment with some UX and colour theories during this process. As a result, we can say that proper graph representation with suitable presentation and interaction can provide more insightful information than images and data. For example, a map plotted with a colour hue is far better than a table showing the list of countries and can convey insightful information easily. Similarly, this project taught us that readability and legibility are paramount in data visualization. "Users will not read the content unless the text is clear, the words and sentences are simple, and the information is easy to understand." (Nielsen, 2015)

Since this project is our first step toward data visualization, it opens the door to further studying data visualization and the science behind it. With some background that we acquired through this project, we will continue our research on improving user experience on data visualization and how to do storytelling via data visualization.

References

Freije-Rodríguez, S., Woolcock, M., Castañeda, R., Cojocar, A., Howton, E., Lakner, C., Nguyen, M., Schoch, M., Yang, J. and Yonzan, N., 2022. *Poverty and Shared Prosperity 2020: Poverty and Shared Prosperity 2020: Reversals of Fortune*. [online] Washington, DC: World Bank, p.28. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/34496/9781464816024.pdf> [Accessed 5 April 2022].

Rumford, H. and Whitehead, A., 2022. *Eradicating extreme poverty: the role of UK aid*. [online] Bond. Available at: <https://www.bond.org.uk/news/2022/03/eradicating-extreme-poverty-the-role-of-uk-aid> [Accessed 5 April 2022].

Chapman, C., (2022a) *Exploring the Gestalt Principles of Design*. [online] Toptal Design Blog. Available at: <https://www.toptal.com/designers/ui/gestalt-principles-of-design> [Accessed 6 April 2022].

Robitaille, R., 2013. *Communicating ideas - "if content is king, then CONTEXT IS GOD"*. [online] Tableau Public. Available at: <<https://public.tableau.com/en-gb/s/blog/2013/10/communicating-ideas-if-content-king-then-context-god>> [Accessed 6 April 2022].

Chapman, C., (2022b) *The Role of Color in UX*. [online] Toptal Design Blog. Available at: <https://www.toptal.com/designers/ux/color-in-ux> [Accessed 6 April 2022].

Nielsen, J., 2015. *Legibility, Readability, and Comprehension: Making Users Read Your Words*. [online] Nielsen Norman Group. Available at: <https://www.nngroup.com/articles/legibility-readability-comprehension/> [Accessed 7 April 2022].