Summiting Risks

FIT5147 – Data Visualization Project

Name: Sanchita Reddy
ID: 33483086
Applied Class: 06
Teaching Associate: Mohit Gupta

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1.0 Introduction

The allure of the eight-thousanders, those **14 mountains exceeding 8,000 meters** that pierce the Himalayan and Karakoram skylines, has long captivated the mountaineering world. Recently, expeditions to these peaks have seen a surge reflecting a growing passion for high-altitude exploration, it has also gathered significant **attention due to the concerning rise in fatalities** (Callaghan, 2023). As an individual with a connection to mountaineering, this project is driven by my desire to leverage data to contribute to a future where expeditions are undertaken with a heightened focus on **safety for all climbers**.

1.1 Findings from Previous Analysis

Our prior analysis of eight-thousander fatalities revealed an interplay between **geographical location and climber safety**. Mountain range played a significant role, with Everest, Manaslu, and K2 emerging as particular danger zones. **Weather conditions**, especially **temperature**, proved to be a key factor, and these variations differed significantly by mountain. For instance, while extreme cold remains a threat throughout, thin air and low pressure create a harsh environment at high altitudes on certain mountains.

The analysis also identified a trend of fatalities among climbers from Nepal, Japan, and South Korea. This suggests a link between **nationality and cause of death**, possibly due to differences in preparatory facilities available in various countries. Furthermore, each mountain presents a unique set of challenges that change **throughout the year**. Avalanche risk due to heavy snowfall might be highest in one month on a particular mountain, whereas another might be most dangerous during periods of extreme cold. This emphasizes the critical importance of planning expeditions for the right time of year, considering the **specific location and historical weather patterns** of the chosen mountain.

1.2 The Message of This Dashboard: Climb Smarter, Summit Safer

Each eight-thousander presents a unique challenge, with distinct risks and demands that vary from mountain to mountain. This report empowers climbers with data-driven insights, highlighting the diverse hazards associated with each peak, such as avalanches, extreme weather, and technical difficulties. By providing detailed information on these risks, the dashboard enables climbers to plan their expeditions more effectively, allocate resources wisely, and tailor their training programs to address specific challenges. Ultimately, this informed approach enhances both safety and the chances of a successful ascent, demonstrating the critical importance of understanding and preparing for the unique conditions of each eight-thousander.

1.3 Targeted Audience: Eight-Thousander Expedition Groups and Planners

The targeted audience primarily consists of **mountaineers, expedition organizers, and outdoor enthusiasts** with an interest in high-altitude climbing. These individuals may have varying levels of experience, ranging from seasoned climbers looking to conquer new challenges to novices seeking to learn more about the complexities of mountain expeditions. They are likely to be analytical and detail-oriented, valuing data-driven insights to inform their decision-making processes. The secondary audience includes researchers, safety experts, and organizations involved in mountain rescue and expedition planning, who rely on comprehensive information to enhance safety protocols.

2.0 Design Process

In Sheet 1, the goal was to explore various visualizations that effectively convey the message described above. On consideration, three elements — number of fatalities, mountain ranges, and months of the year were carefully picked as these elements are essential for **understanding the risks associated** with climbing different eight-thousanders. *Refer to Section 1.1 of the Appendix for the Five-sheet-design.*

Data Types and Visualization Considerations:

- Number of Fatalities: Quantitative data, critical for assessing risk levels.
- Mountain Ranges: Categorical data, representing the different eight-thousanders.
- Months of the Year: Ordinal data, highlighting seasonal variations in climbing risks.
- Nationality: Categorical data, representing the deceased climbers.
- Cause of Death: Categorical data, critical risk by mountain.

Ten visualizations were explored in Sheet 1 that were carefully selected to ensure they effectively **communicated critical information** about climbing risks. Each visualization was chosen for its ability to handle **specific data types**, **visual appeal**, and potential to **engage the target audience**. By balancing these elements, the visualizations provided clear, comprehensive, and engaging insights into the risks associated with eight-thousanders.

	Quantitative	Ordinal	Categorical
Position	Good	Good	Good
Shape	Poor	Poor	Good
Size	Good	Good	Poor
Orientation	Moderate	Moderate	Good
Hue	Moderate	Moderate	Good
Value	Moderate	Good	Poor
Saturation	Moderate	Good	Poor
Texture	Moderate	Moderate	Good

Figure 1: Visual elements scale for Data Types (Monash University).

Other elements such as **colour (hue and saturation)**, **size (markers)**, and area, using the adjacent table to effectively present the data:

- Colour: Different **hues** to distinguish between mountain ranges and months, with **saturation** adjustments to highlight fatality depth.
- Size and Area: Marker sizes represented the number of fatalities, making it easy to identify higher-risk mountains or months.

Filtering: Visualizations that **did not effectively convey** the message or were **difficult to interpret** were filtered out, ensuring clarity and user focus. For instance, a stacked bar chart presented a challenge where the stacks on different bars (months) could not be compared easily making it ineffective.

Visualizations were categorized into univariate and bivariate:

- Univariate: Focused on a single variable, such as **bar charts and scatter plots.**

- Bivariate: Combined two variables, providing deeper insights, such as **flow maps and heat maps.**

Combining and Refining: Univariate visualizations were combined to create more **meaningful insights** while avoiding information **clutter**. This approach helped in presenting a clearer narrative by linking related data points.

Two key questions guided the layout options:

1. How crucial is the geographic location of mountains for climbers to plan logistics and assess terrain-specific risks?
2. Psychology of the Target Audience: Considering whether climbers plan expeditions based on the mountain or the time of year, influenced how the information was presented.

In the subsequent sheets, different layouts were considered to test various narrative strategies: **author-driven, reader-driven, and hybrid approaches**. The objective was to determine which approach was most effective at conveying the message about climbing risks associated with eight-thousanders. Additionally, different genres, such as a **magazine-style** (create a visually engaging and structured narrative) and **flow chart** (progression of information and decision points, making complex data more understandable.), were explored to enhance the narrative and engagement.

Sheet 2: Hybrid Approach

In Sheet 2, the layout was designed to test the importance of a hybrid approach, where the narrative is loosely controlled, and the flow of information is predetermined. This approach used **interactive filters** and followed a visualization hierarchy starting from a map.

Layout: A **hierarchical layout** was adopted, beginning with a **map** that provided the essential geographic context, showing the locations of the eight-thousanders. This helped users immediately grasp the **spatial relationship** between the mountains and understand the distribution of fatalities. The map was followed by a **scatter plot and bubble map**, which added layers of insights about climate factors and nationalities, respectively. This progression from general to specific information allowed users to build their understanding step by step, reducing the **cognitive load**.

Typography with Serif fonts: Serif fonts, notably Times New Roman, were considered for their association with a formal aesthetic.

Visual Variables: Colour hue was used to distinguish different data types (fatalities, climate, nationalities), aiding quick differentiation, and reducing **cognitive effort**. A **consistent colour** scheme was maintained for **each mountain** throughout the dashboard, making it easy for users to relate different visualizations to specific mountains. **Marker sizes** represented fatality magnitudes, making scale comparisons easy. A **grey background** was used to enhance visibility and reduce eye strain.

Pros and Cons:

- **Geographic Importance**: The author-driven approach successfully demonstrated that geographic location mattered to climbers (*ANALYSIS of SPATIAL SIGNIFICANCE of MOUNTAIN OBJECTS EXTRACTED from MULTISCALE DIGITAL ELEVATION MODELS*, 2014).
- **Temporal Patterns**: However, this layout was less effective in conveying the fatality patterns across different times of the year.
- The chosen **font** was not suitable for digital formats, something that is essential to this dashboard. The **grey background** did not highlight the colours well.

Sheet 3: Reader-Driven Approach

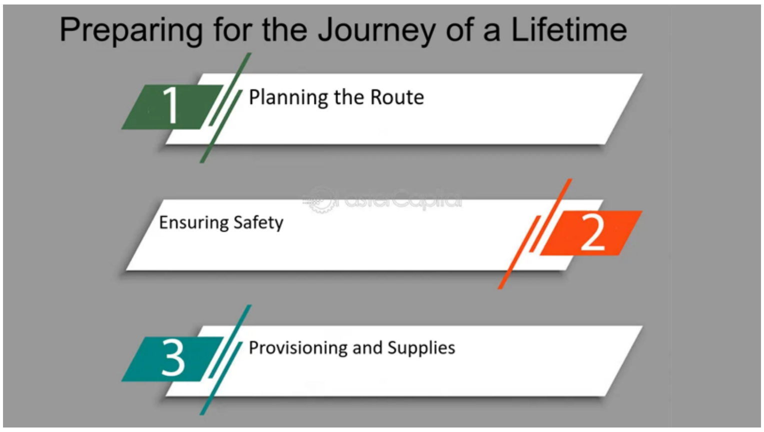


Figure 2: Climber Psychology (Draper et al., 2008)

Sheet 3 focused on giving **users control** over the data they wished to explore. This approach was designed to **enhance user engagement** by allowing climbers to filter information based on the **specific mountain** they were interested in.

<u>Layout</u>:

- <u>User Filters</u>: Users could select a mountain from the dataset, **tailoring the visualizations** to their choice.
- A **rose plot** was included to show the dangerous months for the selected mountain. This visualization highlighted fatality patterns and the causes of deaths during each month, providing **seasonal risk insights**.
- A **word cloud** displayed the nationalities of climbers involved in fatalities. This element captured the **viewer's attention** and provided a quick, comprehensive view of the affected groups.
- A **white background** was tested with this layout, highlighting all colours and having a clean look to avoid distractions.

Typography: In terms of typography, a **sans-serif** font was employed for its modern and clean appearance, enhancing readability, and ensuring consistency across the dashboard.

Visual Variables: A **continuous colour palette** was used to differentiate months and fatality causes, reducing cognitive load for the user. The **size of elements** in the word cloud and rose plot effectively reduced the **cognitive load** for the users, allowing them to grasp the message with a glance.

Pros and Cons:

- **User Control**: Giving control to the user proved essential. Climbers need to view data based on the mountain of their choice, and this layout facilitates personalized exploration.
- **Attention Capture**: The rose plot and word cloud effectively highlighted critical data points.
- **Potential Over-Simplification**: By prioritizing ease of use and visual appeal, there is a risk of oversimplifying the data, missing out on more complex relationships and insights that could be valuable to experienced climbers.

Sheet 4: Author-Driven Approach

This approach is characterized by **minimal interactivity** and a strong focus on delivering a **predefined message**. This approach aimed to guide the user through the data in a tightly controlled manner, ensuring that the narrative was communicated without distractions. No filters were provided, and interactivity was kept to a minimum.

Layout:

- A **line plot** shows the number of deaths at each mountain by month. This visualization was chosen for its simplicity and ease of interpretation.
- A **tree map** displays total deaths by cause, providing a comprehensive overview of the different fatality causes.
- To communicate the message about climate, a **scatter plot** was included with hover functionality. This added a layer of detail without cluttering the primary visualizations.
- The **background** employs a **subdued blue colour** to maintain focus on the data while providing a neutral backdrop for visualizations.

Typography: Script fonts are utilized for their modern and clean appearance, enhancing readability. However, this font might not be best suited for a professional dashboard, with the font having a childish appearance.

Visual Elements: The line plot uses **colour hue** variations for mountain differentiation, while the tree map employs **saturation and size** to convey cause frequency and magnitude efficiently, minimizing **cognitive load** for users.

Pros and Cons:

- By controlling the flow of information, the approach ensured that the message was delivered clearly.
- The line plot and heat map were **straightforward to interpret**, making it simple for users.
- This approach did not allow users to focus on a particular expedition they wanted to plan. The absence of filters and interactivity limited the ability to **tailor insights** based on individual needs.

Category	Sheet 2	Sheet 3	Sheet 4
Vizualization Elements	Map, Scatter plot, Bubble Map	Rose plot, Word Cloud	Line Chart, Tree Map
Background	Grey	White	Light Blue
Typography	Serif	Sans-Serif	Script
Narrative	Hybrid	Reader-driven	Author-Driven
Interactivity	Filters for Months, Tooltips	Filter for Mountain, Tooltips	Tooltips

Figure 3: Sheet 2, 3 and 4 Comparison with Green highlights for elements chosen for Sheet 5.

Ultimately, the decisions on the final layout made above were made based on **Munzner's What-Why-How Framework**:

The final layout adheres to the principles of the framework. The **"What"** refers to the data (fatalities, mountain ranges, months, climate factors, and nationalities), the **"Why"** focuses on understanding spatial distribution, temporal patterns, and categorical relationships, and the **"How"** involves using the map, rose plot, scatter plot, and bubble map to achieve these objectives. This structured methodology ensured that each visualization **was purposeful and effectively communicated** the intended message, thereby reducing unnecessary **cognitive load**.

Sheet 5: Hybrid Approach

Sheet 5 combines the best elements from Sheets 2 and 3, creating a hybrid approach that balances **narrative control with user interactivity**. This decision was based on a comprehensive analysis of the approaches tested in each sheet, focusing on **climber psychology and the hierarchy of information.**

- **Climber Psychology** suggests that climbers often have a **specific mountain** in mind for their expedition. Therefore, allowing users to tailor insights based on their chosen mountain is crucial.
- **Tailored Insights**: Interactive elements like a filter for mountain ranges enable climbers to filter data according to their specific needs, enhancing the relevance and usefulness of the dashboard.
- From the visualizations explored in DEP, it was clear that presenting information in a **hierarchy of importance** helps deliver a clear and informative message. Thus, starting with a **broader context and drilling down** into details ensures that users can grasp the overall picture, reducing **cognitive load**.

Layout: A hierarchical structure to **control the flow** of information was used in the order - a map, scatter plot, rose plot, and bubble plot, all against a **white background** to enhance visual clarity. For the map, a **Mercator projection** is employed to represent geographic features accurately and maintain spatial relationships between mountain locations. This projection is chosen for its widespread familiarity and suitability for displaying data at global scales.
Interactions are facilitated through **filters for mountain ranges**, allowing users to refine data visualization according to their preferences. This feature enables users to focus on specific **mountains of interest**, enhancing engagement and customization options. They are further allowed to customize the rose plot to focus on specific causes of death and filters for the bubble plot to identify patterns of fatality with specific nationalities.

Typography: Sans-serif, chosen for its modern and clean appearance, **enhancing readability**, and maintaining a professional aesthetic. **Headings are bolded** and two sizes larger to emphasize visual hierarchy, ensuring key information stands out effectively for users.

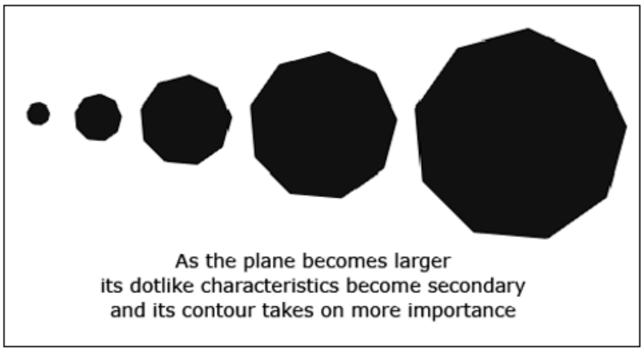


Figure 4: Importance of Size (*Forms: Surfaces and Planes, Volumes and Mass: The Elements of Design Part III - Vanseo Design*, 2010)

Visual elements: **Size** serves as an effective element to **draw attention to significant insights**, such as circle markers on the map indicating fatality intensity, **petal sizes** in the rose plot denoting fatality numbers per month, and **bubble sizes** in the bubble plot highlighting nationalities. Colour schemes vary, using **hue to differentiate causes** of death and a **continuous scale** for the bubble plot to signify death intensity alongside size, ensuring message clarity. (Forms: Surfaces and Planes, Volumes and Mass: The Elements of Design Part III - Vanseo Design, 2010).

In summary, the design choices for Sheet 5 prioritize **user experience and comprehension**. With interactive filters for mountain ranges, clear Sans-serif typography, and strategic visual elements against a white background, the dashboard offers **intuitive navigation and insightful data** exploration. By utilizing size and colour effectively, the design ensures key insights are easily discernible. Overall, Sheet 5 presents a cohesive and engaging design, empowering users to extract meaningful insights effortlessly.

3.0 Implementation

3.1 Technical Implementation

Utilizing R Shiny technology, an interactive dashboard was developed to enhance user engagement. A comprehensive selection of packages was employed to optimize user experience and streamline coding implementation. The following packages were utilized:

- **shiny**: Foundation for building interactive web applications.
- **shinydashboard**: Creates interactive dashboards with a clean and professional layout.
- **shinythemes**: Enhances dashboard aesthetics with a variety of theme options.
- **shinyWidgets**: Integrates interactive widgets for enhanced user interactivity.
- **leaflet**: Facilitates interactive world maps for geographical data visualization.
- **dplyr**: Provides efficient data manipulation functionalities for data preprocessing.
- **ggplot2**: Enables the creation of customizable plots for data visualization.
- **readxl**: Simplifies reading Excel files into R for data importing.
- **plotly**: Generates interactive and dynamic plots for enhanced data visualization.
- **tm:** Supports text mining tasks such as text preprocessing and analysis.

Overall, the final dashboard was implemented with a few minor changes from the design plan:

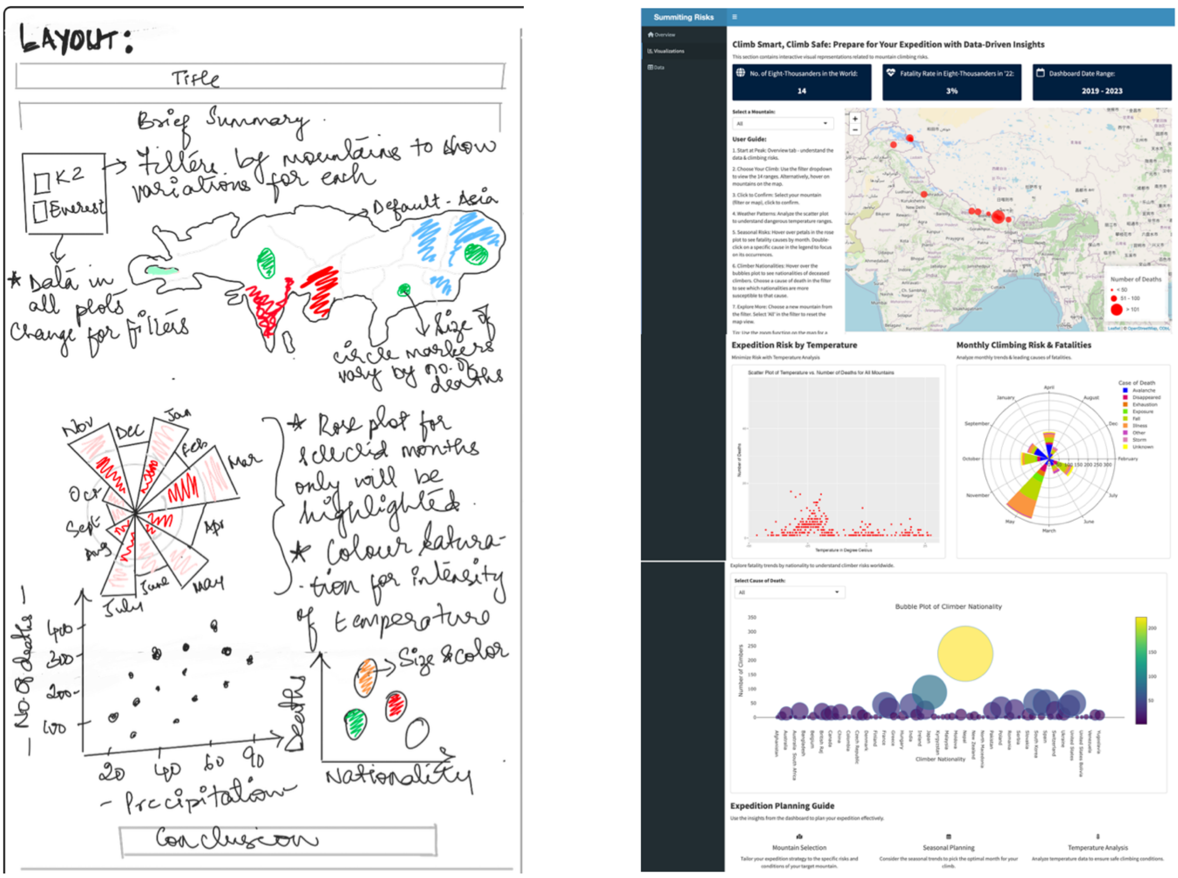


Figure 5: Sheet 5 of Design Phase VS Implement dashboard comparison.

1. The layout now includes **separate tabs for the Introduction/Overview section, Visualization, and Data Details**. This change was made to enhance user focus and presentation by allowing them to navigate between specific aspects more easily.
2. Another modification was the addition of a **filter for the bubble map**. This decision was influenced by the **chosen hybrid narrative**, providing users with the option to filter **nationalities by fatality causes** for a more detailed view. This feature aids users in understanding areas of focus or potential improvements for specific nationalities in the future.

Project Complexity:

The dashboard's implementation showcases sophisticated utilization of various data sources, including non-tabular data integration and handling of large datasets, exemplifying advanced practices in R Shiny development.
The dataset comprises **1700+ entries** detailing **fatal incidents** on eight-thousanders, encompassing mountain names, climber details, and fatality specifics. Integration with supplementary data on **mountain characteristics** was executed through a **left join operation**, enriching the data. Leveraging the **ArcGIS API and Python**, precise geographic coordinates were retrieved for each mountain and nationality, vital for spatial visualization. Historical weather data spanning 1940 to 2023, sourced via the **Open-Meteo API**, augmented the dataset with daily temperature and precipitation metrics. Rigorous data cleaning procedures included data normalization and other formatting to ensure data uniformity. **Transformative operations**, such as temperature and precipitation categorization, enhanced data interpretability. These meticulous processes yielded a curated dataset for in-depth analysis and visualization.

The advanced implementation of R Shiny is evident through features like:

- Interactive dashboard **tabs**.
- Sidebar functionality, with interactive elements such as **opening and closing of the sidebar**.
- Leaflet map with automated **zoom capabilities**.
- The incorporation of a **rose plot**

Moreover, the dashboard exhibits enhanced user interaction mechanisms, including:

- **Filters** for mountains in the map and causes of death in the bubble plot.
- **Click functionality** for map circle markers.
- **Double-click and single-click** functionality on the rose plot for focus in and out, respectively.
- User selection from filters and/or clicks will **dynamically update** other visualizations on the dashboard.
- **Dynamic text** for total fatalities in a mountain based on user selections.
- **Hover functionality** provides additional context. Hovers are designed to show in the **same colour as the hue element** for easy interpretability.
- The integration of **user guides** for each visual element ensures users can navigate and interact with the dashboard seamlessly.

3.2 Narrative Implementation

This section explains the final implementation of the dashboard and how it conveys data insights to the audience.

Overview Tab

Upon opening the dashboard, users are greeted with a user-friendly interface featuring a **sidebar** that can be opened and closed. The sidebar provides different options for navigating the dashboard. The first tab, **"Overview,"** gives the reader essential context about the dashboard, including:

- **Objective**: The purpose and goals of the dashboard.
- Findings from the **Exploration Project**
- **Motivation**: The reasons behind creating the dashboard, highlight the importance of the data.
- **Target Audience**: A description of the intended users and their needs.
- **Criticality of the Dashboard**: The significance and potential impact of the dashboard for users.

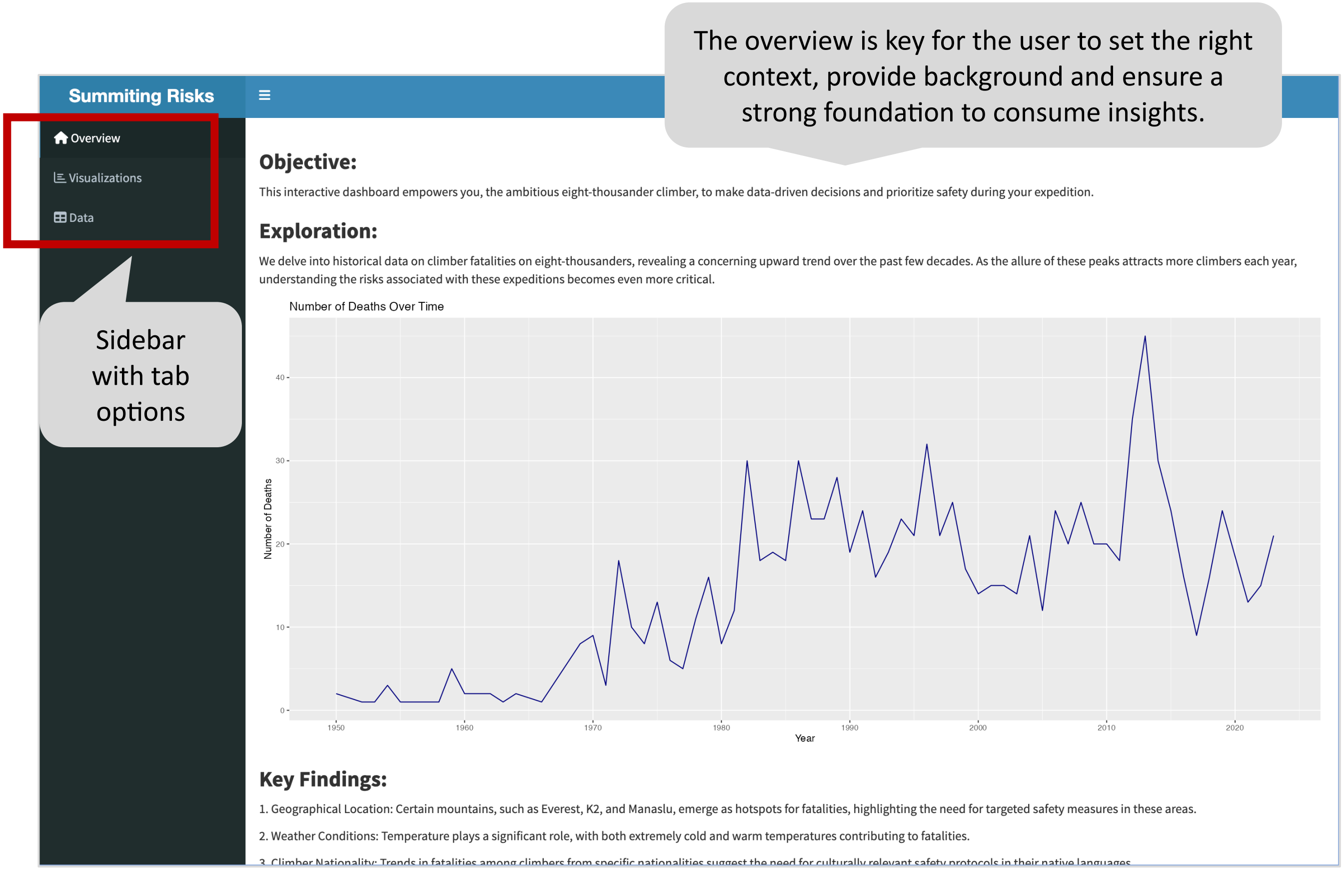


Figure 6: Overview Tab of the final Dashboard.

Visualization Tab

Moving on to the second tab, "Visualization," the top section provides an introduction and **presents crucial facts** to the user about the topic and the dashboard. This includes:

- **Number of Mountains**: The specific mountains covered in the dashboard.
- **Fatality Rate**: The overall fatality rate, providing context about the risks involved.
- **Date Range**: The timeframe covered by the data, indicating the historical scope of the analysis.

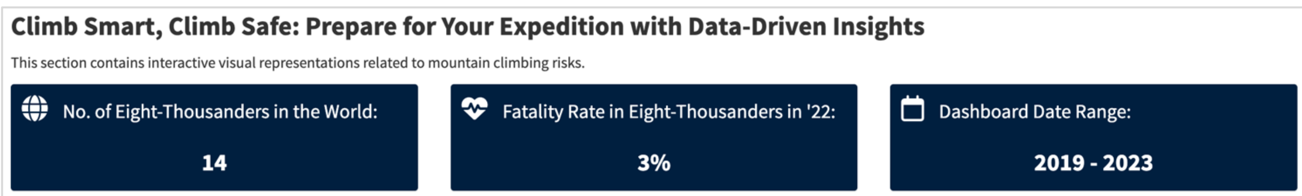
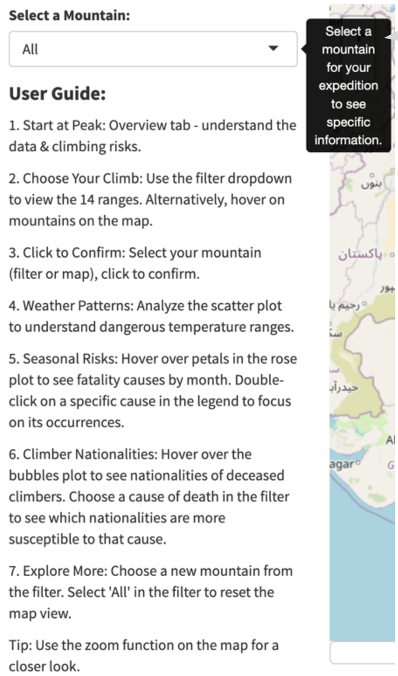


Figure 7: Introduction section of the Visualization tab in the dashboard.

Providing these key facts at the top is essential for the user because it **sets the stage** for the visualizations below. It helps users quickly understand the **scope and context** of the data they are about to explore.

<u>User Guide</u>



The dashboard includes multiple ways for users to access the user guide, ensuring a seamless and intuitive experience:

- **Step-by-Step Guide**: On the left side of the dashboard, a detailed step-by-step guide is available. This guide walks users through the functionalities and features of the dashboard, helping them navigate and understand each section effectively.
- **Tooltip on Hover**: For every visualization, hovering over an element triggers a tooltip that provides contextual guidance. These tooltips explain what actions can be taken, and how to interact with it.

These features are designed to **enhance usability**, making it easier for users to understand and interact with the dashboard, regardless of their familiarity with the tool.

Figure 8: User Guide on the dashboard

<u>World Map</u>

The world map was implemented using the **R package leaflet** to provide an interactive and visually appealing representation of the data. Here's a brief overview of its features and implementation:

- **Default View**: The map is set to coordinates that display **all eight-thousanders**, ensuring users can <u>immediately see the areas of interest</u>.
- **Circle Markers**: Circle markers indicate the location of each mountain, **varying in size** according to fatality density. Larger markers represent higher fatality rates, providing a quick **visual cue.**
- **Legend**: A legend executed in the server explains the meaning of the circle marker sizes, aiding in data interpretation.
- **Choropleth Map and Projection**: The map projection ensures accurate spatial relationships, enhancing geographic understanding.

Interactivity:

- **Mountain Selection**: Users can select a mountain from a **filter dropdown or by clicking on circle markers**. The map then **zooms into the selected mountain**, and a **tooltip** displays the mountain's name, location, and an informative fact.
- **Dynamic Updates**: Selecting a mountain automatically updates the scatter plot, rose plot, and bubble plot, facilitated by **reactive inputs and datasets** for seamless server-UI communication.

Data Insights

The world map effectively conveys the **geographic distribution** of fatalities, allowing users to easily identify **high-risk mountains** with the most fatalities. Before selecting a mountain, users can see all mountains either in the **dropdown or by hovering over circle markers**. This comprehensive and interactive approach enables users to explore data meaningfully, supporting the narrative of understanding and mitigating risks in high-altitude mountaineering.

Before selecting a mountain:

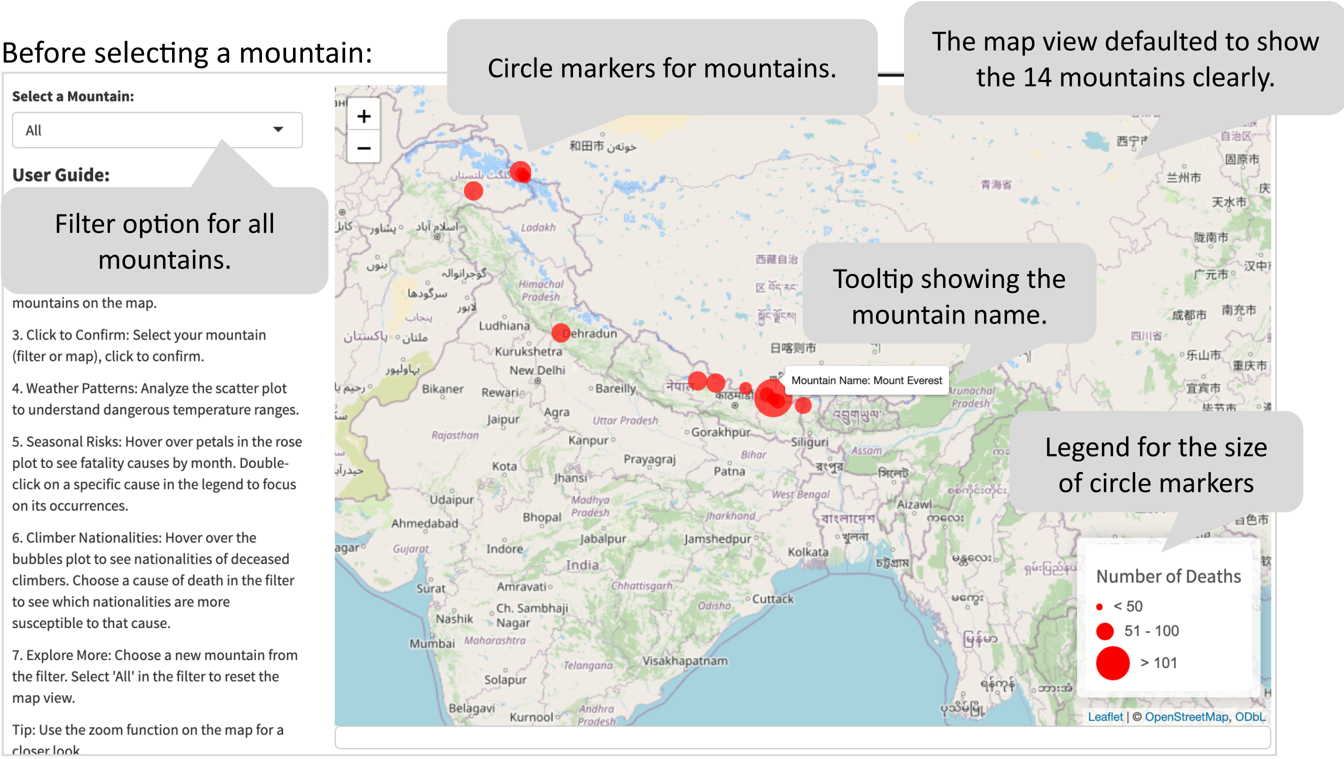


Figure 9: Map View before selecting a mountain on the dashboard.

After selecting a mountain:

Figure 10: Map View after selecting a mountain on the dashboard.

Scatter Plot

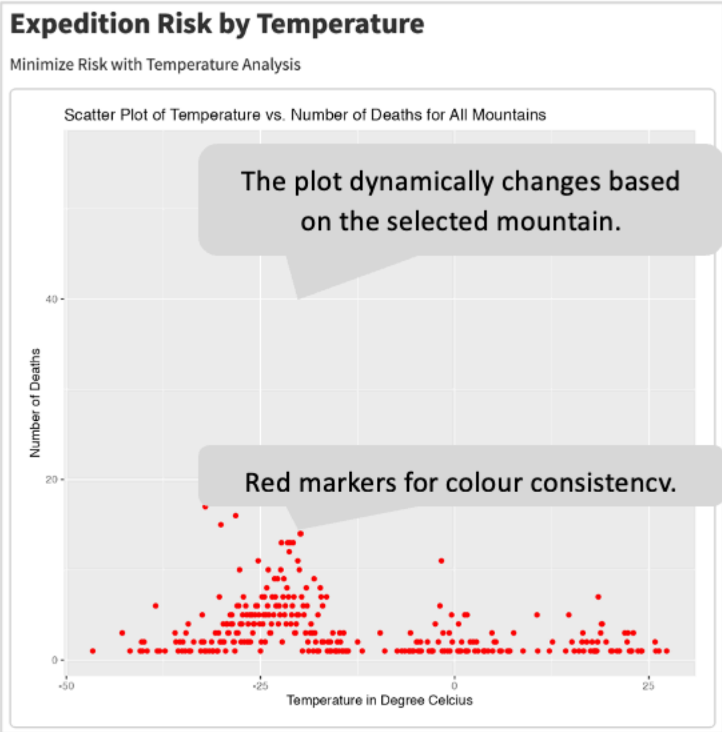


Figure 11: Scatter Plot on the dashboard.

The scatter plot was created using the **ggplot2 package** in R to visually represent the relationship between **temperature and the number of fatalities**. Here are the key aspects of its implementation and the insights it provides:

- **Axes**: The x-axis represents temperature, and the y-axis shows the number of deaths.
- **Dynamic Updates**: The scatter plot dynamically changes based on the **selected mountain**. If no mountain is selected, it **defaults to displaying data** for all mountains.
- **Visual Consistency**: The markers are **coloured red**, matching the circle markers on the map.

Data Insights

The scatter plot effectively conveys the crucial message of **identifying fatal temperature ranges** for each mountain. Understanding these temperatures is key for climbers to **avoid dangerous conditions**. By providing a clear, dynamic, and visually consistent tool, the scatter plot empowers climbers to make informed decisions about **when to plan their ascents**, thereby enhancing their safety and preparedness.

Rose Plot

The rose plot, created using the **Plotly package** in R, provides a dynamic and interactive visualization to represent the causes and timing of fatalities. Here are the implementation details and the insights it offers:

- **Petals**: Each petal represents a **month**, with **colour hues highlighting different causes** of fatalities.
- **Dynamic Updates**: The rose plot updates dynamically based on the selected mountain, ensuring the data displayed is relevant to the user's specific interest.

Interactivity:

- **Tooltip**: On hover, the tooltip displays the month and fatality cause, coloured according to the cause shown in the legend, which aids in quick and easy interpretability.
- **Legend Interactions**:
    - **Single Click**: Excludes the selected cause, updating the rose plot to show data for the remaining causes.
    - **Double Click**: Highlights only the selected cause, providing a focused view.

Data Insights

Dangerous Months:

- **Seasonal Risks**: The rose plot highlights the months with higher fatality rates, helping climbers identify dangerous climbing seasons. While this data might be influenced by the number of climbers in each month, it remains a critical factor in planning expeditions.

Fatality Causes:

- **Preparation**: Understanding the common causes of fatalities allows climbers to prepare adequately. For instance, if avalanches are common in a particular month, climbers can take specific precautions.
- **Fitness Levels**: Knowing the prevalent causes of death can guide climbers to enhance their fitness levels and skills, ensuring they are well-prepared for the challenges they might face.

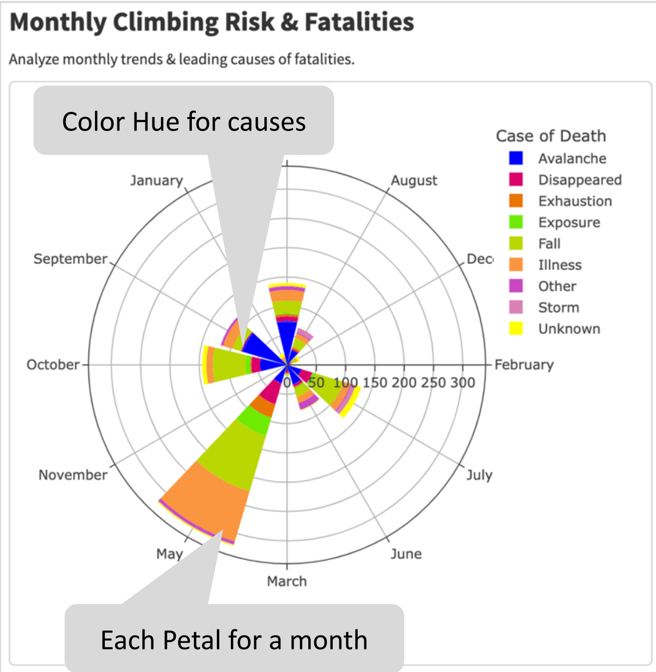


Figure 12: Rose plot on the dashboard

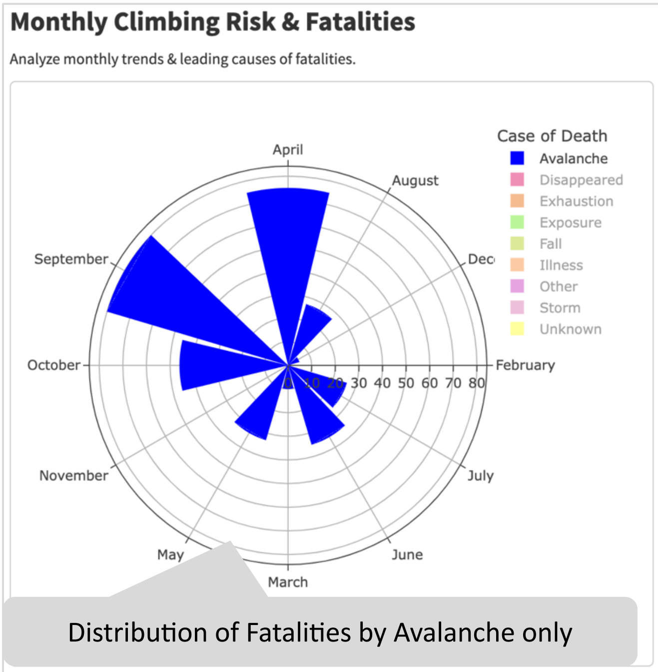


Figure 13: Rose plot on the dashboard focusing on Avalanche only.

<u>**Bubble Map:**</u>

The bubble map visualizes fatalities by **nationality**, with both **size and color** representing the fatality data. Here are the key implementation details and insights:

- **Bubble Indicators**: **Size and color** of the bubbles represent the number of fatalities, using a **continuous color scale** to highlight higher fatality rates.
- **Dynamic Updates**: The plot dynamically changes based on the selected mountain, ensuring relevant data visualization.

Interactivity:

- **Filter Options**: Users can filter the view by fatality causes, which updates the plot to show bubbles for the selected mountain and cause.
- **Hover Functionality**: Each bubble displays a tooltip on hover, coloured based on the nationality it represents, providing immediate visual feedback and detailed information about the fatalities.

Data Insights:

- **Analysis of Fatalities**: The bubble map helps users identify patterns in fatalities among different **nationalities**. This can indicate which countries might need to improve their training or preparation for high-altitude climbs.
- **Fitness and Training**: Understanding the nationalities of the deceased allows users to analyze if there are **specific fitness or preparation levels lacking in their own country**. This information can guide climbers in preparing better for their ascent, ensuring they meet the required physical and technical standards.

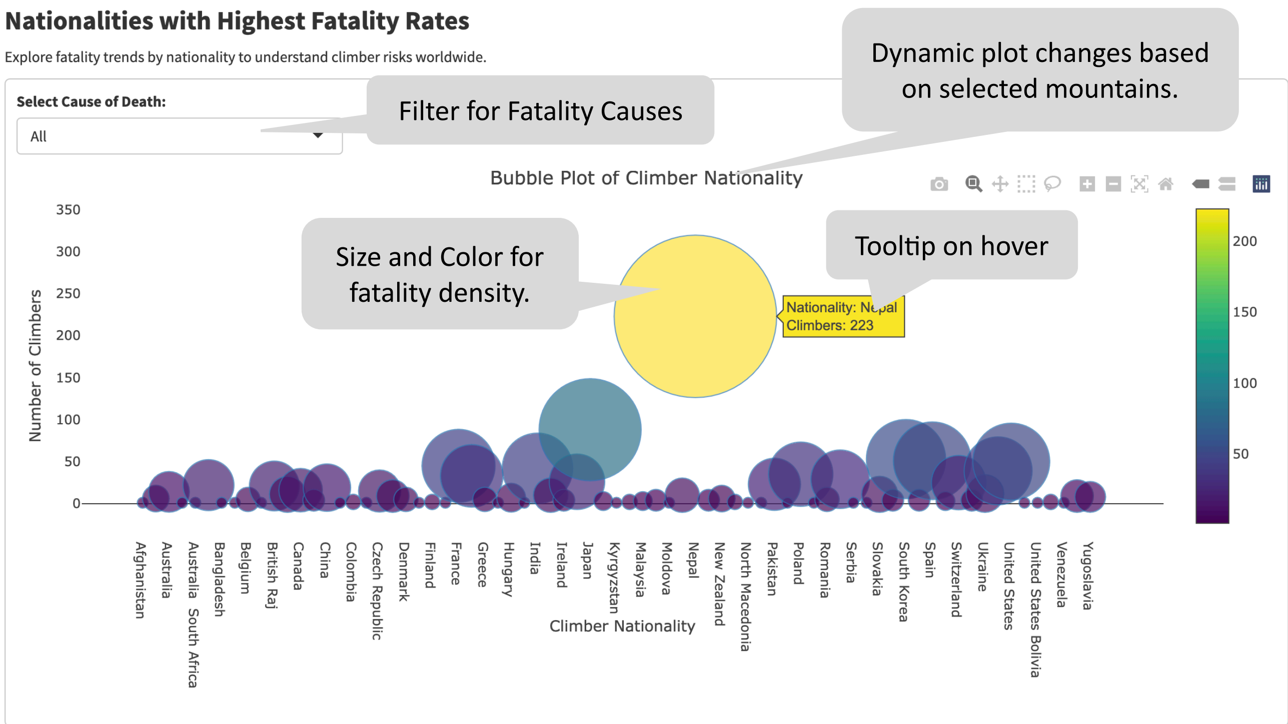


Figure 14: Bubble plot on the dashboard.

Data Tab

The Data Tab provides comprehensive information about the **data sources** used in the dashboard. It features a data table with **robust search and sort functionality**, allowing users to easily explore and understand the dataset.

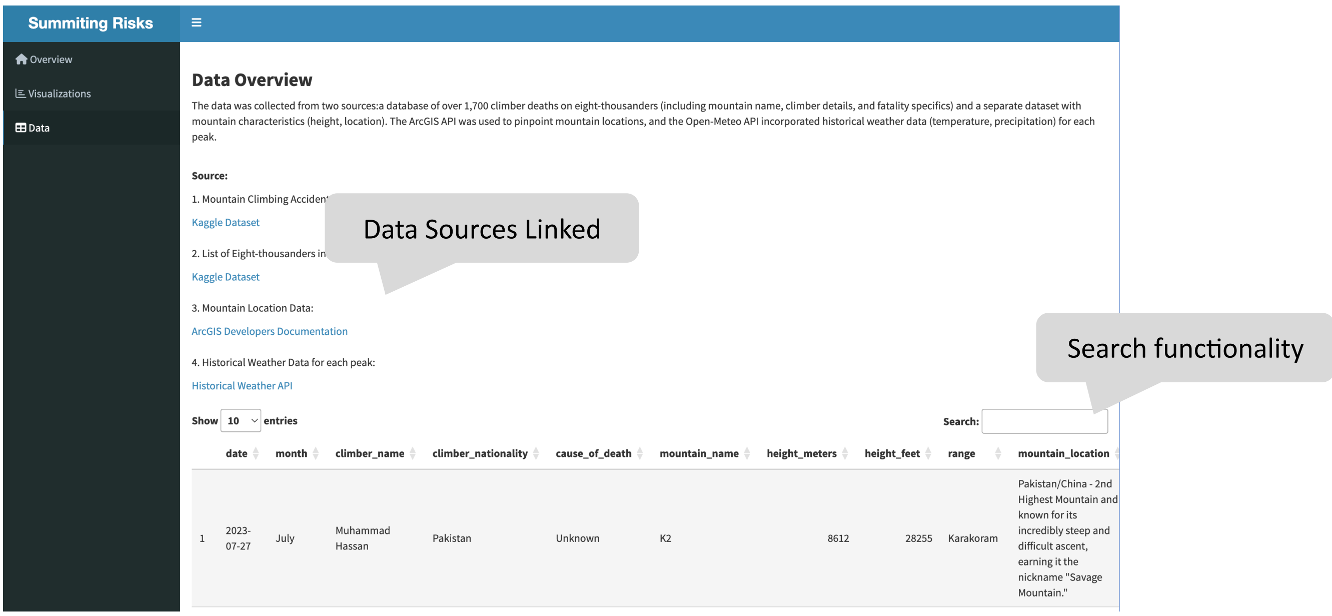


Figure 15: Data Tab on the dashboard.

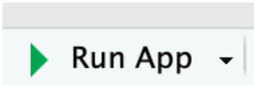
3.3 User Manual

1. **Update required packages by uncommenting** top sections of the UI and Server files.

```
#installing required packages - uncomment if any installation is required
# install.packages("shiny")
# install.packages("shinydashboard")
# install.packages("shinythemes")
# install.packages("shinyWidgets")
# install.packages("leaflet")
```

Remove the hashtags.

2. Click on **"Run App"** to run the dashboard on the "app.R" file



3. Refer to the **"Overview"** and **"Data"** Tabs for context on the Dashboard.

4. Upon clicking on the **"Visualization"** tab, analyze the layout and User Guide for assistance.

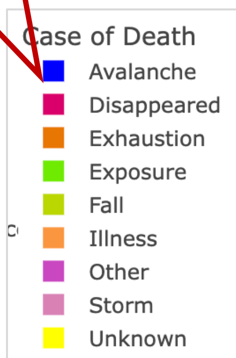
5. Click on the **"Select a Mountain"** filter to view all the mountains and select one of your choice.

Hovering over the filter will guide you

6. Alternatively, analyze the mountains on the map, hover over the **circle markers** for more information and **click on a mountain** to select.

Click on the marker to select a mountain.

Single/Double-click a legend item.

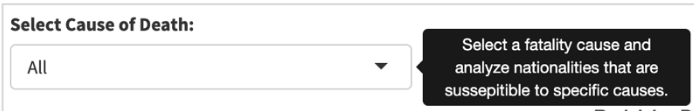


7. To zoom out or reset selection, **choose "All**" from the filter dropdown.

7. Take note of the **Dynamic Text** and the **Scatter plot.**

8. **Hover over the Rose Plot** for tooltips. Simultaneously, single-click on the Rose plot **legend** to remove that cause, or double-click to focus on that cause only. Double-click to come back to regular mode.

9. Select an item from the **"Select Cause of Death"** filter in the bubble plot to filter the view by fatality cause.



10. **Hover over the bubbles** to get a tooltip for more details.

11. To explore a different mountain, select a **different mountain in the first filter above**.

4.0 Conclusion

In this project, I developed a comprehensive dashboard that visualizes fatalities on eight-thousanders, providing insights into the distribution of fatalities by mountain, season, nationality, and cause of death.

- **Mountain-Specific Challenges**: Each mountain presents unique hazards. For instance, avalanches are a significant cause of death on K2, while Everest's primary concerns are altitude sickness and falls. This highlights the necessity for climbers to prepare for **specific dangers** associated with each peak.
- **Seasonal Patterns**: The rose plot revealed that certain months are particularly perilous, with increased fatalities due to adverse weather conditions. Understanding these patterns helps climbers plan safer expeditions.
- **Nationality-Specific Risks**: The bubble plot indicated that certain nationalities face distinct challenges. For example, **French climbers** predominantly suffer fatalities due to exposure, whereas **Japanese climbers** see a higher incidence of altitude sickness-related deaths. This suggests varying levels of preparedness and experience among different national groups.
- **High-Risk Mountains**: The geographic map allowed for easy identification of mountains with the highest fatality rates, such as Everest and Nanga Parbat. This helps highlight which mountains require more stringent safety measures and preparation.

What I Learned:
Through this project, I significantly improved my skills in implementing **advanced features in R Shiny**, such as dynamic filtering and hover plots. The experience underscored the importance of effective visualization techniques and **proper planning** during the **design phase**. Additionally, I learned the necessity of a **user-centric approach**, incorporating interactive guides and tooltips to enhance user experience.

Improvements:
In hindsight, incorporating **climate forecasts and legal aspects**, such as designated climbing seasons for each mountain, would have provided a better understanding of fatality patterns and further enriched the analysis.

Future Work:
For future work, I aim to integrate **predictive analytics** into the dashboard. This would involve **forecasting potential fatalities** based on current and historical data, offering climbers actionable insights to plan safer expeditions. Predictive models could analyze various factors, including weather conditions, climber experience levels, and seasonal trends, to provide real-time risk assessments and recommendations.

Overall, this project has been a valuable learning experience, combining technical skills in data analysis and visualization with a user-focused approach to create a meaningful and informative tool.

4.0 Bibliography

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Callaghan, A. (2023, July 13). *29 People Died in One of the Worst Mountaineering Accidents in History. What Happened?* Climbing. https://www.climbing.com/people/deadliest-mountaineering-accident/

Draper, N., Jones, G. A., Fryer, S., Hodgson, C., & Blackwell, G. (2008). Effect of an on-sight lead on the physiological and psychological responses to rock climbing. *Journal of Sports Science & Medicine*, *7*(4), 492–498. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3761930/

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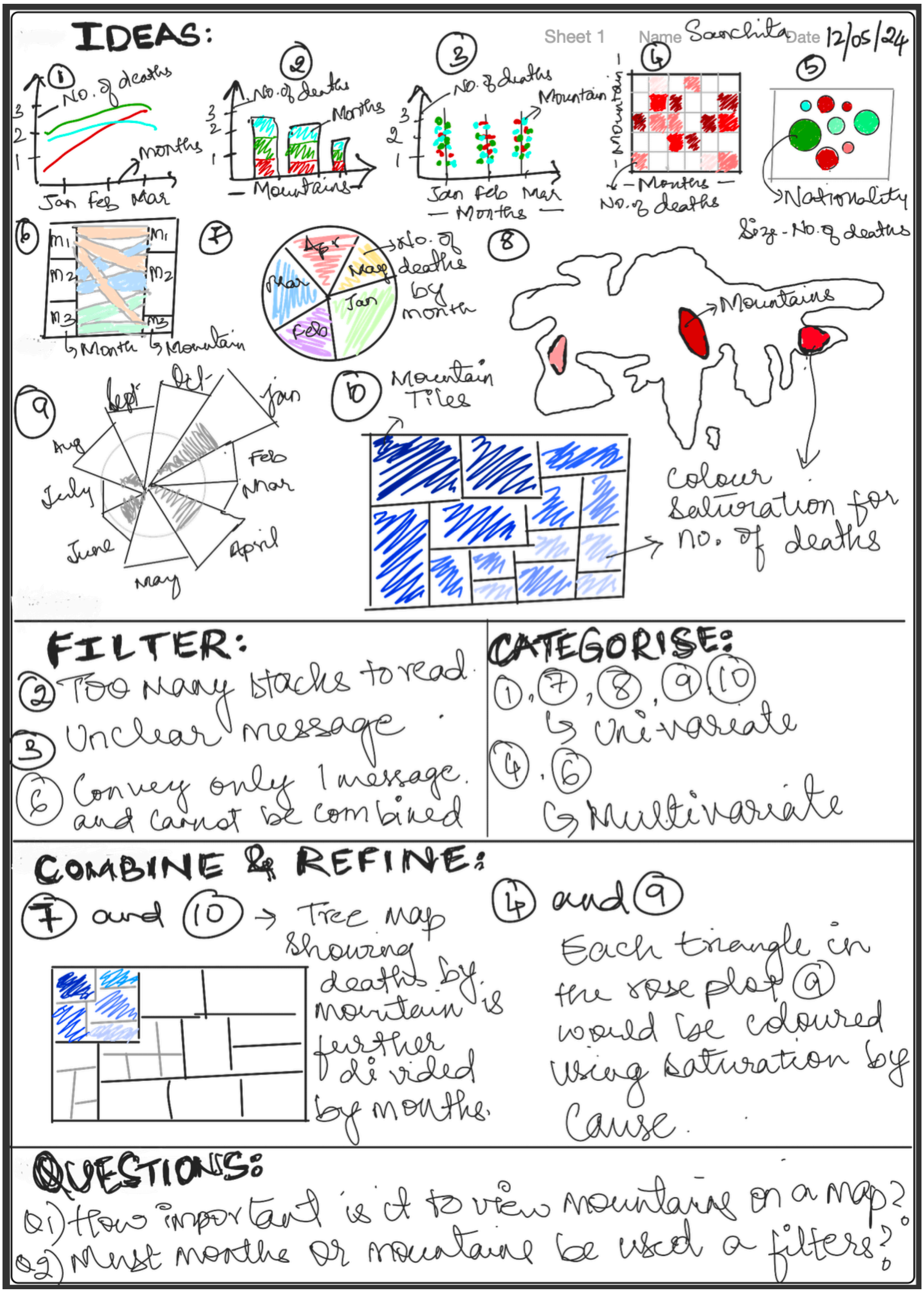
5.0 Appendix

1.0 Design Process

1.1 Five Sheet Design

Sheet 1:



Sheet 2:

TITLE: Summits of Sorrow
AUTHOR: Sanchita
DATE: 12/05/2024
SHEET: 02
TASKS: Spacial representa-tion on a map

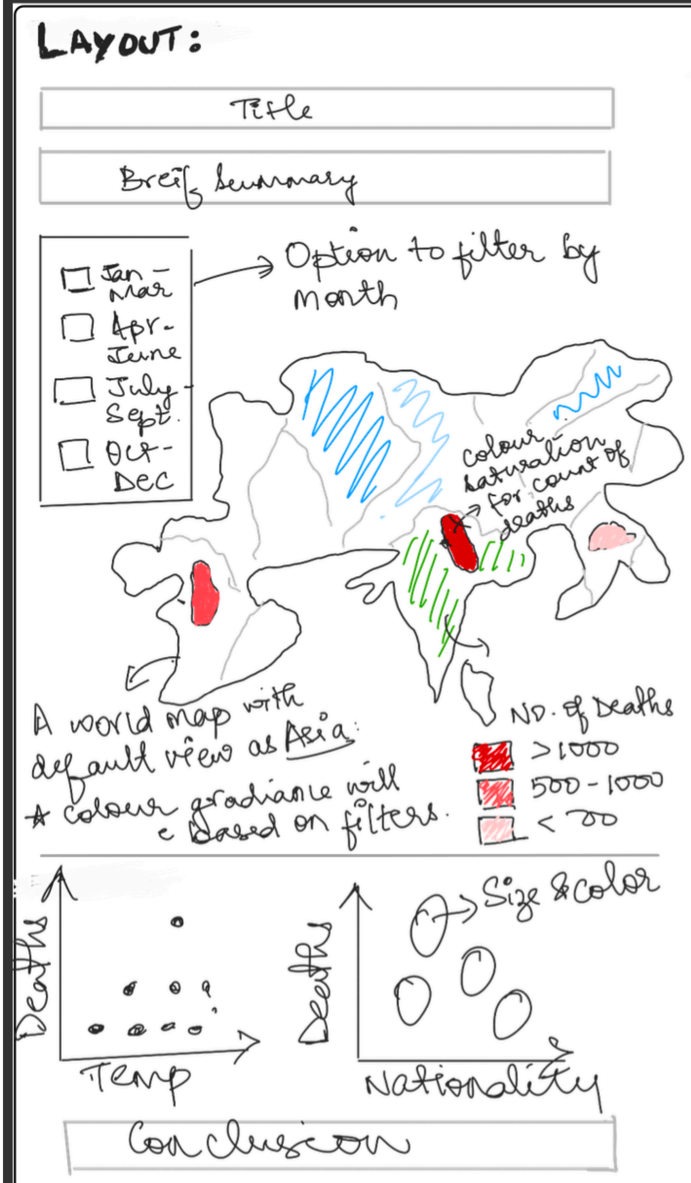
COMPONENTS:
* A world map showing 14 mountains, their location & no. of deaths.
* A scatter plot for deaths by temperature
* A bubble plot of fatalities by nationality

OPERATIONS:
* Filter operations for months users are planning to hike.
* Mouse hover for each polygon on the map.
* A tooltip that opens up a scatter plot.

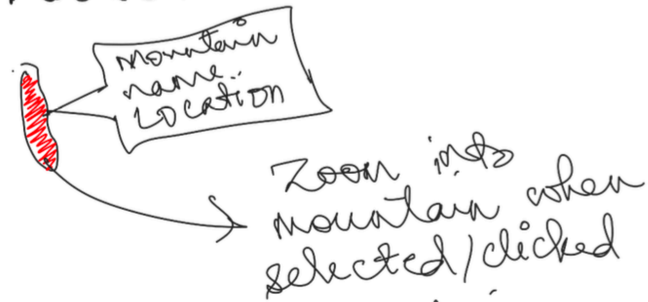
PROS:
* Spacial view for mountains aids users to better its location and associated challenges.
* Understanding fatal temperature aids hike planning based on temperature forecasts.

CONS:
* Does not talk about fatality causes.
* Gives a seasonal view, not a monthly comparison.

LAYOUT:



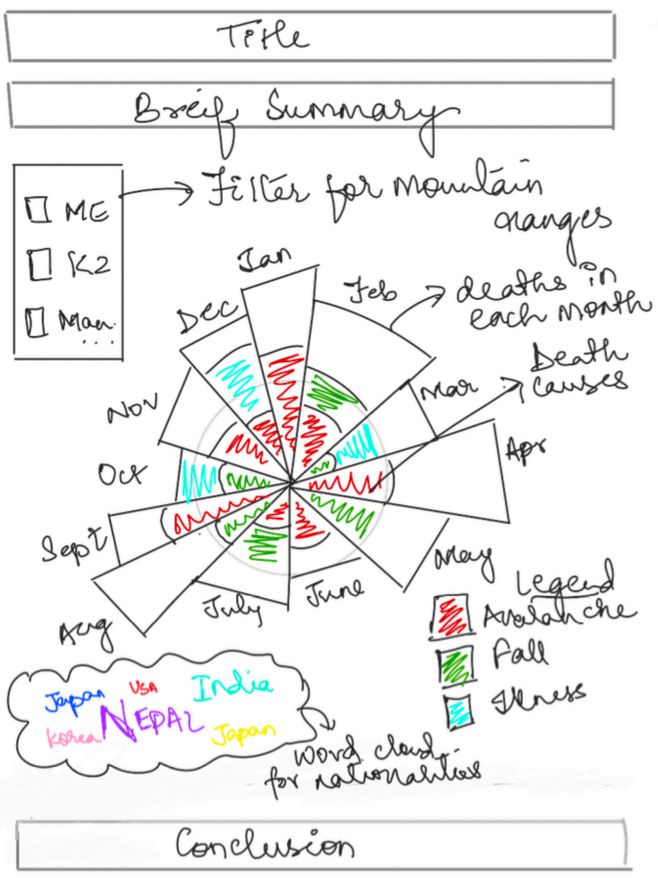
FOCUS:



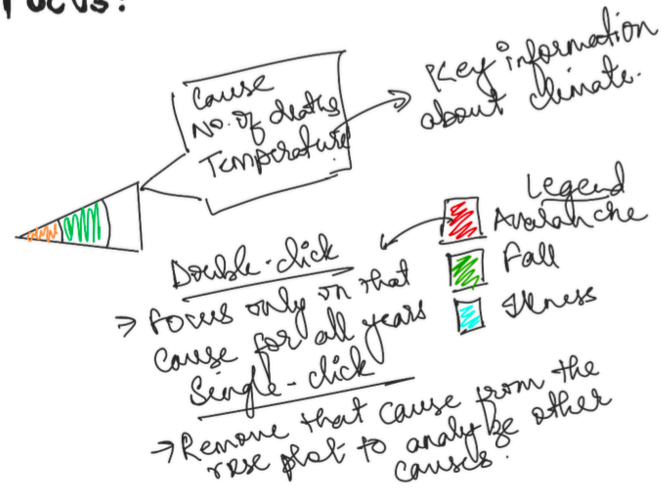
* Focusing on mountain location for spacial context.

Sheet 3:

LAYOUT:



FOCUS:



* The focus will occur @ a cause level
* clicking on the legend will allow easier for the user to focus.

TITLE: Summits of Sorrow
AUTHOR: Sanchita Reddy
DATE: 12/05/2024
SHEET: 03
TASK: A rose plot of each month and message led by filtering mountains.

COMPONENTS:

* A rose map indicating deaths by month and temperature.
* A word cloud for nationalities
* Tooltips for details

OPERATIONS:

* Users can filter their view by mountains
* Mouse hover for each cause.
* A tooltip on hover for rose petals
* click functionality for cause on the legend.

PROS:

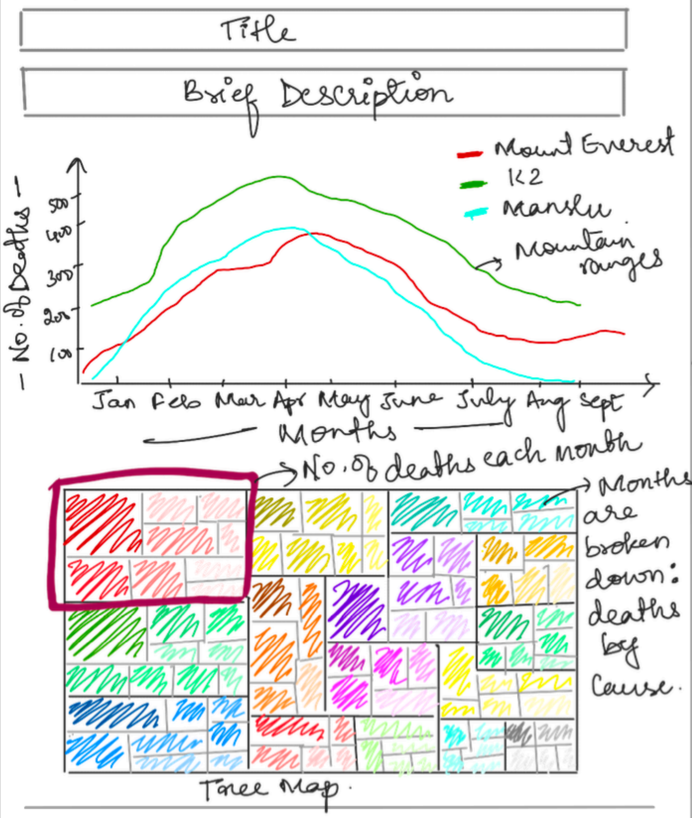
* Clear message communication - deaths by range, climate, causes of death.
* Use of size (rose petal size) and color by cause enables easy communication of the message.

CONS:

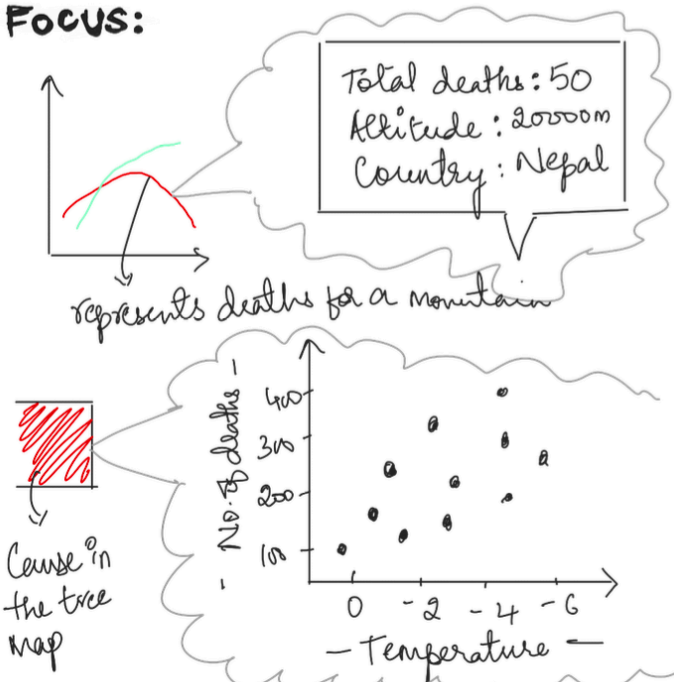
* Lack of geographical context for the user.
* Not enough information about climate.

Sheet 4:

LAYOUT:



FOCUS:



* Draws focus on climatic conditions and location, providing context on conditions during fatality.

TITLE: Summits of Sorrow
AUTHOR: Sanchita Reddy
DATE: 12/05/2024
SHEET: 04
TASKS: A line and tree plot to show message more in detail on view.

COMPONENTS:

* A line plot showing deaths by month for different mountains.
* A tree map for deaths by month, further broken by cause of death.
* A scatter plot of fatalities @ different temperatures.

OPERATIONS:

* Mouse hover for both plots
* Tool tips that add focus on fatality causes.

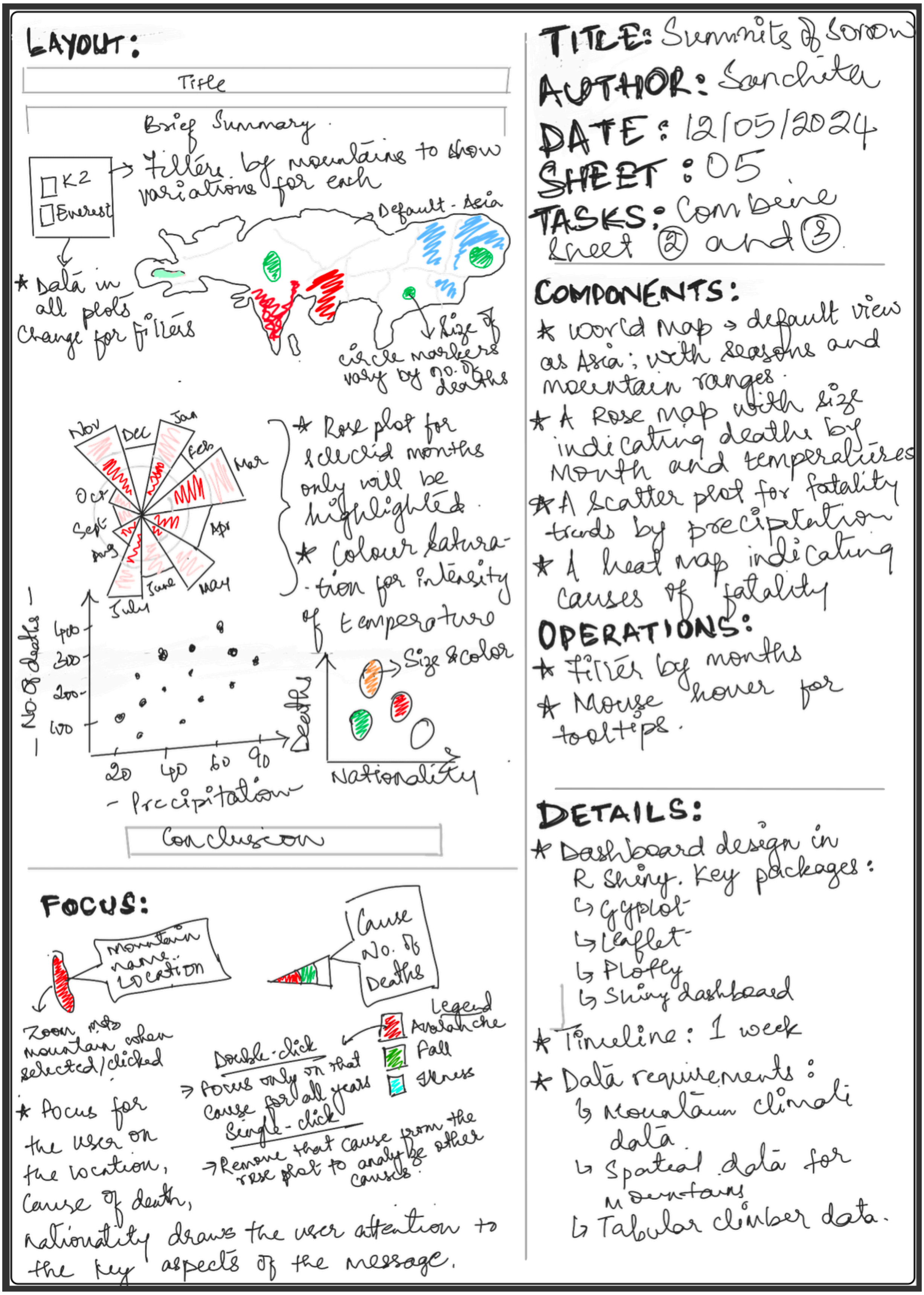
PROS:

* Colour and size visuals in both plots successfully convey the message.
* All aspects of message are conveyed.

CONS:

* Includes duplicated data like month
* Lack of filters will not give users a customised view.

Sheet 5:


LAYOUT:
Title
Brief Summary
K2
Everest
Filters by mountains to show variations for each
Default - Asia
* Data in all plots Change for filters
Size of circle markers vary by no. of deaths
Nov Dec Jan Feb Mar Apr May June July Aug Sept Oct
* Rose plot for selected months only will be highlighted.
* Colour satura-tion for intensity of temperature
No. of deaths
400 300 200 100
20 40 60 90
- Precipitation
Size & color
Deaths
Nationality
Conclusion
FOCUS:
Mountain name, Location
Zoom into mountain when selected/clicked
Cause No. of Deaths
Legend
Avalanche
Fall
Illness
Double-click → Focus only on that cause for all years
Single-click → Remove that cause from the rose plot to analyze other causes.
* Focus for the user on the location, cause of death, nationality draws the user attention to the key aspects of the message.
TITLE: Summits of Sorrow
AUTHOR: Sanchita
DATE: 12/05/2024
SHEET: 05
TASKS: Combine Sheet ② and ③.
COMPONENTS:
* World map → default view as Asia; with seasons and mountain ranges.
* A Rose map with size indicating deaths by Month and temperatures
* A Scatter plot for fatality trends by precipitation
* A heat map indicating causes of fatality
OPERATIONS:
* Filter by months
* Mouse hover for tooltips.
DETAILS:
* Dashboard design in R Shiny. Key packages:
↳ ggplot
↳ Leaflet
↳ Plotly
↳ Shiny dashboard
* Timeline: 1 week
* Data requirements:
↳ Mountain climate data
↳ Spatial data for mountains
↳ Tabular climber data.

1.2 Visualization Justification

1. **Bar Chart**: Displaying the number of fatalities per mountain.
   - Data Type: Quantitative (number of fatalities).
   - Effectiveness: Excellent for making direct comparisons between mountains, helping users quickly identify the most dangerous peaks.
   - Visual Appeal: Simple and clean, with the potential for colour-coding to enhance readability.
   - Engagement: Users can immediately grasp which mountains are most hazardous, maintaining their interest through clear and impactful data presentation.

2. **Line Chart**: Showing fatalities over the months for each mountain.
   - Data Type: Ordinal (months), Quantitative (fatalities).
   - Effectiveness: Reveals temporal trends, allowing users to see how risk changes over the year.
   - Visual Appeal: Smooth lines and colour gradients can make the chart visually appealing.
   - Engagement: The dynamic nature of trends over time keeps users engaged as they follow the fluctuations.

3. **Heat Map**: Highlighting the causes of fatalities by month and mountain range.
   - Data Type: Categorical (causes), Ordinal (months).
   - Effectiveness: Displays density and patterns effectively, showing concentrations of different fatality causes.
   - Visual Appeal: Color intensity and gradients make it visually striking and informative.
   - Engagement: Users can quickly identify hot spots of risk, which is both informative and engaging.

4. **Scatter Plot**: Illustrating the relationship between fatalities and variables such as altitude or temperature.
   - Data Type: Quantitative (fatalities, altitude/temperature).
   - Effectiveness: Useful for uncovering correlations and deeper insights.
   - Visual Appeal: Clear dots with varying sizes and colours can highlight key data points attractively.
   - Engagement: Interactive elements like hover effects can increase user interaction and engagement.

5. **Bubble Chart**: Visualizing the number of fatalities by mountain and month.
   - Data Type: Quantitative (fatalities), Ordinal (months).
   - Effectiveness: Combines two dimensions effectively, showing quantity and time simultaneously.
   - Visual Appeal: The size and colour of bubbles add an appealing visual element.
   - Engagement: The variation in bubble size and colour can capture users' attention and maintain their interest.

6. **Rose Plot**: Displaying fatalities by month, highlighting dangerous periods.
   - Data Type: Ordinal (months), Quantitative (fatalities).

- Effectiveness: Clearly shows seasonal patterns and cyclic trends.
- Visual Appeal: The circular format is unique and eye-catching.
- Engagement: The distinctive shape and ability to highlight key months engage users effectively.

7. **Word Cloud**: Representing the nationalities of climbers involved in fatalities.
   - Data Type: Categorical (nationalities).
   - Effectiveness: Quickly communicates the diversity of affected climbers.
   - Visual Appeal: Visually engaging with varying font sizes and colours.
   - Engagement: The artistic layout captures users' attention and makes the information memorable.

8. **Stacked Bar Chart**: Showing the causes of fatalities over time.
   - Data Type: Categorical (causes), Ordinal (time).
   - Effectiveness: Demonstrates the composition of fatality causes over a period.
   - Visual Appeal: Layered bars with distinct colours for each cause.
   - Engagement: Users can see changes over time and understand the proportionality of different causes.

9. **Geographic Map**: Plotting fatalities on a map of the mountain ranges.
   - Data Type: Spatial (location), Quantitative (fatalities).
   - Effectiveness: Spatial context enhances understanding of geographical distribution.
   - Visual Appeal: Maps are inherently engaging and visually striking.
   - Engagement: Users are drawn to geographic data, especially when it involves familiar or interesting locations.

10. **Flow Map**: Visualizing the flow of fatalities from mountains to months.
    - Data Type: Sequential (flow), Quantitative (number of fatalities).
    - Effectiveness: Provides a clear representation of the progression of fatalities from one location (mountain) to another (month), aiding in understanding temporal patterns.
    - Visual Appeal: Flow maps are visually compelling, offering a dynamic representation of data movement.
    - Engagement: Users are likely to be intrigued by the visualization of the flow of fatalities, especially when it involves understanding patterns and trends over time, fostering deeper engagement with the data.