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INFOSCI 301
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Information Visualization Redesign Project

Theory – Critical Engagement with Visualization Methodologies

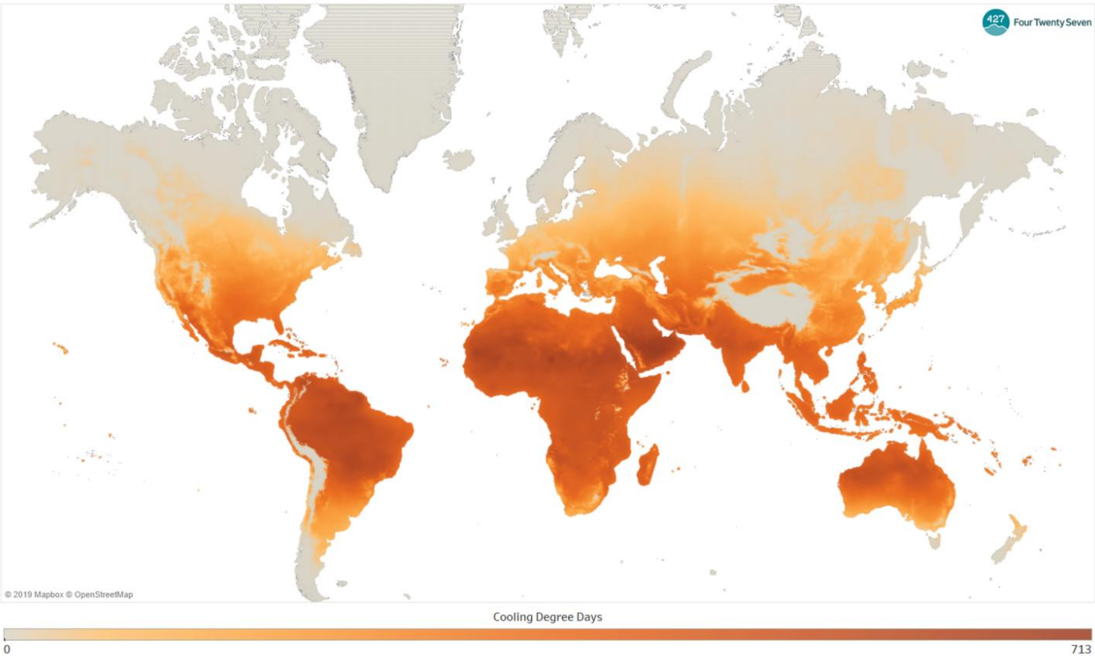

Figure 1: Cooling Degree Days

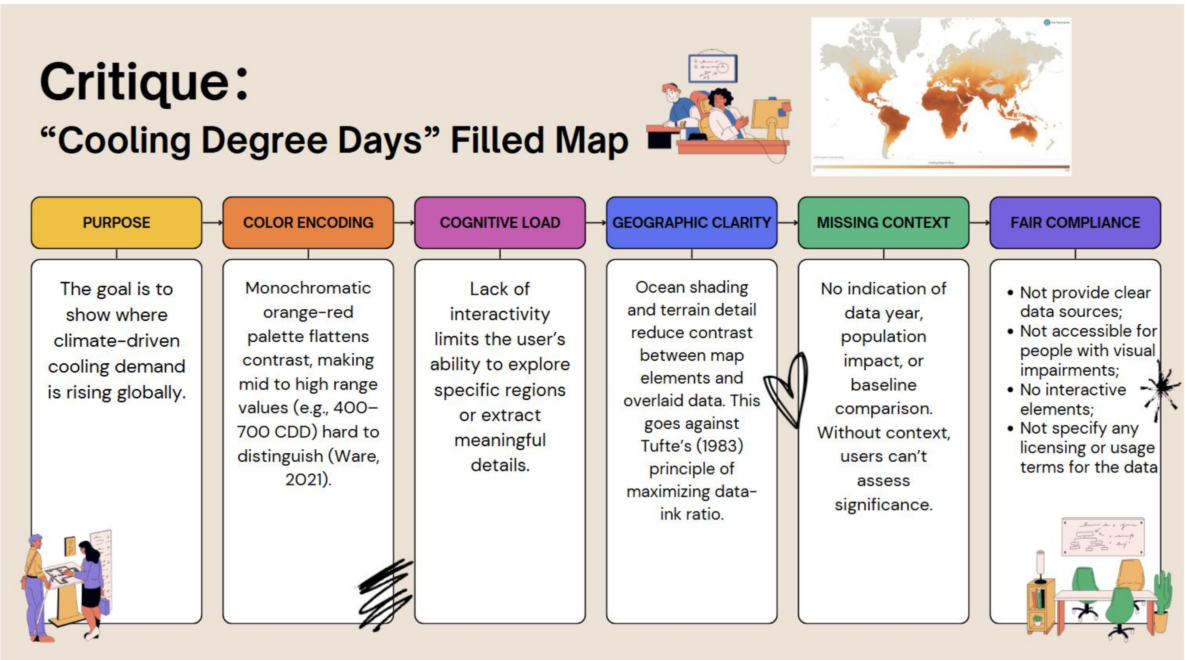

Figure 2: Critique of Cooling Degree Days

Concise explanation

This critique(Figure 2) of the cooling degree visualization(Figure 1) applies a structured method based on visual perception theory and data ethics. The process begins with identifying the infographic's intent—to communicate global cooling energy demand under climate change scenarios. It then analyzes visual encoding strategies (color, layout, resolution), evaluates perceptual clarity and assesses compliance with the FAIR data principles. The critique incorporates theoretical references from Edward Tufte (1983), Colin Ware (2021) and Wilkinson(2022). Based on these evaluations, specific recommendations are made to enhance interpretability, accessibility, and data transparency.

Reference

Ware, C. (2021). Information Visualization: Perception for Design (4th ed.). Morgan Kaufmann.

Tufte, E. R. (1983). The Visual Display of Quantitative Information. Graphics Press.

Sandia National Laboratories. (2022). FAIRer Data. Retrieved from https://www.sandia.gov/fairer-data

Research – Literature-Inspired Analysis

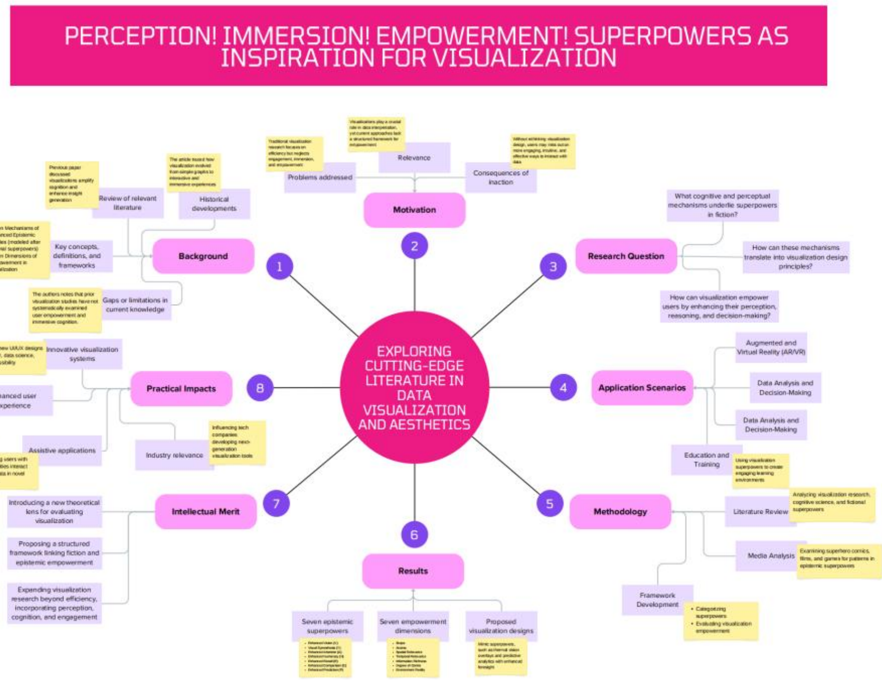

Figure 3: Flowchart of *Perception! Immersion! Empowerment! Superpowers as Inspiration for Visualization(2022)*

The visualization flowchart in Figure 3 systematically explores the research process, illustrating how fictional superpowers can be integrated into data visualization. This study follows the eight structured research facets outlined by Card et al. (1999) and Munzner (2014) to establish a framework for immersive and empowering visualization techniques. While traditional visualization prioritizes efficiency and accuracy, it often lacks user engagement and cognitive enhancement. Inspired by sci-fi superpowers, this research investigates how visualization can augment perception and cognition, thereby making data interaction more intuitive and impactful (Willett et al., 2021). By incorporating elements like enhanced vision, predictive analytics and attention amplification, visualization has the potential to improve decision-making and user experience in various fields.

A central question in this research is how superpower-inspired metaphors can be translated into effective visualization techniques that enhance user perception and interaction. To address this, the study explores key application scenarios, including AR/VR interfaces, assistive technologies, predictive analytics, and immersive education, demonstrating the practical value of these concepts (Card et al., 1999). The methodology involves analyzing superpower mechanics in fiction, mapping them to cognitive and perceptual frameworks, designing visualization prototypes, and conducting empirical user testing to measure effectiveness (Munzner, 2014).

Findings reveal seven superpower-inspired visualization models, each offering unique improvements in data perception, interactivity, and predictive capabilities. These models bridge the gap between HCI, cognitive science, and visualization research, shifting the focus from efficiency-driven design to experience-driven and cognitively empowering approaches (Willett et al., 2021). The study's intellectual merit lies in two key aspects. First, it contributes to the literature by expanding the theoretical foundation of visualization research, referencing both seminal works like Card et al. (1999) and recent advancements in immersive visualization frameworks (Munzner, 2014). Second, it identifies key limitations, such as the need for further empirical validation across diverse user groups and adaptation to real-world datasets, providing a basis for future research on superpower-inspired visualization techniques.

The practical impact of this research extends to AR/VR innovation, accessibility tools, interactive education and business analytics, where visualization can empower users through enhanced cognitive capabilities. Future studies can refine these techniques, exploring new cognitive frameworks and evaluating their long-term impact on data interaction and decision-making. By integrating fictional cognition into real-world visualization, this research redefines visualization as an immersive, empowering medium for human-computer interaction.

Reference

Card, S. K., Mackinlay, J. D., & Shneiderman, B. (1999). Readings in information visualization: Using vision to think. Morgan Kaufmann.

Munzner, T. (2014). Visualization analysis and design. CRC Press.

Willett, W., Heer, J., & Agrawala, M. (2021). The role of perception in information visualization: A survey of perceptual principles and their application. IEEE Transactions on Visualization and Computer Graphics, 27(2), 1 – 19. https://doi.org/10.1109/TVCG.2021.3049999

Practice － Tool-Driven Redesign Preparation

Experiment with Amazon QuickSight (Theory & Practice)

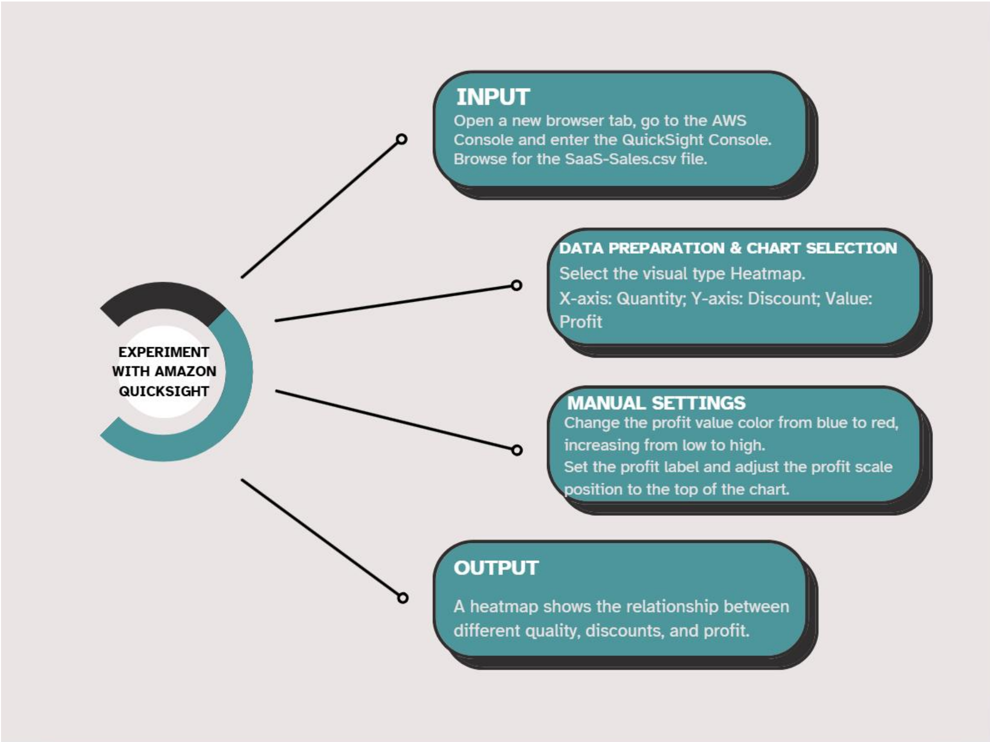

Figure 4: Workflow of the Visualization Process by Amazon QuickSight

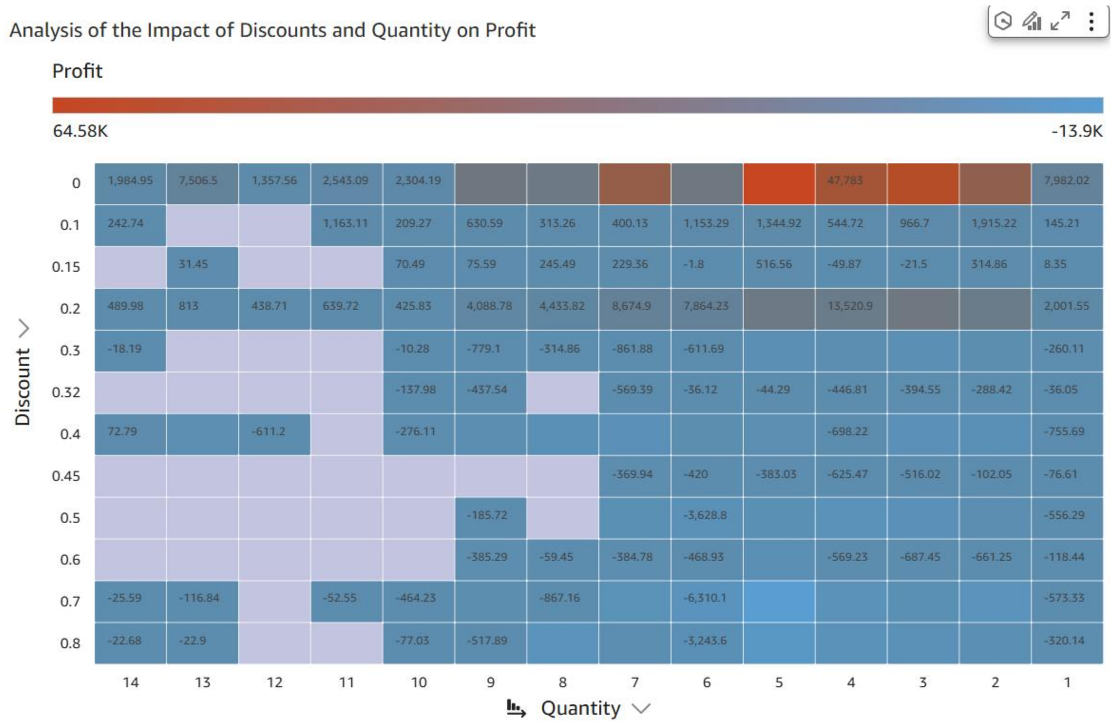

Figure 5: Analysis of the Impact of Discounts and Quantity on Profit

Dataset Description

The dataset used in the heatmap visualization is sourced from SaaS-Sales.csv and analyzes the relationship between Discount, Quantity, and Profit (Amazon Q, n.d.). It contains 9,994 transaction records from SaaS product sales, covering multiple industries, customer segments, and regions. This dataset helps businesses understand how discounting strategies impact profitability by examining different discount levels and purchase quantities.

Key Variables

Discount (%) – The percentage reduction applied to sales prices, which directly influences revenue and customer purchase decisions.

Quantity – The number of units sold per transaction, affecting overall sales volume and revenue generation.

Profit ($) – The total profit generated after applying discounts, reflecting the financial performance of sales strategies.

Dataset Scope and Structure

Figure 5 (Analysis of the Impact of Discounts and Quantity on Profit) visualizes profitability trends across different discount and quantity combinations. Key insights derived from this visualization include:

1. Trends and Patterns Identified

   High-profit regions (red areas) emerge when discounts are low and sales quantities are high, highlighting the effectiveness of moderate pricing strategies.

   Significant losses (blue areas) occur when high discount rates coincide with low sales volumes, emphasizing that excessive discounting without sufficient demand erodes profitability.

   Missing data points (purple areas) indicate that certain discount-quantity combinations were either rare or nonexistent in recorded transactions.

2. Decision-Making and Understanding the Data

   The insights from this dataset assist businesses in refining their discount strategies by:

- Identifying the optimal discount levels that maximize revenue while maintaining profitability.
- Avoiding discounts that lead to negative profits, ensuring sustainable business performance.
- Using data-driven pricing models to balance competitive pricing with financial health.

By leveraging these insights, businesses can develop strategic pricing policies that drive long-term revenue growth while minimizing financial risks (Gartner, 2023).

Critical Evaluation of Amazon QuickSight

Amazon QuickSight is an effective data visualization tool that efficiently extracts insights from datasets and provides interactive visualizations without coding. The tool provides customization options for legends and labels, allowing users to adjust visual elements to some extent. Additionally, Amazon Q helps users generate relevant tables for exploring specific analytical questions and enables modifications based on requirements. Furthermore, QuickSight includes predictive modeling capabilities, allowing users to identify trends and forecast future outcomes, making data-driven decision-making more effective.

However, QuickSight has several limitations. For instance, in the heatmap visualization, it does not allow setting a middle reference value, such as zero for Profit, which makes it harder to differentiate between positive and negative values effectively. Amazon Q struggles with handling complex modifications, making it difficult to refine charts beyond basic settings. Additionally, the interface lacks flexibility for advanced users who require detailed adjustments to elements like axis scaling and conditional formatting, making it not versatile enough to use.

Improvements & Recommendations

To improve the user experience, QuickSight should introduce more customization options, such as allowing manual adjustments to color scales and axis references. Enhancing Amazon Q's AI capabilities to interpret and execute complex modifications would also make the tool more adaptable to user needs. Gartner's 2023 BI report highlights QuickSight's strong cloud-based analytics but acknowledges its UI limitations. Addressing these areas would help QuickSight compete more effectively with industry leaders.

A Summary of Tool Exploration and Redesign Strategy

As part of my visualization critique and redesign process, I explored Amazon QuickSight as the primary tool for reworking the filledmap visualization. This choice was driven by QuickSight's strong capabilities in building interactive visual dashboards, as well as its ability to handle large datasets efficiently through seamless cloud integration. My goal was to address several issues identified in the original filledmap, particularly the lack of perceptual clarity, limited interactivity, and absence of contextual information such as data sources or definitions.

QuickSight allowed me to experiment with dynamic filtering, tooltip customization and enhanced legends, enabling viewers to interactively explore the relationship between discount, quantity, and profit. In contrast to the original static heatmap, the redesigned version provides a more engaging user experience by supporting on-hover values, filtering by regions or customer segments, and even enabling drill-down views. These features make it easier for users to extract insights relevant to their business context.

Moreover, QuickSight addresses a key color issue from the original: by adjusting the color gradients and assigning diverging color scales, I was able to clearly distinguish different value zones that the original visualization failed to do. I also included background elements like dataset descriptions and contextual labels, which help ground the viewer in the purpose and scope of the visualization, thereby improving cognitive accessibility and data transparency.

In short, Amazon QuickSight not only enhanced the visual clarity and interactivity of the filledmap but also supported a more user-centered, narrative-driven approach to data visualization.

Reference

Amazon Q. (n.d.). AI assistant — Amazon Q — AWS. Retrieved from https://aws.amazon.com/cn/q/

Gartner. (2023). Magic quadrant for analytics and business intelligence platforms. Retrieved from https://www.gartner.com

Innovation – Final Redesign and Integration

Redesign Summary

Title

Enhancing Climate Risk Communication

Inspiration and Theoretical Foundations

This redesign is inspired by a combination of theoretical and practical sources:

Tufte (1983) – For minimizing chartjunk and maximizing data-to-ink ratio.

Ware (2021) – For applying perceptually effective color schemes and reducing cognitive load.

FAIR Data Principles (Wilkinson et al., 2022) – To ensure data transparency and reuse.

Tools

Amazon QuickSight

Redesign Improvements Over Original

The redesign introduces several key improvements over the original filledmap. First, a color gradient from red to yellow to blue was applied, clearly distinguishing the Climate Risk Rank across regions while also improving accessibility for visually impaired users. Additionally, the dark mode of the QuickSight map was utilized, reducing background clutter and enhancing data contrast, making the filledmap more readable and focused. The background source data was also provided, allowing users to accurately pinpoint the location of the visualized data in the source tables. To further enhance interactivity, a hover function was added to the chart, allowing users to view the Climate Risk Rank and Climate Risk Score for each region when hovering over different areas.

Furthermore, the redesign includes metadata links and relevant licenses, ensuring that the data is open and compliant with the FAIR principles—Findable, Accessible, Interoperable, and Reusable. These improvements not only make the heatmap more visually intuitive and accessible but also significantly enhance the user interaction experience, while ensuring the data meets high standards for transparency and usability.

Implementation

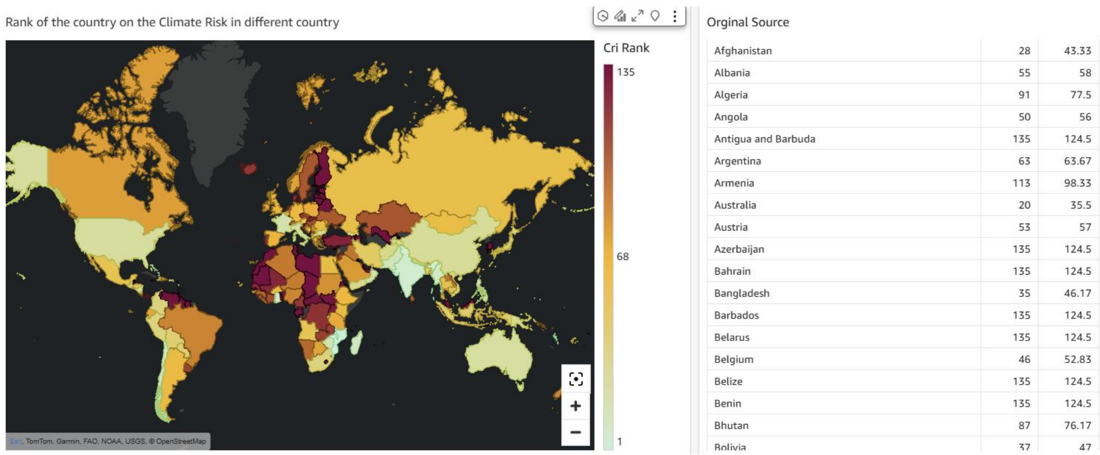

Figure 6: Simulation - Enhancing Climate Risk Communication

Reference

Amazon Q. (n.d.). AI assistant — Amazon Q — AWS. Retrieved from https://aws.amazon.com/cn/q/

Ware, C. (2021). Information Visualization: Perception for Design (4th ed.). Morgan Kaufmann.

Tufte, E. R. (1983). The Visual Display of Quantitative Information. Graphics Press.

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Additional Flowcharts

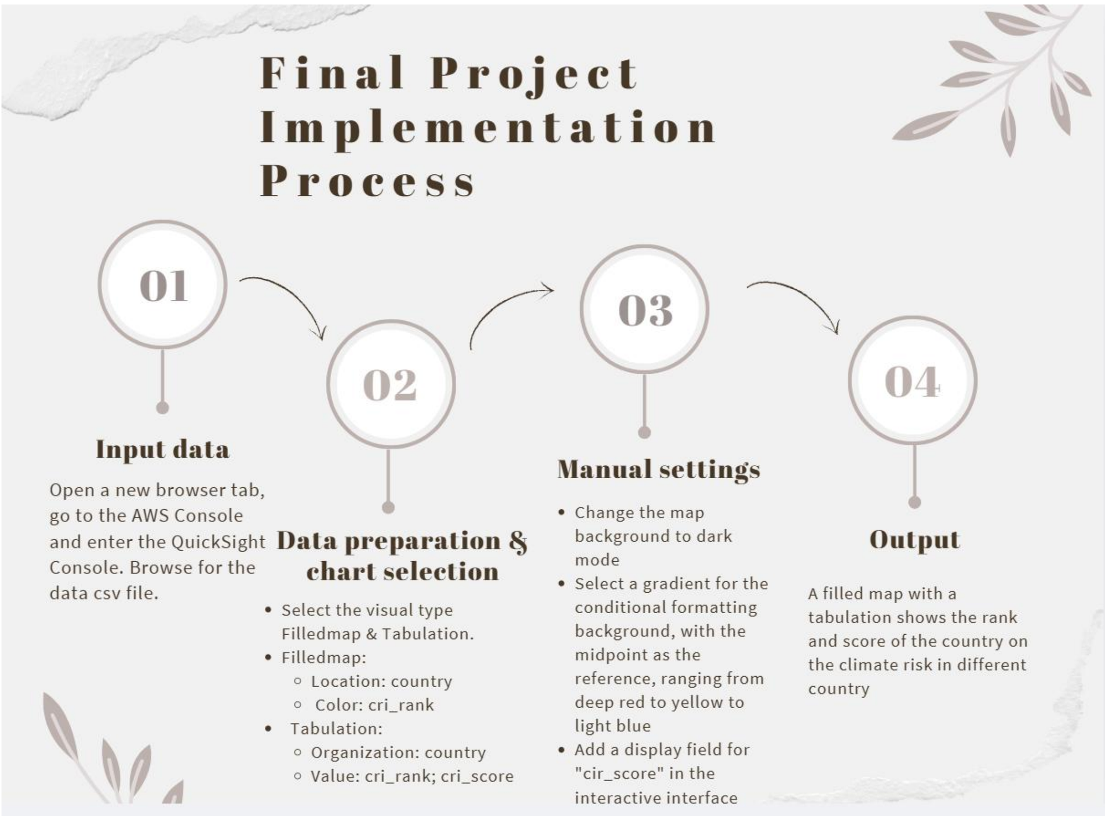

Figure 6: Final project implementation process

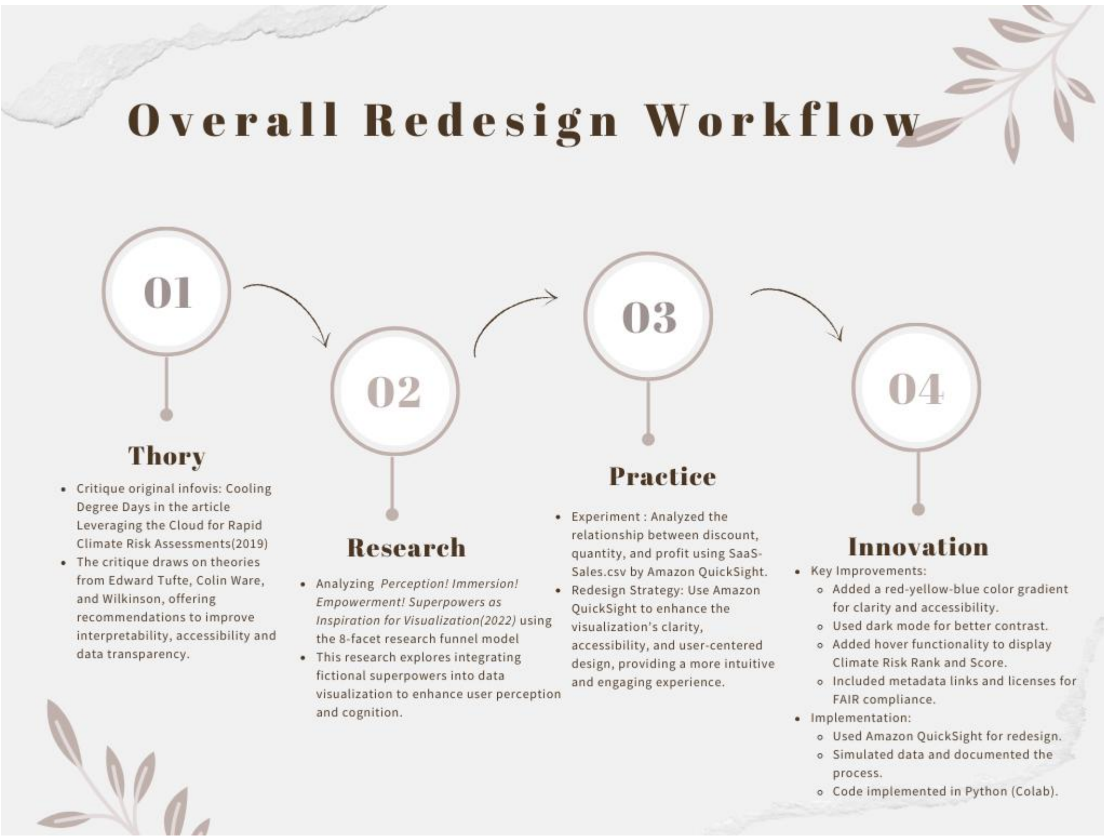

Figure 7: Overall Redesign Workflow