

Ethical Fashion: Wear with Care

Marisa Tania

College of Arts and Sciences

Department of Computer Science

University of San Francisco

San Francisco, California 94117-1080

Email: mtania@dons.usfca.edu

Abstract—There is a growth in the global shift toward a more ethical way to produce and consume fashion. This project uses D3.js to visualize recent facts and predictions regarding ethical fashion trends. This paper dissects data collection processes, visualization approaches, and website storytelling. There are four main objectives that this project intends to convey: showcase the comparison of the fashion market value, the correlation between apparel consumption and environmental impact, clothing price comparisons, and companies' fashion transparency index scores. The website presents a story and unique findings from each visualization objective. Additionally, this paper discusses future features that are likely to be implemented.

I. INTRODUCTION

As educated consumers discover the nightmare of fast fashion and its impact, there is more demand for changes needed in producing and consuming fashion. Consumerism, mass production, and the endless demand for more create a mass denial of the whole range of issues in the fashion industry. There is increasing awareness of the dangers of industrial chemicals in clothing production, environmental damages from industrial practices, and unsafe working conditions. From workers' rights to carbon footprints, from animal abuse to fashion waste, consumers are slowly considering the concerning impact of the industry on the environment, people, and animals.

Ethical fashion is apparel design, production, and distribution that focuses on reducing harm to people and the planet. This paper aims to provide insights into the current state and predictions about the ethical fashion industry. The goal is to tell a data visualization story by gathering the latest facts and statistics and informing readers of the numbers behind ethical fashion trends. There are four objectives that this project highlights:

- 1) *Fashion Market*: Comparison between estimated values of the ethical fashion market, the secondhand apparel market, and the fast fashion market from 2020 to 2025
- 2) *Emissions*: Correlation between apparent consumption of apparel worldwide and environmental impact
- 3) *Price*: Comparison of ethical clothing prices compared to the average market prices for men's and women's apparel
- 4) *Fashion Transparency Index*: The average fashion transparency index (FTI) score and the top 20 companies with the highest FTI worldwide in 2022

The project website is <https://mt-cs.github.io/marisatania/ethical-fashion>.

II. RELATED WORK

This section presents previous research papers, online resources, and libraries categorized by three relevant topics, ethical fashion studies, data journalism stories, and data visualization techniques.

A. Ethical Fashion Studies

Early research on a better practice of fashion circles around the sustainability topic. Gazzola et al. [7] focus on sustainability as an important phenomenon that affects the fashion market. Kutsenkova [17] dives deep into the recent movement of sustainable fashion for the environment while opening the discussion on the increasing ethical treatment of workers and slowing down global production and consumption. Brands' transparency also plays an important role in influencing consumers' purchasing decisions. Smith [20] provides an insight into the fashion retail landscape, followed by a closer look at circular fashion, and consumer attitudes toward sustainable fashion. Grankorg et al. [9] look into the impact of the COVID-19 crisis on consumers' behavioral change toward sustainability goals.

Though the major topic of the existing papers written is sustainable fashion, there are recent studies about ethical fashion itself. Mukherjee [18] uncovers the damage from fast fashion clothing life cycles and the explosion of consumption. Fast fashion creates natural and social environmental, and occupational hazards. Ethical fashion is the answer to commercial hazards caused by the fashion industry.

B. Data Journalism Stories

Lee-Robbins et al. [15] explain the importance of affective objectives over cognitive learning objectives. By telling a story, this project intends to pay more attention to outcomes to make viewers care about Ethical Fashion and strengthen a stance of opinion, leading viewers to take an action.

A number of online resources inspire the design of the final website. This project was partly inspired by Dottle et al. [4], who analyze the various environmental impacts of over-consumerism in fashion. This type of data journalism is a hybrid between fashion journalism and other fields such as design, computer science, and data science.

Amed [1] talks about the state of the fashion industry in 2023. Although the report focuses on market research, the piece analyzes and filters datasets and shows the increased

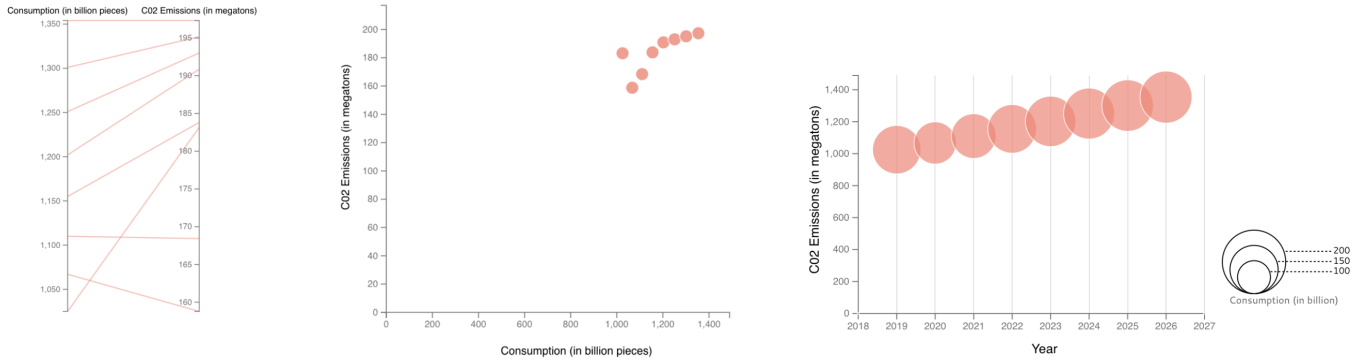


Fig. 1. Picking the right visualization technique to display a small dataset is challenging. Objective two shows the correlation between CO2 emissions and apparel consumption. The selection process began with just a parallel coordinate chart with two columns, to a scatter plot, then lastly a bubble chart.

role of numerical data in information distribution nowadays. This form of data-driven stories can also be seen in Owens et al. [19] insights on the shifting behaviors of fashion and beauty consumers in the United Kingdom.

C. Data Visualization Techniques

This project utilizes D3.js to create data visualizations. Holtz [13] inspires small-multiple line charts that repeat the same chart style multiple times to show trends over time. Eberhardt [4] creates an interactive small multiples visualization by highlighting all charts on mouse-hover.

Holtz [10] shows how to use bubble charts to compare three numerical variables' and shows patterns. Holtz [9] uses parallel coordinates plots to automatically build y-axes vertical lines and to plot a series of lines connected across each axis. Zhu [21] inspires the clean look of small-multiple bar charts. Bremer [3] creates a nicely structured radar graph with a small tooltip that appears when viewers hover over a point to show percentages. Holtz [12] builds a horizontal lollipop chart to make labels easier to read.

III. APPROACH

A. Data Collection

The data was collected from two main sources. The primary source was Statista [20] dossier and the secondary source was Fashion Transparency Index Score 2022 [6]. The data is cleaned and converted into CSV format. The FTI data contains a huge dataset. It was processed using Google Sheets to select useful features and to create a CSV file.

B. Libraries

This project uses D3.js to visualize the data. D3.js offers the flexibility to bring data to life using SVG, HTML, and CSS. To clarify information, the project utilizes D3 Legend (v4) and D3 Annotation. A cohesive color palette is an important aspect of this project. The final choice is to generate color using Colorbrewer 2.0 by selecting seven data classes, qualitative nature, and Set3 color scheme. The interactivity elements including tooltips and hovers are implemented using

D3 events. The website is created using Karmo Template which uses HTML and CSS.

C. Required Pieces

To implement a good practice of data visualization, this project ensures to show the chart titles, axis labels, color legends, and sources for each visualization. Each objective is also accompanied by a story that highlights the key points of data.

D. Challenges

When working on the project, the first obstacle was creating small-multiple charts. The small-multiple format makes it complicated to break down the data per graph. For example, in Figure 1. the dot plots were plotted in all charts instead of the intended one. The workaround is by using a for-loop and creating the same graph multiple times.

There is a challenge in handling the sizes of the data. A very small dataset definitely has disadvantages and it was tricky to pick the right visualization technique. As shown in Figure 2, to show the comparison between apparel consumption and emissions, parallel coordinates with two columns might not be the best choice. Hence, the second approach was to create a scatter plot. However, this caused an unbalance data-to-ink ratio. The last resort was to replace the scatterplot with a bubble chart.

A large dataset also has its own challenge. The beta release of the lollipop chart sorted the entire 250 companies from the original dataset which caused clutters and uncertainty. The final version ranks and sorts the top 20 companies with the highest FTI score.

Another obstacle is displaying the D3 visualization on the main website. Many features ended up not showing correctly when the code is merged to the main index.html as can be seen in Figure 3. For example, the small-multiple bar charts' tops section and the color legend were missing. The solution was to display the color legend in a separate Javascript file. There was a struggle in showing D3 annotation on the main page. For some reason, all of the annotations ended up showing in one graph when they were intended to highlight multiple charts.

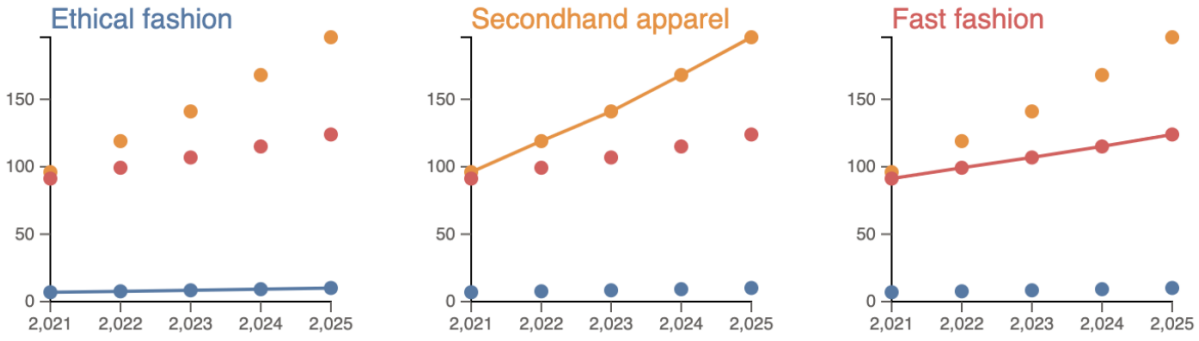


Fig. 2. A challenge in plotting dots on small-multiple line charts. The set of dots is plotted repeatedly instead of just one at a time.



Fig. 3. A challenge when merging codes to the main index.html: the "tops" category bar graph and the color legend were missing.

A decision has to be made to keep just one annotation for the parallel coordinate since it needs the most explanation.

The last challenge is to implement interactivity between multiple graphs. An optional feature that this project would like to have is to have the lollipop chart interact with the radar graph. The plan was to change the radar graph based on each company's data. In the end, the two charts are displayed individually with the radar graph showing the average score for each field.

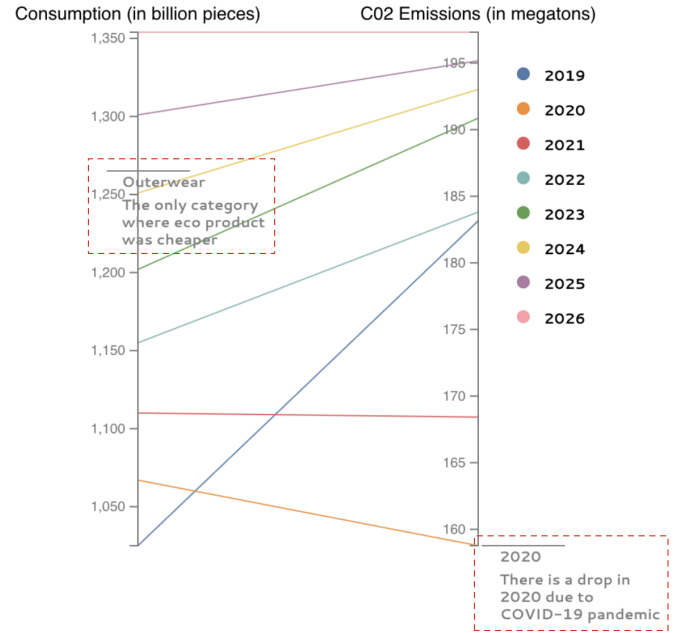


Fig. 4. A challenge when merging codes to the main index.html: annotations from the entire index.html are only displayed in one graph.

IV. RESULTS

A. Small-multiple Line Charts and Interactive Graphs

The first set of small-multiple line charts shows the estimated values of the ethical fashion market, the secondhand apparel market, and the fast fashion market from 2020 to 2025. As can be seen in Figure 4, each chart represents each market with estimated market values on the Y-axis and years on the X-axis. On hover, a tooltip will show the year and market value of each data point. In 2022, the global market value of the ethical fashion market was estimated to be worth 7.7 billion U.S. dollars. The fast fashion market is forecasted to reach 99.2 billion U.S. dollars by 2022.

The second set is an interactive small-multiple line chart that is intended to show a clear comparison of the three market segments. This was done by keeping the Y-axis at the same

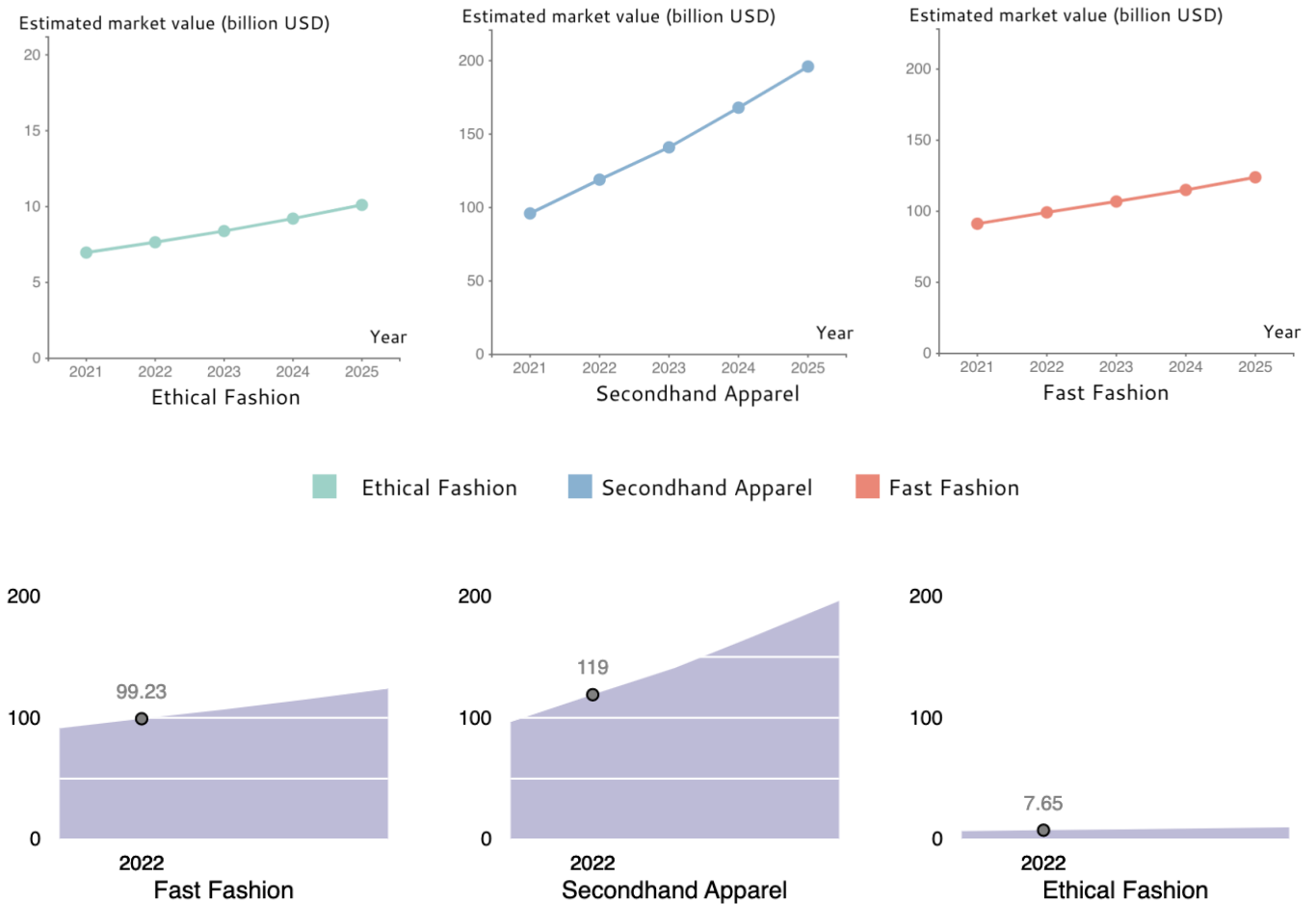


Fig. 5. Small-multiple line charts of the estimated global market value from 2020-2025 (in billion U.S. dollars). The Y-axis values vary depending on each dataset (top). Interactive comparison of the three market segments. All of the charts have the same Y-axis value from 0 to 200 to display a more accurate comparison between the three market segments (bottom). Source(s): BRC[8], Statista[20]

scale from 0 to 200 for the three graphs. In Figure 5, it is clear that the growth of the ethical fashion industry is much slower than others. Surprisingly, the secondhand apparel market is estimated to grow faster than fast fashion in the upcoming years.

B. Bubble Chart and Parallel Coordinates Chart

For objective two, a bubble chart and a parallel coordinate chart are implemented to show the correlation between apparel consumption and CO2 emissions. The bubble chart has years on the X-axis, CO2 emissions on the Y-axis, and apparel consumption as the size of the bubble. For the parallel coordinate chart, each line represents a year.

As seen in Figure 6, In 2020, there is a drop in consumption and emissions due to the COVID-19 crisis.

It was calculated that in 2019, the apparel industry emitted approximately 1.01 gigatons of carbon dioxide equivalents into the atmosphere. This is estimated to increase to 1.35 gigatons by 2027 if no drastic action is taken.

In 2021, the apparent consumption of apparel worldwide was approximately 168.4 billion pieces. According to estimates of the Statista Consumer Market Outlook, this value is expected to increase in the coming years to 197.3 billion pieces in 2026.

C. Small-multiple Bar Chart

One of the biggest reasons that consumers are not shifting toward ethical fashion is the price of the garments. The small-multiple bar charts as seen in Figure 8 show the comparison between the ethical clothing price to the average market price for men's and women's tops, bottoms, outerwear, and footwear apparel categories.

Eco-clothing at mass retailers in the United States tended to be sold at a slightly higher price point than the average market price for similar items of clothing. The only category of clothing that was actually cheaper as an eco product was outerwear. The category with the biggest price gap was footwear, as eco shoes were on average 18 U.S. dollars more expensive.

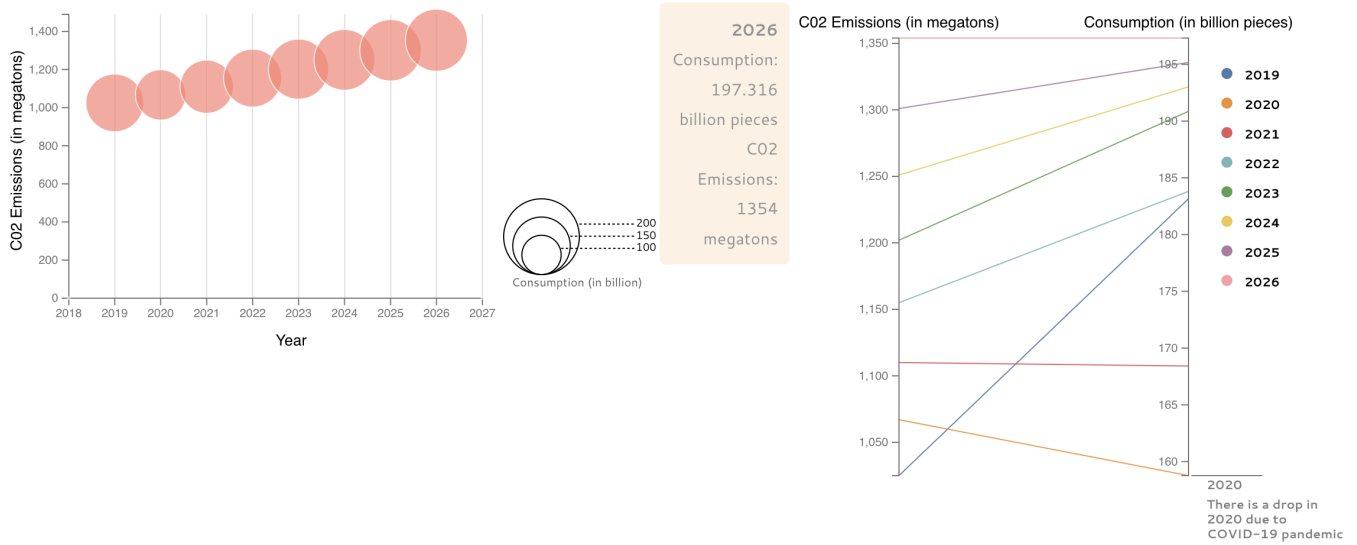


Fig. 6. The projection worldwide of the consumption volume vs. carbon dioxide emissions of the apparel industry from 2019 to 2026 (in billion pieces and in megatons). Source(s): Apparel Institute[2], Statista[20]



Fig. 7. The average price of eco clothing vs. average market price in the United States by product category in 2021. Source: Edited[16]

D. Radar Graph and Lollipop Chart

As seen in Figure 8, The spider chart shows the average subcategories of the FTI score. The seven subcategories are animal welfare, biodiversity and conservation, diversity and inclusion, energy and greenhouse gas emissions, equal pay, health and safety, and waste and recycling. On hover, the tooltip displays the average percentage of each category.

The average FTI score in 2022 from 250 companies worldwide is 59.9 or 24 percent, a gain of only one percent versus 2021. Companies' efforts in diversity and inclusion and energy and greenhouse gas emissions are increasing with an average of more than 70 percent.

The lollipop chart displays the top 20 fashion companies with the highest FTI score. There are two buttons that enable users to sort the chart by brand name and by score.

Three fashion brands are tied for the top slot — mass-market retailers Kmart Australia and Target Australia, and Italian retailer OVS — which scored 78 percent each. H&M, The North Face, and Timberland are following the top three.

V. DISCUSSION

Overall, the final approach undertaken was promising, since all the objectives aligned with the visualizations. There is a stepping stone from the proposal, alpha release, beta release to the final release. D3.js is proven to be extremely stable, powerful, and versatile. However, it takes learning progress to make the most of it. This project carefully considers visualization best practices including color palette, legends, and layout. This project provides an opportunity to implement a comprehensive data visualization website, from making design sketches to displaying visuals on a web format.

Upon implementation, if there were a chance to do things differently, the author would choose a larger dataset, and

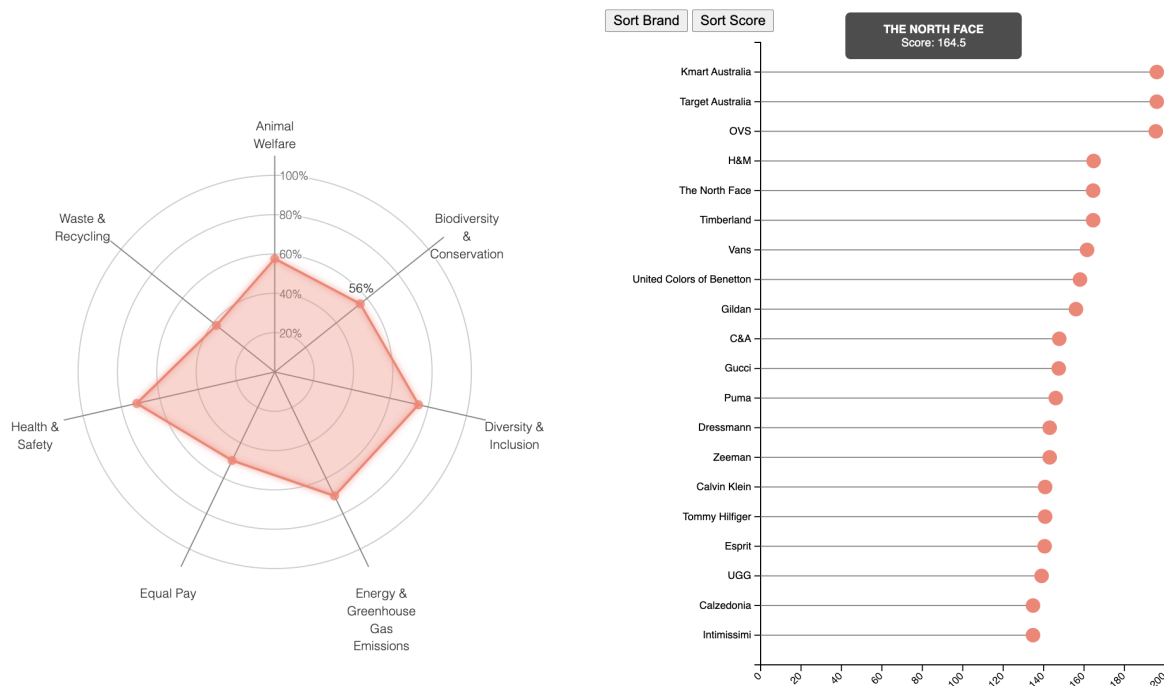


Fig. 8. Fashion Transparency Index Score 2022. On the left: the radar graph shows subcategories of human rights and environmental Policies. On the right: the lollipop chart sorts the top 20 most transparent fashion companies worldwide. Source: Fashion Revolution [6]

improve story quality for the data journalism aspect of the project. The author would also incorporate the data visualization codes to the main website page sooner in the project to catch bugs earlier and to help avoid the risk of making major changes during subsequent implementations.

VI. FUTURE WORK

For future work, this project intends to implement scrollytelling to present the content as viewers scroll through the website. Another thing that could be implemented is to replace the parallel coordinate chart with a slope graph since there are only two data variables. In the future, the goal is to add more annotations on each chart to highlight important key points. To improve the user experience, this project aims to connect the radar graph and the lollipop chart interactively.

VII. CONCLUSION

This data visualization project aims to make readers more aware of the current state of ethical fashion and to consider the entire life cycle impacts of clothing – from raw material to disposal. Instead of turning a blind eye, the fashion industry needs to adequately address the impact of production processes and consumption patterns.

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