Accessible Customer Analytics: Building a Webapp for No-Code Customer Analytics at a Major Retailer

(Technical Report)

Coastal Climate Change Response: An Analysis of the Use of Technology by Governments, Nonprofits, and Private Businesses in Coastal Climate Adaptation

(STS Research Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In the fall of 2024, two major hurricanes made landfall in the southeastern United States, causing destruction and major flooding even in mountainous areas far from the coast. Devastating floods ripped through the mountains of western North Carolina, bringing rivers to some of the highest levels ever seen while razing entire towns in areas where flooding could never have been anticipated (Cohen, 2024). Throughout the entire southeast, students were forced home from school, with thousands still unable to return to school due to flood damage; this has disproportionally affected low-income students, who often live in areas most susceptible to damage and whose parents rely on school for childcare while working (Closson & Sandoval, 2024). For months, people in Florida were forced to recover and rebuild after Hurricane Milton tore across the coast a mere two weeks after Hurricane Helene; the compounding effects of these two storms were exponentially worse than if they had occurred separately, with already damaged infrastructure often impeding rescue efforts (NY Times, 2024). Throughout these areas, FEMA and state and local governments have often been the most immediate responders, with many NGOs stepping in soon after and private businesses often donating funds to relief efforts (ABA, 2024).

Flooding, rising water levels, and other consequences of climate change affect coastal areas all over the world to varying degrees, with residents relying on several different types of organizations to respond to and mitigate the effects of climate change. Specifically, many of these aiding organizations can be divided into three categories: governments, nonprofits or NGOs, and private businesses. Often, their use of technology has been critical to their success, with each type of organization using different types of technologies for the different effects of climate change that they intend to mitigate.

For all three types of organizations, collecting and analyzing data has been one of the most powerful tools in combating and adapting to climate change. Apart from climate change, most companies use data analytics in all aspects of their business; as the ability to collect data on all aspects of life has improved, so has the usefulness of this data. However, most forms of data analytics require technical knowledge and coding skills that most people in the workforce do not possess. To better take advantage of the vast amounts of data most companies collect, a method of easily performing data analytics tasks for employees without technical knowledge should be created.

The following technical section proposes a paper reflecting on my experience building a webapp for a large retailer that easily and quickly creates customer analytics dashboards. The STS paper focuses on a research project assessing the differing use of technology by governments, nonprofits, and private businesses to aid in climate adaptation.

Technical Project

To many modern businesses, data is their most valuable asset. With proper data use, companies can make more informed decisions, better capture market trends, and better predict the needs and desires of their customers, allowing them to operate more efficiently and increase overall revenue. For retailers, data analytics can be transformational, allowing them to track customer preferences and trends to improve efficiency in ordering, tailor marketing, and better serve the needs of their customers, improving profits in the process. Importantly, employees must be able to easily access and create data analytics insights, allowing them to take full advantage of the data they collect.

While working as a software engineering intern at a major global retailer in the summer of 2024, I was tasked with creating a webapp called Data Explore to help other associates easily and quickly create dashboards from customer analytics data. Previously, associates used Looker, a Google platform that allows users to draw data from different sources and create easy-to-digest graphs, charts, and dashboards. However, to create these dashboards, users needed in-depth knowledge of Google's proprietary Looker coding language called LookML. Data Explore abstracted this LookML layer away, allowing no-code configuration of Views, Looker's term for the object that collects data from a single source and transforms it for future use, and Explores, objects that join several views to allow users to draw graphical insights and create dashboards. I am proposing a paper that overviews my contribution to this project; it will discuss the main challenges faced in the development process, demonstrate the importance of this project to the organization, and reflect on my experience working for a large, multinational company.

The webapp used ReactJS, HTML, and CSS for the frontend, with components and styling from the retailer's internal design guide. Figma, a tool used to create and prototype user interfaces, was used to create a skeleton of the final webapp for initial approvals. The backend was built in Java Springboot, the standard backend framework for all applications designed at the company. All code was deployed to the retailer's proprietary multi-cloud platform, which automatically provisioned computing resources from both Azure and Google Cloud depending on current traffic and computing load. Analytics data was stored in either BigQuery or Hive, both large data warehouses, allowing users to select from a range of company data in their analysis and dashboard creation.

Through Data Explore, users were able to both select preconfigured Views and create their own from a new data source, configure and select database columns to use for analysis, and

join the selected Views on different properties or columns to create a final Explore. Once an Explore was created, dashboards containing graphs and insights could be configured either within the webapp or directly on Looker without the need for extensive LookML knowledge. These Explores could also be edited and updated with new data as it arrived, something not previously possible without LookML experience.

STS Research Project

There are many devastating effects that climate change can have on coastal areas, with severity depending on the specific geography and ecosystems present in that area. According to the US Environmental Protection Agency, the top climate impacts on coasts are coastal property and infrastructure damage, damage to coastal ecosystems, and climate change related land loss, with much of the concern revolving around the financial and economic damage caused by these climate change effects (EPA, 2024). These are very broad challenges faced by nearly every coastal population and are among the most severe consequences of climate change on the coast. Many of the most used technologies in responding to climate change respond to flooding risks and include both artificial measures, such as sea dikes and barriers and infrastructure floodproofing, and natural remedies, such as dune rehabilitation and wetland restoration (Linham & Nichols, 2010).

In coastal areas, different types of organizations adopt very different roles and employ different tactics in responding to climate change effects. Local governments are often the most active in climate adaptation, bolstering infrastructure and regulating activities known to worsen climate change (Barbi & Ferreira, 2014). In the private sector, climate adaptation initiatives often arise to protect existing company infrastructure and resources; however, there is a growing

market for private investment in government-led adaptation projects (Gibbs, 2020; Bisaro & Hinkel, 2018). Nonprofits, with more freedom in directing and allocating resources, are able to assist other actors in a very nuanced way, filling the gaps left by government regulation and private sector intervention (Saitgalina et al., 2022).

While the broader impacts of governments, NGOs, and private businesses on climate change response have been studied, an analysis of their respective uses of technology in responding is needed. Through my research, I plan to answer the following question: How does the use of technology differ across governments, nonprofits, and private businesses when responding to and adapting to climate change in two US coastal areas? Based on the analysis of the most efficient documented climate adaptation initiatives, I also intend to provide recommendations on the roles of each type of organization and their best uses of technology in an ideal climate response plan. To do so, I will carry out a meta-review of existing literature, adopting a case study approach to evaluate current climate adaptation practices in an east coast and a west coast location. I plan to use Google Scholar and Web of Science to find peer-reviewed academic research and government, nonprofit, and corporate reports from 2010-2024 relating to climate change adaptation efforts in the two chosen locations. Potential candidate locations include King County, WA, known for its long-standing and aggressive climate initiatives, and the Virginia coastline, where nonprofits and local governments work in conjunction to enable wetlands conservation and living shoreline development (Poyar & Beller-Simms, 2010; Saitgalina et al., 2022).

Conclusion

Increases in the frequency and severity of hurricanes in the southeastern US are directly caused by climate change. With water temperatures rising in the Gulf of Mexico and the Atlantic, hurricanes are able to grow stronger and remain stronger than ever before, causing damage to coastal areas and, increasingly, inland areas in their path. Now, more than ever, it is important to examine the ways to respond to the effects of climate change, determining the most effective mix of governmental, NGO, and private business aid. With increasing amounts of climate refugees leaving areas most affected by rising water levels and worsening disaster events, efficient and effective response plans are needed to ensure the safety and prosperity of these areas. Technology plays a crucial role in this response; with better infrastructure, improved monitoring and data collection, and the adoption of more effective disaster relief technology, the effects of climate change can be mitigated, lessened, and, eventually, reversed.

Across applications, data improves efficiency and overall effectiveness; in the private sector, data transforms the operations of many companies, helping them tailor all aspects of their business to better suit their specific, individual needs. In order to fully access the benefits of data being collected, a solution for employees without deep technical knowledge is necessary. Given the ability to perform customer analytics without complex technical expertise, employees at major retailers are able to gain valuable insights on purchasing trends and customer preferences, allowing them to more efficiently sell products that customers truly want. Instead of relying on technical experts for data analysis, a no-code data analysis webapp allows employees to quickly and easily perform specific, tailored analyses needed to best improve their working effectiveness.

References

Bisaro, A., & Hinkel, J. (2018). Mobilizing private finance for coastal adaptation: A literature review. *WIREs Climate Change*, *9*(3), e514. https://doi.org/10.1002/wcc.514

Closson, T., & Sandoval, E. (2024, October 7). For Some Children, Hurricane Helene's Ruin 'Could Take Years to Get Over.' *The New York Times*. https://www.nytimes.com/2024/10/07/us/hurricane-helene-school-closures-education.html

Cohen, L. (2024, October 1). *Here's how Hurricane Helene brought "biblical devastation" to western North Carolina in a near "worst-case scenario"—CBS News*. https://www.cbsnews.com/news/hurricane-helene-biblical-devastation-north-carolina-near-worst-case-scenario/

Gibbs, M. T. (2020). The two-speed coastal climate adaptation economy in Australia. *Ocean & Coastal Management*, *190*, 105150. https://doi.org/10.1016/j.ocecoaman.2020.105150

Hurricane Milton Relief Efforts. (n.d.). https://www.aba.com/about-us/press-room/press-releases/hurricane-milton-relief-efforts

Linham, M. M., & Nicholls, R. J. (2010, November). *Technologies for Climate Change Adaptation: Coastal Erosion and Flooding*. United Nations Environment Programme Global Environment Facility. https://ndcpartnership.org/knowledge-portal/climate-toolbox/technologies-climate-change-adaptation-coastal-erosion-and-flooding

Milton Kills at Least 5 in Florida, With Toll Expected to Rise: Hurricane Live Updates—The New York Times. (n.d.). https://www.nytimes.com/live/2024/10/10/weather/hurricane-milton-florida-live-news

Poyar, K. A., & Beller-Simms, N. (2010). Early Responses to Climate Change: An Analysis of Seven U.S. State and Local Climate Adaptation Planning Initiatives. *Weather, Climate, and Society*, *2*. https://doi.org/10.1175/2010WCAS1047.1

Saitgalina, M., Yusuf, J.-E. (Wie), & Covi, M. (2023). Shoreline Management and Coastal Resilience in Virginia: Analysis of the Roles of Environmental Nonprofit Organizations in Encouraging Living Shorelines. *Coastal Management*, *51*(3), 172–185. https://doi.org/10.1080/08920753.2023.2199790

US EPA, O. (2022, July 29). *Climate Change Impacts on Coasts* [Overviews and Factsheets]. https://www.epa.gov/climateimpacts/climate-change-impacts-coasts