6-7-2017

Taking Afrobarometer Data Everywhere

Christen Nguyen
Santa Clara University, ctnguyen@scu.edu

Sean Thomas
Santa Clara University, sthomas@scu.edu

Adrienne Tina
Santa Clara University, atina@scu.edu

Santa Clara University
DEPARTMENT of COMPUTER ENGINEERING

Date: June 7, 2017

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Christen Nguyen, Sean Thomas, and Adrienne Tiña

ENTITLED

Taking Afrobarometer Data Everywhere

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF

BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING

THESIS ADVISOR

DEPARTMENTCHAIR

Abstract

According to statistics gathered by research group Afrobarometer, many countries in Africa lack infrastructure and basic necessities. In fact, Afrobarometer knows the specific rates of need and availability sampled across thirty-six countries but more prosperous African countries do not know these numbers. These more developed countries are in a position to help their less fortunate neighbors if only made aware of the social and economic climate in the respective areas. Our partnership with Afrobarometer will allow us to advertise these statistics through the use of a mobile application. The data will be displayed in a way that is easy for the average reader to digest and understand. By exposing a larger African audience to the results from these public opinion surveys, Afrobarometer hopes to inspire these people to take action and make donations to the appropriate social benefit groups. The countries represented by the surveys can then receive help in the areas expressing need.

Acknowledgements

This research was supported by Santa Clara University's School of Engineering and the Frugal Innovation Hub at the university.

We would like to thank Dr. Silvia Figueira, Associate Professor of Computer Engineering and Director of the Frugal Innovation Hub for trusting us with this project and for her assistance in its development.

We would also like to express our gratitude for Afrobarometer for granting us access to their survey data and for allowing us the opportunity to create this application.

Contents

List of Figures

1 Introduction

The continent of Africa is home to over one billion people, with many of these citizens living in rural areas. The majority of countries within Africa are considered developing countries, which means they lack many of the modern amenities developed countries take for granted. One of the most important aspects of the modern world is the ability to find information quickly about the people around us, to keep tabs on our country and/or continent. However many Africans lack the ability to access the information. Organizations like our client Afrobarometer collect data in Africa on economic, social, and political issues aggregated by rural, urban, and gender demographics. This information is not easily accessible and often indigestible, thus reducing the number of people who can utilize the data. This lack of information accessibility contributes to a less informed population, which is not conducive to the progression of a country. In the current age of technology, every person should have access to information vital to his or her improvement.

Currently, the only way for Afrobarometers target audience, Africans from developed areas, to view public opinion poll results is if they seek it out in the form of an online query or through social media and news outlets. These solutions are likely to lack accuracy but also require internet or television access, which is limited in many countries in Africa. Because the standard user has to go out of his or her way to find this type of information, most Africans are not made aware of neighboring countries political climates or general welfare. No solution exists today that places this information in the public eye with ease of access. For the webpages that do display poll information, the data is not arranged in a way that is intuitive and meaningful to the average reader. Additionally, very few of these resources prompt a response from readers or call them to take action. African countries in need do not get the help they deserve while their more prosperous neighbors capable of making an impact remain ignorant of the issues they are facing.

Our solution is an interactive infographic mobile application that displays results gathered by Afrobarometer surveys. Since Afrobarometer is a reputable and authoritative source, displaying their data will guarantee people access to reliable information. Our application will reach broad audiences as smart phone ownership in Africa is catching up to global rates. The general user will be able to easily understand the data, as it will be presented in charts, tables and other infographics. This would provide a unique and educational experience for people to access data about not only local areas, but also other countries across the continent. Our system will bring

independent peoples together through a wealth of knowledge made readily available at just the touch of a button. Furthermore, our solution will work toward raising awareness amongst people in Africa. We hope that with this awareness, people will gain insight that inspires them to take philanthropic action.

2 Background or related work

Previous senior design projects have tried to achieve similar results for similar issues. One such project was a group from the 2016 Senior Design Conference titled Tanzania Education Graphing, Ranking, and Mapping. The solution was a webpage that allowed users to interact with a graph or map page and view statistics on educational data in Tanzania.

Our solution is specific to another dataset entirely and also has very different functional and non-functional requirements as well as design constraints. For our senior design project, we are working on creating an infographic display specifically for Afrobarometer's aggregated data. Because Afrobarometer employed the help of the Frugal Innovation Hub and Dr. Silvia Figuiera to carry out this task, our project will be the first attempt to solve this problem. Our solution will play a pivotal role in raising awareness about a variety of issues in Africa.

3 Use Cases

The use case diagram visualizes all of the potential users (actors) in a system. The diagram outlines all of the ways that an actor can interact with the system. Each actor is represented by a stick figure which has a line drawn connecting it to an activity bubble. Our project's use case diagram only involves one actor, as there is only one way to interact with our project from a user's side. Figure 1 shows the use case diagram as well as a table outlining pre-conditions, post-conditions, steps, and exceptions for the use case.

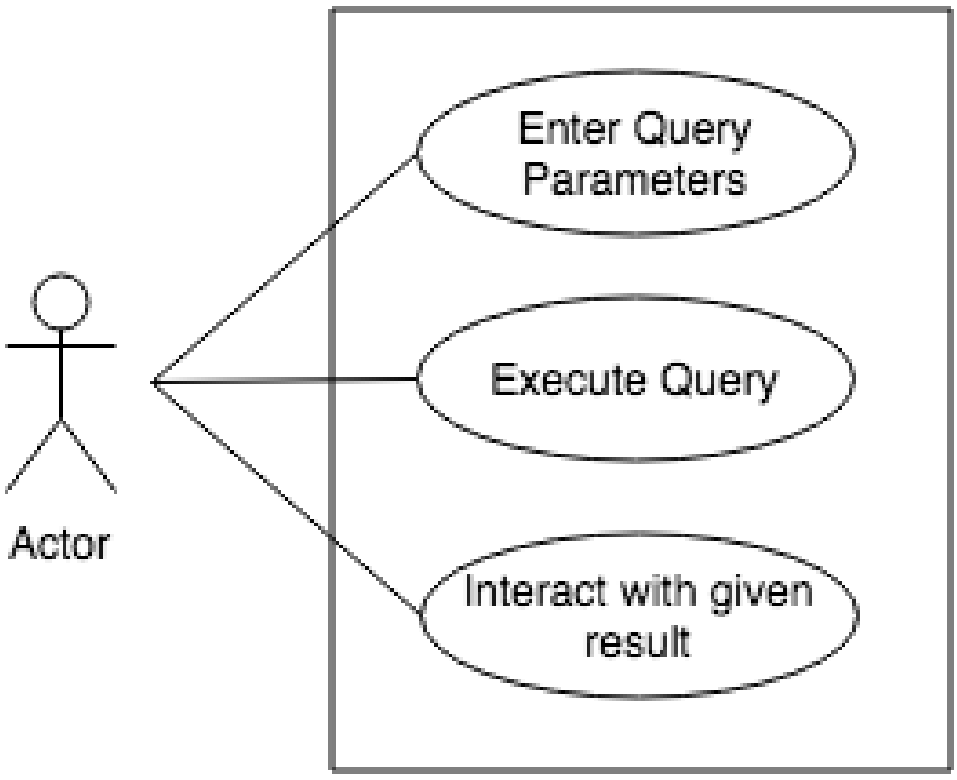

Figure 1: Use Case Diagram

4 Conceptual Model

4.1 Introduction

Our conceptual model is made up of a low fidelity prototype. It is a simple wireframe mockup that shows a generalized view of the application without getting too concerned with design and usability. Our conceptual model also does not concern itself with marketing and using the companys exact colors though that is a crucial detail in the final application. The figures below outline the major features in our application.

4.2 Figures

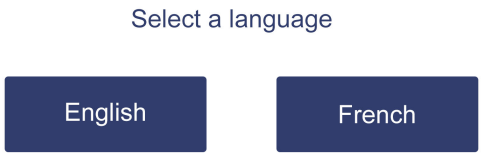

Figure 2: Conceptual Model: Language selection page

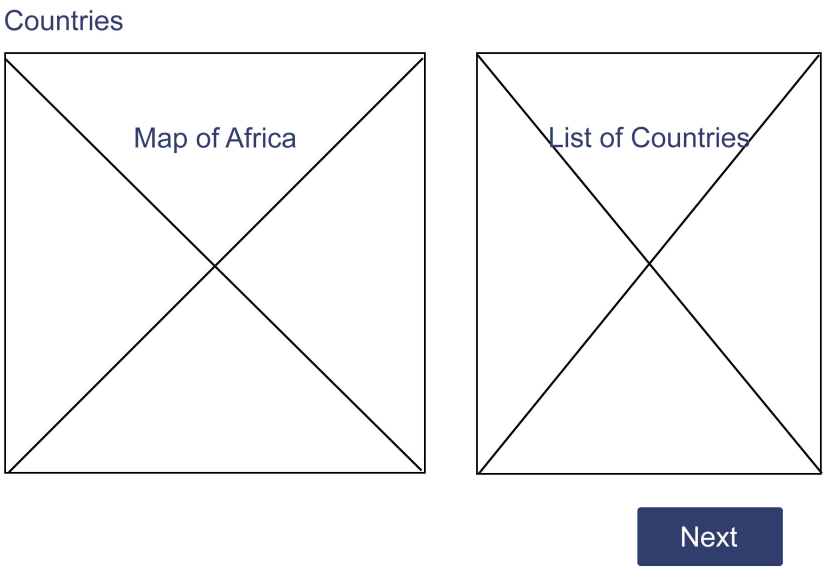

Figure 3: Conceptual Model: Country selection page

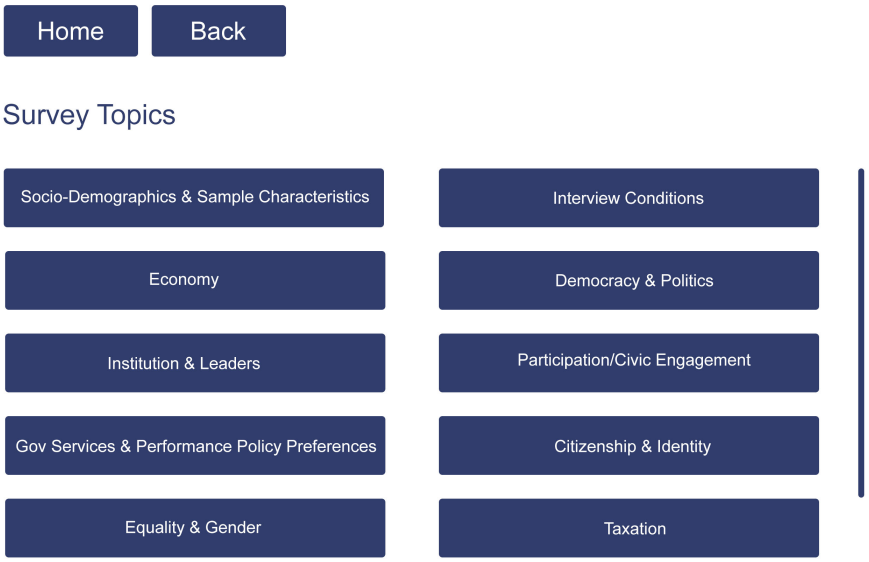

Figure 4: Conceptual Model: Survey topic selection

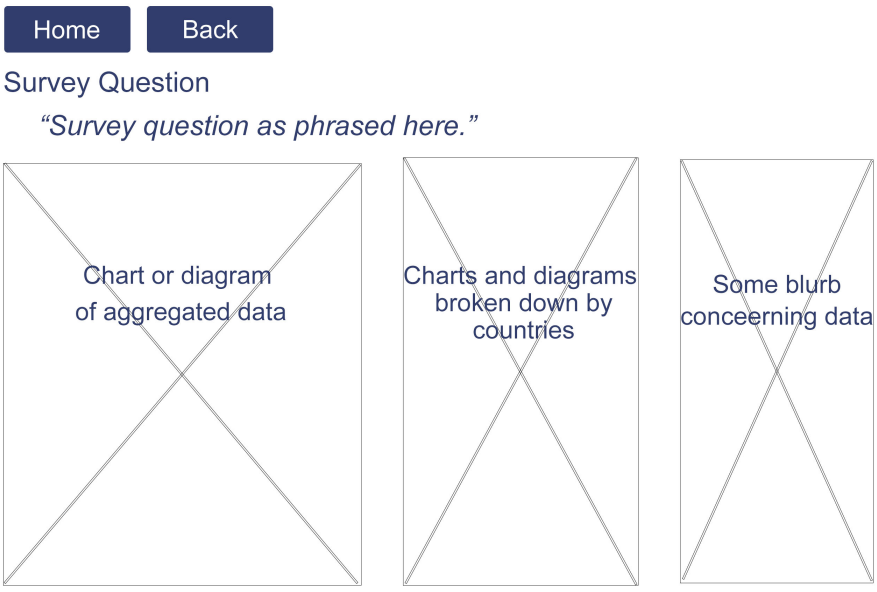

Figure 5: Conceptual Model: Result page

5 List of Requirements

5.1 Introduction

This section organizes the requirements of the project into three categories: functional requirements, non-functional requirements, and design constraints. Functional Requirements are those which the project must perform. Non-Functional Requirements are those which impact user experience. Lastly, Design Constraints are limitations on the scope of the project. Additionally, each of these requirements are further divided into subcategories based on their level of priority: critical, recommended and suggested.

5.2 Functional Requirements

- Critical
  - The system will aggregate associated data by country
  - The system will produce the appropriate infographics based on the users selections
  - The system will accredit all data used to Afrobarometer and acknowledge copyright holders
  - The system will allow the user to browse results on specific topics
    - Examples: gender equality, economy, taxation and national identity
- Recommended
  - The system will allow the user to select the survey rounds (year when survey was taken)
    - Implementing selection of several rounds depends on how much is needed for prototype
    - User can choose from six rounds (years when survey was taken)
- Suggested
  - The system will support language selection
    - English or French

5.3 Non-Functional Requirements

- Critical
  - The system will be intuitive for the user to make specifications on the data to be viewed
  - The system will be easy to use
  - The system will be quick and responsive
  - The system will produce clear and understandable infographics
  - The system will be extendable/scalable
- Recommended
  - The system will be flexible/adaptable to possible requirement changes
- Suggested
  - The system will be internationalized to support a multilingual audience
  - The system will be extensible for future projects

5.4 Design Constraints

- Critical
  - Must function on iOS and Android devices
  - Must be easily transferable to other hardware
- Recommended
  - Should quickly render graphs that are easily intelligible
  - Should utilize a database-centric architecture for data access
  - Should utilize an event-based architecture for user interface

6 System Sequence Diagram

6.1 Introduction

This system sequence diagram outlines the basic flow of user activity when using our system. When users first access the system, they are prompted to select the survey round they would like to review. The user then specifies which country or countries to investigate given the specified round. Afterward, the user selects which survey question to interpret. This step is multifaceted; a survey topic is first selected, and each survey topic is divided into subcategories. Under each subcategory is a series of particular surveys from which the user makes his or her selection. The user is then presented with the appropriate infographics containing all information specific to the round, countries, and survey topic chosen. After viewing these infographics the user can start a new data analysis session or exit. At any point, the user always has option to perform the subsequent action or exit the system entirely.

6.2 Diagram

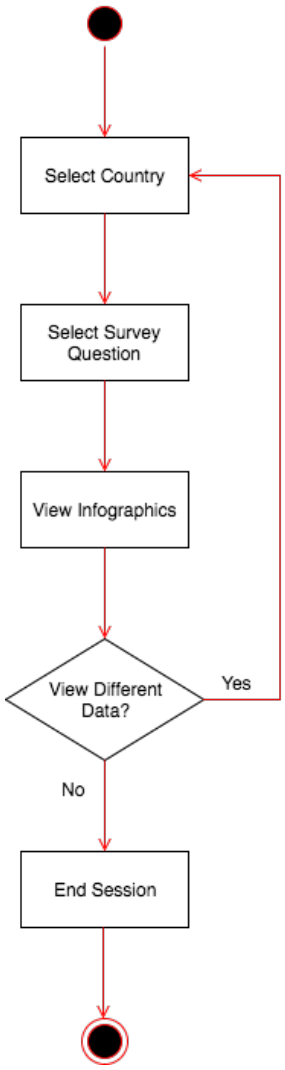

Figure 6: System Sequence Diagram

7 Design Rationale

The design rationale describes features in our application and the justification for including each feature.

7.1 Features

- Startup Page

  Description: Displays an option to select between two display languages (English and French)

  Rationale: We expect to have the majority of our audience be English-speaking, but we want to accommodate the French-speaking audience in Africa as well.

- Back Button

  Description: Allows users to move one page back

  Rationale: We want to give users the ability to freely navigate the application as well as going back to make different selections.

- Home Button

  Description: A button that allows users to return to the first screen

  Rationale: Gives users ability to start over and make new selections

- Category Selection

  Description: A page that allows users to select from a multitude of categories

  Rationale: Allows users to fully personalize the results they are most interested in seeing

- Analyze Button

  Description: A button to display results after categories have been selected

  Rationale: This button is necessary because we want to allow users to select from several different categories before choosing to view results rather than automatically displaying results after the selection of just one category.

7.2 Suggested Features

These features include functionality that was not required and could benefit the application users in a later and future build or extension.

- Donate Button

  Description: Navigates to donation page when clicked

  Rationale: If users are compelled to take action and donate, we allow them to with the simple selection of this button

- Donate Page

  Description: A form that takes user's payment information as well as an option to select from different charities

  Rationale: This page allows users to make a transaction and select their desired charity for a more meaningful experience. If in the future our application is scaled up for use in public spaces, this page would only take the user's email address and desired charity. They would be emailed more information about the charity as well as ways to donate.

8 Technologies Used

The technologies used outlines the languages as well as hardware used to complete the design and testing of our product. These particular technologies were chosen because of our familiarity with web development as well as their ability to complete the project. The technologies we used are listed below:

- Client Side
  - JavaScript
- Front End
  - HTML
  - CSS
- Server Side
  - Node.js
  - MongoDB
- Deployment
  - Adobe PhoneGap

9 Architecture Diagram

The Architecture Diagram outlines the kind of software architecture utilized to create our project. Our project utilizes a Database Centric architecture with a NodeJS server acting as the intermediary between the client's phone and the MongoDB. The MongoDB database is the center of our project. Using the data stored there, we can populate the various client screens that will be connected to the database.

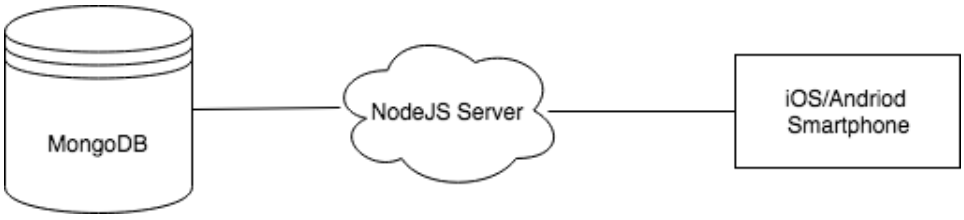

Figure 7: Software Architecture Diagram

10 Design

10.1 Original Requirements and Scope Changes

Upon our first meeting with Afrobarometer, we had a solid outline of our original project. We were initially tasked with creating a touchscreen application that would allow a user to query data and display graphs of Afrobarometer's data. Afrobarometer would place these screens in various common areas with high foot traffic in order to further proliferate their survey results. With this in mind, we set out to research and begin the process of creating this touchscreen application.

Our initial idea was to write the program in Java and utilize a computer to host the application. Users would then interact with the application on a 40-inch or larger touchscreen. After a lapse in our communication with Afrobarometer and some confusion on both ends, we realized that there was a requirements and scope miscommunication. The Afrobarometer party believed that we would be constructing the physical screens as well as the application. They were also lead to believe due to extenuating circumstances that there was a team developing a mobile application for them. Due to this miscommunication, as well as their interest in a mobile application, our group decided that the best course of action would be to pivot and create a mobile application instead of the original touchscreen idea. With this scope change our group set out to develop the application using the Adobe PhoneGap framework as well as standard web development technologies which we were comfortable using.

10.2 Final Design

After settling on our final project scope, our group set out to create an application with a simple flow, intuitive for those familiar and unfamiliar with technology. The application flows from one stage of selection to the next, allowing a user to appropriately narrow their search to their desired results. The country selection page, shown in Figure 8, allows the user to select the country about which he or she would like to learn. The subsequent topic screen sorts surveys by general topic, ranging from socio-demographics to politics, as shown in Figure 9. Once a general topic is specified, its corresponding subtopics are then listed for the user to browse. The following screen allows the user to select a particular survey question for which they wish to view the resulting data, as shown in Figure 11. The results are displayed on the final screen in the form of a pie and bar chart - shown in Figures 12 and 13 - between which the user can toggle.

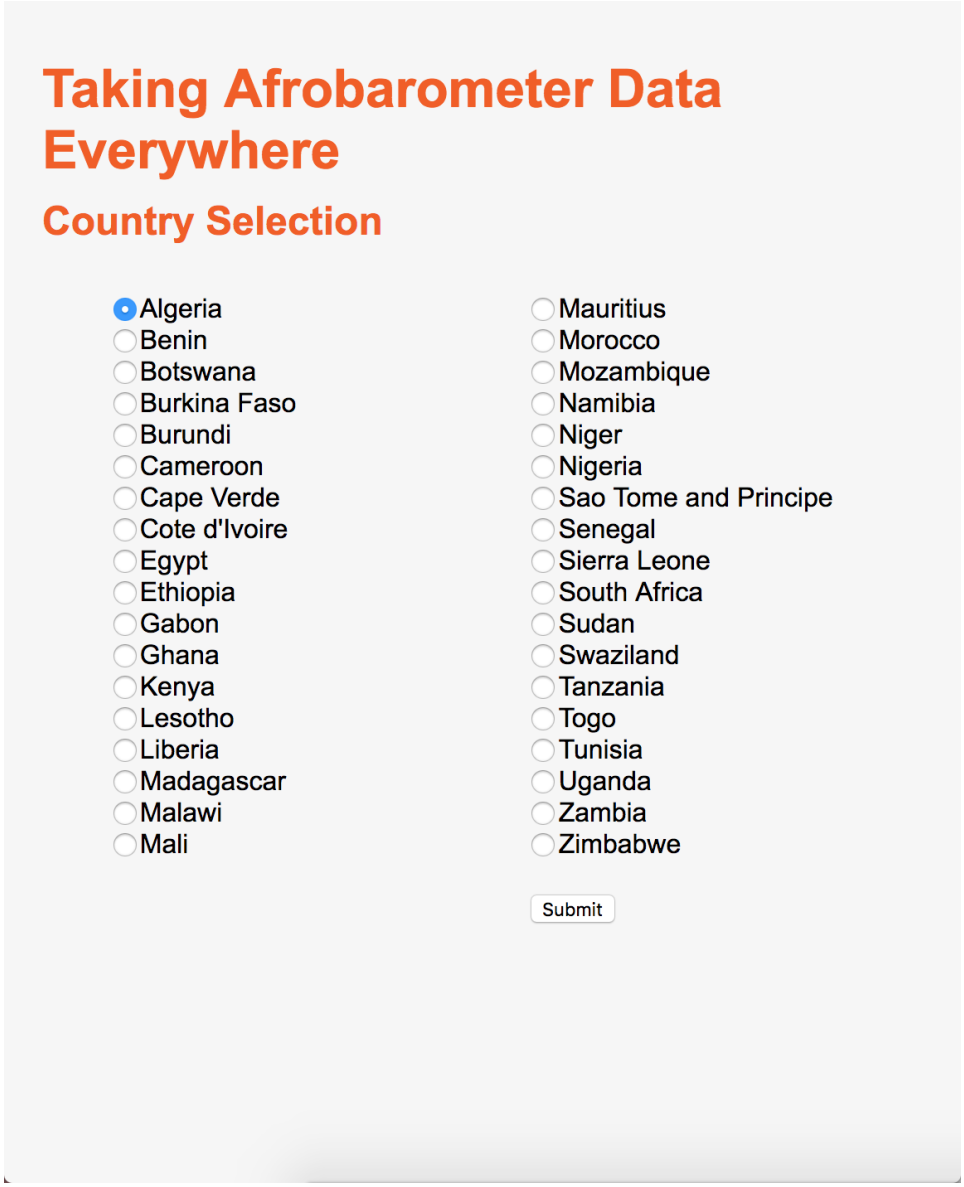

Figure 8: Country selection screen

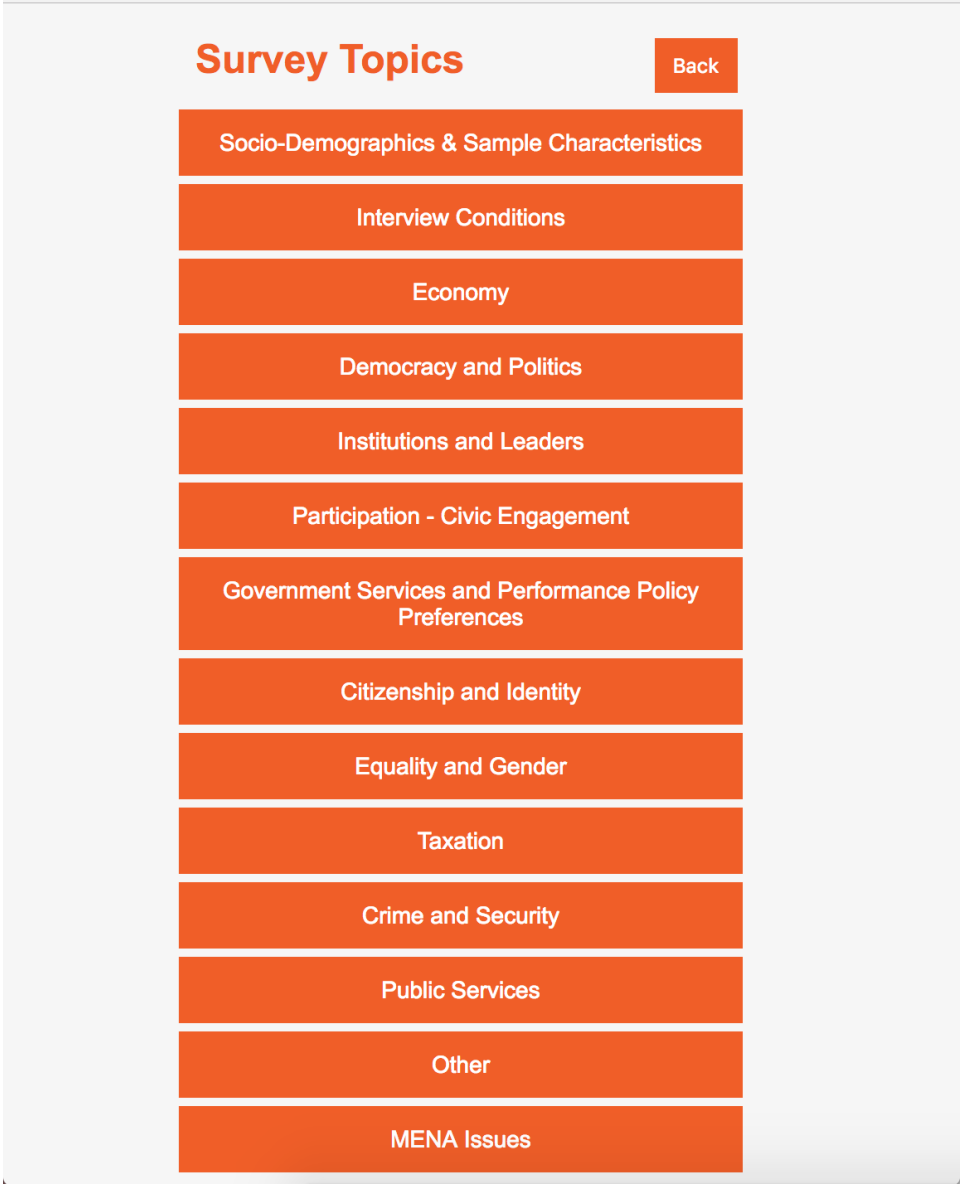

Figure 9: Main topic selection screen

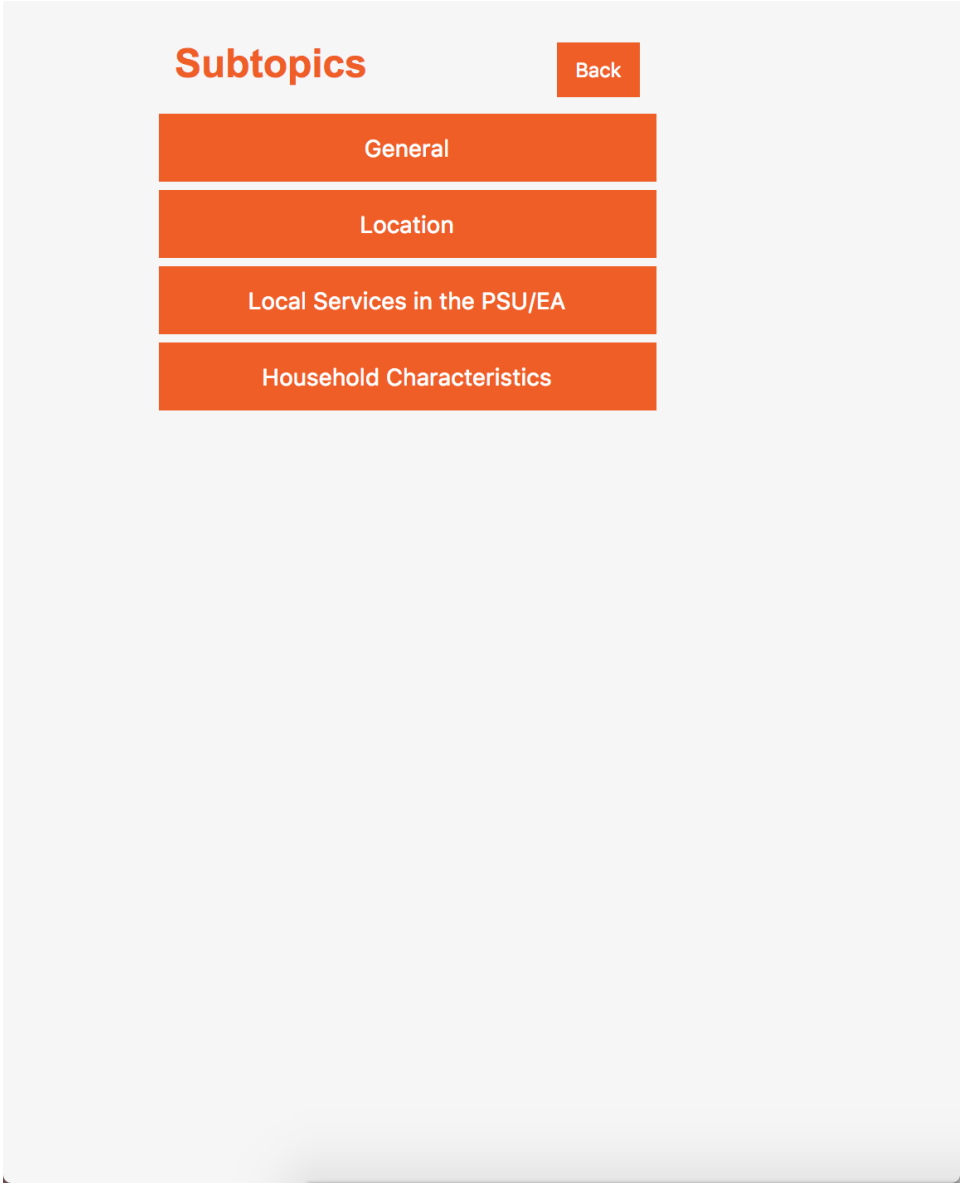

Figure 10: Subtopic selection screen

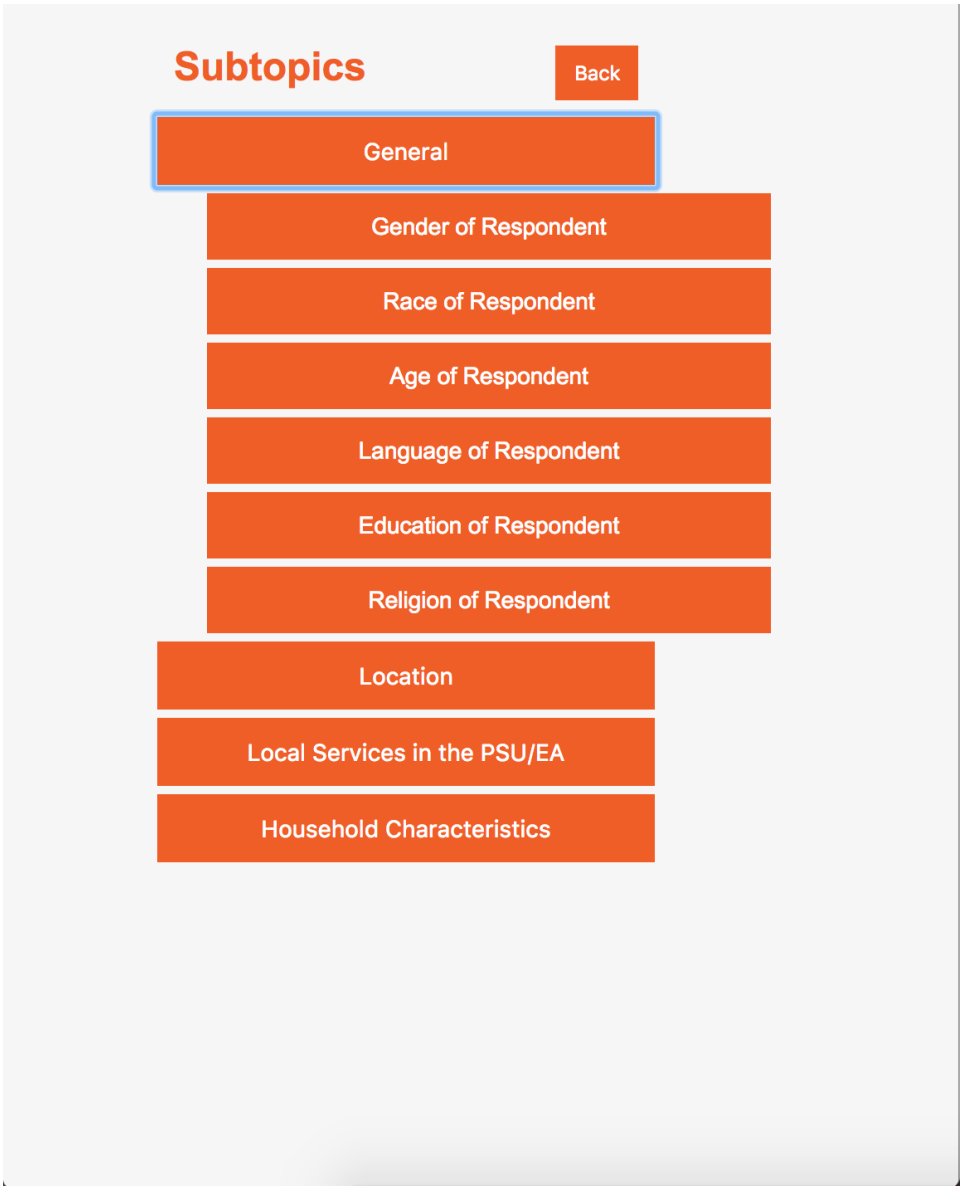

Figure 11: Subtopic screen with subtopic selected

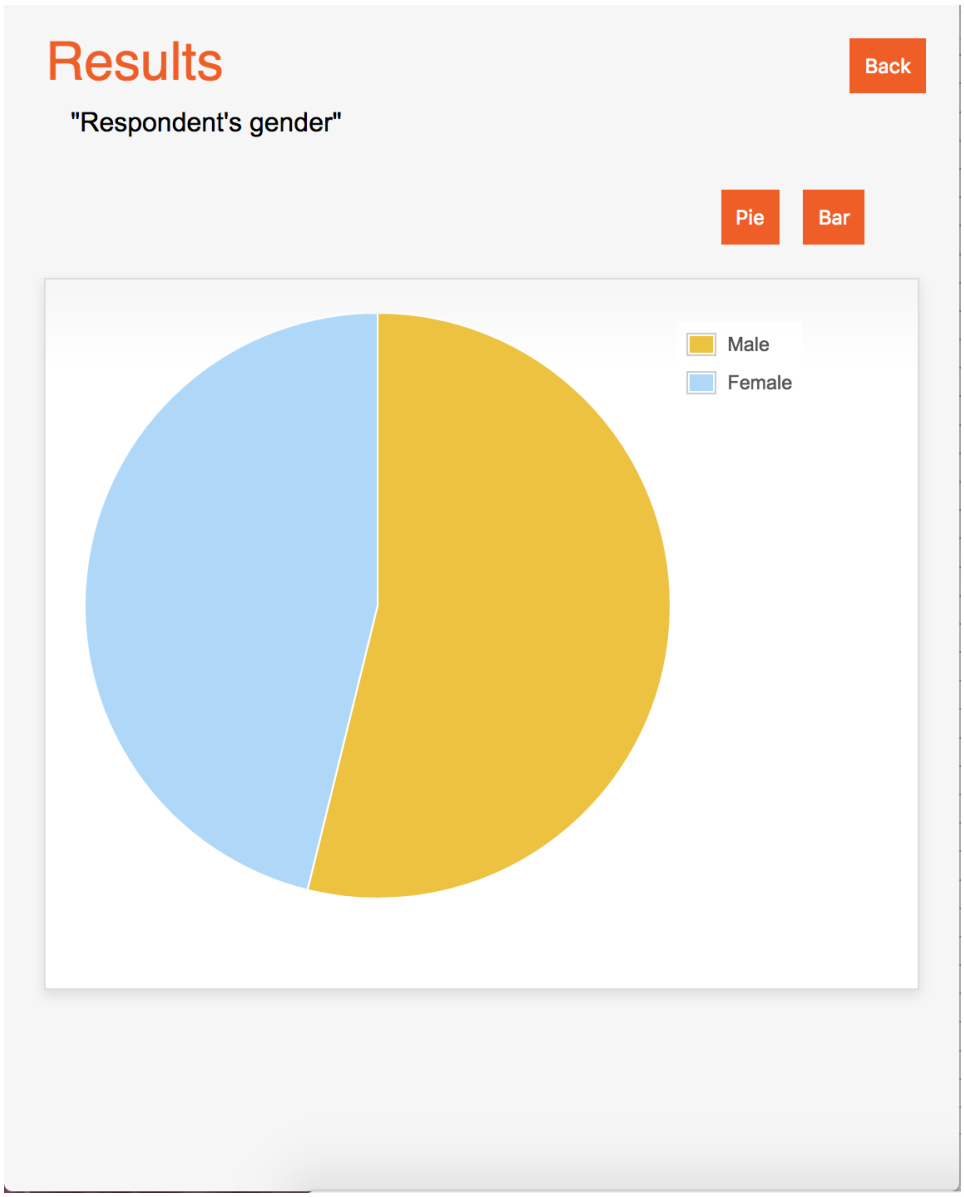

Figure 12: Result page displaying sample results via pie chart

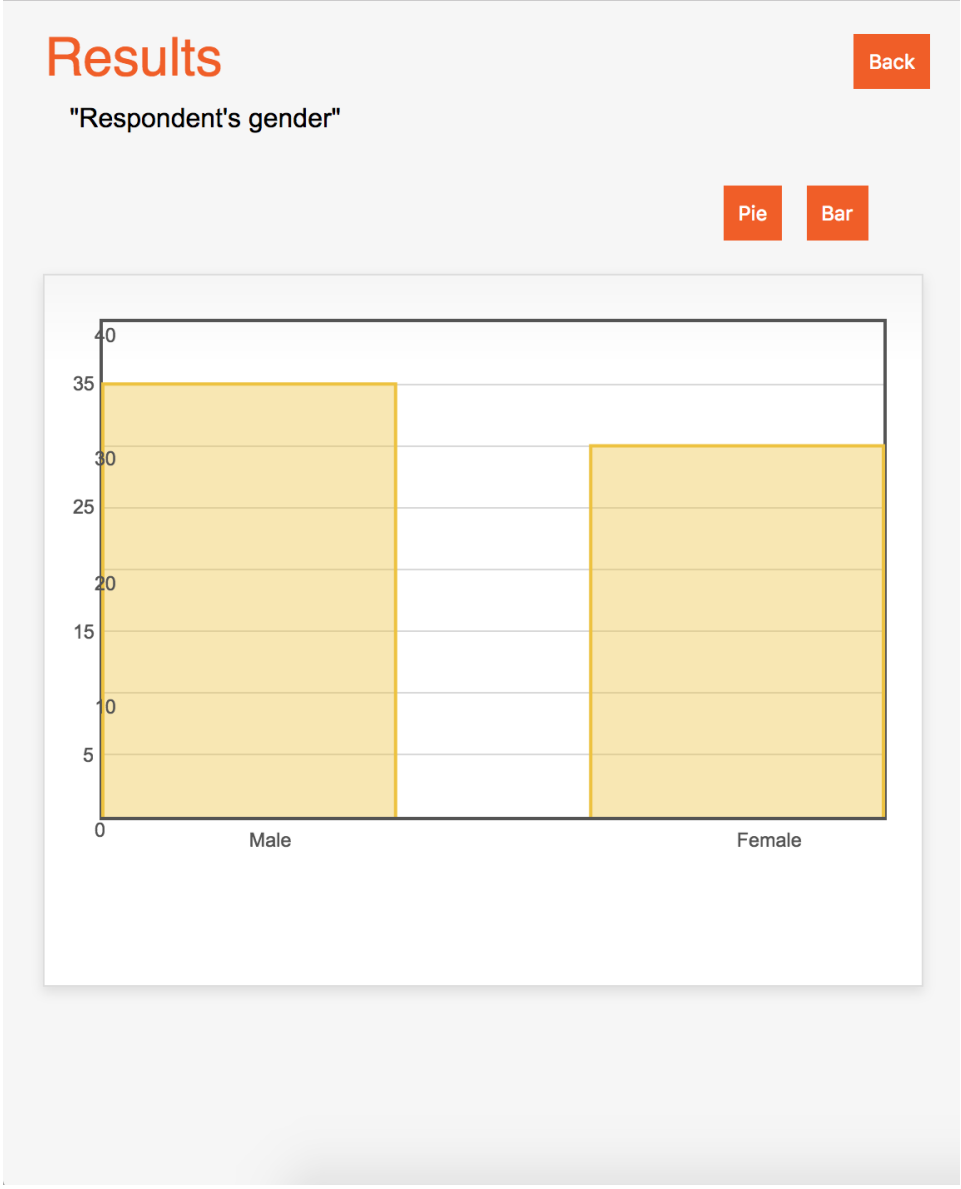

Figure 13: Result page displaying sample results via bar graph

11 Test Plan and Test Cases

11.1 Introduction

The test plan describes the steps we planned to take in testing our application as well as the types of testing that were to be performed at each stage. The test cases track specific actions and features that should be tested in addition to expected results of each action.

11.2 Test Plan

For our first round of testing, we were in alpha testing stage. In this stage, each member performed white box testing for general functionality on the feature they owned. When the code was refined, we followed this with a round of black box testing in which each member tested features they did not implement. We concluded the alpha test stage with a final round of white box testing and unit testing.

11.3 Test Cases

- Country Selection Page

  We tested this page by ensuring that it loaded properly and quickly. We tested each radio button and submitted on each country to ensure that the next page contained the proper country information. Additionally we eliminated the need to disable the submit button until a country was selected by having one radio button selected by default.

- Back Button

  Selection of this button takes users exactly one step backwards in their activity timeline but should still maintain query information from selections made on screens earlier on in the activity flow.

- Survey Topics and Subtopic Selection

  There are a variety of topics that the user can select from. Individual selections and a combination of selections were tested to ensure that the data displayed on the application reflects the selected topics.

- Analyze Button

  After the subtopic is selected, the Analyze button is clicked. This results in the page displaying results based off of the selected subtopic. The question at the top of the page should be the question related to

the subtopic. Not only did we test to make sure that the page is updated but also that the information displayed is correct.

12 Risks

A risk table lists all the potential issues that might arise throughout the development of our project. Some of these potential risks are more easy to avoid than others and some have a much greater impact on the project than others. Each risk has a probability, severity, impact (probability * severity), and mitigation strategy associated with it. This table outlines the major risks our project faces. There are other unforeseeable risks outside the ones shown. However, these risks create the biggest issues for out project.

Risk	Consequences	Probability	Severity	Impact	Mitigation Strategy
Requirements change	Complete redesign and loss of previous work	0.8	10	8	Check-in with customer frequently, Perform thorough requirements elicitation from the start
Miscommunication on project scope	Start over, lose progress, fall behind on timeline	0.75	8	6	Clarify terms and plans with client
Delayed response from Afrobarometer	Progress becomes dependent on response of client	0.83	6	5	Ensure we have a good relationship with them, keep contact info up to date, have several points of contact

Figure 14: Risk Analysis Table

13 Societal Issues

13.1 Introduction

Santa Clara University takes pride in crossing high-tech innovation with social consciousness. The School of Engineering emphasizes "engineering with a mission" – that is, supporting students to develop an intellectual curiosity and passion for "building a more just, humane and sustainable world." This entails a regard for numerous societal issues when developing any engineering project. This section describes how our project relates to each of these societal issues.

13.2 Ethical

Due to the fact that our project is a simple application to display simple infographics representing Afrobarometer's survey data, no ethical issues were raised about our project. At the very least, some survey questions could be regarded as ethically inauspicious or pressing (depending on the current state of the country or region), but that is not a matter of concern for our project.

13.3 Social

This is potentially the most important issue that our project addresses. The primary motivation for the development of our application was our concern for the social nature of Afrobarometer's surveyed countries. We anticipate the social impact of our work to be substantial and of good consequence. Since our application will provide thousands of people with powerful and helpful knowledge, the goal is for users to harness this knowledge to generate progress and positive change to improve the quality of life in these developing countries.

13.4 Political

As we've discovered from data compiled by Afrobarometer, many of the questions asked are heavily political. By creating an anonymous platform for citizens to freely state opinions about local and state leadership and government authorities, our application and the information provided by Afrobarometer could lead to the development of changing opinions, grounds for political grassroots movements, or increased political interest and involvement.

13.5 Economic

With our initial project scope we had the economic considerations of purchasing a touch screen as well as finding the appropriate computer to run it off of. However, as our project evolved the need for such purchases disappeared. The only cost for us to create this project came in the form of our time spent on writing code and researching. In terms of the user, they must own a smart phone capable of running our application as well as having access to the Internet. We tried to develop this application in the most frugal way possible. We did not end up spending any money on things during the development of the application.

13.6 Health and Safety

We hope that with the proliferation of the data provided by Afrobarometer's surveys, outsiders as well as the citizens of the surveyed countries will be made aware of the living conditions there. The questions shed light on issues such as availability of water and food to the safety of the neighborhoods. While we agree with Afrobarometer's ultimate goal to give people a voice and also a say in policy-making, our own goal is that exposure to this information will stir people to become involved and take action to better the lives of others less fortunate.

13.7 Manufacturability

Due to the fact that our project definition changed late in our development timeline, the application was merely built to provide all the necessary functionalities. It can, however, be improved in efficiency and perhaps rebuilt using better technologies. Since it is purely software, there are no hardware manufacturing concerns or costs to consider.

13.8 Sustainability

In narrow terms of sustainability, our application, if used over a long period of time, will certainly require constant updates so to be useful for our client and users for a reasonable amount of time. As Afrobarometer projects to continue surveying for as long as possible, we suspect that the need for our application will persist equally as long. Since our application will be used on tablets or smartphones, the sustainable impact it will have in the broader sense will be significantly low. We are simply making use of resources –

in our case, devices – that already exist and extending their usefulness by providing important data to the people who would most benefit from it.

13.9 Environmental Impact

As discussed, our project has a low environmental impact because it gives off no emissions and requires no manufacturing in addition to the tablets smartphones that our clients already own. An environmental concern one could link to our project would be how users dispose of their devices, but this is not a direct environmental concern with regards to our specific application.

13.10 Usability

Our application is designed with the lowest common denominator user in mind. Because the process already involves such simple functionality, the application is also easy to learn and easy to use. Each screen minimizes the actions required by the user and breaks down actions to a single clear and concise instruction. In the design of our application, we also decided to use a pie chart and bar graph to represent data as it requires little context and background knowledge to understand. Our design includes standard design features such as affordances, signifiers, and constraints.

13.11 Lifelong Learning

The creation of this application brought the three of us into new territory as none of us had experience in building a mobile app. However, we were able to go off of our understanding of web development and databases and learned the new technologies required for building an application through PhoneGap. This project has encouraged us to learn new technologies and break out of the comfort of using only the technologies we have already learned.

13.12 Compassion

The creation and usage of this application gave us a glimpse into the lesser known areas of life of African citizens. Ideally, Afrobarometer can utilize this application to spread information regarding concerning areas of life throughout the African continent. Things like political freedom, the ability to access food and water, and gender equality are areas that can help educate both those in Africa and abroad while generating compassion regarding the plight of our fellow humans. Hopefully this application can help not only generate

armchair compassion, but empower people to take action to alleviate the suffering of the planet's less fortunate.

14 Conclusion

14.1 Summary

Ideally, this project will result in an increased awareness of the African population regarding the status of their fellow citizens. The quick spread of information and in an easily digestible form allows for a more informed population able to enact change. Technology is ubiquitous in developed countries like the United States, but the developing world lacks the same exposure to the computerized world. By exposing a larger portion of the population to technology and data regarding their countrymen, more people can understand the needs of their society, and ideally enact changes faster. Researchers studying the usefulness of technology from a social benefit perspective will likely see increased social awareness stemming from the spread of information.

If successful, our project would serve as a means for people to learn insightful, statistical information about areas in Africa that Afrobarometer has surveyed. To provide these people in Africa access to this data would be giving them the power to connect through learned knowledge and the motivation necessary to take positive action. Additionally, our project would significantly widen the scope of Afrobarometers audience, thus giving them the power to impact thousands more people than the number currently made possible by their current website.

We hope for the resulting impact of this project to be exponential. It was our team's job to develop the application that would display Afrobarometer's data. Now as we hand our completed work over to Afrobarometer – the final step of our project – the success of the product depends on the manner in which it is deployed. Afrobarometer will take charge of the deployment and oversee its use in the countries in which it will be placed. This project was developed under Santa Clara Universitys Frugal Innovation Hub, a collaborative space under the School of Engineering that focuses on humanitarian projects and partnering with social enterprises. With that said, our project will participate in the social entrepreneur movement to hopefully inspire more projects of similar nature.

14.2 Lessons Learned

Working with a real-world client was a true challenge and privilege as it prepared our team for similar engineering projects in which we will participate in the near future. From working with Afrobarometer, we experienced the

setbacks resulting from major specification changes, particularly those late in the project development timeline. This taught our team to be adaptable and versatile. Additionally, because Afrobarometer is based in Africa, we endured the challenge of communicating with a client in a different timezone. This led to delayed communication and also made our project dependent on the response time of Afrobarometer.

The importance of communication was also made evident when determining the actual specifics of our project. For example, after our first meeting with Afrobarometer, we assumed that we had a clear understanding of what was expected of our team. However, we later learned that our understanding heavily contradicted Afrobarometer's expectations and this called for a reiteration of project specifications and requirements. We attempted constant contact with our client to ensure that we were keeping up to their standards.

Due to several changes to our project, our team developed a number of minor prototypes of the interface we were designing. As a result, we were exposed to a vast assortment of different back-end and front-end technologies as we experimented to determine with which we preferred to develop. We learned that technology research was crucial to finding technologies that work well together and thus creating an optimized version of a product.

14.3 Disadvantages

Although our project covers the breadth of the desired application's functionality, it is not fully implemented depth-wise. In other words, our team prioritized showing how our system works from start to finish, but there are a number of surveys that have not yet been imported into our database, as well as a few countries whose surveys are not accounted for. Our main concern when developing our application was to show that we could complete a full query from selection to data visualization for a sample of Afrobarometer's surveys. In addition, we imported only the most recent round (i.e. survey year) of surveys that Afrobarometer collected. Thus, our database is limited to only a fraction of Afrobarometer's entire database.

14.4 Future Work

Our Senior Design team has several plans for improving our system. These tasks will either be completed by our team or by developers at Afrobarometer, depending on the direction Afrobarometer decides to take with our project. One such improvement includes expanding our application's database

so that it more closely reflects (or mirrors) the size of Afrobarometer's complete database. To do so, thousands more surveys must be imported for all countries and all rounds. Once multiple rounds are available, the user would ideally be able to select the exact round he or she would like to investigate. Another improvement would be allowing the application's user to select multiple countries at once for a single query in order to compare data amongst those selected countries for one specific survey. Finally, we hope to improve the universal usability of our application by increasing the number of languages in our interface. We cannot assume that an application deployed in Africa will be understood by the entire African population if only made accessible in English. Ideally, French would be the first language to implement as it is vastly spoken throughout the continent. Later these languages could include those native to specific countries such as Akan or Ewe, the two most widely-spoken languages in Ghana.

15 References

15.1 Introduction

This section provides a review of the references to which we referred for research and background information. Each section contains a summary of each cited article in our Senior Design project.

15.2 Current System

This section analyzes the two sources from which we obtained information about our client and their current system.

- "Welcome to Afrobarometer." *Welcome to Afrobarometer — Afrobarometer.* Afrobarometer, 2016. Web. 15 Oct. 2016.

  This webpage provided the necessary background information for our team to understand the identity of Afrobarometer in order to implement a system perfectly geared toward their needs.

- "Online Data Analysis." *Online Data Analysis — Afrobarometer.* Afrobarometer, 2016. Web. 15 Oct. 2016.

  This is the direct webpage containing Afrobarometer's current system: The Online Data Analysis Tool.

15.3 Infographics and Data Visualization

This section of our literary review contains the sources to which we have referred for information on creating effective infographics for data visualization.

- Ashman, Rachel, and Anthony Patterson. "Seeing the Big Picture In Services Marketing Research: Infographics, SEM And Data Visualisation." *Journal of Services Marketing* 29.6/7 (2015): 613-621. *Business Source Complete.* Web. 23 Oct. 2016.

  This article describes four guidelines for creating effective infographics that promise to make quantitative data more accessible and impactful. By following these guidelines, researchers can present the information simply without watering down the data too much. The methods in the article allow researchers to appeal to a broader audience, as we hope to do when the app is deployed to audiences in Africa. Our

target audience will range from professionals to children so we need to create infographics that are simple to understand yet maintain a sophistication that will appeal to more informed demographics.

- Gamble, Tim and Jon May. "Transitions in Interface Objects: Searching Databases." *Advances In Human-Computer Interaction* (2016): 1-5. *Applied Science & Technology Source.* Web. 22 Oct. 2016.

  Tim Gamble and Jon May researched different ways to display information for searching across a database like screen. Their results give validity to the claim that close attention needs to be paid when designing informational layouts because the design can have a large impact on how easily a user completes a task. In the case of our project, we will need to closely test and vet different ways to display the information, as a bad display could ruin the usability of the project. May and Gamble mainly focus on the distance that the eye has to travel to find the information in relation to how efficiently participants can complete a task. We have used the results of their study to tailor the design of the display of our information.

- Godfrey, Parke, Jarek Gryz and Piotr Lasek. "Interactive Visualization of Large Data Sets." *IEEE Transactions On Knowledge & Data Engineering* 28.8 (2016): 2142-2157. Applied Science & Technology Source. Web. 23 Oct. 2016.

  This article identifies interactive visualization as an effective method for data analysis as well as the challenges that come with trying to visualize large data sets. The authors focus mainly on the issue of query processing within a database system. This article will help us to form meaningful queries that are relevant to the way we want to manipulate Afrobarometers database. With the authors acknowledgement of the challenges of data visualization, their recommendations have helped us create queries that overcome the difficulties of creating quick query responses and showing sufficient data points.

- Kosara, Robert. "Presentation-Oriented Visualization Techniques." *IEEE Computer Graphics & Applications 36.1* (2016): 80-85. *Applied Science & Technology Source.* Web. 7 Oct. 2016.

  This article focuses on presentation-oriented techniques when displaying data. Since data visuals are the perfect accompaniment to stories or random pieces of information to enhance the audiences level of understanding, the presentation of this data is truly important. Histor-

ically, traditional visualization techniques have been dismissed as less important to the information it accompanies; however, since our system will be presenting infographics, i.e. both content and visuals, we would like to prioritize the visualization aesthetic. This article helped us pinpoint exactly what makes an infographic presentation-oriented so to create the best user experience possible for our audience.

- Otten, J. J., K. Cheng, and A. Drewnowski. "Infographics And Public Policy: Using Data Visualization To Convey Complex Information." *Health Affairs* 34.11 (2015): 1901-1907. *Global Health.* Web. 7 Oct. 2016.

  This article discusses the concept of data visualization from multiple perspectives including psychology, usability, graphic design, and statistics. The article describes how to portray data in easily accessible and appealing formats, which is precisely the problem our project hopes to address. The role of infographics in bridging the gap between producers and consumers of information is a key concept detailed in this article. Our project hopes to present complex information in an absorbable format so that the users of our system will not only be more informed, but they will also feel exceptionally more knowledgeable and capable of contributing to a particular cause after being informed. We hope that the users feel as adept as the producers of the information, who are, in this case, representatives of Afrobarometer (our client).

- Parkinson, Mike. "Infographic Tips And Tools." *TD: Talent Development* 70.5 (2016): 26-28. *Business Source Complete.* Web. 23 Oct. 2016.

  This article is a basic starting guide to creating infographics and data visualization. Along with providing tips of its own, the author lists several helpful resources to gather inspiration for infographic design and creation. The article discusses different types of charts, graphs, and tables and how best to decide between a graphic method depending on the data in question. The article also takes into consideration the audience and how to market the information in a way that appeals to them most.

15.4 Databases and Touch Screen Displays

This section analyzes the sources we acquired regarding databases, user interaction with data, and touch screen displays.

- Chen, Travis, and Justin Wong. *Tanzania Education Graphing, Ranking, and Mapping.* BS Thesis, Santa Clara University, 2016.

  Chen and Wong have created a website that allows users to interact with a graph or map page. Users can make selections and queries to view educational data in Tanzania. This senior design thesis is very similar to what we hope to achieve through our project. It was helpful to see how they manipulate data using queries and filters as well as the way they chose to lay out their navigation. Our project varies in that ours will be a mobile application spanning a larger data set with more categories than simply education.

- Clinch, Sarah, Jason Alexander and Sven Gehring. "A Survey of Pervasive Displays for Information Presentation." *IEEE Pervasive Computing* 15.3 (2016): 14-22. *Applied Science & Technology Source.* Web. 22 Oct. 2016.

  This research details how to utilize pervasive screens in an unobtrusive way. As screens become more pervasive, it is important to design screen layouts and information displays in a way that avoids information overload. The authors suggest focusing keenly on the non-expert user while placing the screens in an easily accessible yet unobtrusive place. The ability to interact with a screen also improves the ability of the user to digest the data. This information will be important for when the application is deployed and used by thousands of users on their own devices.

- Coni, Philippe, Jean-Nol Perbert, Lionel Augros, Jean Christophe Abadie, and Yves Sontag. "A New Application of a Touch Screen Display for Data Transfer." *SID Symposium Digest of Technical Papers* 46.1 (2015): 37-40. *Applied Science & Technology Source.* Web. 22 Oct. 2016.

  This article details research being done on the transference of data through a capacitive touchscreen – that is, a custom touch interface system Although this information will not directly influence our current project, it is an interesting path that could be taken in the future to collect data from the touchscreens themselves. By tweaking some software and hardware, users of the screen might be able to transfer data by means of the touchscreen itself, cutting down on the need for external hardware. Since this is still developing technology, it can not be put into use now. However, in the future it could directly apply to the mission of our project.

15.5 Internationalization and Localization

This section of our literary review describes the various sources to which we have referred for information on implementing a system that incorporates internationalization and localization.

- Leiva, Luis A. and Vicent Alabau. "Automatic Internationalization For Just In Time Localization Of Web-Based User Interfaces." *ACM Transactions On Computer-Human Interaction (TOCHI)* 22.3 (2015): 13:1-13:32. *Applied Science & Technology Source.* Web. 22 Oct. 2016.

  This article describes the process of implementing applications that support a multilingual audience. This process consists of two key subprocesses that occur in the following order: internationalization followed by localization. The article discusses how internationalization can be achieved by decoupling translatable text out of the applications source code. Once internationalization is implemented, then the software can be localized to support the requirements of different locales. The two locales specific to our project are English and French interfaces as the primary language of our audience members will be either one of these languages. We have referred to the methods described in this article to successfully implement internationalization and localization.

- Wang, Xiaoyin, Lu Zhang, Tao Xie, Hong Mei, and Jiasu Sun. "Locating Need-to-Externalize Constant Strings for Software Internationalization with Generalized String-Taint Analysis." *IEEE Transactions On Software Engineering* 39.4 (2013): 516-536. *Applied Science & Technology Source.* Web. 22 Oct. 2016.

  This article describes how globalization has affected the software product industry. In order for software products to meet the requirements of various local users, the product itself must be internationalized. The article discusses how difficult it is to internationalize an existing product due to the need for locating certain strings within the existing database. This article proposes an automatic approach to externalizing data within the strings of the source code of a software product. This documentation will be particularly useful for us later on in our project, when we have already successfully implemented our system in English and we would like to internationalize the system for our French-speaking audiences. Since we are prioritizing the implementation in English and will only internationalize given our time frame,

the externalization technique will most likely be of concern if our product will already be considered a “final product before we add French capabilities.