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RECOMMENDER APP DEVELOPMENT FOR ESSENTIAL HEALTH PRODUCTS:
COVID AND BEYOND

Master's Project Report
Submitted to the Graduate Faculty
of Computer Science, Montclair State University

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In Partial Fulfillment of the Requirements
for the Degree of Master of Science (MS)
in Computer Science (CS)

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Montclair, New Jersey

Abstract

The COVID-19 pandemic has affected all of our lives in many ways and as a result people have become more health conscious. Now more than ever it is critical to take cautious steps to prevent being infected and spreading the virus. It is important to be supplied with the right products that maintain us all safe and healthy. Although many stores have health related products, sometimes it is a hassle to find them and even to pick out the best ones. With that, the Health Essentials app was developed to facilitate the findings of health products. The app is solely dedicated to presenting users with health-related products as well as recommendations on trending products and recommendations related to products that are viewed. Although the app implementation includes products specific to the pandemic, the app can be extended to provide more health products in different categories and serve as a one stop shop for health products for Covid and beyond.

Keywords: AI, Coronavirus, Data Mining, E-Commerce, Health Informatics, HCI, IoT, Mobile Application, Recommendation Systems, Software Engineering, Smart Living, Ubiquitous Computing

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Introduction

For over a year now, the COVID-19 pandemic has affected all of our lives in many ways. Those ways include having to quarantine, to work from home, to constantly take safety precautions, to wear masks, to disinfect hands and surfaces, and unfortunately having to lose many loved ones. While making all of these adjustments in our lives during the pandemic, health has been one of the top priorities. Data from more than 10,000 Vida Health users, which is a platform that empowers individuals to transform their lives through better health, shows that COVID-19 has moved people to focus more on their personal health [1]. Other priorities have revolved around being able to quickly shop online and make sure we are stocked with the supplies needed to better protect our health.

With these priorities in mind, the Health Essentials app was developed. The Health Essentials app focuses on facilitating the findings of health products. Unlike shopping in a department store app where there are many types of products, this app is solely dedicated to providing users with health-related products. It streamlines these product purchases since there is no need to browse for a health section in this app. It also provides users with recommendations on trending products as well as recommendations related to products they choose to view. In the case that a product is unavailable or that a user is looking to purchase similar products, the Health Essentials app can quickly provide a similar alternative.

The Health Essentials app features the product categories of masks, hand sanitizers, wipes and disinfecting sprays. While the app implementation only provides these few product categories that are specifically in high demand during the pandemic, the app could be further extended to include a variety of different health products. This would provide users with a one stop shop for health-related products and recommendations.

Background

Previous work on this topic included an exploratory study of two recommender systems techniques, item-based collaborative filtering and association rule mining [2]. Item-based collaborative filtering was used to match a user's rated items to similar items and association rule mining was used to discover buying patterns in products and then recommending other products. The work consisted of products in e-commerce and was to set the stage for mining online data on products pertinent to the COVID-19 pandemic. Although these techniques worked extremely well with the Amazon dataset used, the dataset which was gathered for the Health Essentials app implementation did not include the necessary user data needed to implement those two techniques.

Therefore, a few more techniques were explored that did not require user data. First, an artificial neural network (ANN) was built to classify whether a product would be highly recommended, recommended or least likely to be recommended based on its product type, price, overall rating and total number of ratings. This ANN worked well and was picked to be used for the trending section in the Health Essentials app. Next, the sentiment analysis technique was tested on user reviews, but the results were being categorized mostly as neutral which was not very helpful to recommendations and later it was decided to not use user reviews for the app implementation. Lastly, the content-based filtering technique was tested with the product's description and type of product. This technique showcased great results, giving recommendations of similar products and thus was picked to be used on the app to present users with recommended products when viewing a product.

Methods

The dataset for the Health Essentials app implementation was extracted from products on Amazon.com [3]. Since Covid related products are relatively new popular products, there was no set dataset available to use. A master Microsoft Excel sheet was put together that included the product image link, product name, product description, product price, the total number of ratings, the overall star rating, and the Amazon URL for each product. The dataset was uploaded on to Google Firebase [4] cloud database for the app implementation.

For the app's digital prototype, the platform used was Adobe XD [5]. The app was chosen to be developed as an Android app and therefore the platform used was Android Studio [6]. The coding languages used in Android Studio were both Java and eXtensible Markup Language (XML).

Prototype

This section provides an overview to the steps taken before the actual implementation of the Health Essentials app starting with a low fidelity paper prototype and ending with a revised digital prototype.

Low Fidelity Prototype

Before starting the implementation, low fidelity paper prototypes were created to get an idea of what the app would look like and what the different screens would consist of. The Figures 1-3 below show the home screen, a product category view, and an individual product view. By first drawing out each layout, it was easier to understand the flow of the app before beginning a digital prototype.

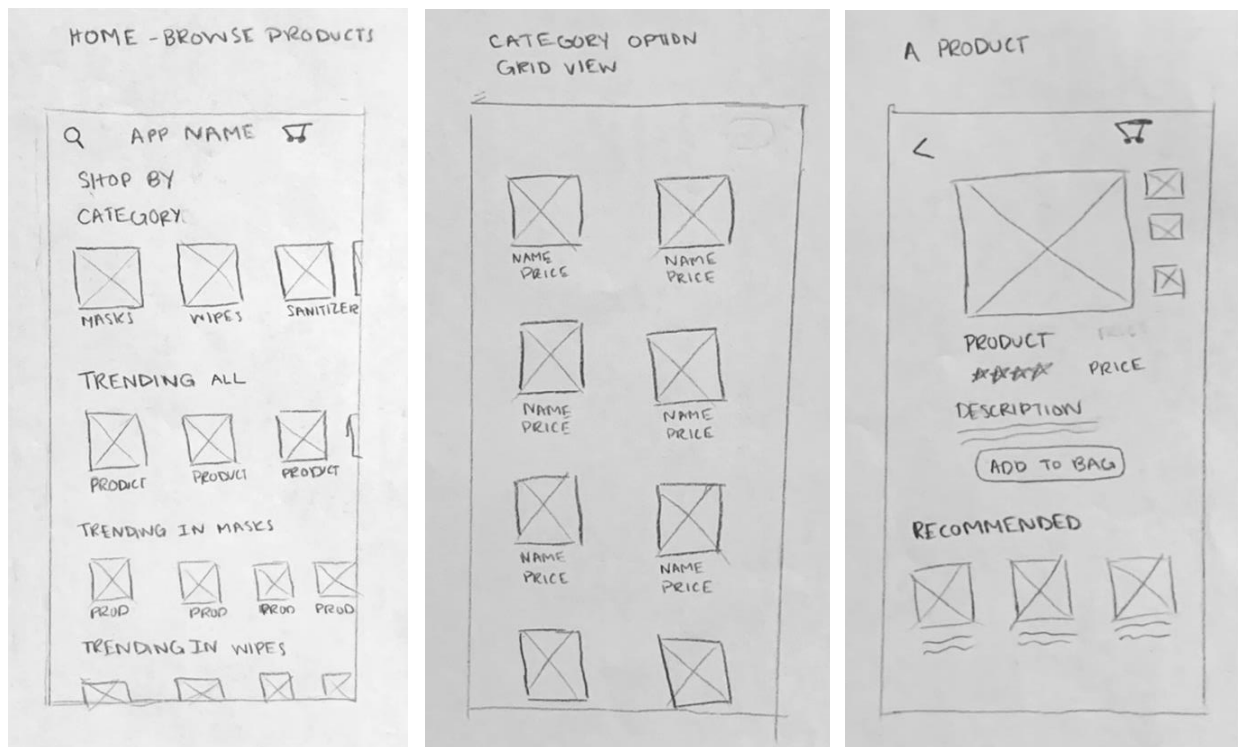


Figure 1, Figure 2, Figure 3: Paper prototypes of the home screen, category view and an individual product view.

High Fidelity Prototype

After the paper prototype was set, a high-fidelity digital prototype was created. At this point the app was only focused on only COVID-19 products and therefore the look and feel were coordinated differently. On Figure 4, we can see the splash screen consisted of the original title, COVID-19 Essentials, with two big virus icons. The home page, which is also on Figure 4, shows how users can shop by category as well as look at the products that are trending overall and trending in each category. On the last screen on Figure 4, a simple search page is shown.

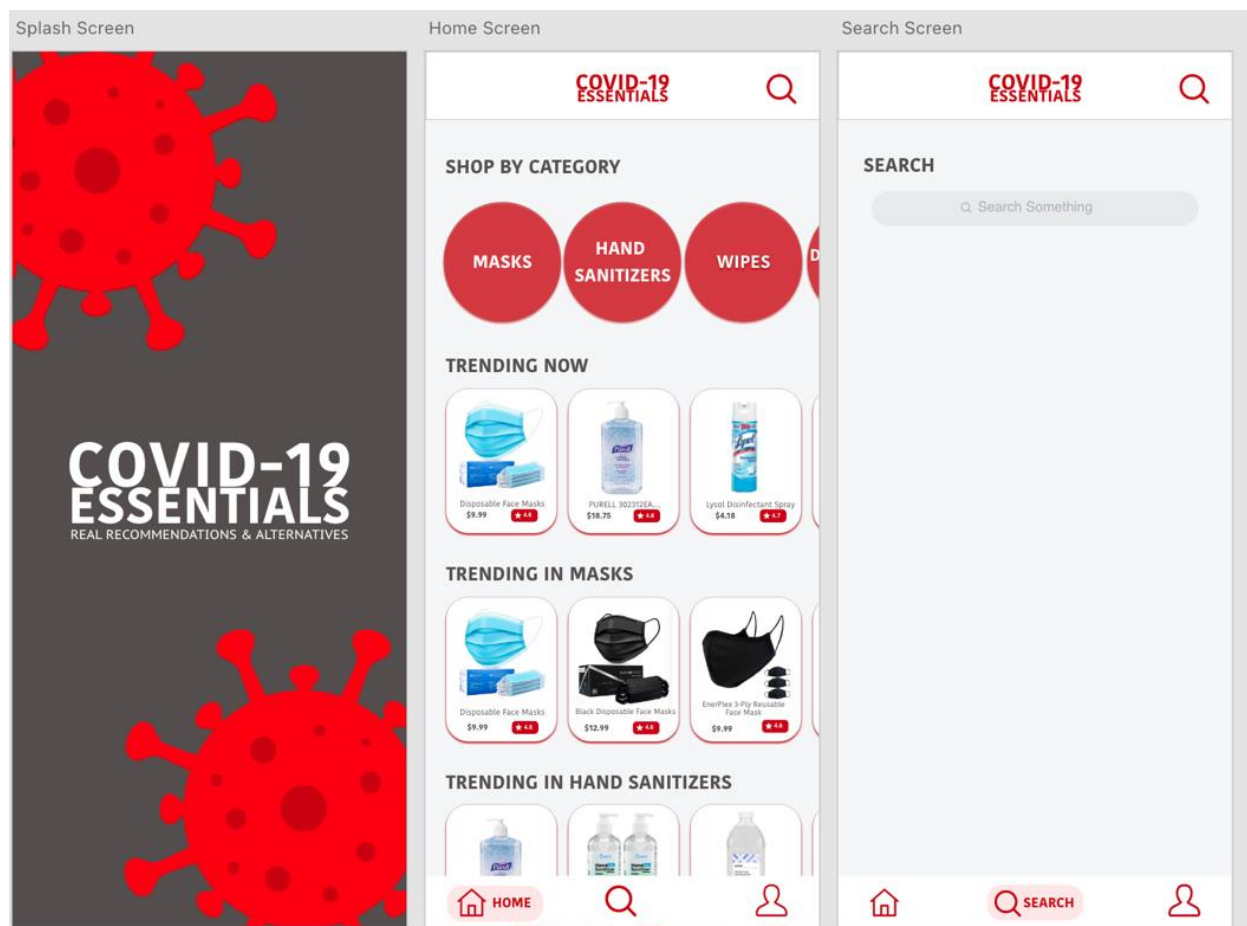


Figure 4: The splash screen, home screen and search screen of the COVID-19 Essentials app.

Next on Figure 5, the digital prototype showcases how the products look after clicking a category as well as when clicking on an individual product itself. The category page shows a 2-column grid view of all of the products in a selected category and the individual product page shows more details. On the individual product page there is the product name, star rating, overall number of ratings, price, description and button to buy the product on Amazon. Originally there was going to be a review section which can be seen on there too. Lastly, at the bottom of the individual product page are the products that are being recommended through the content-based filter.

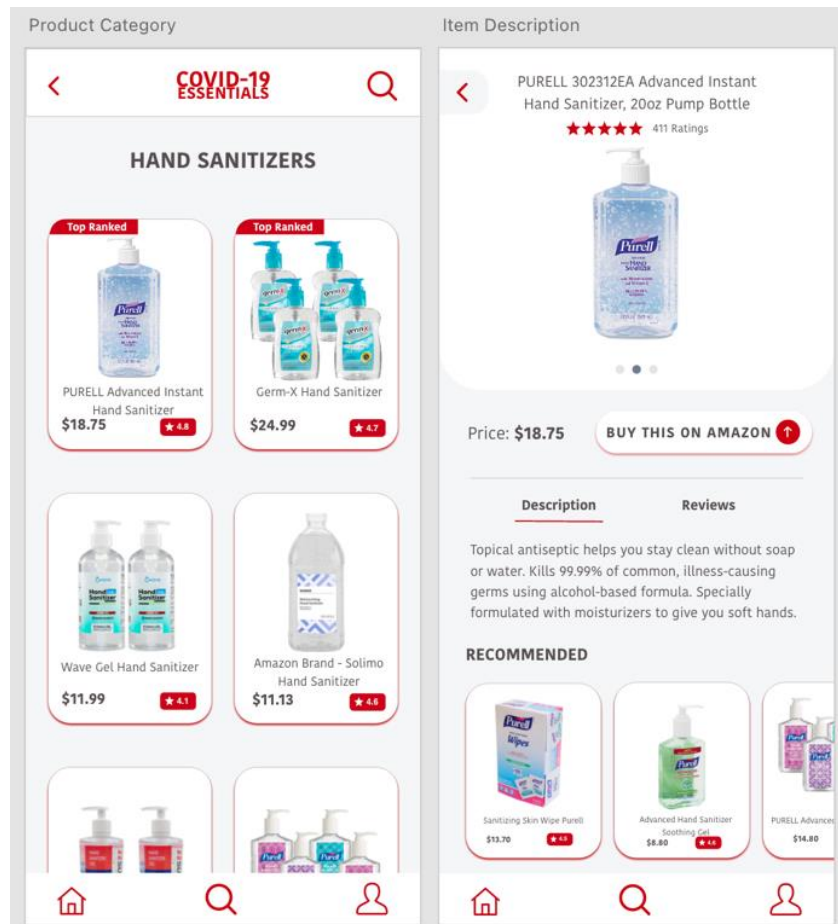


Figure 5: The category page and individual product page of the COVID-19 Essentials app.

Prototype Usability Testing Results

After creating the digital prototype, a usability test was conducted in order to get some initial user feedback. The following Figures 6-8 showcase the results of the testing which include ratings for the overall look and feel of the app, the usefulness of the app and any additional comments the participants had.

1. Please rate the overall look and feel of the app.

6 responses

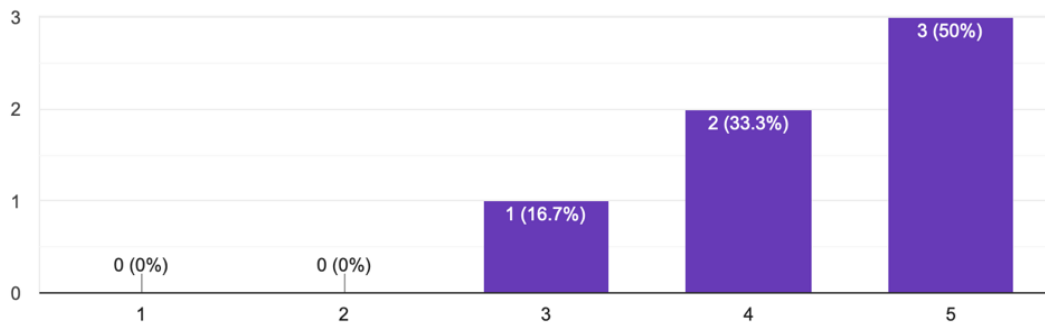


Figure 6: Question 1 – Shows the results of the rating of the overall look and feel of the app.

2. How useful do you find the app?

6 responses

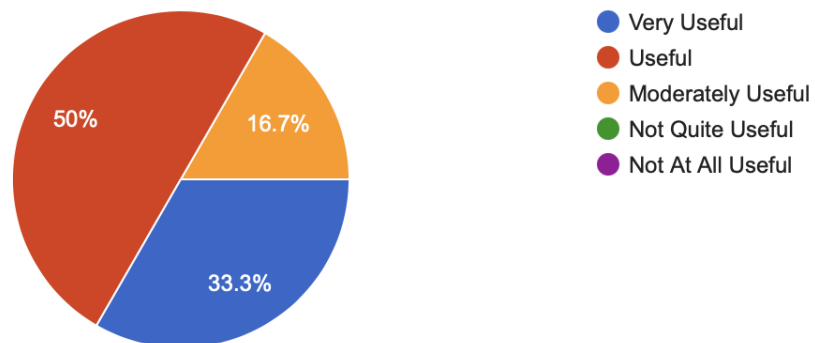


Figure 7: Question 2 – Shows the results of how useful participants think the app is. 50% voted useful, 33.3% voted very useful and 16.7% voted moderately useful.

3. Any comments on the app and suggestions for improvement?

6 responses

1. The home screen might be improved: the two giant virus icons may scare some people away - people may focus on the bad side of the pandemic. Try to use some icons to indicate "helpful/calm" so users want to stay with your APP.

2. You may consider using colors other than "red". Users may perceive a sense of emergency when they browse different pages.

Great work.

Maybe change the color scheme to make it a little more inviting and less "breaking news"

This could be useful in the short-term, but as the pandemic minimizes, the utility of the app could quickly deteriorate. To curb this you could either rebrand, or be prepared to rebrand in the future, to be a more general health products app. You could then organize things by various ailments, or show products based on the time of year and what would be most useful to keep people healthy at that time/location.

Figure 8: Question 3 – Shows results of the question to leave any comments or suggestions for improvement. These suggestions were great and were applied in order to better the app.

From these usability testing results, there was a common observation with the look of the app. Participants noted that rather than the red color, a different color should be used. The red seemed like “breaking news” and the red virus icons would scare people away. Another observation was about usefulness of the app. Originally the app was anticipated to be only focused on COVID-19 products but that would result in it not being a long-term application.

Prototype Revision

Since the usability testing participants had great, useful feedback about the appearance of the app and its purpose, it was best to revise the digital prototype before implementing. The purpose of the app was shifted to an overall health products app called Health Essentials and the new color scheme included a calm blue color rather than red.

On Figure 9, we can see a new splash screen which consisted of a new title, Health Essentials along with a logo for the app. Also on Figure 9 is the home page and the search page which are the same as the original digital prototype expect for the new blue color. Figure 10 shows the same category page and individual product page that was in the original digital prototype but also with the new color. Another small change was the removal of the products reviews section on the individual product page which was decided to not be implemented. For a complete look of the path that can be taken by a user, Figure 11 shows the user flow of this digital prototype.

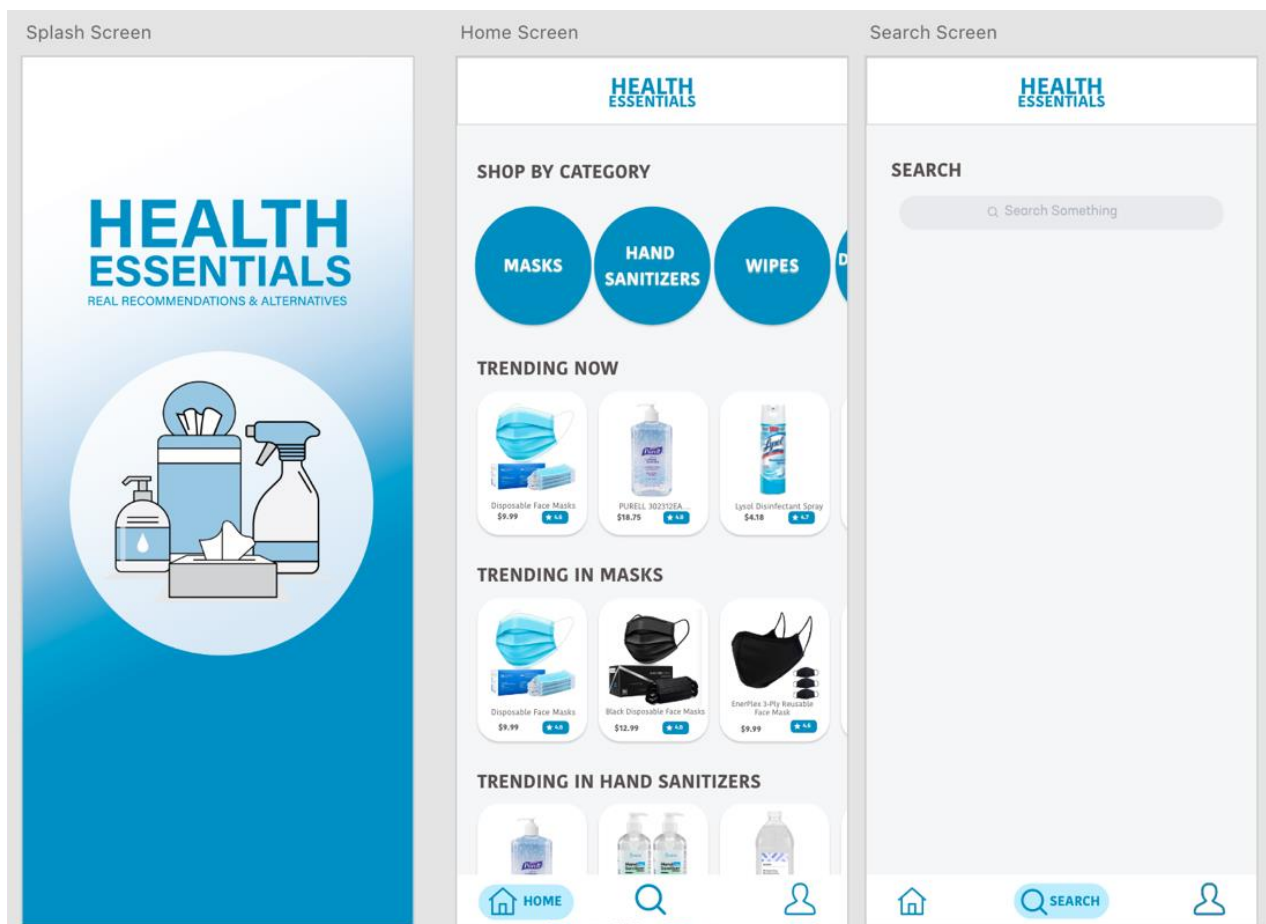


Figure 9: The revised splash screen, home screen and search screen of the Health Essentials app.

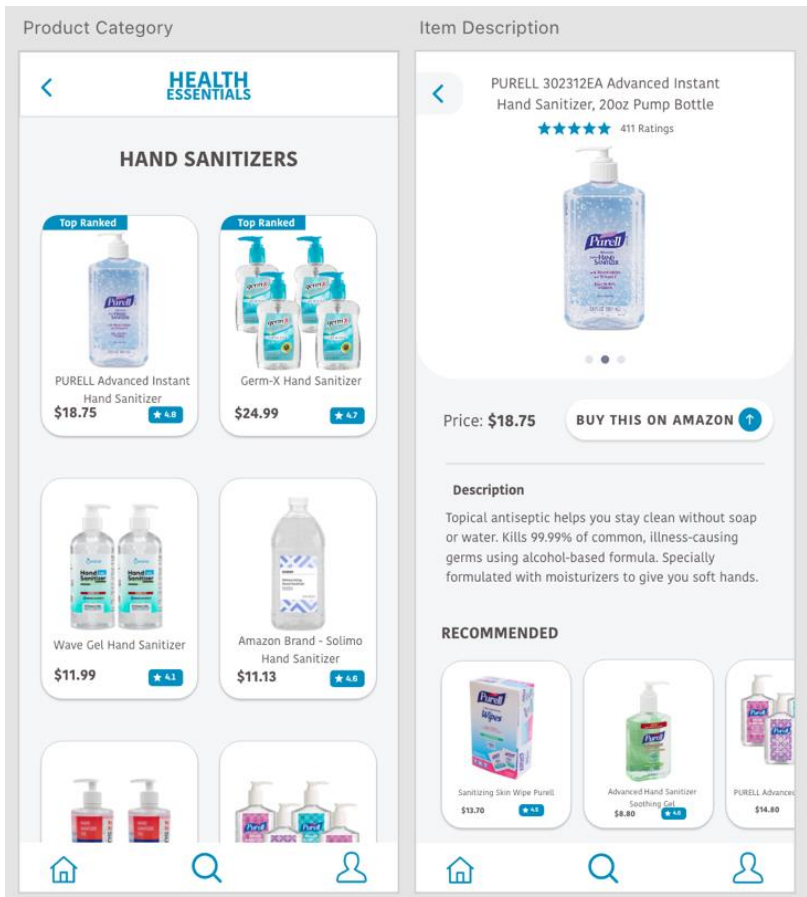


Figure 10: The revised category page and individual product page of the Health Essentials app.

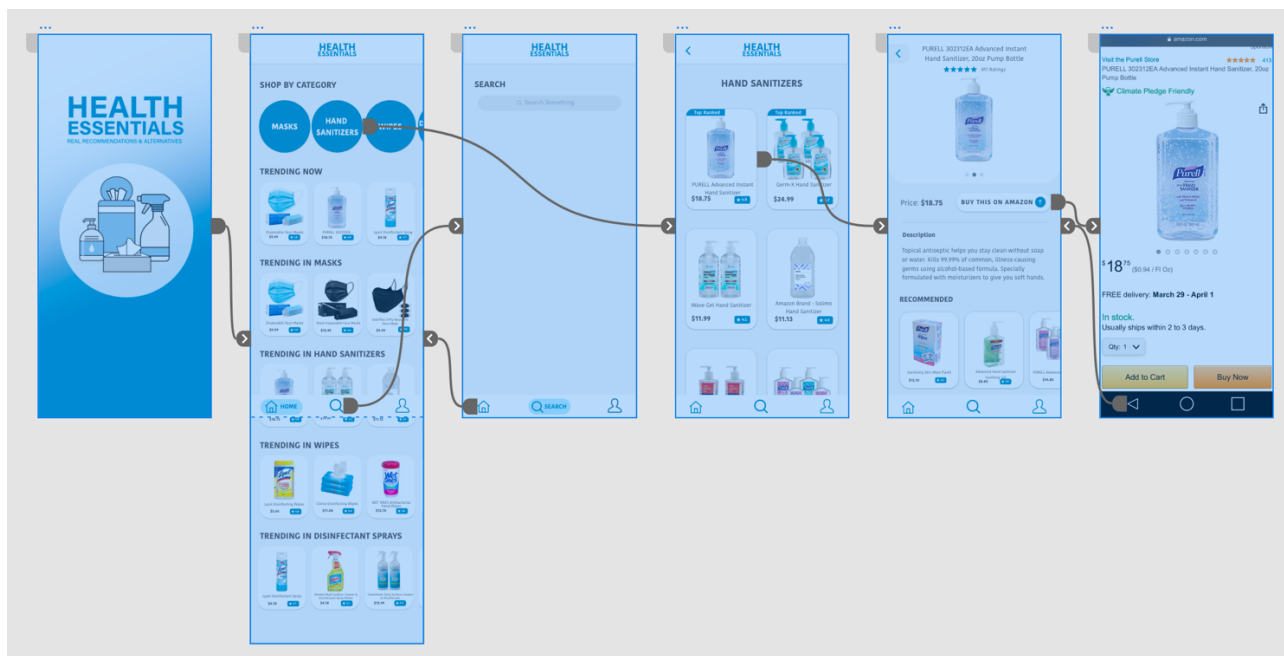


Figure 11: The user flow which shows the path that can be taken by a user in this high-fidelity prototype.

Implementation

This section provides an overview of the app sitemap and the details of the actual implementation of the Health Essentials app.

App Sitemap

Below on Figure 12 is a sitemap of the Health Essentials app. When the app opens a splash screen is shown and a user is directed to the home page. Through the navigation bar a user also has the option to visit the search page. From the search page, after searching, if the user selects a product, they will be brought to the individual product page. On the other hand, from the home page a user can both select to visit the category page or select one of the products on the trending section and be brought to the individual product page. After a user is on the category page, they can select a product and they will then be navigated to the individual product page.

Moreover, Figures 13 and 14 show two different task flows for the Health Essentials app. They focus on a single task and demonstrate the steps needed to accomplish the task. On Figure 13, the task flow showcases the task of a user searching for masks and on Figure 14, the task flow showcases how a user can view a specific product. These two figures are adequate task flows to demonstrate two different ways that a user can access a product on the app.

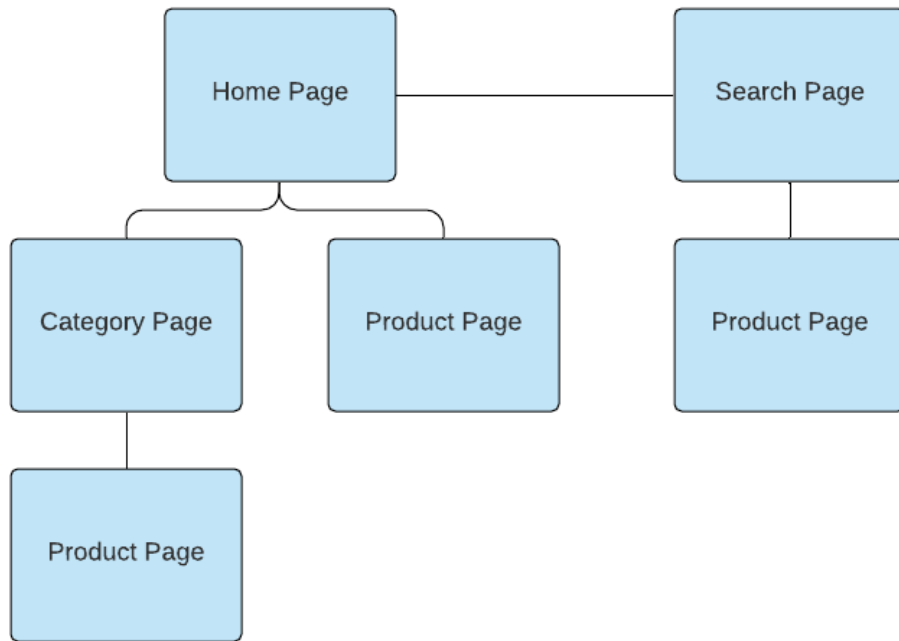


Figure 12: The Health Essentials app sitemap with shows how the app pages are linked.

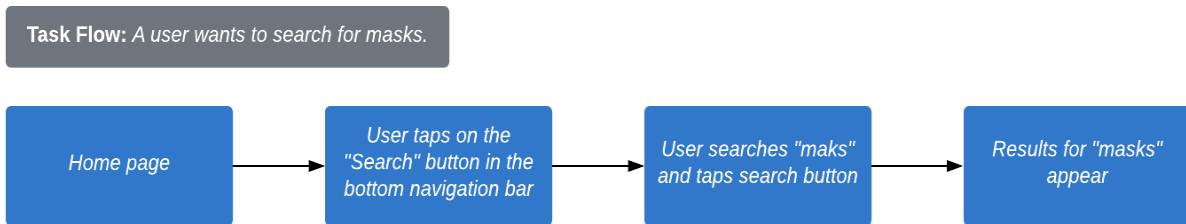


Figure 13: A task flow showing a search for masks.

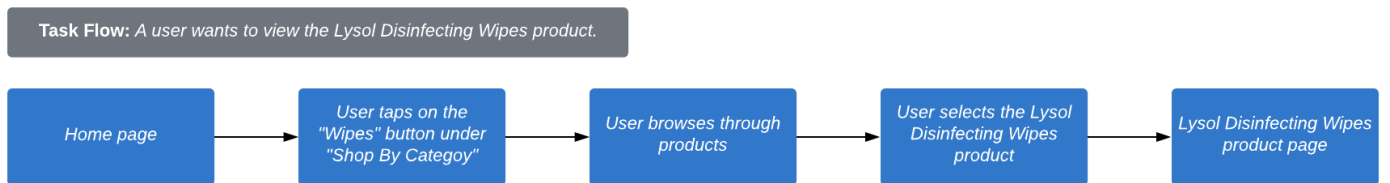


Figure 14: A task flow showing how to view a product.

Home Page

The home page of the Health Essentials app consists of two different sections. The top section features a row of buttons whose implementation can be seen in Figure 15. That row of buttons allows the user to select which category to shop in. Under that section there is a trending now section which begins with a row that shows the overall trending products. Below that first row, the app shows other rows with products that are trending in their select categories. Moreover, the trending now sections include products that are selected through the ANN recommender system which is based off of the product type, price, overall rating and total number of ratings. The final result of the home page can be seen in Figure 16.

```
btn1 = view.findViewById(R.id.masks);
btn2 = view.findViewById(R.id.hand_sanitizers);
btn3 = view.findViewById(R.id.wipes);
btn4 = view.findViewById(R.id.disinfectant_sprays);

btn1.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        Intent intent = new Intent(getActivity(), ViewAllHandSanitizers.class);
        startActivity(intent);
    }
});

btn2.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        Intent intent = new Intent(getActivity(), ViewAllMasks.class);
        startActivity(intent);
    }
});

btn3.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        Intent intent = new Intent(getActivity(), ViewAllWipes.class);
        startActivity(intent);
    }
});

btn4.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View v) {
        Intent intent = new Intent(getActivity(), ViewAllSprays.class);
        startActivity(intent);
    }
});
```

Figure 15: Code for the category buttons on the home page which shows what page each button leads to.

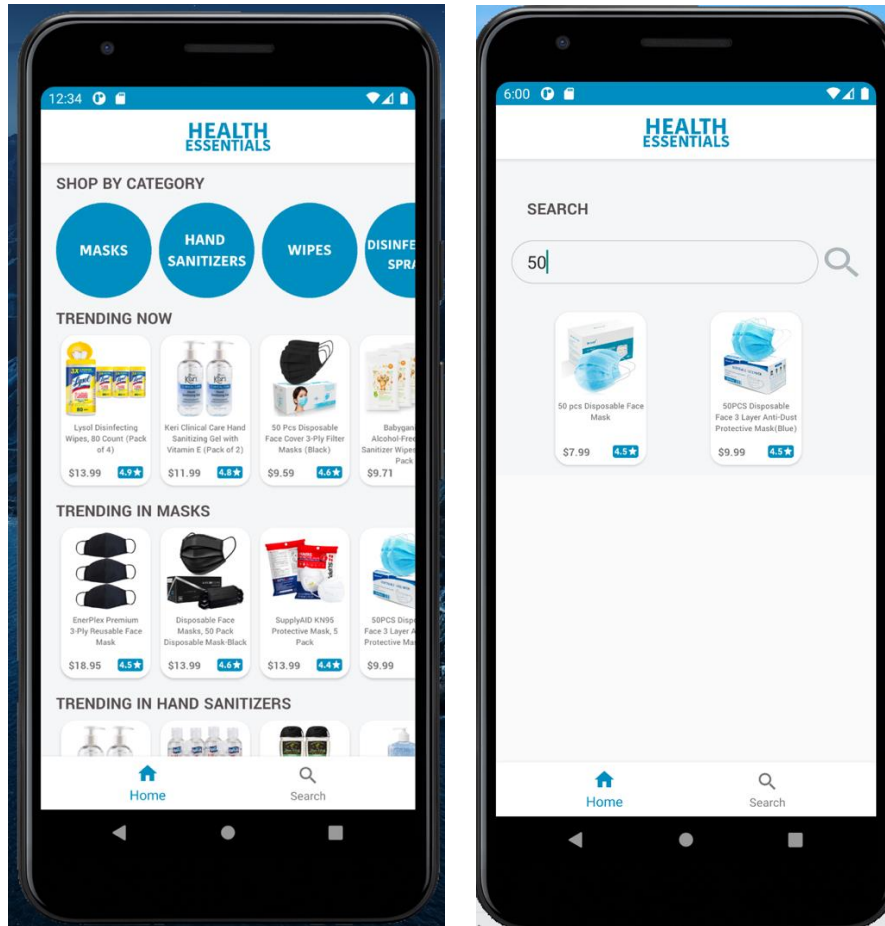


Figure 16 and Figure 17: The left image shows the final home page of the Health Essentials app showing the shop by category section and different trending now sections. The right image shows final search page of the Health Essentials app showing a search query for “50”.

Search Page

The search page of the Health Essentials app which can be seen on Figure 17 consists of a search bar and a search button. This page allows the user to perform a search query by writing in the search bar and clicking the search button on the right. After clicking the button, users will be shown any products that begin with the query in the product name.

Product Category Page

The product category page of the Health Essentials app includes a grid view of products in a selected category. Figure 18 shows how all of the products are retrieved from the Google Firebase cloud database. For each product in that category, an image of the product appears along with the product name, price and overall star rating. The full product category page can be seen on Figure 19.

```
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.view_all_masks);

    db = FirebaseFirestore.getInstance();
    recyclerView = findViewById(R.id.view_all_recycler);

    recyclerView.setLayoutManager(new GridLayoutManager( context: this, spanCount: 2));
    viewAllMasksModelList = new ArrayList<>();
    viewAllMasksAdapter = new ViewAllMasksAdapter( context: this, viewAllMasksModelList);
    recyclerView.setAdapter(viewAllMasksAdapter);

    db.collection( collectionPath: "masks")
        .get()
        .addOnCompleteListener(new OnCompleteListener<QuerySnapshot>() {
            @Override
            public void onComplete(@NonNull Task<QuerySnapshot> task) {
                if (task.isSuccessful()) {
                    for (QueryDocumentSnapshot document : task.getResult()) {
                        ViewAllMasksModel viewAllMasksModel = document.toObject(ViewAllMasksModel.class);
                        viewAllMasksModelList.add(viewAllMasksModel);
                        viewAllMasksAdapter.notifyDataSetChanged();
                    }
                }
            }
        });
}
```

Figure 18: Code for a section of the product category page which connects to the database and retrieves all the items in the "masks" collection.

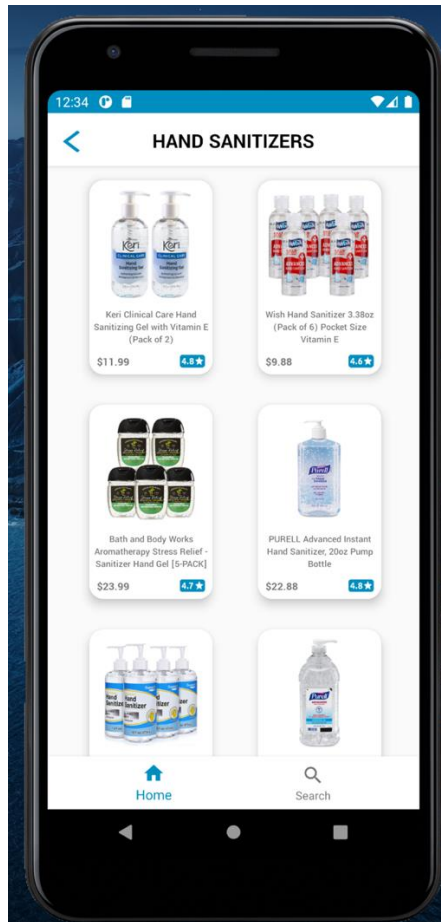


Figure 19: Shows the final category page of the Health Essentials app showing the category of hand sanitizers.

Product Page

The product page of the Health Essentials app, which is shown on Figure 20, is the page that a user can see the most details about a selected product. When a user selects an item, the code in Figure 21 shows how the data is being passed to the app. At the top of the page there is a section with the product name, overall star rating, total number of ratings and image of the product. Under that section is the product price, a button to buy the product on Amazon and the product description. Lastly, at the bottom of the page there are recommended products that are selected through the content-based filter with the product's description and type. In this scenario, the content-based recommender is convenient because if a user is interested in the selected item, there

is a good possibility that they are also interested in one of the recommended items. On the other hand, if the current product is not available, one of the recommended items might be a good substitute for the user to buy.

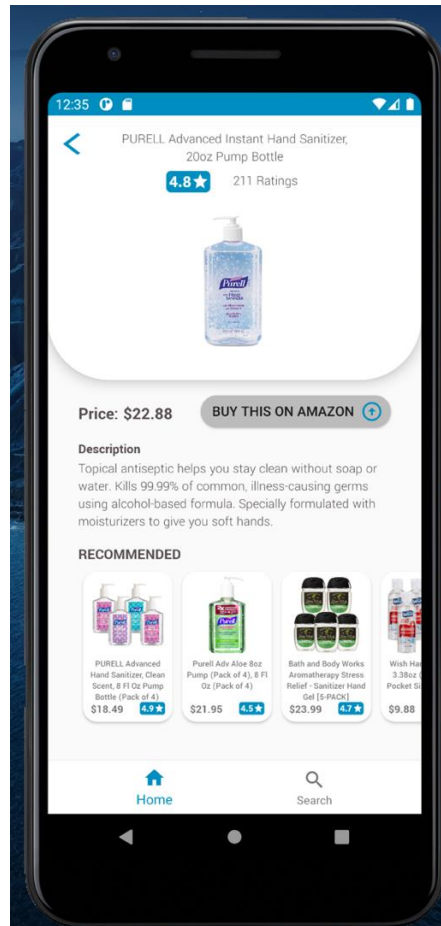


Figure 20: Shows the final individual product page of the Health Essentials app showing an item from hand sanitizers category with all its details and content-based recommendations.

```
if(viewAll != null){
    Glide.with(getApplicationContext()).load(viewAll.getImage()).into(product_image);
    Glide.with(getApplicationContext()).load(viewAll.getRating()).into(star_rating);
    product_name.setText(viewAll.getName());
    product_price.setText("Price: " + viewAll.getPrice());
    description.setText(viewAll.getDescription());
    num_reviews.setText(viewAll.getNum_reviews());
    buy_btn.setOnClickListener(new View.OnClickListener() {
        @Override
        public void onClick(View v) {
            Intent intent = new Intent(Intent.ACTION_VIEW);
            intent.setData(Uri.parse(viewAll.getLink()));
            startActivity(intent);
        }
    });
};
```

Figure 21: Code for a section of the individual product page which retrieves all the details for a selected product.

Usability Testing

Once the Health Essentials app implementation was complete, a usability test was sent out to get feedback on the finalized version of the app. This testing was more extensive than the first and had questions relating to the overall look and feel of the app, app usefulness, frequency of use, navigation ease, likeliness of recommendation to a friend, and optional additional comments. Below in Figures 22-27 are the results of the usability testing.

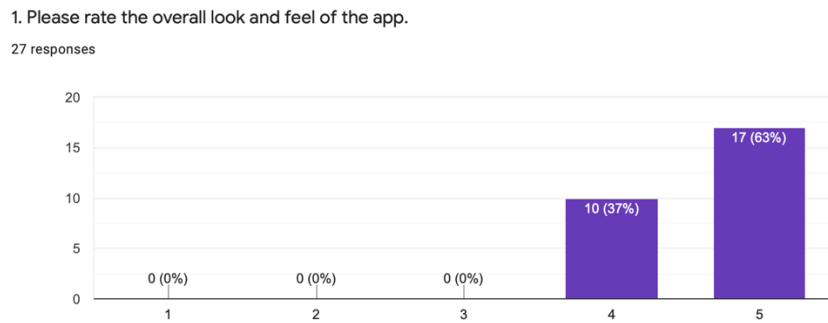


Figure 22: Question 1 - Shows the results of how the 27 participants rated the overall look and feel of the app. 37% rated a 4 and 63% rated a 5 which indicates the app has a very good look and feel.

2. How useful do you find the app?

27 responses

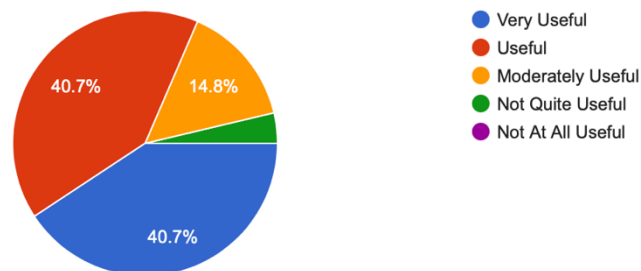


Figure 23: Question 2 – Shows the results of how useful participants found the app to be. The majority found it very useful or useful.

3. How often would you use the app?

27 responses

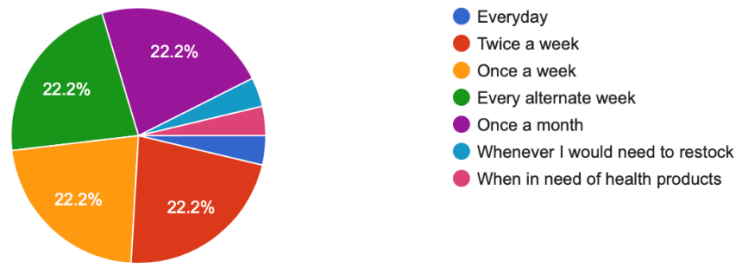


Figure 24: Question 3 – Shows the results of how often users would use the app. There are a mix of answers here, with a mix of twice a week, once a week, every alternate week, once a month and a few other options were users input their own answer. Overall shows that users would use the app.

4. How easily could you navigate through the app?

27 responses

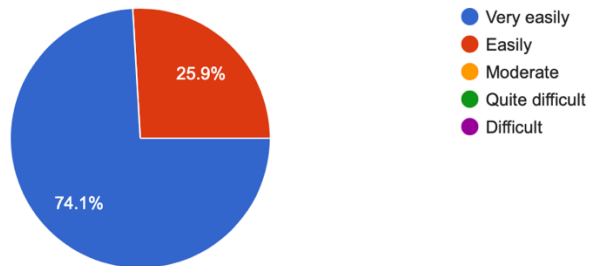


Figure 25: Question 4 – Shows the result of how easily users thought the app was to navigate. 74.1% voted very easily and 25.9% rated it easily which shows that the app is user friendly.

5. How likely are you to recommend this app to a friend?

27 responses

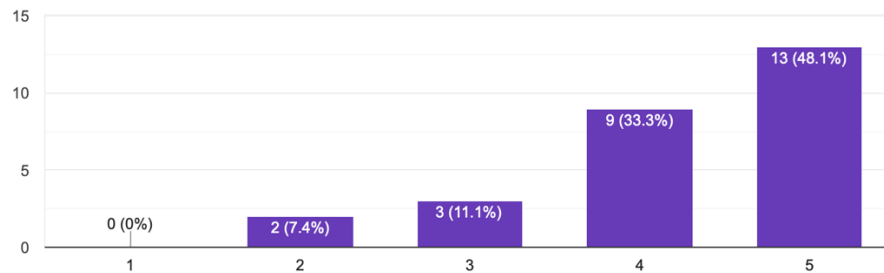


Figure 26: Question 5 – Shows the results of how likely users would be to recommend the app to a friend. There's a bit of a mix here but majority of the participants voted a 4 and 5 so users are likely to recommend the app.

6. Please share any comments or suggestions. (Optional)

18 responses

Very slick and unique design. I'm a big fan of the recommendation system. Great job overall

Excellent work! Please make the app available soon.

Does the app only go through amazon or does it consolidate several online stores into one easy to access place? This looks useful.

- I think the interface is simple and looks easy to navigate
- The only concern would be users unwilling to use it based on it adding an extra step from just purchasing on amazon

Very nice UI design. I also really liked the recommended products at the bottom of the product pages.

This is a very good app Jessica. It looks very useful and can help out everyone. I would recommend this app to everyone that can use it during these challenging times and beyond COVID.

Apart from Amazon, the app can also provide the purchase link to other major department stores such as Walmart, Target, etc. these stores have a bigger stock of the COVID-19 related products when compared to Amazon.

Figure 27: Question 6 – Shows some of the comments left for the optional comments or suggestion. There were many complements and likings of the app and recommendation systems but there were also suggestions on improvement and points to think about to enhance the app.

From these results we can see that there is an interest in the app and that the look and feel of the app are liked by users. Additionally, it seems as if users really like the recommendation system and find the app easy to navigate. Some comments were concerned with the extra step of purchasing on Amazon but there were also good suggestions to either providing several online stores in one place or also including other links to other department stores. Overall users saw the app as useful and are interested.

Related Work

The first idea for this project was due to the COVID-19 pandemic in hopes to assist with finding products needed to remain safe from being infected. Besides the Health Essentials app, there are already apps and websites developed to aid with the COVID-19 pandemic. An online geographic information system (GIS) showcases dashboards and applications [7] that help with tracking coronavirus around the world. This is even work [8] that provides free continuing professional development courses related to the Coronavirus disease for those who working to support our healthcare systems.

Additionally, the COVID-19 pandemic has contributed to rapidly growing data. There are now massive amounts of data associated with the pandemic as provided in [9] and [10]. With that, recommender systems are helpful because they're used to assist with sorting through large amounts of data. Hence, in this project recommenders were used to sort through many products and provide the best relevant recommendations. There are many other works that use recommenders for the same reason. In [11], a study aims to design a recommender system using preferences of customers to increase prediction accuracy. The system creates recommendations by using natural language processing (NLP) with a supervised classification approach over the hotel guest reviews. In [12], sentiment analysis is used over a partially labeled training data and is composed of a combination of supervised and unsupervised learning providing a hybrid approach for recommendations.

Some of the work in this project could be in line with the work on apps [13, 14, 15] where user studies have been conducted as well as on other topics like [16, 17] where case studies and surveys have been presented. This project is orthogonal to such research and has been very well-received in usability testing. We are making the app available via GitHub to interested users. This is accessible via the DOI link in [18] provided in the references.

Conclusion

The Health Essentials app was developed to facilitate the findings of health products. The app provides users with a one stop shop for health-related products in different categories. Providing users with health products in one place along with recommendations on trending products and recommendations related to products they view is truly valuable. Usability testing participants' answers indicate that the app is indeed useful. Although the app has many features that could be improved as well as some features that could be added with more time, the main objective of the app was met. Additionally, the app could be used for a small health products company or extended. It is without a doubt that the Health Essentials app could help streamline health product purchases during Covid and beyond. This app is available on GitHub via a DOI link [18] included in the references herewith.

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First and foremost, I would like to thank my advisor Dr. Aparna Varde for her guidance and support throughout my research and my master's project. It's been a pleasure getting to work with her and learn from her for these past two years of my master's degree. I would also like to thank my co-advisor, Dr. Hongbo Zhou for all the advice during my app implementation and for what I learned in his class in undergrad which I got to apply on this project.

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And lastly, this accomplishment is dedicated to my brother, who passed away just weeks before I got to celebrate this accomplishment with him. I found the strength to finish the semester because I knew it would make him proud as he was always one of my biggest supporters and I knew this would make him proud.

References

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