Application Design for M-Commerce Decision Support System

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ABSTRACT

Although people are comfortable making online purchases, the inability to effectively determine product quality and price to maximize value encumbers purchase decision-making. Existing mobile applications assist in online shopping, but do not offer search capability across different companies or return results with concise product information, customer reviews, and price comparisons. Additionally, the inconsistency of application interfaces impedes usability.

This project examines human decision-making and the design process for a M-commerce application. The application allows people to conduct product research across many retailers and to review product information, explore features, make price comparisons, and obtain deal alerts. The project used the Double Diamond design process model, a framework that aids designers by highlighting key design phases, principles, and methods. It afforded an accessible means by which to explore the design problem and to streamline product research and design processes. In this project, the author discusses user research, prototyping, and testing as well as the implications of using the Double Diamond process framework for designing a M-commerce application.

Keywords: M-Commerce, Human Decision-Making, Decision Support Systems, Interaction Design, Human Factors, Double Diamond Process, User Interface Design, User Experience, UX Research.

INTRODUCTION

The rise of smartphones has changed how people shop. Customers utilize mobile devices because technology provides convenient access and makes shopping easier. The Business Insider

Intelligence report, projected M-commerce to reach $284 billion, or 45% of the total U.S. e-commerce market as early as 2020. While mobile shopping is convenient, it consumes time as shoppers search the Internet for products. Generally, when searching, people read product reviews and compare prices. Ninety-three percent of customers say that online reviews influenced their purchase decisions (Qualtrics report, 2020) and 63% of customers (Wiser, 2019) do a quick Google search for price comparison to optimize their spending. Rigby (2011) noted that prior to purchasing a particular product, customers typically use multiple browser tabs to research customer reviews and prices and find better deals on several items at other retailers. They also use price-comparison sites to compare prices and web browser extensions to automatically find available coupons to save money. Product reviews, price comparison data, and deals for maximizing value support decision-making heuristics that shoppers use. A detriment to using such features is that they are not integrated and exist across multiple interfaces with disparate organization and functionality, which increases the complexity of product research and inhabits decision-making. Because informational sources are dispersed among disparate interfaces, people must open multiple browser tabs on desktop or laptop computers or get support from browser extensions when doing research. These interface configurations can diminish users' ability to attend to important information and interfere with purchase decision-making. They cause constant shifts in the informational context, creating usability issues that further impede decision-making as well as increase task complexity and time on task. These issues are compounded on smaller mobile device displays. While these resources - product reviews, price comparison data, and deals - are meant to afford rapid and convenient decision-making, they may in fact hinder it due to, among other things, limitations of human attention and memory.

LITERATURE REVIEW

Human cognitive processing capacity is limited. When the quantity of information a person is trying to acquire exceeds their ability to process it, performance suffers. The individual "may take longer to understand information, miss important details, or even get overwhelmed and abandon the task." (Whitenton, 2013, para. 2) Intrinsic cognitive load refers to the mental demand imposed on an individual's cognitive system as they perform specific mental or physical tasks (Castro-Meneses, Kruger & Doherty, 2020) in pursuit of a goal. Extraneous cognitive load exists when there are factors that consume mental resources that are unrelated to and interfere with goal attainment (Whitenton, 2013). A poorly design interface, for example, may increase extraneous cognitive load as the user attends to interface distractions rather than goal-related tasks, resulting in mistakes and other negative consequences.

Decision-making involves tasks in which an individual makes choices, often quickly and with limited available information, among a set of alternatives while being uncertain as to which choice is optimal (Stone, Chaparro, Keebler, Chaparro, & McConnell, 2018). It is rarely a rational process (Johnson, 2014). For many everyday experiences such as shopping, limits on cognitive capability and the limited amount of information people can retain at any given time (Simon, 1997) can cause overload. To compensate, people make tradeoffs on values while making choices and use heuristics or mental shortcuts to simplify decisions (Luce, Bettman, & Payne, 1997), such as eliminating choices by their characteristics (eliminate by aspects), deciding based on the information available (availability heuristics), and satisficing (satisfactory but not the most optimal choice), which are less cognitively taxing and allow for speedy decision-making (Stone, et al., 2018). As technology is increasingly used in shopping experiences, interface design patterns (e.g., customer reviews, product-comparison) as well as

decision support systems (Westerman et al, 2006) have emerged that are rooted in and intended to support human decision making.

Human decision-making process and interface patterns

When shopping with a mobile phone, customers are generally thought to engage in a five-step decision process: (1) Identify the product, (2) Search for information, (3) Alternative comparison, (4) Purchasing decision, and (5) Post-purchase behavior (e.g., Grewal & Levy, 2020; Levy, Weitz, & Grewal, 2018). Once customers determine the desired product (step 1), they tend to use search (e.g., Google) for browsing through options and then consult online resources (step 2). They weigh among alternatives (step 3), such as price comparison or review references, to make purchasing decisions (step 4).

During the Search for information stage (step 2), customers narrow down available options and make purchase decisions based on several factors but primarily those that match their immediate needs and budget. Common interface patterns in E-commerce application such as search, filters, and sort, if designed well, can reduce time spent searching, guide customers to relevant content, minimize cognitive load, and aid decision-making. Search is used routinely to find specific items from the vast amounts of online information. Customers enter keywords into a search engine (e.g., Google or e-commerce application or website) and depending on the content of the keyword term, the search oftentimes generates many results pages, most of which may be irrelevant to what customers need. Online sources often offer too much information that overwhelms users. Many retailers offer the same products, consequently customers must determine their credibility and if they offer competitive pricing. It is necessary, particularly for M-Commence applications given small display sizes, to provide customers easily accessed and concise information about products so products can be reviewed quickly, and customers can

identify trustworthy retailers to review and make purchases. In addition, search is open-ended, allowing for an unlimited number of possible keyword search combinations. It requires information recall unlike selection menus, for example, that rely on information recognition. Customers must recollect an adequate amount of relevant information to construct an effective keyword search. When they do not recall, or are unfamiliar with pronunciations or spellings, the complexity of search increases, as do cognitive processing demands. Providing customers alternative options, such as filters, that do not rely on information recall is important. Customers Filter when they want to narrow the list of available items based on specific criteria such as brand, category, price, or color. This interface pattern is useful in situations where customers may not recall information, or they do not know the exact terms to search for or when choosing or recognizing items from a list of search criteria is faster than recalling and typing keyword search terms. Although some filters are restrictive by only allowing users limited or pre-determined ways to isolate information, many afford almost unlimited means to sift through information. Customers Sort when they want to view information from different vantage points such as item price (low to high), age, popularity, or brand.

Effect of customers' review and price exposure on purchase decision making

In the stage Alternatives Comparison (step 3), customers compare product options to minimize potential risks. Their evaluation is influenced by two major characteristics: objective and subjective. Objective characteristics are product features, functionality, and price provided by the firm or brand. Subjective characteristics pertain to assessing a product based on previous experience or input from past customers. This stage of the decision-making process is in line with Kahneman and Tversky (1979) prospect theory which states that people are generally risk averse. To mitigate the risk or potential losses, customers need information about the product,

including price comparison data, review valence (average rating scores given to a product by customers), and review volume (number of reviews written about a product), to fully assess the product's quality. Customer review valence and volume can support decision-making by reducing cognitive load as well as alleviating potential purchasing risks or prospective loss in purchasing. Both present numerical values generated by customers who have previously purchased and reviewed the product. Review valence can help customers assess overall product quality, and review volume can signal the popularity of a product and the intensity of word of mouth. Information provided by other customers is often perceived as more authentic and trustworthy than information provided by the brand. These decision aids based on other customer responses can help one to overcome subjective biases and cognitive processing limitations that may influence the number of options or the information a customer examines (Stone, et al., 2018).

Price impacts purchasing decisions. Price comparison occurs in the Alternatives Comparison stage of the purchasing decision process. Customers usually read through reviews to understand the product's quality and make price comparisons. Prevalent comparison-shopping websites allow customers, who already know exactly what they want to buy, to compare one product with different prices from various retailers or suppliers. However, because these sites typically lack product information and reviews, they may be insufficient for people who want to simultaneously explore product options and compare prices and assess quality. In such cases, customers need to perform multiple searches and browsing tasks across numerous sources, which increases cognitive load and likely negatively impacts the overall user experience. Therefore, an interface that integrates product information, reviews, and price comparison, can aid customer decision-making.

PURPOSE

In general, when shopping online, customers want informative product information presented concisely, information about competitor retailers, and price comparison data in a single interface display. Additionally, the interface should support information searches, browsing, filtering, sorting and ultimately decision-making without overloading users' cognitive resources. The design of M-commerce interfaces presents unique challenges due to the context in which they are used, and display size. While intended to improve the shopping experience, they often distract, and confuse users and impede their experience.

In this paper the authors describe the design of a M-Commerce application interface to support purchase decision-making. The design aims to improve usability by consolidating informational resources on a single user interface (UI), providing a consistent interface and functionally for users to review product information, compare and explore product features, make price comparisons, and obtain deal alerts. The authors review the application design in the context of the Double Diamond process model, a framework that aids designers by highlighting key design phases, principles, and methods. The authors discuss the user research, prototyping, and testing processes as well as the implications of using the Double Diamond framework to guide application design.

METHOD AND PROJECT DESIGN

The Double Diamond design process model (see Figure 1) has four phases by which to explore a design problem thoroughly and to determine an appropriate solution: Discover, Definition, Development, and Delivery (Design Council, 2021). The first diamond consists of two primary phases and is dedicated to gathering information and user research, such as

interviewing and data synthesizing. The second diamond consists of two steps dedicated to information processing and iterative design processes, including solution brainstorming and prototype development. Creating, testing, and designing are the main tasks in the second diamond.

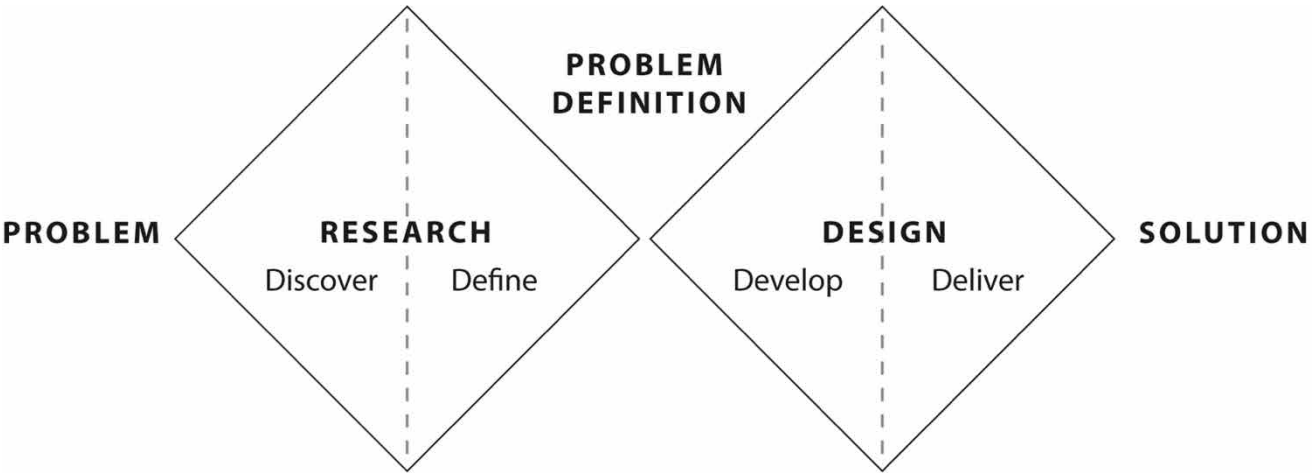

Figure 1. Double diamond design process (Adapted from Design Council, 2021*).*

Discovery

The first diamond of the model has two phases, Discover and Define. For this project, the Discover phase helped the design researcher better understanding the problem. It emphasizes primary and secondary research methods that helped uncover user insights and their pain points in purchase decision-making. The following methods were used to understand the design problem(s), context, and users more thoroughly:

Secondary research:

- Literature review: Academic and professional literature in the M-commerce field, specifically user-interface patterns or features customers expect to find in M-commerce applications, were examined.
- Competitor analysis: Existing M-commerce applications (e.g., Honey, Slickdeal, ShopSavvy) features were tested by one of the authors and feedback and reviews on Google play or the App store were examined.

Primary Research:

- Observations (usability testing) and in-depth interviews: Eight users were provided product search tasks and asked to perform them while being observed. The observer asked users to perform an assigned task and require them to think aloud and explain their actions. By putting users in the contextual environment, the observer carefully watched the details of the ways users normally perform their tasks in a natural setting. The observer recorded the following data: time on task, errors, and success rate. In subsequent interviews, the observer asked questions to better understand what users were thinking and doing.
- Online survey: Users were surveyed to better understand their needs, and pain points and to identify requirements for the design. The survey gathered additional data to compliment in-depth interviews and observations.

Define

In the Define phase, the designer-researcher synthesized findings, identified common patterns, and formed hypotheses to fully understand and define the problem and possibly see the problem from a new perspective.

Literature Review

From a review of literature, the following interface features and functions were identified as important when shopping with an E-commerce or M-Commerce application.

- Search, sort, and filter.
- Repository of top brands and credible sites or sources
- Concise product information
- Customers' review by review valence, volume, ratings by product feature, and review keywords.
- Product specification or features comparison
- Price comparison and price history data between retailers/companies/e-commerce sites
- Deal alert and related data.

Competitor Analysis

There are a few mobile applications that help customers make a purchase decision by providing them with two major functions: 1) price comparison across different retailers and 2) promotional code or coupon find. The design-researcher examined popular apps (e.g., Honey, Google Shopping, Slickdeals) to identify existing useful features. Table 1 lists several useful

features that were present in some of the applications as well as features that were not present at the time of this writing and could be added.

Existing Useful Features	Features to Add
• Browser extension works efficiently • Compare prices between different retailers in Amazon to find competitive price. • Price history and deal alert functions. • Suggest promo codes to help customer save money. • Offer cash back for certain purchases. • Linked with Google account to show appropriate products and recommendations. • Provide product review, price track, price comparison in a single UI. • Offer dynamic and flexible filters based on product features. • Active and passionate deal hunters sharing deals. • Specific deal instructions, authentic assessment, and price research from deal hunters. • Service deals.	• Automatically apply multiple promo codes at check-out. • Product comparison - compare between different product options and brands. • Deemphasize advertising of products unsuitable for customer needs. • Products comparison. • Improve interface design. • Search function results tied to product. • Expand variety of deal types (e.g., deals for men, women, teens) • Product price comparison.

Table 1. Useful features included in some applications and features to add.

Survey Findings

Data were collected from 61 participants, ranging from age from 18-24 (89%) and over 25 (11%). More females (55.7%) participated in the survey than males (44.3%). Participants described themselves as: Caucasian (70.5%), Asian (9.8%), African American (8.2%) and Other (11.5%). Key takeaways from the survey include:

- 59% of participants prefer both in-store and online shopping, while 24.6% prefer online shopping by laptop/desktop and 6.6% prefer online shopping using a mobile device.
- Amazon is the most preferred website to search for products.
- Participants visit credible sites/retailers to do product research and make a purchase from there (e.g., Walmart, Target, Macy, Best buy).
- Participants have favorite websites for shopping based on type of purchase.
- If participants are not looking for a particular product, they tend to Google search using generic search terms. (e.g., air fryer, best air fryer).
- Most participants (68%) rated the product research process (read information, price comparison, find deals/promo code, etc.) very-to-extremely important.
- Most participants (55%) rated reading product reviews as very-to-extremely important. Reliable sources they read for product reviews are official brand websites (62.3%), Amazon (57.4%), social media influencers or experts (45.9%).
- Most participants (54.1%) had not used decision support shopping mobile apps.
- Of participants familiar with M-Commerce apps, Honey is the most well-known (44%), followed by Google Shopping (32%), and then Slickdeals and Wikibuy (6%).
- Participants identified the following as top features of decision support shopping mobile apps: 1) compare product price (85.3%), 2) find coupons and promotional codes to save money (67%), 3) compare product features (63.93%), 4) read product reviews (60.7%), 5) deal alerts (21.3%), 6) product price history (14.8%).
- The steps in the shopping process that participants found to require the most time and effort (ordered from most-to-least difficult): 1) search for the product fitting customer' needs and

budget; 2) compare the product among different options; 3) find the best product price at trustable sites.

- Participants identified three main types of difficulties in the shopping process (see Table 2): 1) product comparison (25%), 2) initial search for the right product (21%), 3) finding the best price (20%). Participants identified several other challenges that were categorized as Other (17%).

Difficulty	User Quotes
Compare Products	"Comparing products can be difficult. I typically have several tabs open on my browser if I need to compare products, which can be a hassle if I'm using a mobile device." "Comparing different product features that fit within a budget. It can be hard because you might have to compromise on a feature due to a limited budget." "Comparing different brands of products is very time consuming and requires a buyer to compare many different brands which could be distracting."
Initially search for the right product	"Finding the exact product, I'm looking for. Sometimes I don't know exactly what I want so I will search keywords until I can find something close to it" "Getting the search terms right in order to show me the most relevant product." "Figuring out which options or version of the product would work best for you and is exactly what you need."
Find the best price	"Trying to find the best deal. Some stores could offer a lower price, but the shipping costs make it more expensive." "Finding the best price from a trustable source." "There are so many different retailers online so finding the one that has the best price takes the most amount of time." "Comparing pricing and finding legit companies, making sure you're getting what you are paying for."
Others	"Reading product reviews because some of them could be misleading which you only find out once you get the product." "Not knowing if an unknown site is legit or if I'm going to get scammed."

Table 2. Participants identified the most difficult aspects of the shopping process.

Observations and in-depth interview findings

To better understand shopping behavior and to identify a typical customer journey for researching and purchasing a product, the design-researcher asked eight people to use a

smartphone to perform the shopping tasks of buying the “best air fryer of 2021”. Table 3 represents the general steps of these users:

General Steps	Tasks
Step 1	Use a generic search term on Google (e.g., best air fryers 2021).
Step 2	Narrow down the list to the top 3 or 5 products for comparison research.
Step 3	Look for the best option based on criteria: brand reputation, price range, and product reviews.
Step 4	Compare prices across different retailers to find the best price.
Step 5	Go with credential retailer (Amazon, Target, Walmart, Best Buy, etc.).
Step 6	Consider other factors: online/in-store purchase, shipping time, shipping cost.
Step 7	Search for the promo codes/coupons.
Step 8	Make a purchase.

Table 3. General steps in customer journey.

During these observations, the design researcher asked follow-up questions to obtain additional insights and the following three primary pain points were identified:

1. Customers want to find the right product based on their specific criteria within budget.
2. It's time-consuming for customers to compare different products and prices or read reviews to assess the product’s quality.
3. Customers consistently try to get the best price at trustworthy sites and find coupons/promo codes to save money.

Develop and Deliver

In the second diamond of the model, there are two phases, Develop and Deliver. In the Develop phase, based on clearly defined problems and insights gathered in the Define phase, the design researcher begins the search for possible solutions. Techniques such as brainstorming and ideation help generate a variety of ideas that may serve as potential solutions. By answering "How might we" questions created from identified problems, the design-researcher generates as many ideas as possible to address the issue. Because not all solutions are applicable and impactful, this step also helps determine critical features for the design solution, around which prototypes are created. With prototypes or models of possible design solutions, the design-researcher can test ideas and try to establish an understanding of customer interactions or behaviors during shopping, and from which create workflow diagrams, and begin formulating the information architecture.

After narrowing down concrete and feasible solutions, the design-researcher builds low fidelity prototypes of the solution and presents them to target users to get relevant feedback. In this low-fidelity stage, many changes are likely and, to save time and effort, prototypes need to be in a low-fidelity state so they can be changed quickly before moving to another medium and a higher fidelity. After numerous iterations, the designed solution is rendered as a high-fidelity prototype. In the final phase, the design-researcher aims to produce a concrete, realistic representation of the final designed solution. Prototypes are put through usability testing with target users. There are many design iterations during this stage to ensure the design solution meets the intended needs.

Develop-Test

The project designed an M-Commerce application that supports customers' purchasing decisions while shopping. Guided by the Double Diamond process model, it provides a single, consistently designed interface to assist decision-making when retail shopping. It is designed with several decision-making support features to help the customer make a purchase decision *(see Table 4).*

Decision-making Process Step	Decision Support Features
Step 1 - Search for information	Search | Filter & Sort
	Generate popular product keywords
	Consolidating product information into a single UI interface
Step 2 - Alternative comparison	Suggest top brands and credible retailers for products
	Providing price and product comparison
	Product reviews and ratings from credible sources
Step 3 -Purchasing decision	Summarizing available promo codes/discounts

Table 4. Features based on the decision-making process.

Search; Filer & Sort helps users narrow down available product options using specific criteria, features which are similar in other M-commerce apps. The intent is to reduce excessive amounts of information presented to users that impede decision-making and to enable them to

pinpoint relevant information quickly and easily. When keyword searching for products, users are often unfamiliar with specific terminology that represents a product, or they may use phonetic spellings, which can be inaccurate. Attempts to identify accurate terminology and spellings is cognitively taxing and time consuming. *Generating product popular keywords* is a feature that helps users when typing keyword search terms. When typing a keyword search, the search interface will recognize terms and make relevant suggestions from which users can choose. This helps users recognize items from a list of terms rather than having to recall product terminology or the correct spellings. As terms appear in the search interface and users narrow their searches, the interface will suggest popular, credible bands (*Suggesting top brands and credible/legitimate shopping sites*) that correspond to the searched products, which potentially reduces the mental effort required of users in assessing brand or retailer credibility. Based on these search results, the application provides an interface for users to compare product features and prices across bands and retailers (*Providing price and product comparison*), thus supporting users in making effective and speedy decisions. It helps to expose them to unnoticed features or items and to engender alternate "better" choices. Because price is an important factor for shoppers, the application highlights promotional codes and promotions in general (*Summarizing available promo codes/discounts*). In addition, an important attribute of an electronic decision support system is making available unbiased data and so the app provides price comparison and promotional data, as well as customer reviews and product rating data (*Product reviews and ratings from credible sources*).

Application Architecture

Data collected from observations and in-depth interviews about shopping behaviors helped the design-researcher identify general steps in the customer journey purchasing path (see

Table 3). Figure 2 depicts a high-level, generally linear, overview of these processes. Generally, a search is initiated that provides search results, which often must be filtered or sorted. As users' queries are refined, they begin making comparisons by products, price, and based on reviews. Based on the customer journey, a general architecture (see Figure 3) of the application primary requirements was created that included the *Decision support shopping features* (see Table 4). This specific architecture was essential in the design stage because it helped the designer create drawings-sketches of the application interface based on the customer journey and key *decision support* features.

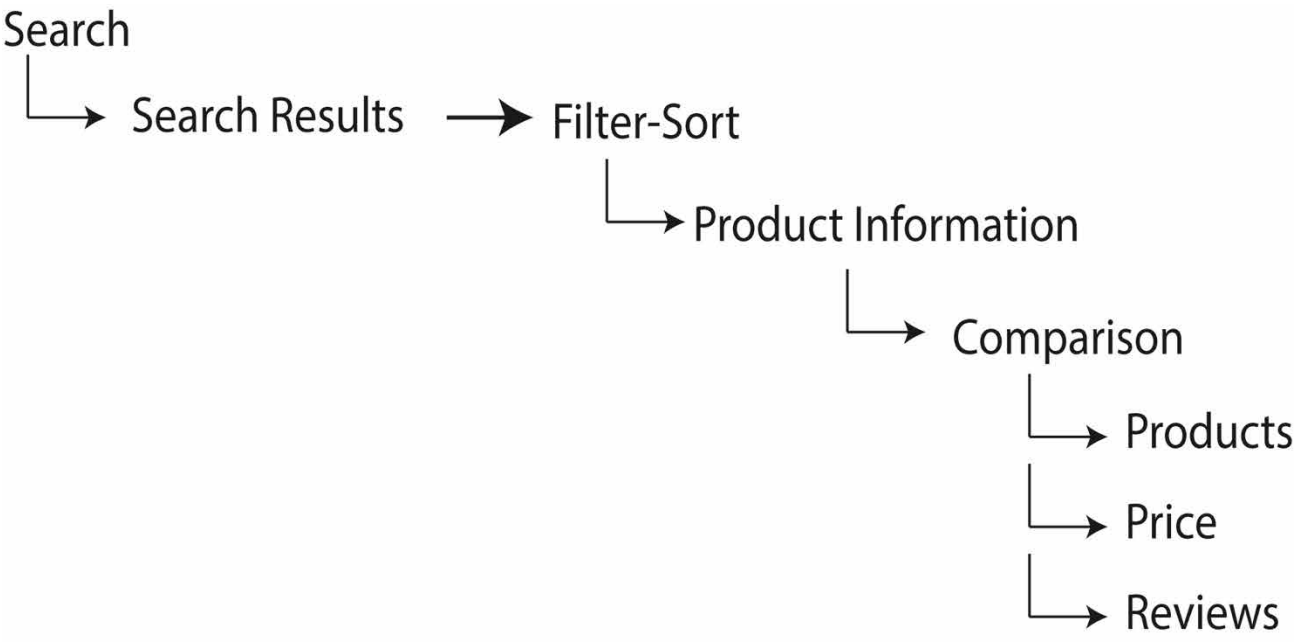

Figure 2. High-level workflow of purchasing processes.

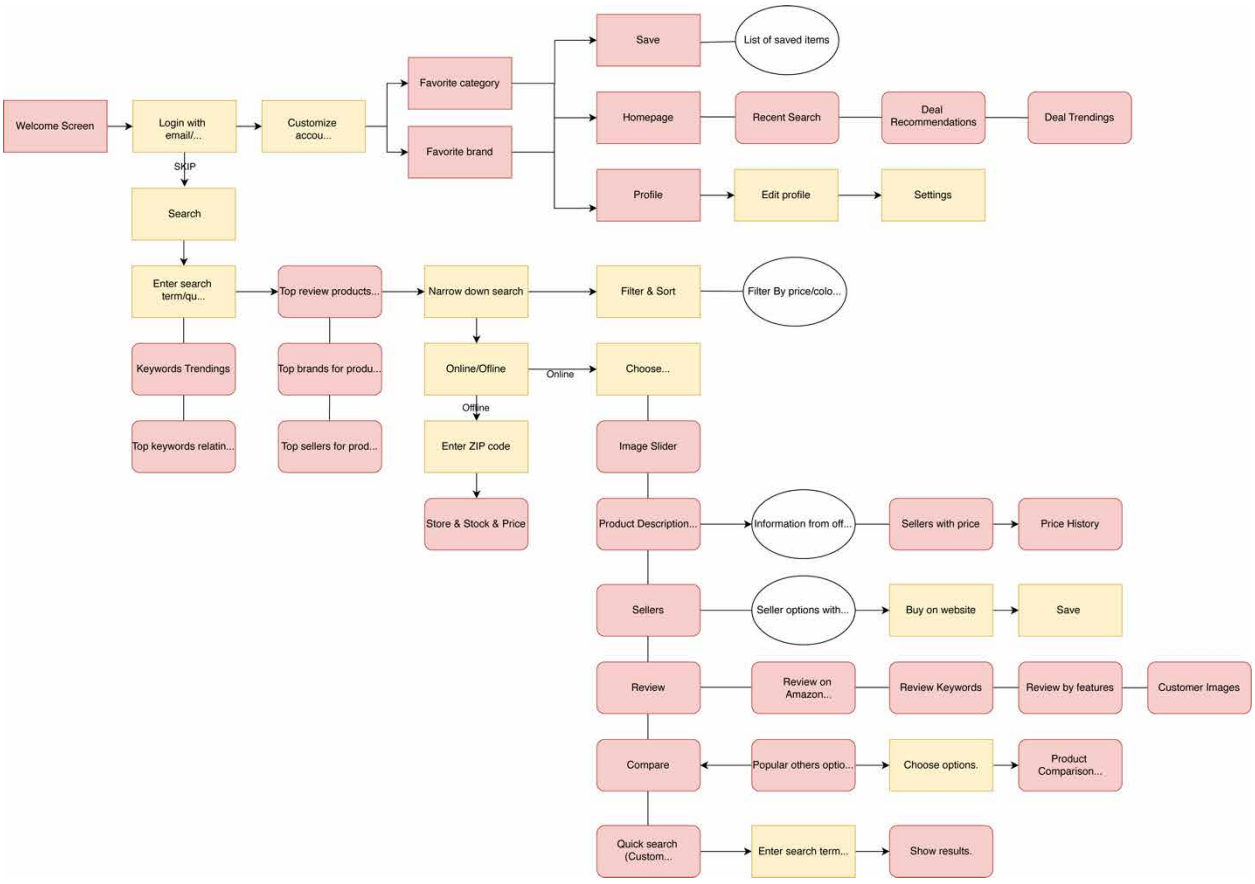

Figure 3. Decision support shopping mobile app architecture.

Sketches and High-fidelity Prototype

Based on the application architecture (Figure 3), the designer made drawings-sketches to visualize the interface with corresponding features (Table 4). After several rounds of iteration of drawing-sketching to refine design ideas, the designer eventually transformed the drawings-sketches to digital form. To work on the interaction design, the designer created a high-fidelity functioning prototype. The designer again engaged in several rounds of iteration to refine the prototype, moving from a low-fidelity prototype with limited interaction to a high-fidelity prototype with application-like interactivity and functionality. Throughout prototyping, the designer performed user testing to evaluate each design iteration. During testing the interface

design, information architecture, content, and interaction design were assessed. User feedback collected from each round of testing was studied and when appropriate incorporated into the prototype for subsequence rounds of testing. Figure 4 illustrates an initial drawings-sketch of the search interface and a corresponding higher fidelity prototype. Figures 5 through 12 depict main features (see Table 4) mapped to the interface.

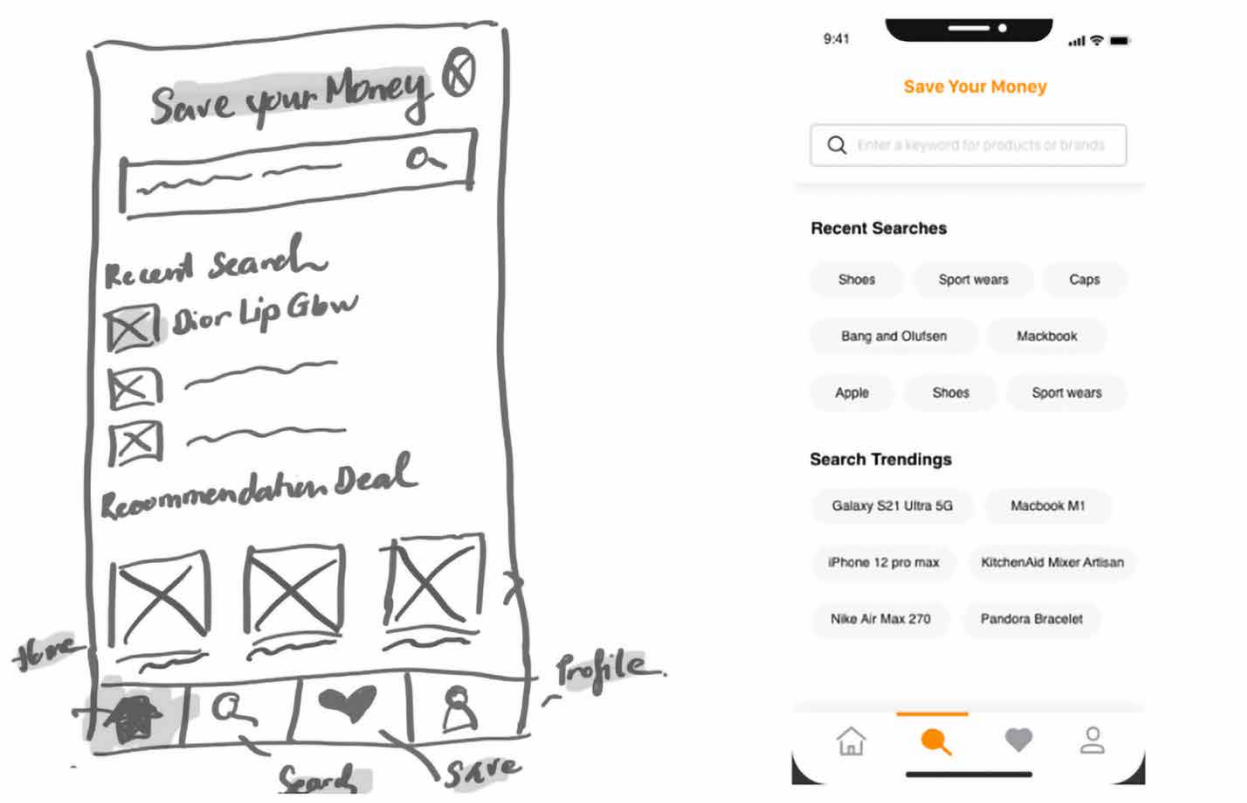

Figure 4. Primary Features: Search - Design iteration Sketch to High Fidelity

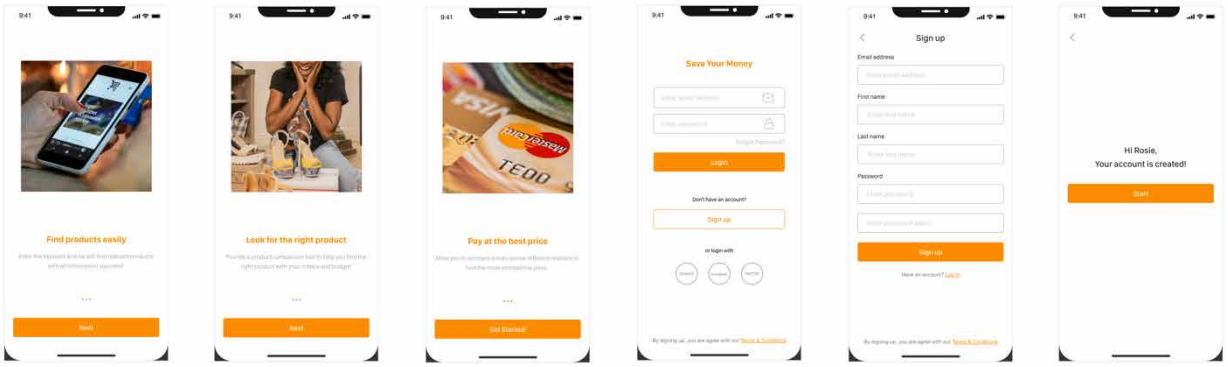

Figure 5. Onboarding

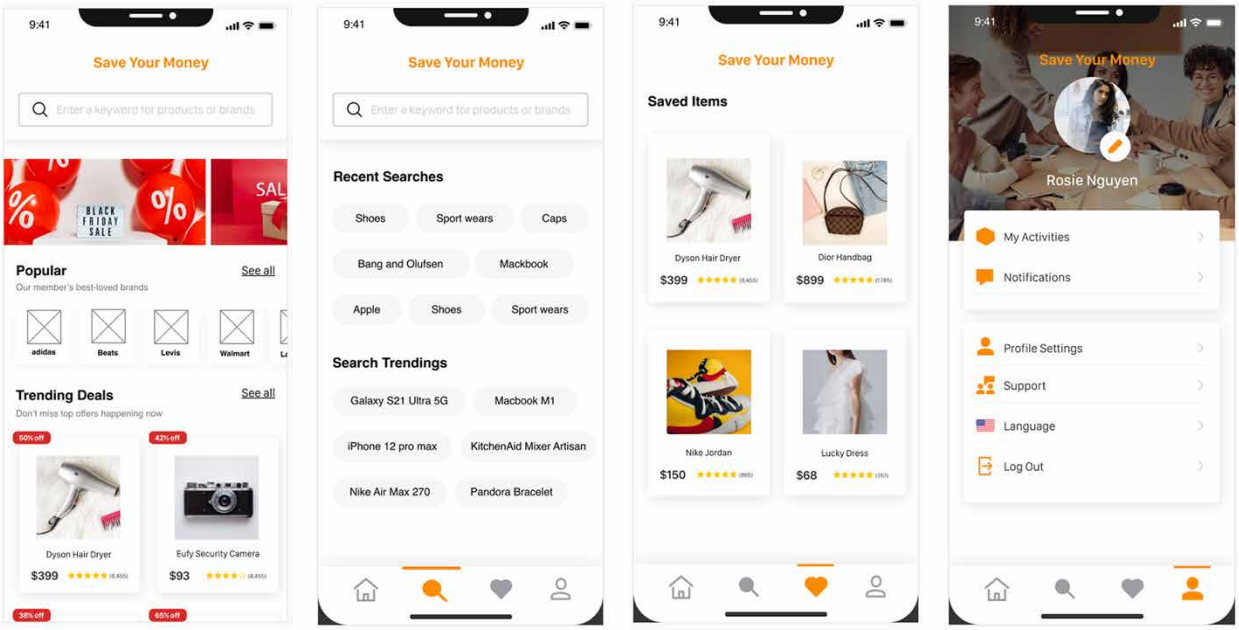

Figure 6. Main Navigation Home Screen, Search, Saved Items, and User Profile.

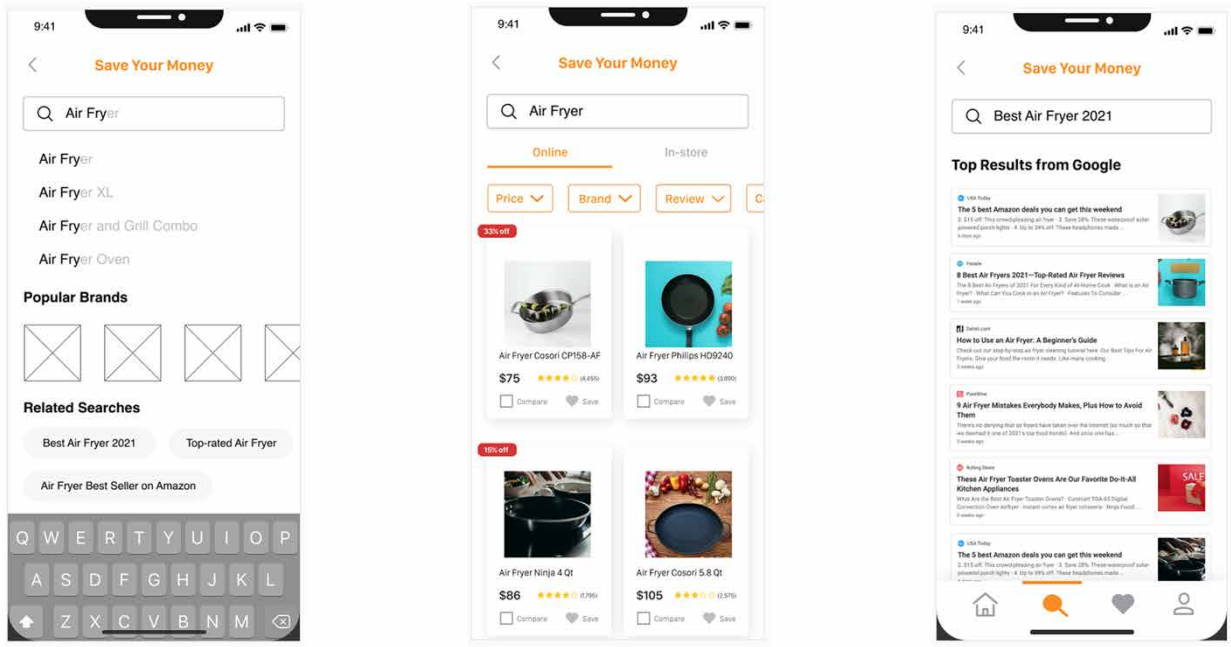

Figure 7. Features: Generating product keywords and suggesting top brands and credible sites.

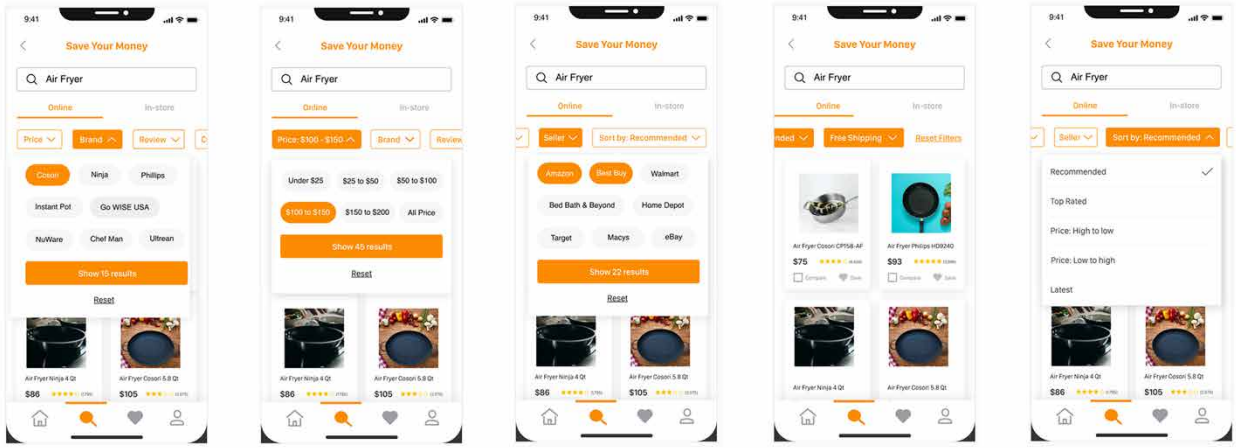

Figure 8. Feature: Filter and Sort. Filter by brand, price, retailer, shipping, and sort.

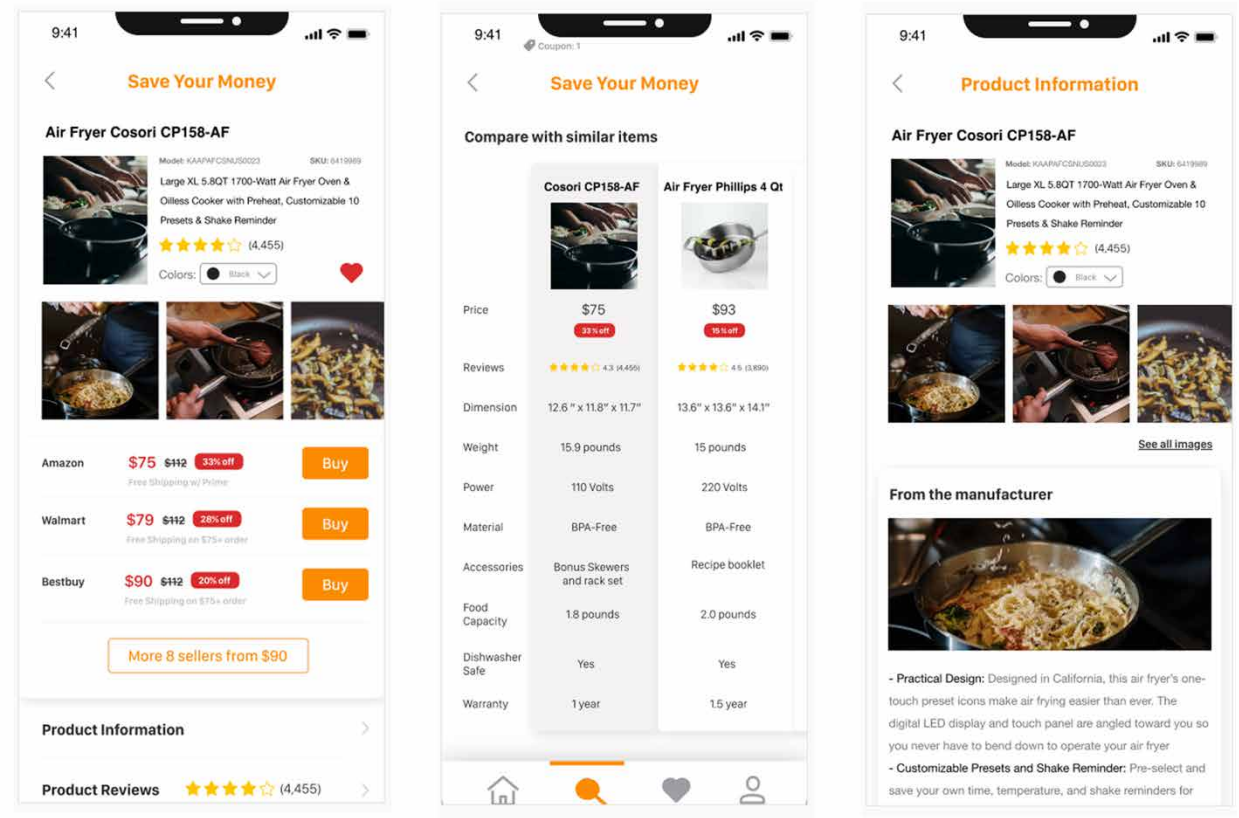

Figure 9. Features: Product screens - Summarizing available promo codes/discounts, and price and product comparison.

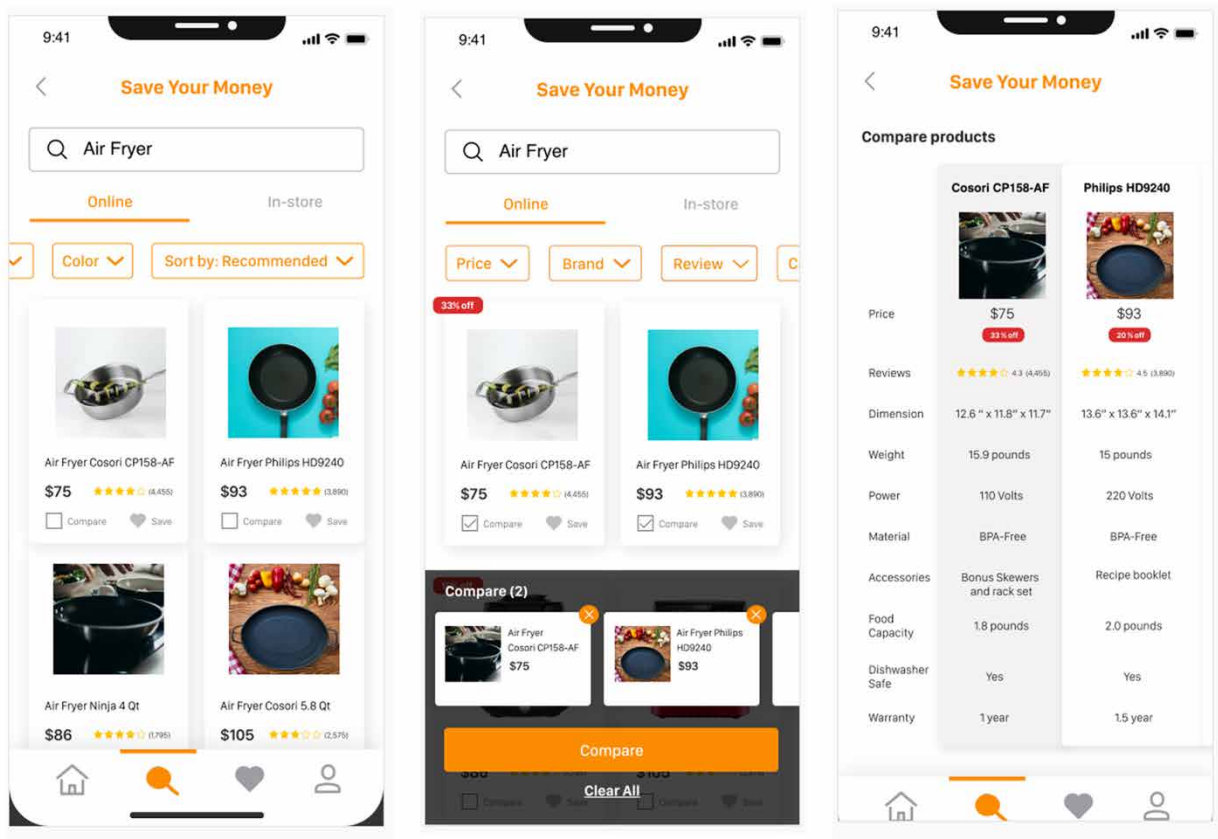

Figure 10. Feature: Product comparison.

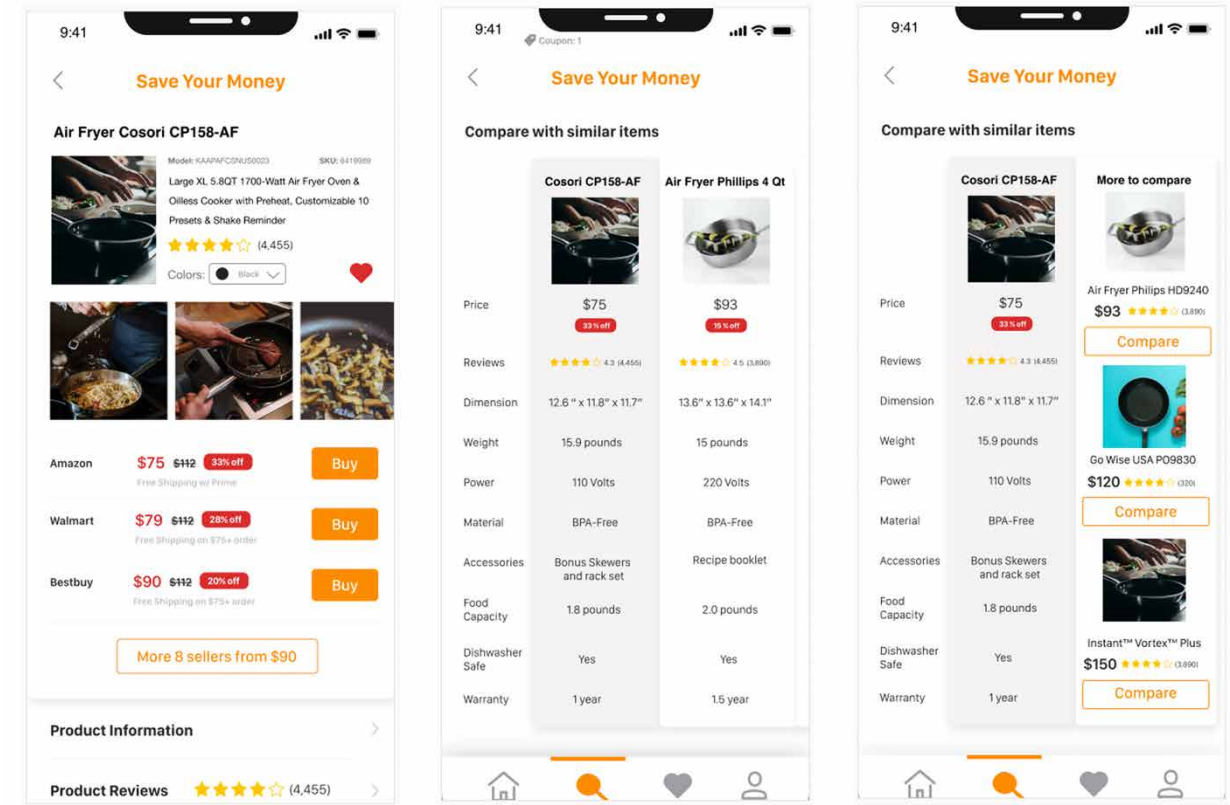

Figure 11. Features: Summarizing available promo codes/discounts, price and product comparison.

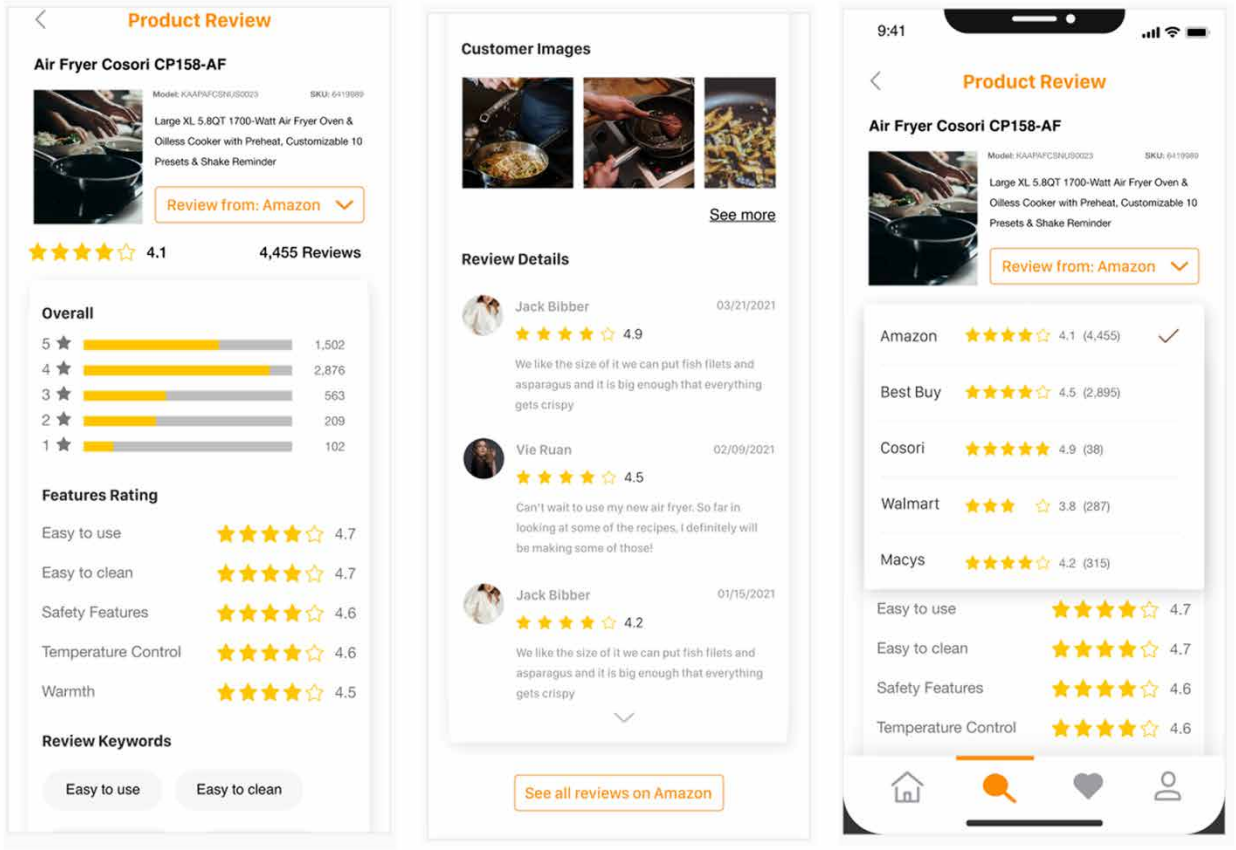

Figure 12. Feature: Product reviews and ratings from credible sources. On left product reviews. On right Product Review Sources.

Deliver-Listen

Summative usability testing, to evaluate a near finished design, occurred with six users who evaluated application functions. Two users used the high-fidelity prototype mobile app, which yielded the most realistic mobile experience while the four others used the prototype through Zoom conferencing system. All users were given the same task, to use the application to walk through the shopping process to purchase an air fryer. They were asked to think aloud while performing the task. The observer limited interruptions to not affect the usability tests.

After usability testing, the results were summarized, and revisions were made to the application. Below are key takeaways after user testing:

- There were vague and misleading labels in the application, which confused users. For example, instead of using the word “offline” (compared to online shopping), “in-store” is better to describe the shopping activity. For obscure headlines, the designer added a brief description under the headline to inform users about the purpose of the section.

- The home screen looked like an E-commerce application and did not convey the primary purpose, which is to help the user make purchase decisions. The home screen was revised by removing the categories section and adding more descriptive banners (see Figure 13).

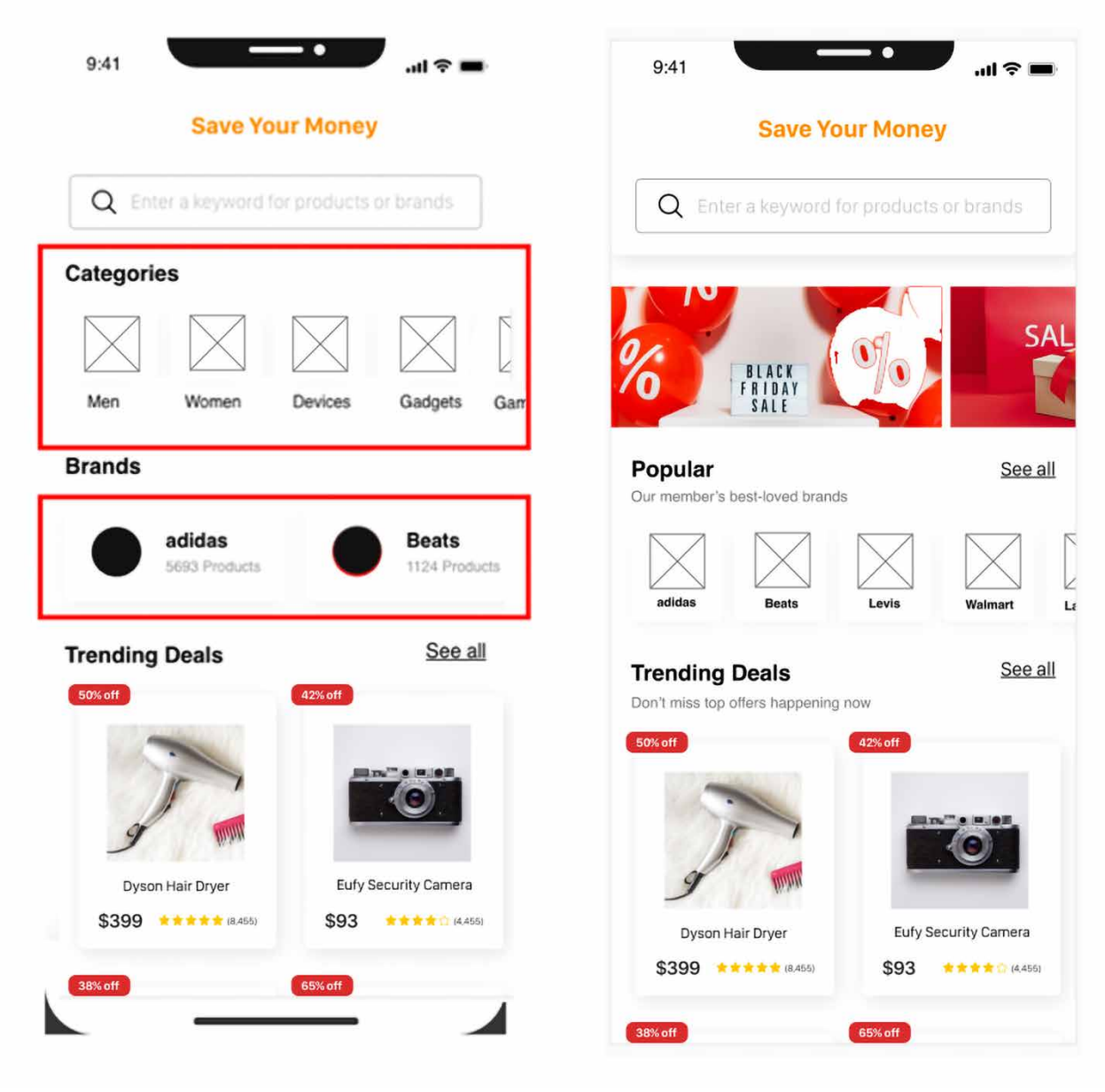

Figure 13. Summative usability testing: UI changes to home screen. Onleft the original home screen. On right, the revised home screen.

- Call-to-action buttons were not easy identifiable and were made more visible by adjusting the position of the button or making them bigger. For example, the "Sign up" option was too

small for users. The designer made it a secondary button under the primary button “Log in” (see Figure 5). In the Price comparison section, to indicate that users can choose the retailer by price, primary buttons with the label “Buy” replaced arrow graphics because users did not recognize the arrows as actionable (see Figure 9).

- Some users wanted to compare several products in the explore section where the application displays different types of products. Other users narrowed their search and wanted to compare products on a specific product page and the “Compare with similar products” section is design for them. It automatically generates a comparison table with popular similar products at the bottom of the product page (see Figure 11).

- After usability testing, the main sections of the product page, including the product information, price comparison, product review, product comparison, were revised. For example, in initial versions, users could only see one price, and if they wanted to check other retailers, they needed to click on “Sellers” section positioned below the “product information” section. However, during usability testing, the designer observed that the primary task at that stage was to compare prices across retailers, and users expected the price comparison to be displayed in one place. In the earlier versions, users had to navigate to another screen, which confused them by shifting the context and displaying unrelated products that they felt were unrelated to what they were looking for. In the later version, users do not navigate to another screen, as product information, price comparison, product review, product comparison are all consolidated (see Figure 14).

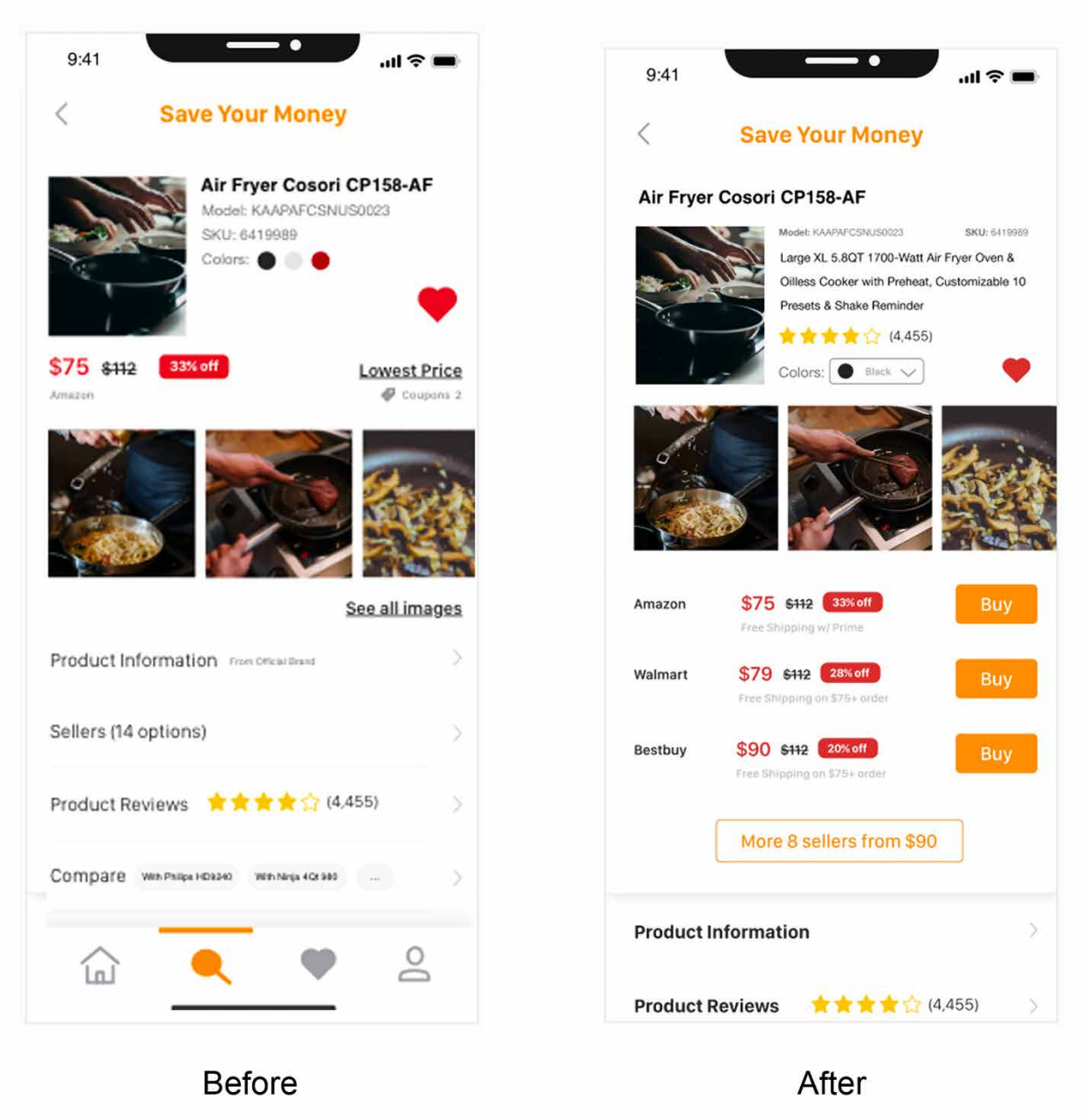

Figure 14. Summative usability testing: UI changes consolidated features.

CONCLUSION

Because decision-making is cognitively demanding, people use decision-making heuristics or mental shortcuts, such as eliminating choices by their characteristics (eliminate by

aspects), deciding based on the information available (availability heuristics), and satisficing, which allow for speedy decision-making (Stone, et al., 2018). People increasingly shop using mobile devices. Digital interfaces can interfere with decision-making due to information overload, inconsistent interfaces, small screens, unethical vendors, and a host of other factors that demand cognitive resources, impeding decision-making, and the user experience. The application designed for this project includes features to support decision-making heuristics. For example, allowing users to sort or filter, and compare multiple products supports *eliminate by aspects heuristic*. Deal alerts and finding product availability from trustworthy vendors support *availability heuristics*. Interestingly, during design research, many features requested by participants related to helping them make decisions and supporting the heuristics people often use in decision-making. In addition, to circumvent the confounding factors (e.g., disparate, and inconsistent interfaces) that plague today shopping-assist interfaces, the application designed for this project provides a single user interface through which people locate product information (features, price, and reviews) and then use comparison tools in the interface to aid in making purchase decisions.

For this project user research consisted of secondary (Literature review: Competitor analysis) and primary methods (observation-interviews with eight people, survey with 61 respondents). In addition, generative user testing was conducted throughout the project design process. From this research several conclusions can be made:

Shopping and M-Commerce Decision Support Systems:

- People think the product research process (read information, price comparison, find deals/ promo code is one of the most important, if not the most important, part of the shopping process. M-Commerce Decision Support Systems must account for this.

- People spend the most time and effort: 1) searching for products that fit their specific needs and budget, 2) comparing products and options, and 3) locating the best product from trustworthy vendors. It is time-consuming for people to compare different products and read product reviews. They want to find the right product based on their criteria within budget. They want the best price from trustworthy vendors, and they want coupons/promo codes to save money. Decision Support Systems that assist people in these areas will likely be viewed favorably by shoppers. The application designed for this project addresses these needs by providing two primary features (Search; Filer & Sort) and six main features to help the customer make a purchase decision.

Double diamond Design Model:

The Double Diamond process consists of two main stages, Research and Design. Following the processes outlined in these stages, the designer was able to design an application that potentially saves customers time and supports their decision-making and makes the mobile shopping experience more effortless and enjoyable.

1. The Research Stage: This stage helped the designer, as the design-researcher, to better understand the design problem, user needs and pain points. From a literature review it was identified that many of today's digital interfaces meant to support people make purchase decision impede human decision-making. Small poorly designed interface displays, excessive informational sources, untrustworthy vendors, among other things, increase cognitive load, user frustration and add complexity to purchase decision-making as well as the overall shopping experience. These findings were corroborated by data collected from user observation, online survey, and in-depth interviews. The research stage helped the designer narrow down the scope of the project and identify features to be designed in the application.

2. The Design Stage: After determining the problem, the second stage of the Double Diamond process pertains to proposing solutions to address these issues. At this stage, generative user testing was extremely important to enhance the application through successive design iterations, as user feedback and usability errors allowed the designer to identify where design improvements were needed. In addition, user testing allowed the designer to define shopping behaviors among users, which were distinct in many ways, because these behaviors depend heavily on individual perceptions, characteristics, and culture. Every user had distinct perspectives, practices, and experiences during testing. The different ways they interacted with the application-prototype were useful to observe so that the designer could make changes in the application, so it better suited user needs.

RECOMMENDATIONS

Although this project aimed to help people do product research more easily and efficiently and to shop online using mobile devices, some limitations should be noted. First, with data being collected using an online survey, there is a chance that participants did not fully understand a question and did not have the opportunity to ask clarifying questions, generating erroneous answers. Moreover, this study only collected data from participants using convenience sampling, meaning the results may not be able to be generalized to the other populations. Additionally, most of the survey participants were students ranging in age from 18-24, which means the project did not cover other demographics with a wide range of age and occupations.

Another limitation of this study is that it only focuses solely on “online shopping” and did not explore other aspects of in-store shopping or using the app to support customer in-store

experience. Therefore, there is room for future projects to develop other functions that support customers in the brick-and-mortar stores, for example, “in-store mode” or filter by “in-store deals” or suggest “deals near me”. Moreover, the project could not present the “*Feature 4: Summarizing available promo codes/discounts*” as proposed, because promo codes vary by different availability times with complicated terms and conditions, and often depend on a customer’s specific situation. The project did not find a solution to list all requirements for promo codes. Hence, futures projects can explore this aspect to support the user’s needs.

Lastly, due to the pandemic situation, almost all interviews were done over Zoom, which sometimes causes certain limitations and inconveniences. There were no face-to-face interviews and usability tests, which may have been less effective compared to offline interviews that put the user in a real environment and potentially yield more accurate or different results. Also, with resource and time constraints, the project only did summative usability tests with six users. There are more opportunities to improve user experience overall or develop more functions that meet different user’s demands in mobile shopping.

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