CODESIGNING A MOBILE INTERFACE FOR TRAVEL PLANNING ON DIGITAL MAPS

by

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ABSTRACT

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Nowadays, increasing numbers of people do travel research on their smartphones. More precisely, digital maps provide locational information, which is important during the planning process. However, smartphones are restricted by their small screen size, resulting in fragmented information delivery; also, the design of digital maps lacks features. The aims of this study are to investigate users' travel-planning behavior on smartphones, identify the pain points and missing contexts when using digital maps on smartphones, and provide design guidelines for future digital map design. The study was done by conducting a travel-planning activity and a codesign workshop to bring users into the design process, promote in-depth discussion, and explore a new design possibility for digital maps with users. The results showed that people's goals when planning travel include reducing their workload, improving effectiveness, and ensuring flexibility. People use digital maps to support not only information searching but also information compiling, including saving locations and routes. In addition, several difficulties have been pointed out: cross-platform planning, information hierarchy, and retrieval on digital maps.

CHAPTER 1. INTRODUCTION

1.1 Statement of Problem

Nowadays, digital maps have become a part of people's lives as navigation aids. In travel planning, users need locational information and other supportive services on maps, including address, distances, transportation times and modes, photos, reviews and ratings for accommodations, attractions, and restaurants. In order to connect locations, the common practice is to form a route between those points of interest (POIs), to understand their orientation and distance. However, when people change to other POIs and connect them, the previous results will disappear. And if they want to connect the POIs again, they need to type the POIs into the search bar again. In addition, people need to switch the view if they want to find detailed information about a place. This repeated process requires extended effort because users have to memorize the results they find and build their spatial knowledge (Baudisch & Rosenholtz, 2003; Brodkorb, Kuijper, Andrienko, Andrienko, & Von Landesberger, 2016; Gustafson, Baudisch, Gutwin, & Irani, 2008; Miau & Feiner, 2018).

Furthermore, the ubiquity of smartphones worsens the situation. Google (2018) found that 48% of people in the United States use smartphones to conduct travel research. The percentages in some other countries were even higher, including in India, Japan, South Korea, Brazil, and Australia. In addition, Panko (2018) proposed that 36% of users use navigation apps before leaving their location. Since digital maps on smartphones have become important, however, due to the small screen size of phones, the exact locations on digital maps are usually beyond the screen's limits. Moreover, previous research has pointed out that because mobile map users only acquire fragmented information surrounding their current location, they have poor spatial knowledge and distance estimation (Schmid, 2008; Willis, Hölscher, Wilbertz, & Li, 2009).

Based on the smartphone issues identified above, the design of personalized digital maps on smartphones is a current challenge. Several studies have focused on visualizing off-screen locations as a design solution for the zooming issue, by offering on-screen hints to allow users to quickly make decisions (Baudisch & Rosenholtz, 2003; Brodkorb et al., 2016; Gustafson et al., 2008). Other researchers have offered different design models for digital maps: Manrique-Sancho, Avelar, Iturrioz-Aguirre, and Manso-Callejo (2018) designed different maps for

different types of users; however, the effects were unknown on smartphones. Miau and Feiner (2018) improved users' planning workflow on digital maps on smartphones; however, too many gestures were needed, and they did not consider the visual presentation of any complicated routes created. On the other hand, Google Maps, as a pioneer of the current market that is capable of collecting large amounts of user data, is the only service producer to offer personalization services. Still, these services' lack flexibility and unclear user models have been pointed out as problems (Ballatore & Bertolotto, 2015).

Consequently, this research focuses on a specific scenario, aiming to investigate the tool ecology for people planning travel on smartphones as well as the importance of digital maps. This was done by collecting data from a screener survey, a travel planning activity, and a codesign workshop. I identified user challenges and users' favorite features when planning travel on digital maps on smartphones, including searching, saving locations, identifying locations, connecting POIs, and planning routes to and between POIs. The goal of this study was to propose design guidelines for travel planning on digital maps on smartphones. Another aim was to understand participants' preferences and behaviors, to collaboratively design a new interface that can cater to their needs.

This paper is divided into seven chapters. The first chapter provides a broad introduction and narrows the topic down into specific research questions. The second chapter illustrates the development of digital maps, the interfaces and interaction techniques, the design challenges, and the possible solutions provided by different researchers. In the third chapter, I give a detailed explanation about the methodology, including the data collection from a screener survey, a travel-planning activity before the workshop, and a codesign workshop, and the data analysis using thematic analysis. In the fourth chapter, I illustrate the findings through an explanation of five main themes; following this, a discussion takes place in the fifth chapter. Finally, I conclude the study and explain the limitations and future work in the last chapter.

1.2 Research Questions

In order to conduct the study, the following questions will be investigated:

RQ1: What is the tool ecology that people use for travel planning on smartphones?

RQ1.1: How do digital maps function for travel planning on smartphones?

RQ1.2: What are the pain points for people using digital maps for travel planning on smartphones?

RQ1.3: What are the users' favorite features on digital maps?

RQ2: How can the user experience of information integration be improved when using digital maps for travel planning on smartphones?

1.3 Scope

This research focuses on understanding tourists' travel-planning behavior, instead of improving vehicle or pedestrian navigation. Although navigation on the road is a major use of digital maps, before going on a trip, tourists needed to spend large amount of time planning and creating an itinerary. During this process, the interface design and workflow of digital maps play important roles in helping tourists get the information they want efficiently. Since it is unnecessary to distinguish between before and during the travel because the planning behaviors can show up in either case, roughly speaking, this paper focuses on the before-travel phase, which relatively few researchers have studied.

Choosing an unfamiliar place for travel planning is also an important element of this paper. Although previous experience does not affect people's reference systems or change their styles (e.g., from guided to explorer) in how they perceive a place (Manrique-Sancho et al., 2018), people may still hold different knowledge, which can influence their workflow when planning on maps; for example, they may already save previous POIs or know how to take public transportation. Without preliminary knowledge, people need to integrate more information from different platforms to form spatial knowledge so as to create itineraries. Therefore, I can have deeper understanding about people's needs.

1.4 Significance

This research integrates knowledge from four domains—mobile visualization, interaction design, cartography, and tourism—and extends their coverage to different fields. Few studies emphasize redesigning digital maps on smartphones or people's workflow on digital maps when planning travel. Digital maps have become increasingly important in free exploration. When people find several places after searching on a search engine, they need to look for detailed

information through maps to find the locations as well as use ratings or comments to decide where they want to go. Such processes give maps a crucial role in information integration. Therefore, in this paper, I describe how people work with digital maps to combine information, to further explore chances to modify the current design of maps.

Additionally, the methodology is another focus point in this paper. I use different approaches to investigate tourists' behavior, specifically travel-planning activity and codesign workshop. This does not mean that an experiment or interviews cannot be used to understand people's behavior; rather, a travel-planning activity gives people a real scenario that can actually let them manipulate tools under a casual context, which can both help participants to provide rich feedback during the process and help me to learn how people think and what they think about and do. On the other hand, the codesign workshop provided a chance for the participants to express their thoughts and participate in the design process. From this active role, they may have become more aware of some contexts that were missed by previous research and provided different design direction, which can also be beneficial for both designers and researchers in the cartography and tourism fields.

CHAPTER 2. LITERATURE REVIEW

Complex cognitive processes happen in people's minds when planning travel. This requires different kinds of information based on context. In recent years, digital maps have become a part of people's daily lives due to the popularity of mobile devices, of which smartphones account for the largest proportion. However, it is challenging for designers and researchers to provide an appropriate solution for smartphones due to their small screen size and mobility. Because of these, map design on smartphones is an issue. Moreover, people had different needs when using maps. Many previous studies have attempted to deconstruct and understand the relationship between use context and user types. In response, researchers have tried to deliver different layouts for visualizing digital maps for travel-planning purposes, to help people succeed in multiple tasks and improve overall experiences.

In this chapter, the challenges posed by digital maps on smartphones will be discussed, particularly concerning the relationship between small screen size and spatial knowledge and the resulting mental workload. Also, some examples of interaction techniques in map design on mobile devices will be introduced, as will research about tourists' planning behaviors.

2.1 Travel-Planning Behavior

In recent years, several researchers have pointed out the prevalence of smartphone use in travel planning (Huang, Goo, Nam, & Yoo, 2017; Tussyadiah & Wang, 2016). A Google (2017) travel study analyzed the numbers of users doing travel research on smartphones in different countries and showed that the percentage of users was higher than 50% four out of nine countries. India even had 87%, while countries such as the United States, Australia, the United Kingdom, and France also had percentages near 50% (Google, 2017). Panko (2018) addressed the findings of a study conducted by The Manifest and found that Google Maps was the most popular navigation app in the market, with a 67% of popularity, comparing with Waze (12%), Apple Maps (11%) and MapQuest (8%). Moreover, 77% of users use navigation maps regularly, and 36% of users use navigation maps to look up directions before leaving their location (Panko, 2018). Based on these findings, user smartphone behavior has drawn attention from the travel market and researchers in the tourism and cartography fields.

Smartphones have advantages in the following dimensions: easy accessibility of information, efficiency of finding information, ease of sharing information with others, better image construction of destinations and attractions, and better support planning on the trip rather than in advance. These could provide positive effects on tourists' overall experiences (Wang, Park, & Fesenmaier, 2012). Specifically, in the travel-planning process, people need to make many decisions on destination, the travel date, length of the trip, travel partners, activities, attractions, rest stops, food stops, transportation, and expenditures. These decisions are interrelated with each other, which takes great effort for users to check and compare information across platforms (Jeng, 1999). Yilmaz (2017) found that over 80% participants in a survey looked for ratings and online reviews to collect information before making travel-planning decisions. The information-seeking process was time-consuming, with a significantly increased workload. Companies have strived to develop personalization engines that can predict users' movements, optimize personal contexts, and provide appropriate information to users by collecting data from mobile technology (Kim & Kim, 2017). Smartphones, specifically different types of smartphone apps, have mitigated people's anxiety and enriched their travel experiences by providing them with recommendations and instant support based on their preferences and needs (Wang et al., 2012).

2.2 The Rise of Digital Maps

Throughout history, cartographers have strived to understand different kinds of geographic knowledge of the world. Maps have become an important mediator with which to represent the world, similarly to in our minds, and have facilitated people's communication. Although they may overlap, map research can be differentiated into three domains: map-design, map-psychology, and map-education research. Of these, map design is influenced not only by psychology and education but also artistic thinking, quantitative science, and behavior geography (Montello, 2002). The components of maps consisted of geographic information, user interface and content visualization (Reichenbacher, 2004).

Compared with paper maps, mobile cartography has a short history but is rising in usage and spreading very quickly due to "mobility [leading] to the fact that more people travel and move in areas unfamiliar to them" (Reichenbacher, 2004, p. 1). Ballatore and Bertolotto (2015) proposed a framework to represent the complex relationship between users, digital maps, and

personalization engines (Fig. 1). Personalization engines are expected to analyze users' models and then reflect the results in digital maps. In the current market, Google Maps has been one of the most well-known digital map apps for a long time. Since Google is a large Web search engine company providing multiple services, Google Maps can collect users' data to upgrade algorithms and anticipate users' behaviors through user clicks, typed words, and locations being saved. Following this, Google Maps provides appropriate recommendations or quick information-retrieval services to meet users' needs. Its performance has been evolving in different scenarios, such as for driving, walking, and indoor navigation. Map structures have been improving as well, including in icon density and building details (O'Beirne, 2017). Although Google Maps is widely used and provides automated and personalized services, some problems still exist, including unclear target users and yet-to-be-improved personalization features (Ballatore & Bertolotto, 2015).

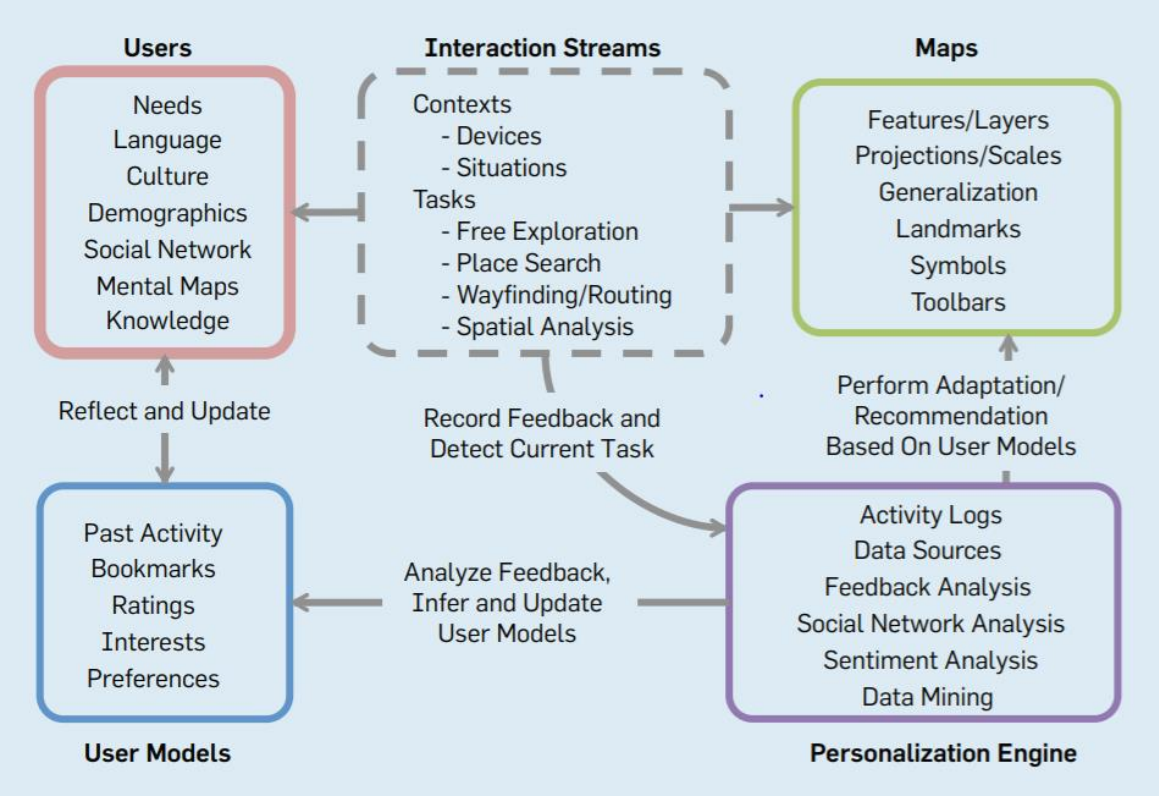


Figure 1. The interrelationship between users, maps, and personalization engines. Reproduced from Ballatore and Bertolotto (2015)

2.3 The Design Challenges of Digital Maps on Smartphones

Two main factors influence map design. The first is use context, which varies by the task users need to complete and their environment. The second factor is user characteristics, which varies by user type, such as explorers and followers (Griffin et al., 2017; Manrique-Sancho et al., 2018). Different use contexts require different forms of cognitive processing and spatial knowledge. However, due to the small screen size, smartphone users using digital maps can only receive fragmented information about spatial knowledge and distance estimation (Schmid, 2008; Willis et al., 2009). Moreover, zooming the interface, as one of the main design features to help users dig into detailed information, has the drawback that even within a short time period, users still need to memorize different layers of information in different contexts. Users can easily lose the targets they have identified if they receive many search results or when they look at another area or target (Baudisch & Rosenholtz, 2003; Brodkorb et al., 2016; Gustafson et al., 2008; Miau & Feiner, 2018).

2.4 Interactivity as a Design Solution for Digital Maps

Based on the design challenges of smartphones identified above, smartphones restrict the views of the map's interface. When maps have large amounts of information, people have limited capabilities of understanding them on smartphones. Hence, offering interactivity is crucial to help users deal with system complexity and encourage their autonomy (Munzner & Maguire, 2015). Preece, Rogers, and Sharp (2002) defined interaction design as "designing interactive products to support people in their everyday and working lives" (p. 6). Because providing interaction functions changes how information is displayed, the functions not only provide an overview of products or interfaces but also help people explore the products or interfaces in detail. Therefore, several studies have emphasized supporting users in navigation tasks and with increasing their efficiency through visualizing off-screen locations and POIs on digital maps. Based on interface schemes, Cockburn, Karlson, and Bederson (2008) categorized interaction techniques into four approaches: overview + detail, zooming, focus + context, and cue-based techniques. Each technique offers interface design possibilities, as illustrated in the following section.

(a) (b)

Figure 2. Examples of overview + detail. (a) Classic Google Maps design (reproduced from Cockburn et al., 2008). (b) Landmark-icon-based layout (reproduced from Li & Zhao, 2017)

2.4.1 Overview + Detail

Overview + detail is a spatial-separation technique that divides the screen into two separate screens. Most of time, one screen is larger than the other, and the larger screen shows the details or information that users focus on, while the smaller screen shows an overview of the information (Fig. 2a). Li and Zhao (2017) added icons to a layout design to help users identify off-screen locations (Fig. 2b). However, in the user study, participants had difficulty perceiving the distance of off-screen landmarks and had lower accuracy in selecting the furthest landmarks (Li & Zhao, 2017).

2.4.2 Zooming

Zooming is related to temporal separation. Users can use either a mouse or a two-finger gesture to zoom in and out and pan to different areas. This is an important and widely used technique to help users quickly explore detailed information in specific areas but does not allow users to see the big picture and have a general understanding of areas in a larger context. Another drawback is that even in a very short time period, users still need to memorize different layers of information in different contexts and to spend time doing so when they switch areas or targets (Baudisch & Rosenholtz, 2003; Brodkorb et al., 2016; Gustafson et al., 2008; Miau & Feiner, 2018).

(a) (b) (c)

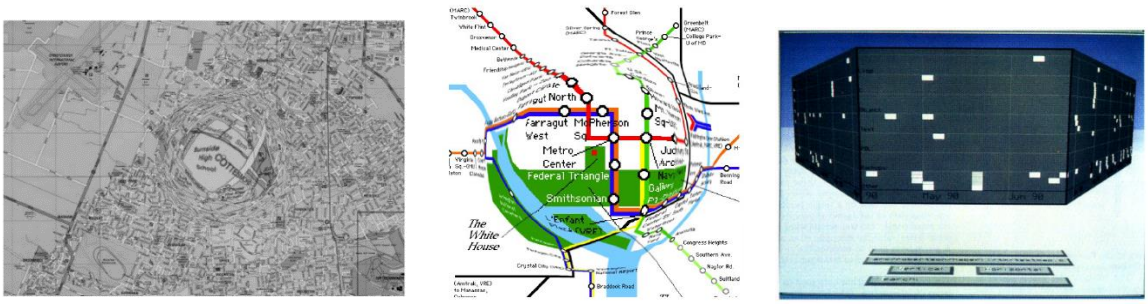


Figure 3. Examples of focus + context: (a) Map (reproduced from Cockburn et al., 2008), (b) metro map (reproduced from Keahey & Robertson, 1996), and (c) perspective wall (reproduced from Mackinlay, Robertson, & Card, 1991)

2.4.3 Focus + Context

Focus + context is "aimed to blend the seams between overview and detail, usually through the means of modifying the presentation of an information space" (Miau & Feiner, 2018, p. 21). Famous examples include the fisheye view and the perspective wall, which use distortion to emphasize the focus area while maintaining the surrounding context (Fig. 3). However, research has found that using distortion affects readability and does not benefit users in viewing and understanding the content (Wang & Chi, 2011).

(a) (b)

Figure 4. Examples of the cue-based technique: (a) Halo (reproduced from Baudisch & Rosenholtz, 2003) and (b) Wedge (reproduced from Gustafson et al., 2008)

2.4.4 Cue-Based Technique

The cue-based technique uses different kinds of cues to highlight information on a given layout space and direct users' attention. Baudisch and Rosenholtz (2003) proposed Halo, using arc shape, arc length, and opacity to present information and extend the screen space (Fig. 4a).

To avoid overlapping, the arcs were modified to merge into a single multiarc when the off-screen locations are similar. Compared with the arrow-based technique, users had better task efficiency when using Halo, including in identifying off-screen locations, finding the closest location, creating a shortest route, and choosing a location to avoid traffic jams; however, the users had lower location accuracy.

Gustafson et al. (2008) pointed out that overlapping problems still exist with Halo when there are large numbers of off-screen locations and locations in the same direction. They improved upon the previous design and proposed Wedge by using acute isosceles triangles to convey distance and direction without overlapping and clutter (Fig. 4b). However, Burigat, Chittaro, and Vianello (2012) had different findings when comparing the wedge with the overview + detail layout. As an interface based on cue-based techniques, Wedge makes it hard to visualize large numbers of off-screen locations because of overlapping.

2.5 Digital Map-Design Models

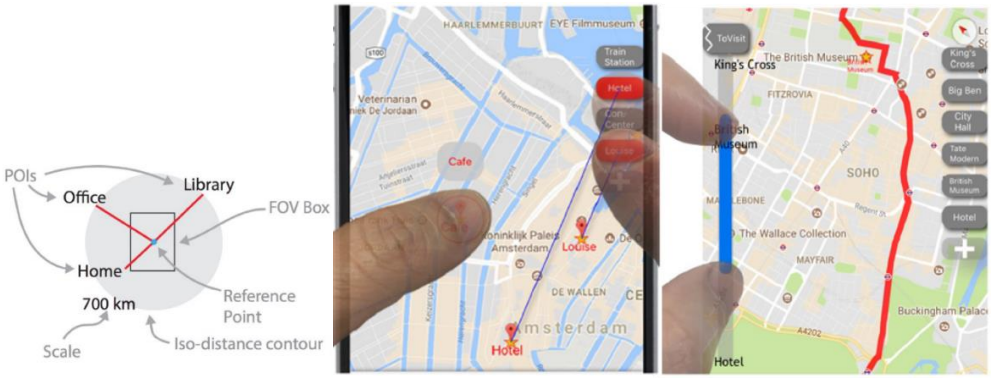


Figure 5. P-Compress, SpaceToken, and SpaceBar (reproduced from Miau & Feiner, 2018)

Miau and Feiner (2018) proposed P-Compass to establish reference frames by using minimum POI lines (Fig. 5, left). Compared with Wedge, P-Compass was better at helping users to understand the big picture of where they were, while Wedge was better at helping users know the off-screen locations nearest to them. P-Compass still had problems for users in estimating the distance of off-screen locations. The reason may be the distance between the current location and off-screen locations, which users needed to convert due to the scale and its position. The design also had overlapping issues; the authors recommended trying color or thickness in future designs. The researchers also developed the SpaceToken system (Fig. 5, middle), which provides a visible

shortcut for frequently used POIs and allows users to see digital maps and link to them directly without the needing to switch pages or type the POIs again. Finally, SpaceBar (Fig. 5, right) provides a scrollbar that allows users to zoom in and out and to easily check a specific place within the routes that they created. Compared with Google Maps, this new design has the advantage of reducing mental workload while performing navigation tasks.

In order to categorize tourists and provide design guidelines for maps, Manrique-Sancho et al. (2018) investigated the reference systems that tourists use and the spatial knowledge they acquire. They used a questionnaire with a thinking-aloud activity to observe tourists' behaviors; moreover, they chose some participants to write travel diaries during their stays and sketch the places they went to, including bus and subway stops, streets, attractions and restaurants, to analyze the users' spatial knowledge (Manrique-Sancho et al., 2018). The results showed that the tourists' spatial knowledge and types were not affected by age, gender, previous experience, level of education, or place of origin; instead, travel motivation and numbers of group members were factors (Manrique-Sancho et al., 2018). The researchers divided tourists into three types—guided, explorer and conditioned—associated with the reference system framework built by Moore (1976), which were egocentric, differentiated, and coordinated. Users were classified into nine categories under a 3 by 3 grid (Manrique-Sancho et al., 2018). Based on these findings, Manrique-Sancho et al. (2018) suggested that different types of tourists should use different types of maps; however, the things tourists would be concerned about, including POIs, street names, transportation lines, and zones, would be all highlighted by special icons. Radar-like maps emphasizing key POIs have been designed (Fig. 6; Manrique-Sancho et al., 2018). They use icons and labels to show off-screen locations and different colors to show zones; on the sides, the sizes of radar icons are also different because the zones covering tourists' itineraries are different (Manrique-Sancho et al., 2018).

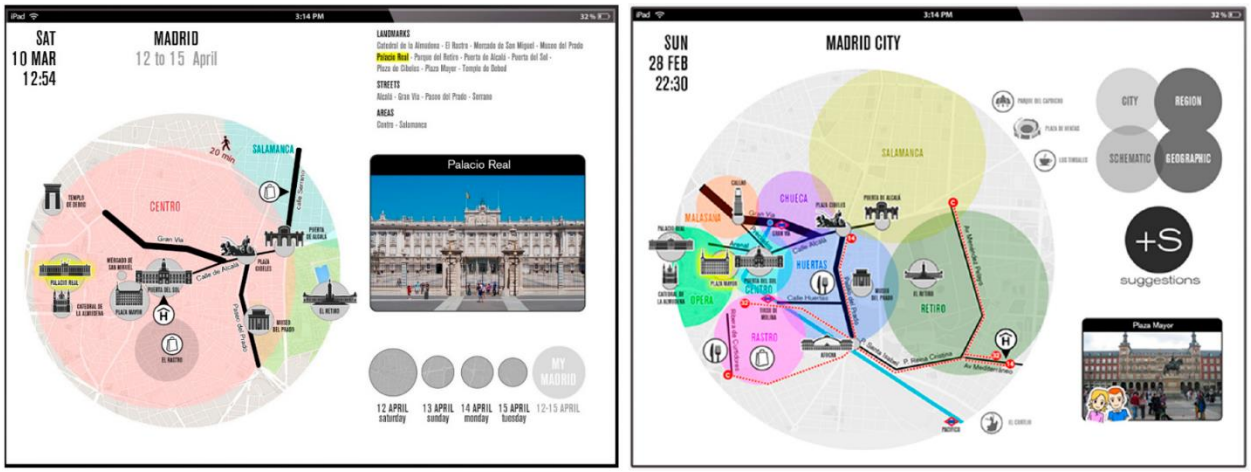


Figure 6. Interface design of digital maps for guided and explorer tourists. Reproduced from Manrique-Sancho et al. (2018)

2.6 Summary

Based on these studies' findings, mobile cartography faces challenges in terms of smartphones' characteristics, lack of knowledge about tourist behavior when using digital maps, and scant personalization features in digital maps. Previous research has provided solutions, however. Miau and Feiner (2018) found several existing issues of their design models, including complicated gesture interactions, inappropriateness for place exploration, and an inability to show proper visual feedback if complicated routes are created. On the other hand, the example from Manrique-Sancho et al. (2018) was not designed for smartphones, which makes the effects of radar-like maps unknown.

CHAPTER 3. METHODOLOGY

This chapter gives a comprehensive description of the methodology used in this research. I explain the participants' criteria; the kinds of data collected; and how they have been collected, presented, and analyzed. In addition, the reasons and justification for the research design are discussed. Ethical issues are illustrated in this chapter as well.

3.1 Study Design

Qualitative methods were applied to help me to investigate both the tool ecology for people doing travel planning on smartphones and the importance of digital maps as well as to propose design guidelines for future digital map apps on smartphones. A travel-planning activity and a codesign workshop were the two data-collection tools used for this study, which were aimed at exploring the issues in a flexible and in-depth way. The travel-planning activity, which was done before the workshop, allowed people performed tasks in a real-life situation, revealed new information and provided insights into people's behaviors, thoughts, and habits. In the codesign workshop, each participant brought the activity outcomes into the workshop and discussed and created paper prototypes with other participants, which resulted in knowledge gained from the interactions between the participants.

3.2 Recruitment

A screener survey was used to recruit the participants. The survey included five categories: travel behavior, travel-planning behavior, experience using digital maps on smartphones, demographic information, and future participation (Appendix A). It was aimed at finding participants who had previous experience using digital maps on smartphones for travel planning and also at ensuring participant diversity, to acquire different opinions. Moreover, the survey helped me to have a general understanding of the participants' experiences and facilitated the codesign workshop's progress.

The survey was distributed throughout Purdue University. In the email sent out, I revealed the study's purpose, the participant requirements, and the potential compensation for participants who completed participation in the research and met the requirements. Before participants

entered the survey, a consent form was given digitally that the participants could download independently. Six participants were chosen from the survey, and they were informed to reserve time for the workshop and advise me a day ahead if they had other arrangements. However, in order to prevent participants from dropping out of the research, I made a wait list to ensure sufficient participants. Other participants in the wait list would be reached out to by email as soon as I received a drop-out message.

3.3 Data-Collection Sampling Strategy

A purposeful random-sampling strategy was used to find participants who could provide rich information about travel planning through digital maps on smartphones. Considering the time the participants needed to spend on the research activity as well as the limited budget for the project, I chose a small random sample. This also helped me to acquire in-depth insights about map-use experiences from users' discussions in the workshop.

The participant requirements were to be above 18 years old, currently live in West Lafayette or Lafayette, Indiana; not be on medication to help with attention; and have experience using digital maps for planning trips on smartphones before departure, such as with searching, saving locations, and planning routes. Limiting the participants' age allowed both the participants and me to have more flexibility for time and research activity arrangements if there was no need for parental consents. The regional limit was because participants had to attend an in-person workshop. It would have caused difficulties in terms of time or budget if the participants lived far from the Lafayette area. Next, the participants were to have limited time to focus on both the planning activity before the workshop and the workshop's research activities. It would be hard for participants to complete these tasks if they had medical attention issues. Finally, based on the research questions, the study was aimed at gaining in-depth insights from participants with similar backgrounds in planning a trip on smartphones. They may provide more feedback if they related to each other while working together and sharing their experiences.

3.4 Travel-Planning Activity

3.4.1 Purpose

The travel-planning activity was inspired by the travel diaries idea proposed by Manrique-Sancho et al. (2018), who recruited six participants before they travelled to Spain and asked them to provide sketches of the city and daily travel experiences during their stays. The purpose of their study was to understand tourist types and the link between spatial knowledge and experiences. The travel diaries and sketches offered insights into the participants' thinking and decision-making processes, which would also be beneficial to this study. However, in this study, I changed the diaries to a one-time reflection for the sake of time. Correspondingly, I added detailed questions to guide participants' answers.

This activity was done prior to the workshop, to help the participants understand the study's purpose and make the workshop run more efficiently and smoothly. Although some map-use behaviors and challenges were supposed to be identified in the screener survey, I believed people would notice some problems after they did the travel-planning activity under real-life situations. The participants were able to reflect on their experiences and became more aware of issues with digital maps on smartphones.

3.4.2 Procedure

I set the requirements of a destination and the length of stay for the participants to plan travel in their spare time before the workshop. The participants needed to plan a trip in Berlin, Germany, from July 5 to 9 using digital maps and other smartphones platforms, and to integrate all information of the in their preferred ways. The participants were asked to do this activity like they usually do. They were required to make an itinerary that included accommodations, expenses, restaurants, attractions, and transportation. In the end, they reflected on this experience through an online survey (Appendix B), which contained their workflow description, the time they spent, the platforms used for searching and integrating information, their favorite functions on the digital maps or other platforms, and the difficulties they faced, especially in digital-map use, including saving locations, searching, planning routes, and switching views from other platforms to digital maps. Since the participants were allowed to do the activity in a flexible way, they did not need to or may have been unable to create an itinerary in one period of time. The whole process took the participants approximately 2 hr.

3.5 Codesign Workshop

3.5.1 Purpose

The codesign approach emphasizes user experience and use context, which is used "in a broader sense to refer to the creativity of designers and people not trained in design working together in the design development process" (Sanders & Stappers, 2008, p. 6). It transforms passive users into active users and designers into facilitators. The value behind codesign is that everyone is creative. Although designers may have expertise in design skills and creative thinking, they are not capable of thinking thoroughly and dealing with all kinds of situations; instead, users from other professions could provide their points of view and previous experiences, which are valuable for brainstorming and thinking outside the box (Sanders & Stappers, 2008).

Based on these advantages, this workshop was aimed at collecting wisdom from the participants. Furthermore, instead of one-to-one interviews, the workshop could facilitate internal conversation and thought exchanges when participants had tasks at hand. With the role of both designer and researcher, my responsibility was to help the participants express their thoughts, explore design ideas, and keep track of the workshop's progress. The outcomes acquired from the workshop became useful guidelines for designing future digital map apps.

3.5.2 Procedure

At the workshop, I explained the study's purpose and the overall procedure to help the participants anticipate the situation. Then, the participants gave a brief self-introduction, presented their itineraries, and described their decision-making process or other issues they faced during the travel planning. Following this, the participants used different-colored index cards to write down keywords related to four categories: itinerary, workflow, frustrations, and features. The itinerary categories helped the participants to recall the decisions they made. The workflow category was used to understand the processes of searching for and compiling information as well as the role of digital maps. The frustrations category investigated any difficulties the participants faced during the planning activity and digital-map-use experiences. The features category helped the participants to address what they liked about or felt was useful in the digital maps or other apps as well as the features they wished to add to maps. All of the participants

categorized the index cards and used markers to label subcategories. Afterward, they created a persona to help visualize specific target users.

Based on the findings and the target user identified in the first session, the participants were required to draw on sheets of paper with smartphone frame designs. They had to design new interfaces for digital maps that could minimize pain points and add some wished-for functions they had identified. Each of them presented the design ideas and sketches to the others. Then, the other participants gave feedback. In the end, each participant shared their experiences and thoughts about the design process. The total time of the workshop was 2 hr (Table 1).

Table 1. Workshop Schedule

Time (min)	Activity
15	Research introduction
20	Self-introduction and itinerary presentations
20	Affinity diagram and reviews
15	Persona
20	Brainstorming and sketch
15	Share design ideas and reviews
15	Overall feedback

3.6 Research Ethics

Since the research involved recruiting participants, making the research classified as human subject research, permission from the Institutional Review Board was required. The research was conducted and participants' data were collected after receiving Institutional Review Board approval.

3.6.1 Briefing and Consent

Informed consent forms were given before the screener survey and travel-planning reflection activity. I briefly illustrated the study's purpose, participants' requirements, tasks, and potential compensation via email. At the beginning of the workshop, I also explained the procedure to the participants. Because the participants may not be familiar with the design process and terminology in the user-experience field, I introduced each activity before it started and prepared slides to help with explanation. Moreover, to reduce the participants' anxiety during the sketch process, I prepared design prompts created by other researchers to help the

participants if they had a hard time brainstorming ideas. The whole process was completely voluntary. Participants could drop out of the experiment at any time without any negative consequences.

3.6.2 Anonymity and Confidentiality

The participants' identities were made anonymous in reports. Digital audio recordings were made in the workshop, and after they were transcribed, anonymized, and analyzed, some portions of the recordings were retained for presentation or demonstration purposes in anonymized form. Any materials related to a participant were assigned a deidentified ID to ensure the responses to the data analysis and research report would not be linkable to any personal information.

All digital records, including audio transcripts, photography, and data-analysis files, were stored in encrypted files in password-secured computers, and the password was only known by the research team. All physical records, including sketches, post-its, design prototypes, and signed consent forms, were stored in a locked cabinet at Purdue University.

3.7 Data Analysis

3.7.1 Data Recording

Survey responses, travel-planning reflection, transcribed presentations and debriefing records, observation notes, and photographs of the interface and design process during the workshop were collected. For the survey, the preferred participant candidates had experience using digital maps for travel planning on smartphones and had faced issues in manipulation. Therefore, the answer of *yes* was recorded as 1 for each question, while *no* was 0. Those with higher scores who were willing to participate in the study were be contacted afterwards. For the travel-planning reflection, I recorded them in a spreadsheet by participant and compiled all of the information in one sheet to help with further comparison. For other audio recordings, the files were uploaded to transcription software and automatically transcribed. Following this, I cleaned the errors from the transcriptions and compared them with my observation notes to help clarify some confusion and highlight interesting points, such as tone, word usage, and body language.

3.7.2 Thematic Analysis

"The thematic analysis is a method for identifying, analyzing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79). Based on Braun and Clarke's (2006) step-by-step guidelines, there are six phases of analysis: familiarizing oneself with data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report (p. 87). In this research, I used online transcription software to transcribe the verbal data, including the participants' feedback and presentations in the workshop, and then cleared the errors from the sentences. In the first coding session, I extracted meaningful sentences from the survey responses, travel planning reflection and transcription from the workshop discussion, and then sort the data by participant. I generated codes freely, by typing the keywords in sentences or the thoughts from my minds. I reviewed the codes and found potential themes. After that, I created the code book based on the first round of coding. The coding scheme was reviewed, tested by multiple coders, and modified after the internal meeting. Through iterative review and comparison, I provided clear definitions of the themes. Based on the code book, I generated codes in the second round of coding.

CHAPTER 4. RESULTS

4.1 Participants

I received seven responses to the screener survey and selected six participants based on a consideration of diversity. One participant was left in the wait list. However, due to personal reasons, one participant could not join in the following research and another only completed the travel-planning activity but could not attend in the workshop. The remaining five participants completed all tasks with full attendance, including the survey, the travel-planning activity and the codesign workshop. The ratio of men to women was 2:5, but in the final workshop, the five participants were all female, with ages ranging from 25 to 34.

Table 2. Participant in each phase

Phase	Screener survey	Travel planning activity	Codesign workshop
Total	7	6	5
Ratio (men: women)	2:5	1:5	0:5
Age range	18-34	25-34	25-34

Based on the information from the screener survey, all of the participants had spent more than a moderate amount of time planning a trip before departure. Also, all of them had experiences with using smartphones for travel planning and with referring to information on digital maps. All of the participants had moderately high confidence with digital-map use. The only maps they had used were from Google Maps. Most of the participants usually travelled once a semester. They usually planned trips at home, as only two of them planned trips on transportation or in public spaces, such as a coffee shop or library. Most of the participants usually used a smartphone and laptop to do travel research. There was one more smartphone user than laptop users.

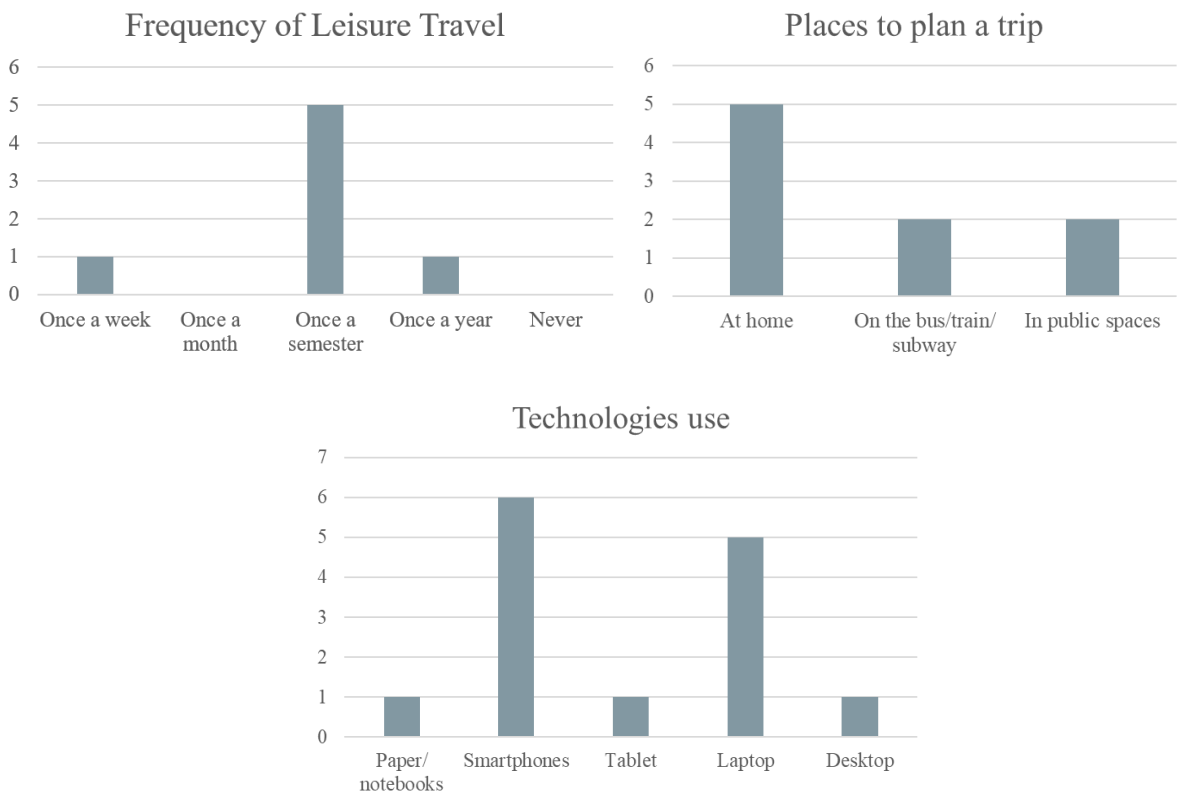


Figure 7. Participants' travel and planning habits

4.2 Workshop Deliverables

Five participants came into the meeting room, one after another. They used markers to write their names and started chatting with each other. At the beginning of the workshop, I illustrated the research purpose and process to the participants and asked them to sign consent forms. The participants took a longer time presenting their itineraries and sharing their travel experiences. I used some follow-up questions to initiate more conversations. For example, one participant was concerned about route planning and preferred to walk between locations. I asked if she would reschedule her visits to locations when she found out that the distances between them were long. Likewise, I asked all of the participants whether they had similar concerns about ground transportation when hearing that a participant had made a detailed plan for it.

In the following affinity diagram activity, I gave four main categories: itinerary, workflow, challenges, and features. The participants were asked to write down keywords on index cards to describe their experiences and identify problems. Then, they compiled these cards and labeled subcategories. The discussion and affinity diagram results showed that although participants

looked for information on restaurants, restaurants were less emphasized in the planning process before departure; rather, the restaurants would be determined during the trip. However, cafés were important to know about when planning trips, which the participants mentioned and agreed upon. Likewise, Internet access was a key issue to plan in advance.

An unexpected process occurred when a participant presented her itinerary. Based on her experience, she thought she did not need to spend five days in the same city, so she decided to add a city to the planning task. On the other hand, some unexpected concepts were addressed in the workshop, including collaboration. The participants valued the sharing functions on both digital maps and other platforms. They wanted to know what had been shared before, what thoughts they had about the locations, and the trip plans recommended by certified users. In addition, the results showed concepts such as the anxiety of scheduling transportation and recording the schedule as well as flexibility. Detailed narratives are illustrated in the next section.

Figure 8. Affinity-diagram activity

Based on the results of the affinity diagram, the participants discussed the persona, or the target user that the participants identified, by describing her goals, needs, frustrations and technology uses. The user that the participants described was aged from 20 to 25 and was aware of costs, flexibility, and health. She preferred a flexible schedule and walking. She did not want to take much effort in planning a trip; on the other hand, she needed guidance to tell her where to explore and what was recommended as well as reminders to tell her when to take public transportation. She would plan and check the information on smartphones, such as about coffee shops, Internet, and transportation. Usually, she used apps including Airbnb, Yelp, TripAdvisor, and TripCase to plan a trip. Pokémon Go was a game app she would play on the road.

Additionally, she would compile information on Google Maps, Google Docs, and Google Sheets. Therefore, phones' low power, slow Internet, and information inaccessibility would not be acceptable and would frustrate her.

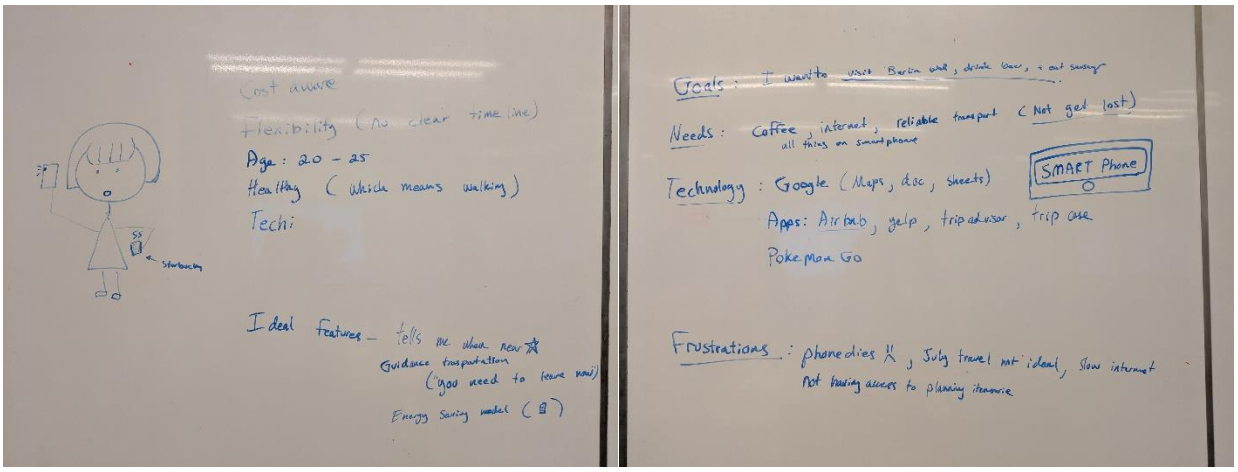


Figure 9. Persona

4.3 Thematic Analysis

I analyzed the screener survey, the reflection survey of travel-planning activity and the data collected from the codesign workshop, including participants' presentations, affinity diagram, persona, sketches, and field notes. Five main themes were created.

Table 3. Data analysis: Themes, subthemes, and descriptions.

Themes	Subthemes	Description
Organization	Schedule management	Participants described their preference for managing the information they found
	Organization of map information	Participants described how digital maps present information
Efficiency	Information searching	Participants made direct or indirect references about the importance of efficiency in searching for information
	Information compiling	Participants made direct or indirect references about the importance of efficiency in compiling information
	Information retrieval	Participants made direct or indirect references about the importance of efficiency in retrieving information
Flexibility	Scheduling flexibility	Participants described their attitude when making a schedule

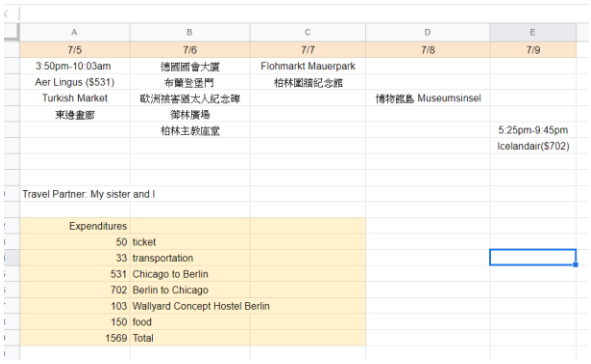
Table 3. continued

	Expense flexibility	Participants described their attitude about expenses
	Destination flexibility	Participants described their attitude about choosing a place to visit (ratings, reviews, Internet)
Mastery	Mastery of destination	The desire to collect information about places, such as hotels, restaurants, and attractions (e.g., their location, open hours, reviews, ratings, transportation time, or distance)
	Mastery of schedule	The desire to keep track of and edit the schedule (e.g., to add and remove places)
Desired features of future digital maps	Map personalization	Participants described the features used based on user preferences
	Information hierarchy	Participants described the features that would help them manage information (layers, pin colors, ranking systems).
	System automation	Participants made direct or indirect references to specific platforms they would use to integrate information they found
	Maps overview	Participants made direct or indirect references to an overview/holistic view about the pins, routes, and day plans.
	Cross-platform planning	Participants described the features they would use to integrate information they found across platforms

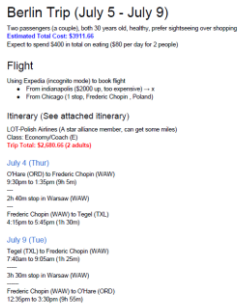
4.3.1 Theme 1: Organization

4.3.1.1 Schedule Management

(a) (b)



A	B	C	D	E
7/5	7/6	7/7	7/8	7/9
3:50pm-10:03am	德國國會大廈	Flohmarkt Mauerpark		
Aer Lingus ($531)	布蘭登堡門	柏林圍牆紀念館		
Turkish Market	歐洲被害猶太人紀念碑		博物館島 Museumsinsel	
東邊畫廊	御林廣場			
	柏林主教座堂			5:25pm-9:45pm
				Icelandair($702)
Travel Partner: My sister and I				
Expenditures				
50	ticket			
33	transportation			
531	Chicago to Berlin			
702	Berlin to Chicago			
103	Wallyard Concept Hostel Berlin			
150	food			
1569	Total			



Berlin Trip (July 5 - July 9)

Two passengers (a couple), both 30 years old, healthy, prefer sightseeing over shopping
Estimated Total Cost: $2911.66
Expect to spend $400 in total on eating ($80 per day for 2 people)

Flight

Using Expedia (incognito mode) to book flight
- From indianapolis ($2000 up, too expensive) → x
- From Chicago (1 stop, Frederic Chopin , Poland)

Itinerary (See attached itinerary)

LOT-Polish Airlines (A star alliance member, can get some miles)
Class: Economy/Coach (E)
Trip Total: $2,080.66 (2 adults)

July 4 (Thur)
O'Hare (ORD) to Frederic Chopin (WAW)
9:30pm to 1:35pm (9h 5m)
—
2h 40m stop in Warsaw (WAW)
—
Frederic Chopin (WAW) to Tegel (TXL)
4:15pm to 5:45pm (1h 30m)

July 9 (Tue)
Tegel (TXL) to Frederic Chopin (WAW)
7:40am to 9:05am (1h 25m)
—
3h 30m stop in Warsaw (WAW)
—
Frederic Chopin (WAW) to O'Hare (ORD)
12:35pm to 3:30pm (9h 55m)

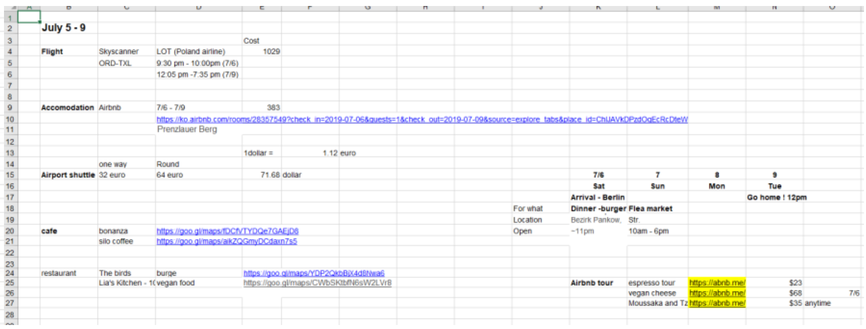
Figure 10. Portions of the itineraries made by the participants in the travel-planning activity before the workshop: (a) P1, (b) P2, (c) P3, (d) P4, (e) P5, and (f) P6

Figure 10. continued

(c)

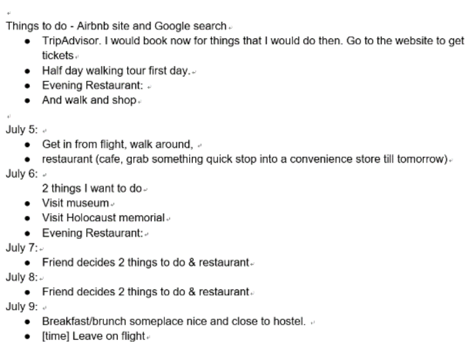
5, July	15:00	EAC	50
	18:00	Arrive at ORD	
	19:30	On Board	1143
6, July	13:05	Arrive at Berlin Airport	
	14:00	Buy a transportation (=subway/bus) Ticket (for 3 days)	30
	15:00	Check-in	150
	16:00	Brandenburger Tor	
	16:30	Dessert & Coffee time	10
	17:30	Walk to Alexanderplatz	
	18:00	Dinner with wine	50
	21:00	Buy some snacks and sandwich for tomorrow morning	15
	21:30	Comeback to Hotel	
7, July	08:30	Check-out	
	09:00	Arrive at ICE station	
	10:05	ICE to Munchen	
	14:38	Arrive at Munchen	
	15:00	Dessert & Coffee time	10
	16:00	Sightseeing and walk around	
	17:30	Check-in	150
	18:00	Dinner with wine	50
	20:30	Sightseeing and walk around	
	21:30	Comeback to Hotel	

(d)



July 5 - 9
Cost
Flight | Skyscanner | LOT (Poland airline) | 1029
ORD-TXL | 9:30 pm - 10:00pm (7/6)
12:05 pm -7:35 pm (7/9)
Accomodation | Airbnb | 7/6 - 7/9 | 383
https://ko.airbnb.com/rooms/28357549?check_in=2019-07-06&guests=1&check_out=2019-07-09&source=explore_tabs&place_id=ChIJAVkDPzdOqEcRcDteW
Prenzlauer Berg
1dollar = | 1.12 euro
one way | Round
Airport shuttle | 32 euro | 64 euro | 71.68 dollar
7/6 Sat | 7 Sun | 8 Mon | 9 Tue
Arrival - Berlin | Go home ! 12pm
For what | Dinner -burger | Flea market
Location | Bezirk Pankow, | Str.
Open | ~11pm | 10am - 6pm
cafe | bonanza | https://goo.gl/maps/fDCfVTYDQe7GAEjD8
silo coffee | https://goo.gl/maps/aikZQGmyDCdaxn7s5
restaurant | The birds | burge | https://goo.gl/maps/YDP2QkbBjX4d8Nwa6
Lia's Kitchen - 1(| vegan food | https://goo.gl/maps/CWbSKtbfN6sW2LVr8
Airbnb tour | espresso tour | https://abnb.me/ | $23
vegan cheese | https://abnb.me/ | $68 | 7/6
Moussaka and Tz | https://abnb.me/ | $35 anytime

(e)



Things to do - Airbnb site and Google search

- TripAdvisor. I would book now for things that I would do then. Go to the website to get tickets
- Half day walking tour first day.
- Evening Restaurant:
- And walk and shop

July 5:

- Get in from flight, walk around,
- restaurant (cafe, grab something quick stop into a convenience store till tomorrow)

July 6:

2 things I want to do

- Visit museum
- Visit Holocaust memorial
- Evening Restaurant:

July 7:

- Friend decides 2 things to do & restaurant

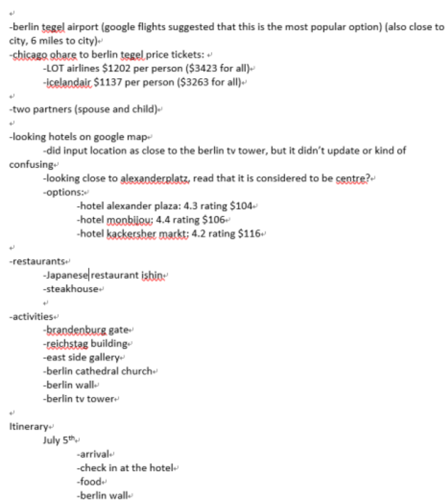
July 8:

- Friend decides 2 things to do & restaurant

July 9:

- Breakfast/brunch someplace nice and close to hostel.
- [time] Leave on flight

(f)



-berlin tegel airport (google flights suggested that this is the most popular option) (also close to city, 6 miles to city)
-chicago ohare to berlin tegel price tickets:
-LOT airlines $1202 per person ($3423 for all)
-icelandair $1137 per person ($3263 for all)

-two partners (spouse and child)

-looking hotels on google map
-did input location as close to the berlin tv tower, but it didn't update or kind of confusing
-looking close to alexanderplatz, read that it is considered to be centre?
-options:
-hotel alexander plaza: 4.3 rating $104
-hotel monbijou: 4.4 rating $106
-hotel kackersher markt: 4.2 rating $116

-restaurants
-Japanese restaurant ishin
-steakhouse

-activities
-brandenburg gate
-reichstag building
-east side gallery
-berlin cathedral church
-berlin wall
-berlin tv tower

Itinerary
July 5th
-arrival
-check in at the hotel
-food
-berlin wall

The results showed that the participants developed different strategies to organize information and make plans. Participant 1 used Microsoft Excel to record her daily plan and list attractions and expenses. Participant 2 used Microsoft Word to compile information and listed seven categories, with options and links attached below the categories. Participant 3 used Microsoft Excel to record dates and a detailed timeline schedule as well as some expenses. Participant 4 used Google Sheets to compile information by listing categories, put information below the categories, and listed day plans beside the information. Participants 5 and 6 used Microsoft Word to record some activities to do and to list a simple daily plan. The itineraries showed different levels of detail that the participants paid attention to.

Some of them also used different apps. For example, Participant 5 used TripCase, an app specifically created for recording travel itineraries, which allowed her to track her flight information. Most of the participants would use digital map apps. Four of them pinned and saved locations by using the “bookmark” function. Furthermore, Participant 4 specified that she would

share the saved locations with her travel partners. Participant 2 stated that she would group nearby locations and circle them or draw the routes, to help her visualize the areas she planned to go to each day. She took these actions on her laptop because "drawing on Google Maps on our smartphones is almost impossible." Participant 1 explained her workflow when she compiled information.

> In Google Sheets, I will type the tourist attractions that I am interested in, including information like opening hours, the time needed, and ticket price, and then rank the places where I am interested in the most. After that, [I would plot] the location of the tourist attractions on Google Maps. In the end, I will plan the detailed schedule based on the distance and opening hours of the tourist attractions. (P1)

4.3.1.2 Organization of Map Information

The information's organization in the digital maps led to participant confusion with the current design. One participant did not know about the location-sharing or timeline functions; another participant was unaware of the pin function; and some of the participants became confused about the hierarchy on the maps. Moreover, Participant 4 stated her specific frustration with identifying icons' meanings:

> I think on Google Maps, there are like two different ways to save the locations. One is like "favorite," and the other one is "want to go." I used Google Maps several times, but I'm not sure what the differences are. (P4)

Other problems occurred. Participants easily felt lost, especially when they had been to the place and made some marks on the digital maps. Although there was a timeline feature, the participants had no idea what the actual interactions with the plan they made for each trip would be. The connections among the features inside the maps and between platforms were weak and not cohesive (P5).

4.3.2 Theme 2: Efficiency

4.3.2.1 Information Searching

Cross-platform planning was unavoidable and increased the participants' workload and time spent looking for different opinions and comparing information through multiple platforms. The

participants had to go back and forth between platforms a lot before they could make a decision. For searching for flights, the participants used platforms such as Skyscanner, Google Flights, Expedia, and Kayak. For accommodations, they used platforms such as Airbnb and Booking.com. For attractions, they used platforms such as TripAdvisor and Google Maps. For restaurants, they used platforms such as Yelp and Google Maps. Other platforms that the participants used included Google Recommendations, blogs, and sites about the city. The participants paid attention to information about attractions, restaurants, and transportation, specifically their operating hours, peak times, locations, Internet reviews, and prices.

Participant 2 favored the "near" function on the digital maps, which allowed her to avoid typing in the search bar, especially when the locations were in a different language, such as German in the travel-planning task I assigned to the participants. It was hard to spell German in the search bar and identify attractions in German. Another participant also implied that typing was time-consuming:

> I'm saving routes, especially like ones that you've already taken but you just want to, like, click and go into it because I get really annoyed to keep typing in addresses, um, adding multiple trips. . . . I think it is annoying: that repetition. (P5)

4.3.2.2 Compiling Information

After searching for information across platforms, the participants used multiple ways, mainly digital, to compile that information. As in the information-searching phase, participants often needed to switch platforms, which took extra time to "input every tourist attraction from Google Sheets to Google Maps" (P1). Google Maps supports locational information, while other platforms can show detailed schedules, the prices of flights, and hotel bookings. Participant 6 suggested that "it is easier to access, I think; I can just throw everything into one Word document." In addition, it was easier for participants to keep track of expenses, edit items, and obtain an overview of each day's plans (P2, P3, P4). Participant 2 even stated that she would not put much effort into making a detailed schedule:

> I know a lot of friends that use physical notebook and then they will, like, try to attach some small pieces in them, so cute. But I would say I just don't have energy to sort all

> that stuff and then put them together and write some sentences to make it like a diary. (P2)

4.3.2.3 Information Retrieval

The participants organized information to easily check and retrieve it. Moreover, they would share itineraries or preferred restaurants with their other travel partners. However, there were problems during the process. One of the participants stated that she could not remember what had been shared before and what comments she and her partners had at that time. No hints were provided on the digital maps or the other platforms' interfaces.

Another situation was when participants saved and pinned locations on the digital maps. The system would generate a long list but without a hierarchy and annotations. Participant 4 stated that there was no place for her to add notes to the locations. In addition to restaurants or attractions, some locations, such as parks, streets, and corners, did not show enough information like the restaurant or attractions did, such as operating hours, menus, or photos. It took more time to find out why she had saved these kinds of locations. Moreover, having too many saved locations may have been overwhelming:

> I just maybe like to use one of them [bookmarks] and make a green flag or something. But in previous travel, I realized that when I used that function too much, then I couldn't find which one is the best place now that I want to go. (P4)

4.3.3 Theme 3: Flexibility

4.3.3.1 Scheduling Flexibility

Nearly all of the participants mentioned the quality of flexibility. They tended to make flexible schedules and make sure they had plenty of time to walk around the areas. However, as the itineraries showed (Fig. 11), each participant had different levels of flexibility. Some of the participants preferred high flexibility, which let them feel more relaxed, and they left room for themselves to be able to walk around, find something surprising, and gain a more in-depth understanding of the area.

> I honestly, it's fly by the seat of my pants. So like, I usually say I pick two to three attractions I want to see a day, and then I spend the rest of the time walking between things.

> Because you can sight see a lot by walking around. . . . That's my preference for traveling. (P5)

Some participants made flexible plans because they were sensitive about time and were unable to control it well. Two of the participants mentioned uncertainty about the transportation time and the distances between locations. In the travel-planning activity, the city given to the participants for planning was Berlin, which has a complex public transportation system and may confuse travelers who have little familiarity with the city. One participant showed worries about whether she could reach different platforms on time; therefore, she decided to make a schedule flexible.

> When you're walking, you decide which location is your next step. If I'm using the public transportation because I have a seven-day pass, the train schedule in Berlin is difficult to follow. It's impossible to follow your schedule. You cannot understand which platforms you should choose. Like in central Berlin, there are like 20 platforms for you to choose. And then it has three levels. If you choose it wrong, it's impossible for you to get it on time. (P2)

4.3.3.2 Expense Flexibility

Participants were aware of not only time but also prices. Since all of the participants were students without a full-time job, while doing travel research, prices was a primary factor for them to decide on flights, accommodations, and transportation. Participant 2 specifically mentioned she would choose an overnight flight to have the most time and reducing cost. Moreover, she had comprehensive considerations about the time she would spend in transportation and the prices in deciding upon accommodations. Other participants would also compare prices in multiple platforms; for example, Participant 4 stated that "with the flights, I used Google Flights the first time to just see some trends and then used Kayak and Skyscanner to find the flight."

4.3.3.3 Destination Flexibility

Information about the popularity of a destination often came from ratings and online reviews. Some of the participants paid attention to this kind of information, while others cared less about it. Participant 2 stated that she would choose hotels if their ratings were from 4.5 to

five stars. On the other hand, Participant 5 showed her flexibility with restaurants. She stated, “I don’t like to like choose a restaurant that I'm going to go to but instead be like, ‘What did I smell at this great restaurant like two blocks over there?’” Some participants emphasized another aspect of service influencing their choice of destination: Internet availability. This would also be linked to scheduling flexibility. With Internet access, it would be easy for the participants to check information and reschedule things if needed.

4.3.4 Theme 4: Mastery

4.3.4.1 Mastery of the Destination

Many of the participants illustrated their need to learn more about the destination before they made decisions about where to go. They looked for recommendations online and started by searching across platforms. Any information about the destination was valuable. In Google Maps, specifically, all of the participants needed addresses/locations and ratings/reviews for support; five participants checked photos and their own locations; and four participants needed information on transportation, routes, and operating hours. The following orders were landmarks, commute time, streets and ticket price.

The reasons why the participants checked ratings and reviews were to know about the locations’ reputation and learn about previous travelers’ experiences, such as in buying a city pass for transportation. Some participants listed several candidates for accommodations in the city. Since their decision would be influenced by the prices, reviews, and locations, they would visit hotel websites, digital maps, and blogs to learn details and compare candidates:

> First, I checked the airplane ticket prices for the dates; then, after that, I looked for hotels that were close to the city center or the Berlin TV tower. After exploring a bit, I narrowed down on three possible options based on the price, reviews, and location. Then, I looked for restaurants and places to visit. (P6)

4.3.4.2 Mastery of the Schedule

Although many of the participants stated the importance of flexibility, they still showed a desire to control and keep track of their schedule. The most obvious example came from Participant 2. She proposed that “I also marked, bookmarked those locations on Google Maps. But, um, in some sense, it is not that useful when you’re actually on the road. So it’s better that

the phone can be the reminder." This showed the fact that she wanted to followed her schedule and expected her smartphone to remind her about the next stops. In addition, she addressed her need for smartphone apps to "show all the alternatives that are available in terms of routes, and this is in terms of places, which can categorize by near or not, or categorize by the distance." It would be easier for her to make modifications if she could not catch up with the schedule.

Other participants had a similar tendency to control their schedule. Uncertain distances between locations and uncertain time being spent worsened the situation. Participant 3 addressed that it was hard to manage time because she was unsure whether the time spent walking or taking the subway would influence the time she spent at the next stop. Participant 5 wanted to know the routes' usual situations in advance to help her manage her schedule. Participant 1 wanted a timeline schedule that could quickly be opened up and edited on smartphones. Participant 4 wanted to learn which place she planned to go next on the digital maps. In addition, some of the participants expected that the digital maps would quickly reroute paths, calculate the time, and update the schedule for them.

4.3.5 Theme 5: Desired Features of Future Digital Maps

4.3.5.1 Map Personalization

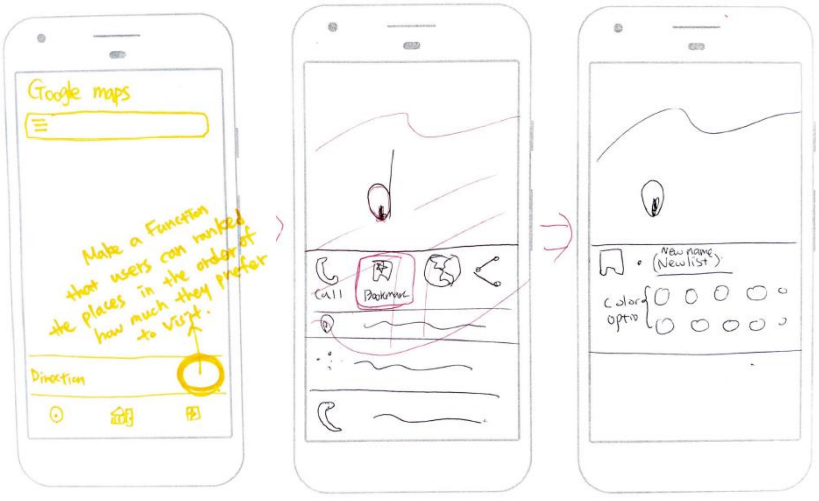


Figure 11. (a) P3: Ranking system. (b) P4: Pin customization

Based on the findings from the previous themes, the participants had many design features they wanted to add on the digital maps to make the travel-planning process easier and smoother. The first one was personalization (Fig. 12). Participant 3 proposed that users be able to rank

places based on their preferences, so that it would be clear for them to know where they wanted to go the most. On the other hand, because the participants addressed their confusion about the meanings of different bookmarks in the current design and the similarity between bookmarks and existing icons, Participant 4 proposed using different colors of pins for customization and differentiation.

4.3.5.2 Information Hierarchy

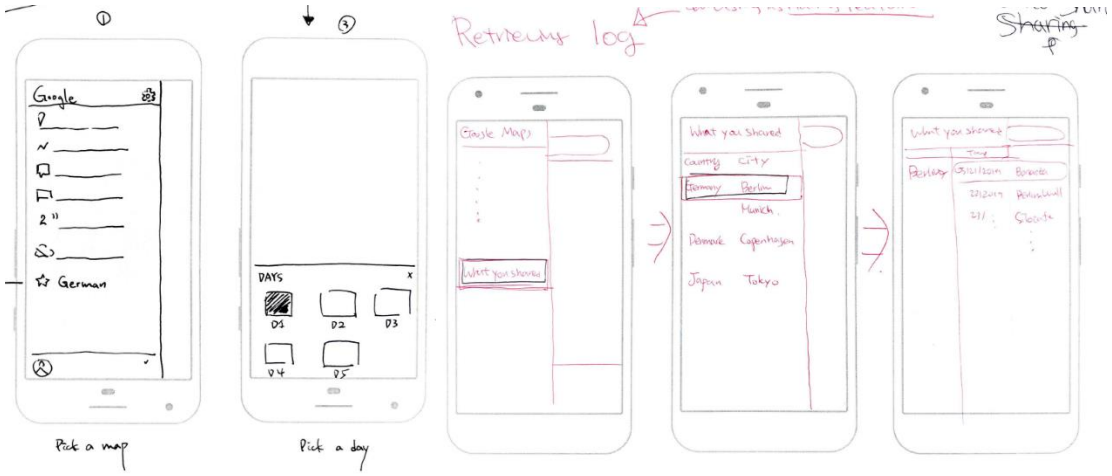


Figure 12. (a) P3: layers design by trips and days. (b) P4: layers design by countries and cities

The second one was about the information hierarchy (Fig. 13). Participant 1 proposed different layers within a trip plan. There was an area, which was separated from the ordinary maps, recording each trip. In the trip plan, users could see plans that were divided into each day, and users could edit plans by clicking the button. Improving the hierarchy of information helped participants retrieve it later. Participant 4 reasoned that if “information is sorted by countries or matches with the city, then I can see what I shared before.”

4.3.5.3 System Automation

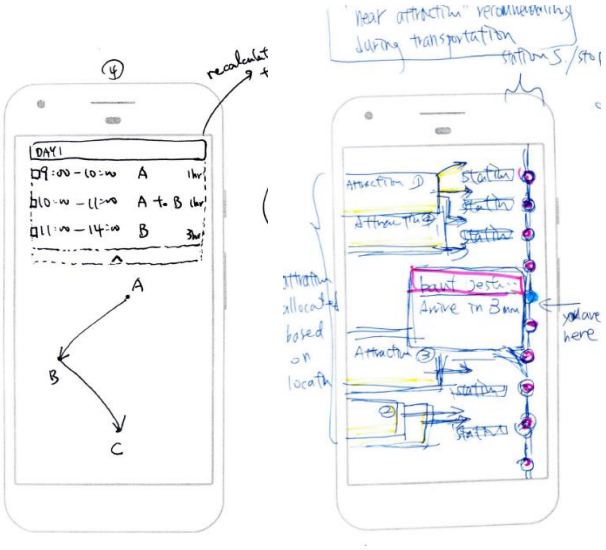


Figure 13. (a) P1: checklist and rescheduling. (b) P2: attractions allocation and alternatives recommendation

The third feature that participants desired was system automation, which would improve the map's effectiveness and reduce the user's workload when planning a trip (Fig. 14). Participant 1 proposed a feature in which the system would help recalculate and adjust the routes automatically if the users change the schedule. And users were able to edit the schedule easily by manipulating a checklist. This feature would help when participants had concerns regarding event scheduling or route planning.

> We always have the issue regarding what are the near attractions, but for the near attractions, if we just specified by the distance, the direct distance, maybe it's not that useful. The most important issue is doing transportation. [We would like to know] which bus or subway we can spend less time on it, or if I missed this one, when the next one come and where the closest station is. (P2)

Moreover, the rescheduling feature may also help with time management by providing alternative options. Participant 2 proposed the system could allocate attractions based on the user's location and recommended the nearest train or subway stations. Also, the app interface showed the timeline, and used colors and icons' size to differentiate the stage users are in, the stage was passed, and the stage is approaching. Therefore, the phone could act a reminder of the schedule, and send message to users.

An opinion from Participant 6 stated that the system could have "the ability to mark off the hotels that I decided I don't want to stay in." Because users could bookmark many locations, however, if users ultimately did not go to those places, a bunch of pins may overwhelm the users. In the current design, users are able to mark places off, but they needed to mark the places off individually, which was time consuming.

4.3.5.4 Map Overview

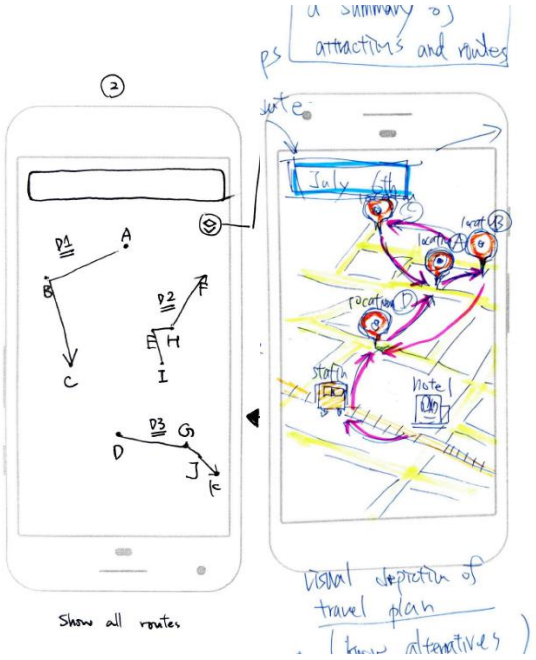


Figure 14. (a) P1: the visualization of multiple routes across different days (b) P2: a more three-dimensional visualization of multiple routes in each day

The fourth feature was the map's overview of all pins, day plans, and routes. Participants 1 and 2 proposed a visualization of multiple routes (Fig. 15) with slight differences between the two designs. The layout Participant 1 proposed showed multiple routes across different day plans. On the other hand, Participant 2 explained that she needed "a feature that is similar to a summary of the entire trip, but in a visual way. It's based on the locations showing on the map that consist of special information." Still, she used the layers feature in the design, and the routes were shown by days. Also, users were able to identify the attractions and the routes in a more three-dimensional way.

4.3.5.5 Cross-Platform Planning

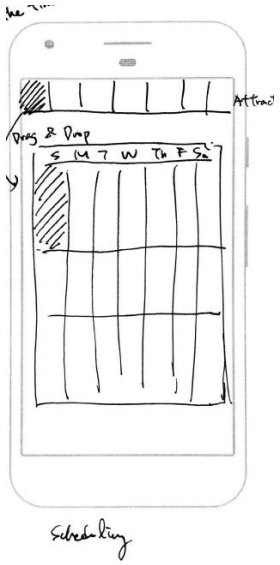


Figure 15. P1: information importing and editing

The fifth feature was cross-platform planning (Fig. 16). Because participants needed information from different platforms and needed to compile it afterwards, making edits and looking at plans in one place would be easier for participants. Therefore, Participant 1 proposed the digital maps could support importing the information from other platforms, such as Google Sheets or Google Docs. Moreover, after searching on Google and social media, users could import the results, which would be an option showing on the top of the screen, to the schedule. Therefore, users did not need to type all locations in the search bar again, and were able to easily and quickly edit the schedule, add and remove locations.

CHAPTER 5. DISCUSSION

5.1 Travel-Planning Behavior

The results showed that participants had similar workflows for searching information on all kinds of websites or apps on smartphones. The general structure was that they decided the dates and travel partners first, then searched for flights, chose some attractions, and finally chose a hotel with considerations for price, distance, location, and reputation. Therefore, participants had a tendency to check online reviews and ratings; Yilmaz (2017) produced similar results, showing that over 80% of users would pay attention to this information. The results of this study also showed the impact of electronic word-of-mouth on users' decision-making, which had been confirmed by previous studies (Banerjee & Chua, 2016; Filieri, Alguezaui, & Mcleay, 2015; Hennig-Thurau, Gwinner, Walsh, & Gremler, 2004). In addition to the reviews and ratings, the platforms participants used, including Booking.com and Skyscanner, allowed them to compare prices easily.

Figure 16. The levels of participant focus on the details in the travel-planning process

Luo, Feng, and Cai (2005) proposed that travelers' personalities and attitudes influenced the level of information seeking. The results and the itineraries the participants made show that the participants stated they wanted to keep flexible and that they enjoyed walking around an area and finding something surprising on the road. However, they had different definitions of flexibility and so-called detailed schedules, which also reflected their personalities (Fig. 17). Participant 2 paid attention to the most details, either in searching for or in managing information. She found many candidates for hotels and attractions, placed them under different categories, and listed them with the links so as to easily get back to original information if needed. Also, she would try to draw the routes on digital maps. Participants 1, 3, and 4 paid relatively less attention to the details. However, they also looked for recommendations and checked reviews and ratings. For compiling information, they also separated the schedule, expenses, and different categories of

information. Moreover, they would pin locations on digital maps. Participant 3 even wrote down a detailed timeline schedule. And Participant 1 ranked the places she wanted to visit to help her make a decision. Participant 6 was the next one focusing on lesser details. He made a rough schedule, and although he made some categories, he put very few things he found on the document. He also stated that he would not save anything on digital maps. Finally, Participant 5 looked for the fewest details. As she stated in the workshop, she was "flying by the seat of her pants." The things she would plan in advance were flights and accommodations, but she would still search for some landmarks and look at the photos.

The results suggested that participants were planners but to different extents. Huang, Hallo, Norman, McGehee, McGee, and Goetcheus (2014) developed a scale of "Style of Independent Travel" to identify users' types: serendipitous or organized. They defined serendipitous as follows: "the ability or tendency to make unexpected discoveries and find interesting or valuable things by chance during the course of one's journey" (p. 5). In this spectrum of users' types, my participants located in between. They were not as organized as Participant 2 stated: Some of her friends would use a diary-like schedule to record everything from planning to after the trip or would follow a strict schedule step by step. Participants were also not extremely serendipitous; instead, they would at least look for ratings and reviews to help them make decisions on their accommodations and flights.

5.2 RQ1: What Is the Tool Ecology That People Use for Travel Planning on Smartphones?

The findings reflected the trend of using smartphones for travel planning. All of the participants have used smartphones for travel planning, although the number of laptop users was only one less than that of smartphone users. Google (2018) conducted a travel study in 2017 with Phocuswright and found similar results: 48% of people studied in the United States had used smartphones to do travel research, and some other countries—including India, Brazil, Japan, Australia, and the United Kingdom—also had near or above 50% of study participants preferring to use smartphones. In fact, during the workshop, participants mentioned the advantages of using smartphones which was proposed by Wang et al. (2012). They said that because of the ease of information accessibility on smartphones, they had no need to be concerned about where to go and where they would be. Hence, many of them preferred to have a flexible trip plan and so only

choose two or three attractions. They took less consideration of restaurants before going on a trip; instead, many of them decided where to have meals on the road.

Furthermore, the findings also suggested that cross-platform planning has become a necessity. Although some platforms offered complex services such as booking flights, hotels, rental cars, sightseeing tours, and restaurant reservations, participants tended to find specific information on specific platforms. However, Google Maps was different from those platforms. For example, when participants were searching for attractions, TripAdvisor would be the first thought coming into their minds, but not for flights. On the other hand, when searching for hotel and flight information, participants would refer to multiple platforms, including Google Maps, Airbnb, Booking.com, Hotels.com, Google Flights, and Skyscanner, to check reviews and compare prices and locations. Specifically, for the locations, participants would check the transportation mode and time and the distances between attractions. In such a case, they needed Google Maps to provide this information. The results showed that participants would use complex services offered on Google Maps: They would search restaurants and hotels through it in addition to checking basic cartographic information such as location, distance, transportation, and time.

5.2.1 RQ1.1: How Do Digital Maps Serve the Function for Travel Planning on Smartphones?

The results suggested that digital maps play a dual role in information acquisition and compilation. First, participants were able to directly search smartphones' digital maps for many kinds of information, including attractions, restaurants, and hotels. They could learn the details of each location, such as operating hours, ratings, reviews, and photos, which helped them decide whether to visit. In addition, digital maps offered distance information. Participants could plan routes between more than two locations, check distance and time under each transportation mode, and then decide the way to approach the locations.

In addition to offering the information-search function, digital maps could also compile information by using a function to save locations and routes. However, few features were available to assist participants with integrating information from other platforms and organizing that information properly. Still, digital maps have advantages because they can provide cartographic information that participants rely on during a trip. Although many other travel-planning apps have launched, digital map apps were intuitive choices for participants.

Ballatore and Bertolotto (2015) proposed a framework of map personalization (Fig. 1) that illustrated the relationship between users and maps. A personalized engine would analyze users' models and update the maps' information. However, the findings from our research suggested that participants were looking for personalization not only within the digital maps, but also across platforms. Participants would search for and refer to information on other platforms and then compile that information on digital maps (Fig. 18). Since users had various interaction with digital maps regarding trip planning, maps have become increasingly important, which features and design need to improve.

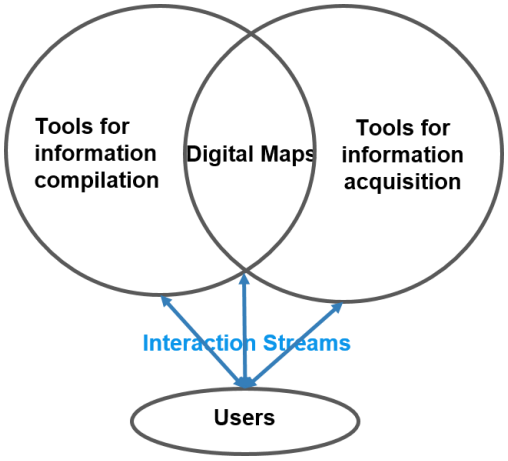


Figure 17. The dual roles of digital maps

5.2.2 RQ1.2: What Are the Pain Points for People Using Digital Maps for Travel Planning on Smartphones?

Participants identified several pain points. First, regarding the maps' interface, participants addressed what they called too much information on the maps, which was really a lack of organization. Finding and retrieving the information that they saved and shared before the trip was hard. In addition, the maps could not show multiple routes at the same time, which affected participants' understanding of their daily schedules. The small screen size of smartphones also made participants unable to have a holistic view of the digital maps.

Second, regarding the maps' workflow, managing locations also was hard, whether adding or removing them. Participants found it time-consuming to click on each location to learn more details, like its popularity and utility, then link those POIs multiple times to check appropriate routes and make arrangements for each day. Also, the maps could not show multiple routes at the same time to allow participants to choose. In addition, the icons for saving locations were

confusing, and some of them were similar. Finally, no space was available for participants to add annotations to a place, which could cause confusion regarding why they saved this place before.

Third, regarding the cross-platform planning workflow, participants had issues integrating information from documents or spreadsheets into digital maps, such as having to repeatedly type in locations. The language showing on the locations being different than the participants' language also caused typing difficulties as well as identification problems.

No and Kim (2015) proposed four attributes—informativeness, accessibility, interactivity, and personalization—that strongly influence users' travel-planning behavior and their satisfaction with a website-interaction experience. As our research findings showed, digital maps had scant personalization features and needed improvements. The same thing had been pointed out by Ballatore and Bertolotto (2015). In addition, my research also found the importance of information accessibility. The Internet was an essential tool for ensuring users' flexibility and giving them a sense of ease and comfort. Similar results can be found in Xiang, Magnini, and Fesenmaier (2015), who specified that travelers are dependent on Internet use for travel planning.

Miau and Feiner (2018) also identified several issues. As they described, the repetitive typing process increased users' workload. Users were tired of typing in the same location. Moreover, they preferred to easily link POIs and make revisions. The authors created a function that lets users add information on frequently researched locations to the side of the interface. Many previous studies had focused on the smartphone's visualization issue (Baudisch & Rosenholtz, 2003; Brodkorb et al., 2016; Gustafson et al., 2008; Miau & Feiner, 2018). Because smartphones' small screen size restricts users from looking at the map with a holistic view, developers created off-screen visualization that allowed users to peruse the directions of locations. Moreover, one participant in our research verified the issue of having difficulty finding his current location on the digital maps as those studies claimed.

5.2.3 RQ1.3: What Are the Users' Favorite Features on Digital Maps?

According to the findings for the current design, participants' favorite features gave them the ability to do the following: quickly check places' prices and ratings, perform a direct search for a specific place, randomly search and explore an area without typing in their needs, share places with travel partners to promote collaboration, retrieve distance information that can help

them decide whether to walk, and obtain a holistic view that will allow them to visualize planned routes and directions. Our findings show that the participants' mindset here was to reduce their workload and increase their mastery of their destination and schedule.

Other researchers have discussed the importance of several features, such as the value of online reviews and the impact of electronic word-of-mouth (Banerjee & Chua, 2016; Filieri et al., 2015; Hennig-Thurau et al., 2004) and the issue of repetitive typing and route presentation on digital maps (Miau & Feiner, 2018). Regarding collaboration in travel planning, Sanders and Geerts (2019) addressed the fact that that other than sharing features on the digital maps, the planning software should be able to support multiple travelers' situations, including their preferences, origin of destination, and any displacement, such as to routes, departure time, transportation modes, and activities, that happened because of social context. According to our results, the digital maps also lacked these kinds of features in terms of collaboration. Although developers of current digital maps did not design the software mainly for travel planning, the design for collaborative workflow in digital maps is important in facilitating multiple travelers to make plans, which needs more detailed discussion and improvements.

5.3 RQ2: How Can We Improve User Experience in Information Integration When Using Digital Maps for Travel Planning on Smartphones?

The empirical findings from this study provide prompts for designing personalized digital maps specifically with the purpose of travel planning. I developed several design guidelines:

- Support cross-platform planning: Because users will employ different platforms to compile information but a lot of digital files are difficult to look at when users are on the trip, the map should be able to import content from other platforms, including Google Sheets, Microsoft Excel, and Microsoft Word, or from the information that is saved in other apps, including Yelp and TripAdvisor. The map will generate a timeline schedule by detecting dates and locations, or the users can choose to manually create a plan. This guideline is to reduce users' workload and improve platforms' connection because users do not need to type in and search for all of their locations again in the digital maps.
- Improve information retrieval: The map design should take into account the hierarchy of information, which can help users easily organize and manage that information. First, the designers should use multiple layers to list each trip, including day plans, and to categorize

the pins and routes that users have saved for the trip and which they can sort by times, countries, or cities. Second, depending on users' needs, they can turn on a function to show the location labels they have saved by trip. Therefore, it can remind users where they may have been or may be interested in. On the next trip, they can easily retrieve those locations' information instead of finding and looking at the files they compiled before. It will also be helpful for users who decide to go to the same place again, who want to avoid going to the same place, or who want to share their information with others.

- Provide personalized services: This guideline is to ensure users' autonomy and respect their preferences. First, the map should provide multiple options for bookmarks to let users modify either labels' names or pins' colors. In addition, it can allow users to rank locations based on their preference. The advantages of the design are that it can help users differentiate the existing icons on the maps and identify where they want to go, and it also can help the system provide suggestions when users cannot follow their original schedule. By clicking the "near" function, the map will show users' preferred locations on the top of the search results. Second, the map can provide a drawing feature or let the system group nearby locations and mark those areas. It can serve as a summary function that helps users have a holistic view and visualize their entire trip plan by the day.
- Strengthen time management and system automation: The map should support users in managing routes and schedules and provide them with alternatives. This guideline is to ensure users feel flexible and relaxed rather than worrying about running out of time or missing some places they want to visit. When users plan their routes, the map should give them multiple options based on the locations they provide, indicate the amount of time they will likely be spending, offer suggestions, and then let them choose which option is the best for them. In addition, users should easily be able to add, modify, or delete locations, including those that they use often, such as hotels and attractions, so those locations will show on the screen without being typed in repeatedly. After that, the system will help recalculate a new route for users. When users spend too much time in one place, the map can offer them alternative attractions, subway stations, or routes.

CHAPTER 6. CONCLUSION

My aims for this study were to investigate users' travel-planning behavior with smartphones and the effects digital maps have on it. I conducted a travel-planning activity to learn about the workflow and difficulties when users are searching for and organizing information and a codesign workshop to promote an in-depth discussion with users and explore a new design possibility for digital maps. As a result, I found out the number of users doing travel research on smartphones was one more than the number of laptop users doing the same. The study also showed that users would search and make reservations for trip components such as hotels or flights and save locations on smartphones' apps; however, most users still preferred to manage their overall schedule and list information on a computer.

The frequently used platforms for information searches included Google Flights, Skyscanner, TripAdvisor, Airbnb, Booking.com, Yelp, Google Maps, and other personal blogs; on the other hand, Google Docs, Google Sheets, Microsoft Excel, Microsoft Word, and Google Maps were the frequently used platforms for compiling information. TripCase was the only app a user identified that was mainly designed for travel-schedule management. Of these platforms, Google Maps was the one that our results showed serves both information acquisition and compilation, which reflects the important role that digital maps play. However, regarding the dimension of information compilation, Google Maps provided fewer personalization features and its organization lacked hierarchy, which caused users difficulty in retrieving the information they saved before.

Following this, the major difficulties for users lie in cross-platform planning. Users needed to look for experienced travelers' recommendations and desired to learn the most information possible about their destination, including ticket prices, distance, operating hours, and busy hours. Ratings, reviews, and photos were important references for them in measuring whether a place was worth visiting. Therefore, they had to put forth a lot of effort and time to search for and compare information across platforms. On the other hand, users saved information on different apps and needed to compile it in one place to be able to make decisions and keep track of their schedule. Hence, continued switching between platforms and checking saved information were also time consuming and increased users' workload.

During the planning process, although most users wanted to collect as much information as they could, gain more knowledge about the destination, and have full awareness of the progress of their schedule, they kept flexibility to some extent, with the purpose of not only allowing them to freely explore an area so as to encounter something surprising, but also making them feel at ease and safe about their time.

Consequently, the results showed that digital maps had the potential to be the main platform for travel planning in terms of information searching and integration. The goals of future digital maps are to reduce workload, improve effectiveness, and ensure flexibility. The design guidelines for digital maps came from the discussion with users' in the codesign workshop and their reflection on the travel-planning activity, which empowered the users to participate in the design process and ensure their concerns and aspirations were addressed. The guidelines include four dimensions: support cross-platform planning, improve information retrieval, provide personalized services, and strengthen time management and system automation.

CHAPTER 7. LIMITATIONS AND FUTURE WORK

Due to the limited time frame, I could not collect a large amount of data from the screener survey, which decreased participant varieties. For example, I collected no data from participants who use Apple Maps. However, people who have other digital map experiences may provide different insights to the study.

In addition, the purposes of the travel-planning activity before the workshop were not only to give participants a general understanding about this study and to easily find problems during the execution process, but also to help me understand the participants and promote the discussion in the workshop. Although I reached those purposes to some extent, the travel-planning activity could have some improvements in the future. In this study, participants took less effort in planning a trip than they usually have done. One reason could be that it was planning for an imaginary trip, which gave them fewer incentives to do the activity. In the future, other researchers may consider finding participants who are actually planning to go on a trip. Also, researchers can apply different methods, such as a diary study, which could track participants' progress in planning a trip and ask them to provide feedback every day. This would be closer to a real-life experience, and instant feedback prevents participants' forgotten problem. The researchers can also collect recently planned itineraries from participants to get a better sense about how they worked before and compare the differences with the study task.

In the workshop, the group dynamic influenced the extent of participants' engagement. Although I used questions to help participants elaborate more on their planning experiences and tried to ensure everyone had equal chances to speak, some participants still needed warm-up activities and more time to cooperate with others smoothly. Because I was novel in holding the workshop, having more practices and training sessions with senior researchers would be better. Also, the activities in the workshop could be divided into 2 days. Because participants may not be designers and are not familiar with the design-thinking process, providing them more time would allow their brains to rest and give them more chances to communicate with each other. Other researchers could also interview participants before the workshop to not only reduce the risk that they may have less chances to share their experience, but also to ensure the researchers have more time to ask deep questions. Furthermore, other researchers can choose focus group or one-on-one interviews rather than a workshop to get participants' opinions.

In addition, future digital map research can focus on collaboration. As I found out, participants usually need to share with others information such as location details from digital maps and reviews from social networking sites. Information sharing would influence the process of information searching and compiling in the digital map apps. Although some travel-planning apps provide sharing services, my findings also showed that participants compile information on a series of Google platforms, a series of Microsoft platforms, and in notebooks. There is a need for more detailed research about people's cooperation in the travel-planning process to improve the users' experiences across these smartphone platforms.

APPENDIX A. SCREENER SURVEY

Travel Behavior

1. When is the last time you went travelling not for business?
2. How often do you travel not for business?
   - ○ More than once a week
   - ○ Once a week
   - ○ Once a month
   - ○ Once a semester
   - ○ Less than once a year
   - ○ Never
3. Whom do you usually travel with?
   - ○ Alone
   - ○ Friends
   - ○ Boyfriend/girlfriend
   - ○ Family
   - ○ Other. (Please specify.)
4. What types of travel do you prefer?
   - ○ In-state
   - ○ Out-of-state
   - ○ International
5. Please name three cities that you haven't been to before but wish to go.

Travel-Planning Behavior

6. Have you previously planned a trip before going on a trip?
   - ○ Yes
   - ○ No
7. How much time do you usually spend on travel planning before departure?
   - ○ A great deal
   - ○ A lot
   - ○ A moderate amount
   - ○ A little
   - ○ None at all
8. Where do you usually do travel planning?
   - ☐ At home
   - ☐ On the bus/train/subway
   - ☐ In public spaces (like a coffee shop or library)
   - ☐ Other. (Please specify.)
9. What tools have you used for travel planning?
   - ☐ Paper/notebooks
   - ☐ Smartphones
   - ☐ Tablet
   - ☐ Laptop

☐ Desktop
☐ Other. (Please specify.)

10. What kinds of information you are looking for when you do travel planning before departure?
    ☐ Accommodations
    ☐ Transportation
    ☐ Restaurants
    ☐ Tourist attractions
    ☐ Other. (Please specify.)
11. What platforms do you usually refer to when you do travel planning?
    ☐ Digital maps
    ☐ TripAdvisor
    ☐ Blogs
    ☐ Google Flights
    ☐ Yelp
    ☐ Airbnb
    ☐ Other, please specify
12. How do you compile the information you find?
    ☐ Digital maps
    ☐ Paper/notebooks
    ☐ Google Sheets
    ☐ Other. (Please specify.)

Digital Map Experiences on Smartphones

13. What digital maps on smartphones do you usually use?
    ○ Google Maps
    ○ Apple Maps
    ○ Other, please specify
    ○ I never use digital maps on smartphones
14. How confident are you in your ability to use the map(s) you specified in the previous question?
    ○ Very confident
    ○ Fairly confident
    ○ Neither
    ○ Not very confident
    ○ Not at all confident
15. How often do you use digital maps on smartphones?
    ○ More than once a day
    ○ Once a day
    ○ Several times a week
    ○ Once a week
    ○ Less than once a month
16. What functions have you used on digital maps on smartphones?
    ☐ Search
    ☐ Save locations
    ☐ Directions

- ☐ Save routes
- ☐ Share locations
- ☐ Write reviews
- ☐ Ratings
- ☐ Other. (Please specify.)

17. Have you faced any difficulties when you use digital maps on smartphones? (e.g., search locations, save locations, or plan routes)
    - ○ No
    - ○ Yes. (Please describe the difficulties.)
18. Have you faced any difficulties when you wanted to store information from other platforms to digital maps on smartphones?
    - ○ No
    - ○ Yes. (Please describe the difficulties.)
19. Have you faced difficulties when you want to retrieve the information that you stored in digital maps on smartphones?
    - ○ No
    - ○ Yes. (Please describe the difficulties.)

General Information

20. What is your gender?
    - ○ Male
    - ○ Female
    - ○ Other. (Please specify.)
    - ○ I do not want to specify.
21. How old are you?
    - ○ 18–24
    - ○ 25–34
    - ○ 35–44
    - ○ 45–54
    - ○ 55–64
    - ○ 65 or older
    - ○ I do not want to specify.
22. What is your race or ethnicity?
    - ○ African American or Black
    - ○ American Indian or Alaska Native
    - ○ Asian
    - ○ Hispanic or Latino
    - ○ Middle Eastern
    - ○ Native Hawaiian or Other Pacific Islander
    - ○ White
    - ○ Other. (Please specify.)
    - ○ I do not want to specify.

Future Participation

23. Are you willing to participate in the following research?

Note: The following research includes a travel-planning assignment and a codesign workshop, which will take approximately 4 hr. Participants who fully attend the workshop and complete the assignment will be able to enter a drawing to win a $50 Amazon gift card. Chances of winning will be one in 10.

○ No

○ Yes. (Please leave your e-mail address below, and the researcher will contact you if you meet the requirements.)

APPENDIX B. TRAVEL-PLANNING REFLECTION

1. What information were you looking for?
2. In what environments did you do this assignment?
3. How much time did you spend on this assignment?
4. How did you find the information? Please describe the workflow, including the platforms or apps you used.
5. What tools did you use to compile information?
6. What information did you need digital maps to support?
7. What features on the digital maps did you prefer? (Please upload screenshots to help explain the features.)
8. What information did you store on the digital maps? How and why?
9. Why did you not store other information that you did not specify in the previous question on the digital maps?
10. What difficulties did you face when you used digital maps? (Please upload screenshots to help explain.)
11. What features might you want to add for when you do tasks on digital maps? (If they are features from other apps, please upload screenshots to help explain.)
12. What made you make the decisions in your itinerary? (Please upload your itinerary.)
13. Is there any other comment, feedback, or question you want to address?

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