Information Scraps in the Smartphone Era

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ACADEMIC ABSTRACT

How people create and use information scraps, the small informal messages that people write to themselves to help them complete a task or remember something, has changed rapidly in the age of mobile computing. As recently as 2008, information scraps had continued to resist technological support. Since then, however, people have adopted mobile connected devices at a rate unimagined in the pre-smartphone era. Developers have, in turn, created a varied and growing body of smartphone software that supports many common information scrap use-cases. In this thesis, we describe our research into how and why people have adopted smartphone technology to serve their information scrap needs. The results of our survey show broad adoption of smartphones for many common information scrap tasks, particularly ones involving prospective memory. In addition, the results of our diary studies show that mobile contexts or locations are highly correlated with people's choosing to use smartphones to record information scraps. Our analysis of our diary study data also provides fresh understanding of the information scrap lifecycle and how mobile digital technology affects it. We find people's smartphone information scraps tend toward automatic archival, and we find their information scraps in general tend toward substantial role overlap regardless of medium. We use these findings to formulate a new information scrap lifecycle that is inclusive of mobile technology. These insights will help mobile technology creators to better support information scraps, which, in turn will allow users to enjoy the huge benefits of digital technology in their information scrap tasks.

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PUBLIC ABSTRACT

Information scraps are the small notes that people write to themselves to help them complete a task or remember something, and making them is a nearly universal behavior. Prior research in this field tried to understand people's pen-and-paper information scrap behaviors in order to enhance them with new computing tools. These tools would aid people in recording, organizing, archiving, and re-finding their information scraps. Until recently, though, these tools had seen little user adoption. Since the arrival of the smartphone era, however, millions of people have gained access to the powerful, pocket-sized information scrap tool that is the modern smartphone.

In this thesis, we describe our research into how and why people have adapted their smartphones to serve their information scrap needs. Our results show that although people still prefer pen and paper for some scrap types, many people are now regularly using smartphones for a variety of common information scrap types, particularly those concerned with future activities. Our research also documents novel information scrap behaviors such as people's tendency to create photographic information scraps, something not commonly done before people had smartphones. Our results improve our understanding of the roles that information scraps serve, as well as help us model people's information scrap behavior in the age of mobile computing. These insights will assist technology makers in designing tools that better fit the way people make and use information scraps. These tools, in turn, will give users more opportunity to enjoy the huge benefits of digital technology in their information scrap activities.

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List of Multimedia Objects

1 Introduction

The term *information scrap* was first coined by Bernstein, et al. in 2007 to describe the small informal notes people write for their own use [1]. People universally create information scraps [3]. This activity supports a huge variety of tasks and can be done nearly anywhere. A person can take down a to-do list on a scrap of paper and stick it in a pocket, write a reminder on a Post-It Note and attach it to a computer monitor, or even jot down a phone number on a hand and enter it into a contact list later. These common scenarios typify what Lin, et al. [2] in 2004 called the *micronote lifecycle*, which describes the state transitions of *micronotes*, now considered a subset of information scraps only focused on present information and its future use [3]. Bernstein, et al. [1] later defined the more inclusive term *information scraps*. Lin, et al. [2] and Bernstein, et al. [3] drew from their research implications for the design of digital tools that could support information scraps and thus help scrap makers enjoy the benefits of computing in this area. However, these were tools envisioned in a previous era of computing. With the dawn smartphone technology, the past eight years have seen an explosion of mobile digital tools that augment, replace or possibly even eliminate some of the most common forms of paper information scraps.

This thesis seeks to answer three overarching questions about information scraps in the age of mobile computing:

- Which, if any, information scrap tasks are moving to smartphones?
- What factors influence people to make information scraps using smartphones?

- How can we better model people's information scrap behavior on smartphones?

1.1 Information Scraps in the Smartphone Era

These days, a person's smartphone likely contains any number of software apps that, in some way, have changed how he or she performs an information scrap task. Where someone might once have made an appointment reminder out of a Post-It Note, now she can create a calendar event in her phone to remind herself. Where someone used to scrawl down a new phone number on any handy scrap of paper, now he can enter it directly into his phone's contact list. Where someone once would jot down the type and brand of a household item to help them buy the right thing at the store, now they can just take a picture of the empty package. These are clear examples of how mobile digital technology has altered people's information scrap habits. What is not clear is the breadth and depth of this impact. We know smartphone users have a wealth of app options, both purpose-built and repurposed by users, for filling their information scrap needs. To fully understand how smartphone technology has changed people's relationships with their information scraps, we carried out a two-part study called *Information Scraps in the Smartphone Era* (*ISSE*) as well as a follow-up study called *ISSE Crowd* that replicated the second part of *ISSE* with a different population.

In studying mobile technology users' information scrap habits, we gathered data with direct bearing on our understanding of the micronote lifecycle. The purpose of the micronote lifecycle, as originally envisioned, was to describe the transitions and transformations of an information scrap, regardless of medium. Although this model was developed mostly using data about users' pen-and-paper micronote habits, Lin et al.'s [2]

goal in developing this model was to help inform the next generation of digital micronote technology tools. Based on this model, their paper predicts the emergence of hybrid paper/digital solutions that allow computer-supported micronotes to finally see wide user adoption. While some likely technologies, such as Livescribe Smartpens, have emerged, each year that passes in the smartphone era makes this prediction seem less and less likely. Simply put, smartphone technology has seen high penetration, but digital pen technology has not. In spite of this, smartphone micronote making is common practice, as our findings will show. By collecting data about users' information scrap habits, particularly as they relate to mobile technology, we provide fresh insights on the technologies people use, new perspective on the roles people's information scraps fill, and a thorough reevaluation of the micronote lifecycle. The remainder of this thesis proceeds as follows.

In Section 2, we describe the related work in information scraps and information scrap technologies. We discuss two papers in particular that greatly influenced our experimental design and our analytical lens, the first of which, of course, is *Understanding the Micronote Lifecycle: Improving Mobile Support for Informal Note Taking* [2]. The second of these papers is *Information Scraps: How and Why Information Eludes Our Personal Information Management Tools* [3]. We discuss these works' methodology, their findings, and their influence on our studies.

In Section 3, we describe how we designed and carried out our two studies, *ISSE* and *ISSE Crowd*, and we provide a breakdown of the questions we intended each study to answer. We also provide a description of the software tools *Study Send* and *Study Send Crowd*, which we developed to help us conduct our research.

In Section 4, we showcase the results of our studies. We provide data and analysis for *ISSE* Part 1's information scrap task survey, *ISSE* Part 2's semi-structured interviews, *ISSE* Part 2's diary study, and finally *ISSE Crowd*'s diary study. Subsection 4.1 discusses the results of our initial survey, which asks respondents how often they do a set of common information scrap tasks and how likely they are to do them with paper versus a smartphone. We document significant evidence that information scraps are indeed moving to smartphones and that prospective memory scraps are leading this shift. Subsection 4.2.1 focuses on the smartphone information scrap behaviors that we discovered in our one-on-one interviews with our *ISSE* diary study participants. We highlight the information scrap roles for which participants create the most smartphone scraps, and we document some novel behavior not possible with paper information scraps. Subsection 4.2.2 provides detailed evaluation of *ISSE* Part 2's diary study data using Lin, et al.'s [2] micronote lifecycle and Bernstein, et al.'s [3] information scrap roles. We break down our data by medium, location, role, and app type and analyze relationships in these data. Finally, Subsection 4.3 provides similar evaluation of *ISSE Crowd*'s diary study data as well as a critical comparison to findings in *ISSE* Part 2's diary study.

In Section 5, we synthesize our major findings based on the evidence in the previous section. We posit that smartphones' inherent ability to organize data around *time* allows apps to automatically organize most types of prospective memory information scraps during creation. We also argue that *mobile* contexts, i.e., situations where one does not have access to all the PIM tools of the home or office, are a crucial factor in people's information scrap behavior, and we discuss possible reasons why our data show

smartphones are preferred in such situations. Finally, we combine evidence and ideas from previous sections to reformulate Lin, et al.'s [2] micronote lifecycle.

In Section 6, we discuss our conclusions as well as revisit Lin, et al. [2] and Bernstein, et al. [3] to discuss their predictions for mobile digital information scraps in light of our findings and the current smartphone technology landscape. In Section 7, we discuss implications of our work for the design of information scraps tools. In Section 8 we discuss ideas for further research that would bring more clarity to this work. We also discuss new questions we have raised that remain to be answered in future information scrap research.

2 Related Work

2.1 Information Scrap Technology

Due to constant technology innovations, the field of information scrap study is in a state of flux. The research of Lin, et al. [2] and Andrew, et al. [4] seems to show that users need and prefer the capabilities that pen-and-paper information scraps provide. These include instant access, i.e., no system booting or program loading, as well as freeform note taking structure. However, features that are easily supported in electronic mediums, such as editing and coloring, are not preferred by users according to Kim, et al. [5]. As such, researchers have put a great deal of effort into bridging the paper-digital divide. Studies such as Lin, et al. [2], Andrew, et al. [4], and Ispas, et al. [6] seek to characterize how people take notes using pen and paper, and they attempt to draw implications for how those behaviors should be supported in digital note-taking tools.

Based on such work, many research efforts have seen the development of prototype technologies that support paper-digital note taking. Brandl, et al. [7] developed NiCEBook, a system that seeks to combine the convenience of taking notes on paper with the benefits of digital representation. Probst, et al. [8], focusing on the special characteristics of Post-It Notes, developed Move-It Sticky notes, a system for enabling ambient reminding in paper notes through motive technologies. Ispas, et al. [9], meanwhile, have advanced the state of software technology for effectively digitizing hand-drawn notes through their segmentation and classification framework. They have also put it to use in an interesting ambient reminder system called ARENO [10]. In addition, Fouse, et al. [11] and Fouse, et al. [12] developed ChronoViz, a tool supporting the digital convergence of multimodal data including paper notes, and which Weibel, et al. [13] have analyzed the usage thereof by researchers. Finally, Ren, et al. [14] have developed a free-form note-taking and sketching system for smartphones that tries to mitigate the problems of a smartphone form factor, i.e., small touch area, imprecise finger strokes, etc., while providing the advantages of a mobile digital device, i.e., convenience, overlay of sketching on images, digital storage, easy sharing, etc.

Other studies have focused on learning how users have (or have not) adopted digital technology to serve their note-taking needs. Lin, Lutters and Kim's [2] paper captured data about a small percentage of the participants they sampled who used devices such as PDAs to capture information scraps. Dai, Lutters and Bower's [15] subsequent study took a closer look at PDA users, coming to the conclusion that note-taking applications on such devices were too structured for note taking and too unstructured for note retrieval. Bernstein, et al.'s [3] 2008 article, arriving as it does at the leading edge of

widespread smartphone adoption, describes people's then-unmet needs in information scrap tools, which smartphones were poised to fill. These include lightweight entry, unconstrained content, flexible use and adaptability, visibility, and mobility. Since the advent of the smartphone and its larger sibling, the tablet, a few other note-taking studies have been conducted that focus on this new wave of mobile devices and their users. Kim, et al.'s [5] 2009 study on digital note-taking tool usage in college classrooms found the vast majority of participants did not use electronic devices when taking notes. However, Leino, et al.'s [16] 2010 study of smartphone usage in personal information management hint that this trend is changing. Indeed, Buttfield-Addison, et al.'s [17] 2012 study found that, at least for some professionals, tablets were supplanting pen and paper for many note-taking activities including information scraps.

2.2 The Micronote Lifecycle

In this work, we update the micronote lifecycle based on current information scrap habits of smartphone users. As mentioned earlier, micronotes constitute a subset of information scraps focused on present information and its future use. The micronote lifecycle, originally devised by Lin, et al. [2], describes the transitions and transformations of micronotes through their useful lives. The lifecycle, as shown in Figure 2.1, "maps the trajectories of micronotes through eight lifecycle stages: *trigger*, *record*, *transfer*, *maintain*, *refer*, *complete*, *discard*, and *archive*." To illustrate, say something triggers in a person an immediate need to make a micronote, e.g., receiving someone else's phone number. They record the information using whatever medium is handy, often a scrap of paper. Then, depending on the person's intent for the micronote—whether they made it for *immediate use*, for *prospective memory aid* use, or for

temporary storage—they either exploit it in that instant, maintain and refer to it over time, or, in the example of the recorded phone number, transfer it to a more appropriate storage medium. Once the micronote has fulfilled its purpose, it is considered to be *complete*. Its owner may either discard the micronote or archive it.

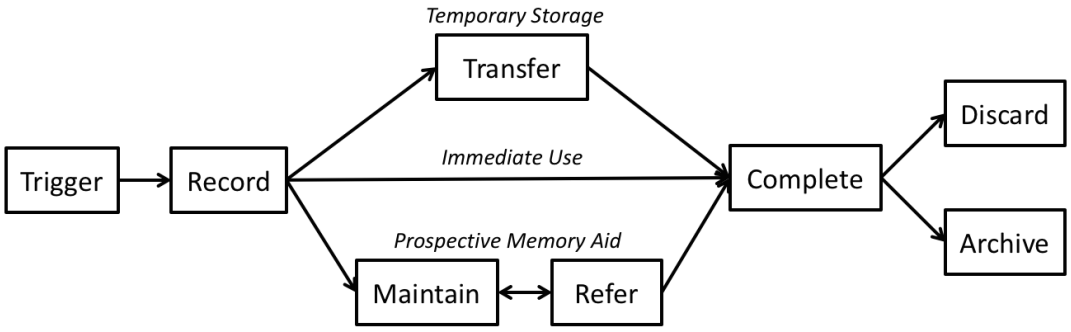

Figure 2.1: The micronote lifecycle [2]

Lin, et al. [2] arrived at their definition for the micronote lifecycle by analyzing data collected from a sample of twenty-nine individuals from a university population. They conducted a semi-structured interview with each participant in order to discover their general micronote habits. They then conducted a second semi-structured interview with each participant in order to discuss samples of that person's micronotes from the preceding week. Finally, they took photographs of each participant's micronotes and analyzed them. Taken together, these data sets revealed patterns that gave rise to the micronote lifecycle. We take inspiration from this process in our research, particularly within the longitudinal studies of *ISSE* Part 2 and *ISSE Crowd*, where we interview participants about their smartphone information scrap habits and follow up with collection of real information scrap sample data. We also draw heavily from the

micronote lifecycle itself in the formulation of our own *information scrap lifecycle* in section 5.3, which accounts for all information scrap types and better describes scraps made with smartphones.

2.3 Information Scraps and Their Roles

The micronote lifecycle describes three distinct usage paths for a micronote and, as a consequence, defines three roles that micronotes fill: *temporary storage*, *immediate use*, and *prospective memory aid* [2]. In "Information Scraps: How and Why Information Eludes our Personal Information Management Tools", Bernstein, et al. [3] take a deeper dive, trying to understand why people do not use traditional PIM applications for information scraps as a whole, as well as what roles information scraps play in people's larger information management habits. In doing so, they define the list of information scrap roles to include *temporary storage*, *cognitive support*, *reminding*, *archiving*, and *unusual information storage* [3]. Like the micronote lifecycle, we consider Bernstein, et al.'s information scrap roles to be a primary theoretical framework in our research methodology.

Similar to Lin, et al.'s [2] study, researchers in Bernstein, et al.'s [3] study conducted semi-structured interviews aimed at uncovering participants' information scraps and information scrap habits. In this instance, however, they interviewed 27 "knowledge workers" at 5 different business organizations outside of academia. They employed their own 3-axis interview process, which they used with the goal of unearthing and documenting all information scraps across all mediums in a participant's workspace and ended up collecting over 500 information scraps in total. They documented dozens of distinct information scrap types while noting that the distribution

between these types follows a "discrete power law probability distribution." That is, the distribution was such that most scraps fell into the highest-ranked categories such as "To-Do" and "Meeting Notes" and a minority of scraps fell into a long tail of other categories. We make extensive use of these scrap types and rankings in our survey in *ISSE* Part 1.

Bernstein, et al. [3] provide an abundance of interesting insights in their analysis. They describe the importance of lightweight capture in scrap medium, noting the need of participants to record data quickly with minimum upfront decision making. They describe the requirement for flexibility in tools for scrap contents as well as organization, noting the abstract representations of information and ad-hoc organizational systems their participants had created. They documented the need for visibility in information scraps that remind, noting how participants placed scraps in the way of future movements. They also note the importance of mobility in information scraps, explaining the particular challenges of data entry, social setting, and information fragmentation in this area.

One of Bernstein, et al.'s [3] primary objectives was to move past their working definition for an information scrap, i.e., the definition they used during data collection, and develop a meaningful universal definition. They arrived at this: *An information scrap is an information item that falls outside all PIM tools designed to manage it*. This definition captures the ad-hoc nature of information scraps, their tendency toward fragmentation, and their lack of tool support. However, in order to explore the nature information scraps on smartphones, we have chosen to set aside this definition. When this definition was written, Bernstein, et al. [3] described the state of mobile information scrap technology as "basic PIM and freeform note-taking functionality." Since then, there has been an explosion of task-specific, purpose-built tools made for mobile computing

platforms such as iOS and Android. We saw that there could have been a great many apps in use for specific information scrap tasks, and we did not wish to preclude such domains from our analysis. For example, we permitted ourselves to treat a reminder as an information scrap even if it was made with the iPhone's *Reminders* app. Thus, we chose a definition that focuses on information scraps' roles rather than how they are stored. For the purposes of this paper, *information scraps* are the hurriedly captured information items that people record to fill one or more of the following roles: *temporary storage*, *cognitive support*, *reminding*, *archiving*, and *unusual information storage*.

3 Methodology

We devised a two-part study in order to answer our research questions about people's information scrap habits as they relate to smartphones. The first part consisted of a widely distributed online survey that asked participants how and how often they perform certain kinds of information scrap tasks. The second part consisted of a diary study with a smaller pool of participants who described some of the information scraps they made and used over a period of two weeks. In addition, we duplicated the diary study portion of our study using a different pool of participants sourced from the crowdsourcing platform Amazon Mechanical Turk.

3.1 ISSE Study Part 1: Survey

Part 1 of our study focused on characterizing how people perform common information scrap tasks. We constructed our survey to provide insight into the following questions:

- Which information scrap tasks do people do on smartphones versus on paper?
- Which information scrap tasks do people do most often?
- Are smartphone information scrap tasks the information scrap tasks that people are doing most often?

To answer these questions, we ran an online survey that asked respondents about their habits regarding 25 particular information scrap tasks. See Appendix A for the contents of the survey. We selected these tasks from among the most commonly identified information scrap types in Bernstein, et al. [3]. Their article, arriving as it does on the leading edge of the smartphone revolution, only provides a glimpse at people's mobile phone information scrap habits. In addition, their research method mostly involved unearthing the extant information scraps that were present in participants' workspaces, i.e., desktops, file cabinets, computer systems, whiteboards, and so on. These information scraps might consequently be quite different from the kinds commonly made by people on their smartphones today. However, they did collect over 500 individual information scraps. Owing to the discrete power law probability distribution of the information scrap types that Bernstein, et al. [3] identified in their data collection, we thought it likely that the most common types of information scraps they found would still be among the most common types made by smartphone users today. The information scrap types that we chose to study are listed in Table 3.1. These scrap types do not match exactly the top 25 types that Bernstein, et al. [3] found, as some of them, such as "Computer Repair Status", seem particular to the work environment of their study's participants.

Make or edit a "to do" list	Record login or password information	Capture part of a text message conversation	Annotate a document or book
Take meeting notes	Make brainstorm notes	Make a reminder	Record plans, goals or a timeline
Record a name or contact information	Record calendar or event details	Record financial data	Record airplane flight information
Make a "how to" list	Record notes at an event	Make a list of events or an agenda	Capture information from a whiteboard
Make a note to help you with work-in-progress	Make a progress report	Retain the content of a paper letter	
Record a web address, URL, directory path, or file path	Keep track of a receipt or a purchase confirmation	Make technical notes	
Record a desired item or a thing you are thinking of buying	Make notes about a voice conversation	Record an idea	

Table 3.1: Information scrap tasks from our study

We constructed our survey using the Qualtrics survey creation and management service. In our survey, we first asked respondents how likely they were to do each of the tasks in Table 3.1 on paper versus on a smartphone. They submitted their answers on a Likert scale whose choices were *Very likely to use paper*, *More likely to use paper*, *Equally likely to use paper or smartphone, More likely to use smartphone, Very likely to use smartphone,* and *Not applicable.* Next, we asked respondents how often they do each of these tasks. They responded on another Likert scale whose choices were *Rarely or never, Monthly, Weekly, Daily,* and *Multiple times per day.* Finally, we asked them some demographic information that included gender, age group, and level of education. We distributed our survey through the Computer Science Department's email lists and the Graduate School's email lists at Virginia Tech. We also employed the Virginia Tech

Psychology Department's SONA experiment management system to distribute the survey. Participants recruited through the SONA system were Psychology students who received 0.5 SONA credits worth of extra credit for completing the survey, whereas participants recruited through email lists received no compensation for their responses.

3.2 ISSE Study Part 2: Diary Study

In part 2 of our study, we sought concrete examples of people's information scraps as they created them. We tried to answer the following questions:

- What information scraps are people making?
- What are people using to make these information scraps?
- What are people doing when they make these information scraps?
- Where are people making these information scraps?
- Why do people make these information scraps?

To answer these questions, we ran a 2-week diary study with each of 14 participants between April and May of 2015. We reference these participants in this paper as "Participant ISSE###", where "###" is a unique 3-digit number. We recruited interested participants from the pool of respondents to the survey in part 1. We also recruited through the SONA Experiment Management System. Participants recruited through the SONA system received up to 2 SONA credits worth of extra credit: 1 credit for completing the pre-study interview and 1 credit for completing more than half of the requested diary entries. Participants recruited from the part 1 survey received no compensation for their participation.

We began each participant's involvement with an in-person semi-structured interview. During each interview, we introduced the participant to the concept of

information scraps and described the different roles they might serve as described by Bernstein, et al. [3]. These roles include *temporary storage*, *archiving*, *reminding*, *cognitive support*, and *unusual information storage*. See Figure 3.1 for a transcript of the description we provided. We then asked the participant to show us examples of information scraps on his or her smartphone that served each of those roles. We recorded the audio of each of these interviews and transcribed them afterwards.

Information Scrap Roles
We've identified five different roles that information scraps can serve. Please read the following descriptions and examples of those roles. In the diary study questionnaires, we will ask you to label your information scraps using these roles.

Temporary Storage
Information scraps can serve as temporary storage, which means they're meant to help you remember something over a short period of time, for example driving directions.

Cognitive Support
Information scraps can serve as cognitive support, which means they're meant to aid your thought process, for example brainstorm notes.

Archiving
Information scraps can serve as archiving, which means they're meant to hold onto important information for long periods of time. For example, if you had a note that contained website passwords, you may want to hold onto that and refer back to it periodically.

Reminding
Information scraps can serve as reminding, which means they're meant to remind you of something, either by notification, or by being placed in the way of future movements and activities. For example, you might place a to-do on a post-it note and stick it to your computer monitor.

Unusual Information Storage
Finally, information scraps can serve as unusual information storage, which means they're meant to hold information that does not easily fit into your normal personal information management tools. For example, an email application is a common personal information management tool. But using an email application to store non-email information, such as notes to yourself, may be an example of unusual information storage.

Figure 3.1: Information scrap roles

The purpose of conducting these interviews was two-fold. First, we wanted the participants to understand the concept of information scraps well enough to be able to record useful information about them during the diary study. Conducting these interviews beforehand gave us the opportunity to not only explain the types of information we sought but also to relate it to information scraps that participants had already made. Second, we wanted to gather data about how participants were already creating and using information scraps on their smartphones. The semi-structured nature of the interview allowed us to quickly cover common ground between smartphone users, and it also let us probe more deeply into novel information scrap usages and management strategies.

Following each participant's interview, we registered the participant in an electronic messaging system we developed called *Study Send*, which is described in section 3.2.1. We used this system to send him or her an email or SMS text message containing a hyperlink to an online questionnaire. We created this questionnaire using the Qualtrics survey website. We sent this questionnaire every 2 days over the 2-week study period for each participant. The questionnaire asked the participant short answer and multiple-choice questions about the last information scrap he or she made. See Appendix B for the contents of the questionnaire. This method of diary study allowed us to directly solicit diary entries from the participants, as opposed to relying on participants to remember to regularly update a diary. This worked well, allowing us to obtain 85% of total diary entries sought with no less than a 57% response rate at worst from any single participant.

3.2.1 Study Send

Study Send is an iPhone app we created to manage the workflow of running a diary study. A researcher can use Study Send to keep track of a list of anonymized diary study participants and send them messages asking them to complete surveys at specific intervals over a period of time. For each listed participant, Study Send keeps a phone number or email address, a URL for an online survey (i.e., our Qualtrics diary entry survey), and a list of dates and times when he or she will be asked to complete the survey. Whenever it is time to send a survey to a participant, the researcher receives a notification from the Study Send app. They can then open the app, verify the email or text message containing the survey URL that Study Send has composed, and send it off to the participant.

Without a system like Study Send, we would have had to compose our messages manually, which would likely have introduced more opportunity for error. Indeed, because participants were trusting us to send them messages over their cellular phones, it was important to us to not annoy them with extraneous or malformed messages. Using Study Send, we received notifications when it was time to send a message, so we could be sure that each message was sent at the appropriate time. And, because each message was composed automatically but verified manually, we could be sure that we made no careless errors in what would otherwise have been a very tedious and error-prone activity.

3.3 ISSE Crowd: Diary Study on Amazon Mechanical Turk

We duplicated the diary study portion of our study on the crowdsourcing platform Amazon Mechanical Turk (AMT). Doing so let us capture information scrap data from a broader participant pool than the first diary study could. Whereas the majority of

participants in the first diary study were age 25 and under, our participant pool for the crowdsourced study skewed a bit older, with the "26 to 35" age group having the most representation. In addition, we were able to source participants from all over the United States as opposed to only those present in Blacksburg, VA. While we did not collect nearly enough data to make generalizations about people's information scrap habits as it relates to their locale, our study benefits from not limiting our data collection to the narrow set of students and faculty at Virginia Tech.

Replicating this diary study using AMT workers necessitated a number of changes from the original experimental procedure. It would have been very difficult to conduct a semi-structured interview with an AMT worker, especially an interview that centered on exploring the contents of the participant's smartphone. Instead we opted to forego the collection of interview data and introduce the concept of information scraps through a paid recruitment survey posted to AMT. In addition, AMT's terms of service prevented us from asking for participants' cellular phone numbers, thus, we could not send diary entry survey links through that channel. Fortunately, we were still able to send links to participants in emails through AMT's worker notification channel. Finally, since AMT workers must be paid for their work, we developed a compensation system based on the work of Yin, et al., [18] that we hoped would counteract any tendency of workers to drop out of our study early. Yin, et al. [18] found that for tasks done by workers on AMT, work quality and effort increase as financial reward increases. Based on this, we compensated workers $0.05 for completing each diary entry survey task with a $0.05 bonus for each previously completed diary entry survey task. We also compensated workers $0.10 just for completing the recruitment survey task.

We posted the initial recruitment survey task with 20 assignments to AMT in November of 2015, and AMT workers completed all of them in less than one day. We reference these workers in this paper as "Participant ISSEC###", where "###" is a unique 3-digit number. Beginning the day after our recruitment survey and recurring every 2 days thereafter, we posted to AMT a diary entry survey task for each participant, and we sent them each an email with a hyperlink to their task. Each survey contained the same questions as the original study. See Appendix B for the survey's contents. We collected data over 2 weeks in November and December of 2015.

3.3.1 Study Send Crowd

We conducted the original ISSE study with the aid of the *Study Send* smartphone app, which we developed to keep track of diary study participants, to manage the dates when participants should receive diary entry surveys, and to send out text messages and emails containing the hyperlinks to diary entry surveys. We developed a similar software system, *Study Send Crowd* (SSC), to manage *ISSE Crowd*'s diary study participants. Because our system needed to interface with our participants through AMT, we elected to develop a server-based web application that could communicate with AMT through its API without human intervention. Figure 3.2 shows an architectural overview.

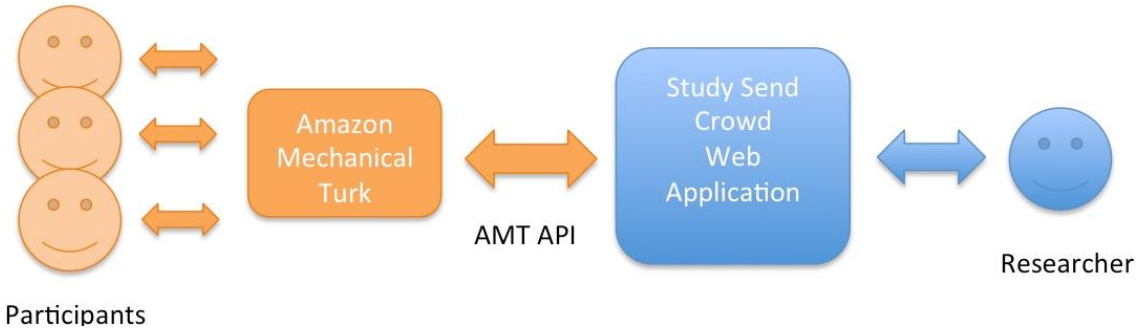

Figure 3.2: Study Send Crowd architectural overview

Unlike the original *Study Send*, SSC is a full-featured system that supports running multiple diary studies across multiple user accounts. Once a researcher creates an account, they can create their own custom diary studies. To create a study, the researcher fills out and submits the study parameters. Then the researcher launches the study, which automatically posts the recruitment task to AMT. The form requires a URL for a consent form, which is displayed in the recruitment task, as well as a URL for the diary entry survey, which is displayed in the diary entry tasks. We developed SSC to make use of surveys created using the Qualtrics survey system. Surveys created using Qualtrics have associated URLs that are ideal for distribution and display within AMT tasks. While we did not test SSC using alternative survey systems, it should be possible to use SSC with other linkable surveys that are compatible with AMT.

Once the recruitment task is posted to AMT, workers can opt in to the study by completing the task. SSC accesses AMT periodically to retrieve the list of workers who have completed the task and add new workers to its list of participants for the study. In accordance with the parameters set by the researcher, SSC automatically creates diary entry tasks on AMT and sends emails to participants containing links to those tasks. SSC keeps track of which participants complete which diary entry survey tasks and makes that information available to the researcher. In this way, SSC relieves the researcher of much of the burden that comes with running this kind of diary study on AMT.

4 Results

We present data and analysis from each part of our *ISSE* study as well as data and analysis of our follow-up study *ISSE Crowd*.

4.1 ISSE Study Part 1: Survey

In our initial survey in *ISSE* Part 1, we asked respondents whether or not they currently used smartphones. Of the 248 responses we gathered, 241 (97%) claimed to use smartphones. We asked those 241 smartphone users to rate how likely they were to do 25 common information scrap tasks on paper versus on their smartphones. We also asked respondents, including ones who did not use smartphones, to rate how often they do those particular tasks. There were 166 female respondents, 65 male respondents, and 17 who did not answer. Two hundred six of the participants were between 18 and 25 years old, 21 were between 26 and 35, 3 were between 36 and 45, 2 were between 46 and 60, none claimed to be 60 or older, and 16 did not answer. One hundred forty-nine of the participants had completed education up to a high school level, 64 had completed education up to a college level, 19 had completed education up to a graduate level, and 16 did not answer.

4.1.1 Paper vs. Smartphone

The bar chart in Figure 4.1 shows the percentage breakdown of the responses that our smartphone-using respondents made to the question, "How likely are you to do the following tasks on paper versus on your smartphone?" for each of the 25 information scrap tasks. The tasks are ordered from left to right by their ratio of "Very likely to use paper" responses to "Very likely to use smartphone" responses. This gives us a rough idea of where each task falls on the continuum of people's preference for paper vs. smartphone. One of the most obvious characteristics of this data is how nearly a third of these tasks seem to skew heavily toward the smartphone, with the 7 rightmost tasks—*Record a name or contact information*, *Record a web address [...]*, *Record a desired*

item, *Record login [...]*, *Capture part of a text message [...]*, *Make a reminder*, and *Record airplane flight information*—having greater than half of responses as "Very likely to use smartphone". In contrast, only 1 of these tasks—*Make technical notes*—has greater than 50% of responses as "Very likely to use paper".

Another interesting feature of the data is that most tasks do not exhibit an even distribution between answers. Even leaving aside the tasks where a "Very likely..." choice contains a majority of the answers, most tasks clearly favor one medium over the other. Only for the *Record an idea* task did the "Equally likely..." choice garner the most responses. As well, only a few tasks—*Make or edit a "to do" list*, *Make notes about a voice conversation*, and *Make a list of events or an agenda*—show strong clustering at both ends of the Likert scale instead of just one end.

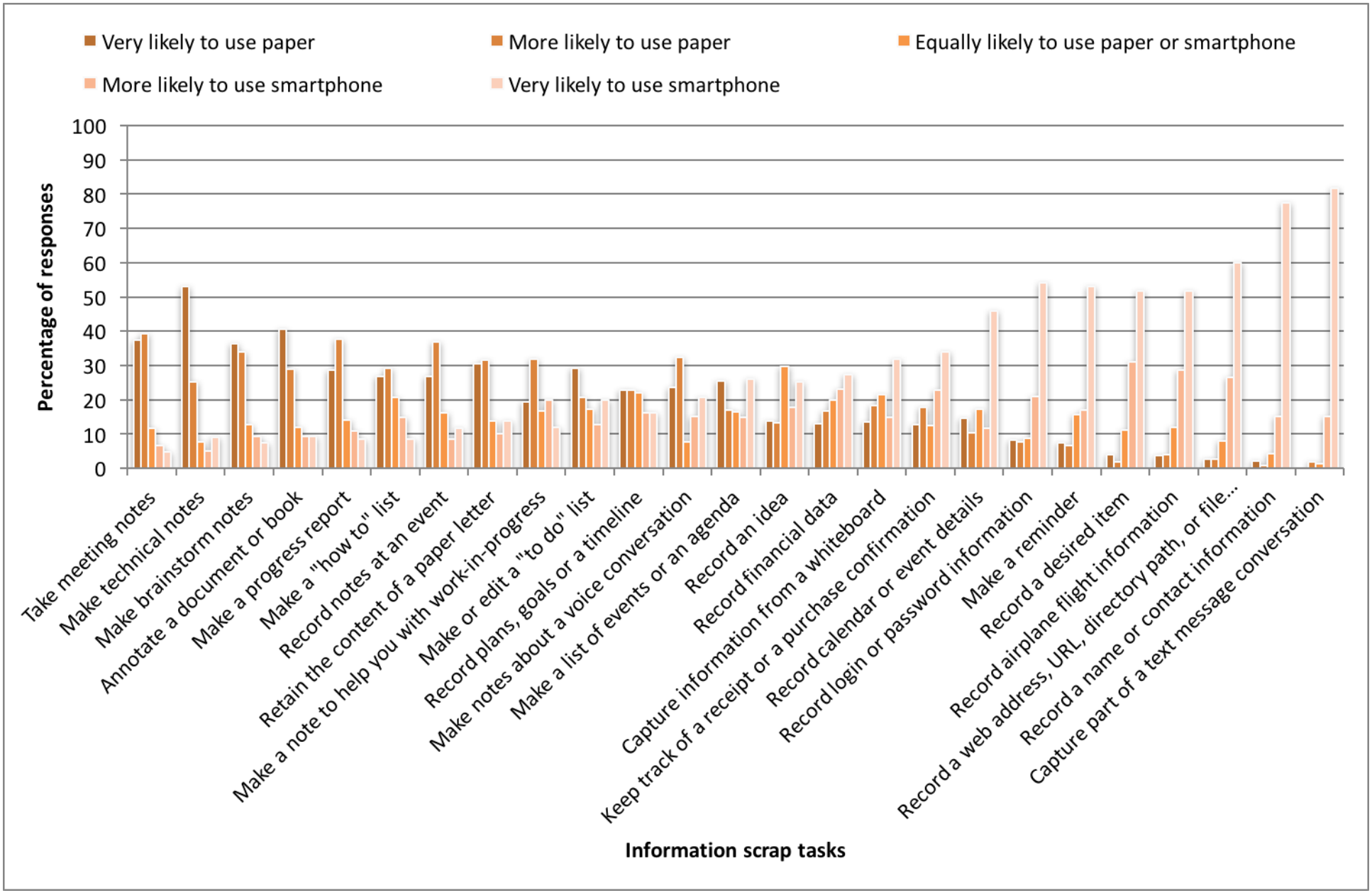

Figure 4.1: Responses to the question, "How likely are you to do the following tasks on paper vs. on your smartphone?"

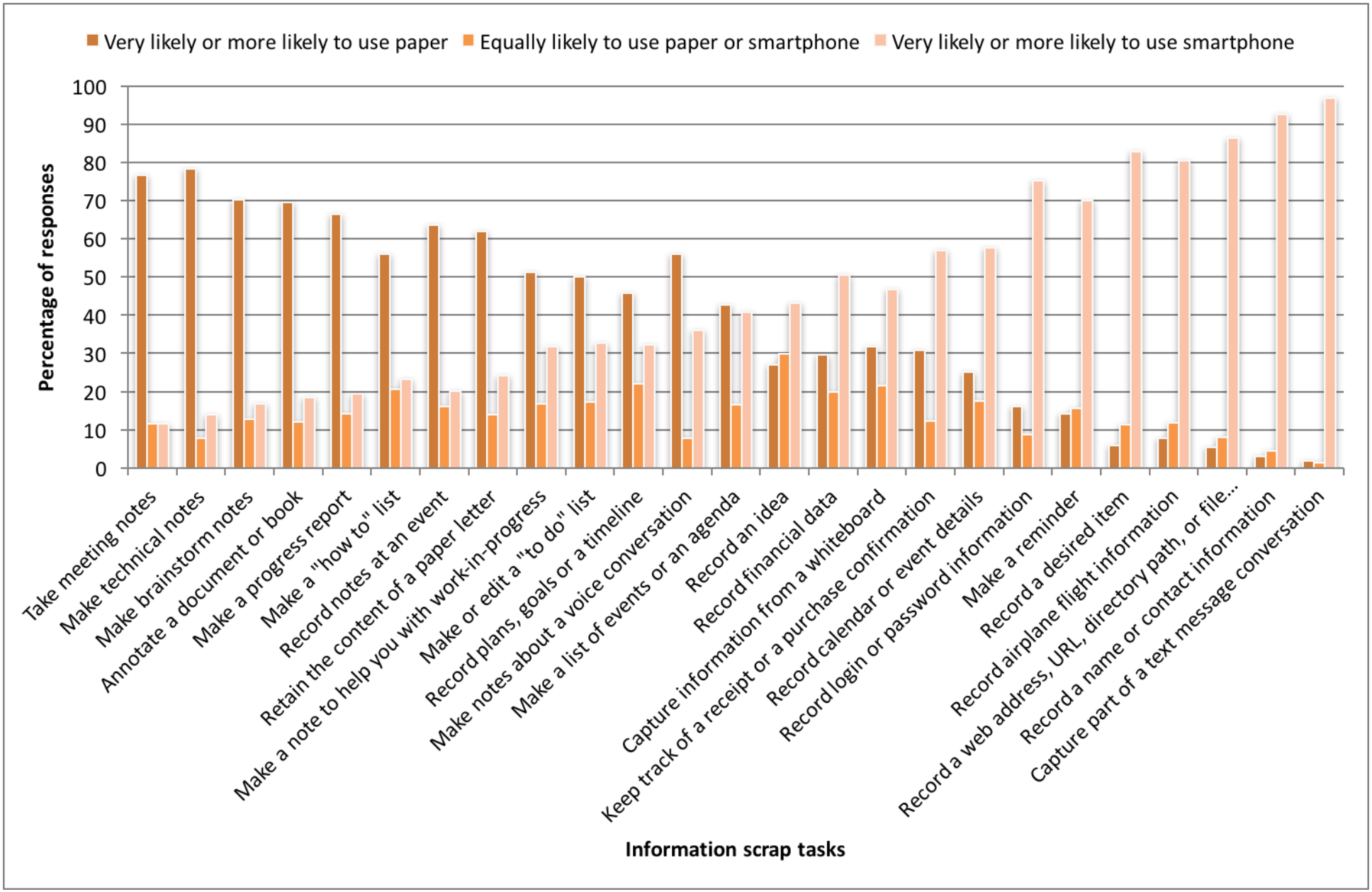

Figure 4.2: Grouped responses to the question, "How likely are you to do the following tasks on paper vs. on your smartphone?"

A different way of looking at this data is to group the "Very likely..." and "More likely..." responses together for each medium as in Figure 4.2. Doing so allows us to see which medium is most preferred for each information scrap task, however, that is not the most interesting reason to look at the data in this way. Rather, we can now see that for 11 of these information scrap tasks—*Make or edit a "to do" list, Take meeting notes, Make a "how to" list, Make a note to help you with work-in-progress, Make brainstorm notes, Record notes at an event, Make a progress report, Make notes about a voice conversation, Retain the content of a paper letter, Make technical notes, Annotate a document [...]*—50% or more of respondents selected answers that favor using paper over smartphones. For 10 other tasks—*Record a name or contact information, Record a web address [...], Record a desired item [...], Record login or password information, Record calendar or event details, Keep track of a receipt [...], Capture part of a text message conversation, Make a reminder, Record financial data, Record airplane flight information*)—50% or more of respondents selected answers that favor using smartphones over paper. This is a different picture than the one painted by the previous graph in Figure 4.1, wherein it appeared that, if clear participant preferences exist, the smartphone medium was preferred much more than paper. Comparing that graph with Figure 4.2, we instead see that participants tend to use paper for 11 tasks but *not to the exclusion of smartphones* for 10 of those tasks. However, because 7 tasks out of the "Very likely or more likely to use smartphone" majorities in Figure 4.2 have "Very likely to use smartphone" majorities in Figure 4.1, it appears that participants do tend to use smartphones for these tasks *to the exclusion of paper*.

Digging deeper, we can start to see trends in the kinds of tasks for which people are using these different mediums. At the far right end of the graphs are the tasks people do almost exclusively with smartphones. Consider the task *Capture part of a text message conversation (SMS, iMessage, WhatsApp, etc.)*. This is an information scrap task where the smartphone may act as both the conduit for receiving the scrap's content and the repository for that content's consumption. In other words, the smartphone and its messaging apps appear to have so thoroughly addressed people's needs for the information scrap type that it has almost entirely replaced paper for this purpose. The same may be true for the *Record a name or contact information* task. Cellular phones have had contact lists for a long time, and they have provided ways to enter contacts into their data schema. But on a smartphone, it has become trivial to exchange contact information by simply exchanging a message (text, email, etc.). Recording a contact like this postpones the cognitive overhead of entering data into a contact list app's data schema while positioning the data for easy entry later. This obviates the need to use a more general-purpose information scrap tool for such a task. Like recording a contact or a text message conversation, the tasks *Record a web address […]*, *Record airplane flight information*, and *Record a desired item […]* may also heavily favor smartphones due to the smartphone's capability as both data conduit and data repository.

At the far left of these graphs, we see the tasks people still do mostly with paper. One group that jumps out immediately is note-taking tasks, i.e., *Take meeting notes*, *Make technical notes*, *Make brainstorm notes*, *Annotate a document or book*, and *Record notes at an event*. These tasks lack the "data conduit" aspect of the smartphone-leaning tasks discussed earlier, which may be one reason respondents favored paper. Another

commonality of these tasks is that they tend to support *retrospective memory*, or memory of things that have already happened, as opposed *prospective memory*, or memory of things that will happen in the future.

In the middle of these graphs is where we tend to find the prospective memory tasks. This indicates people are split in their propensity to use one medium over the other for them. These tasks include *Make or edit a "to do" list*, *Record plans, goals or a timeline*, *Make a list of events or an agenda*, *Record an idea*, *Record calendar or event details*, and *Make a reminder*. Like retrospective memory tasks, these ones also lack the "data conduit" aspect of the tasks for which respondents most heavily favored smartphones. Even still, smartphones seem to be supporting these prospective memory tasks to a far greater extent than they are supporting retrospective memory tasks.

4.1.2 Task Frequency

In addition to asking participants to rate how likely they were to do 25 information scrap tasks on paper vs. smartphone, we asked respondents, both smartphone-using and non-smartphone-using, to rate how often they perform those same tasks, regardless of medium. Participants selected on a Likert scale from among the choices *rarely or never*, *monthly*, *weekly*, *daily*, and *multiple times per day*. The bar chart in Figure 4.3 shows the percentage breakdown of responses that participants made.

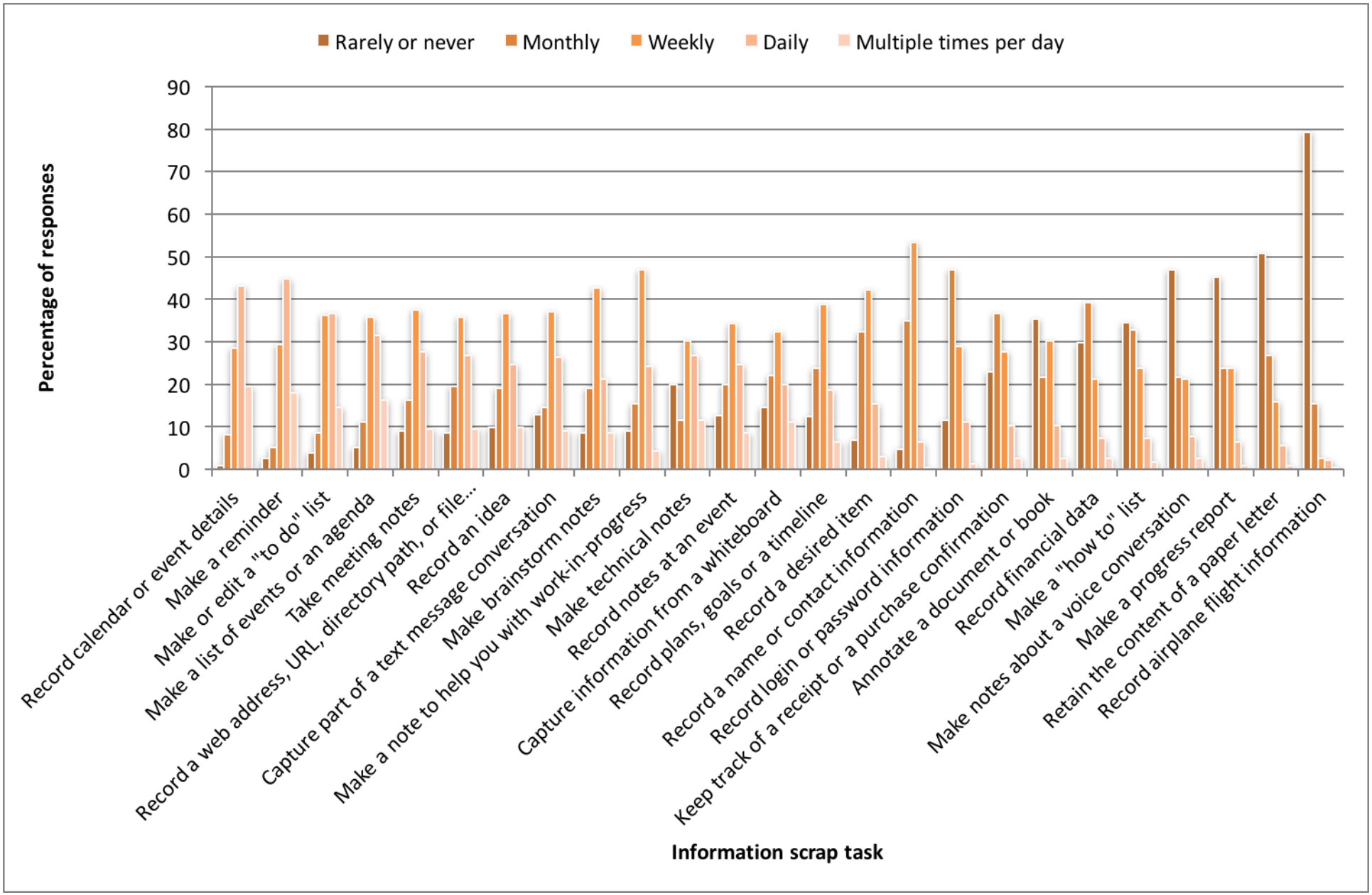

Figure 4.3: Responses to the question, "How often do you perform the following tasks?

In contrast to the paper vs. smartphone graph in Figure 4.1, most tasks' frequency answers roughly approximate a bell curve with an apex at either weekly or daily. Since these are information scrap tasks, i.e., work that helps people to do other work, these results are not surprising. We would not expect an information scrap task to have a majority of *multiple times per day* answers since that might indicate that a particular information scrap task had become a significant portion of many people's day to day lives. More interesting are the 6 tasks that each have a majority of "Rarely or never" answers. These results are somewhat surprising since the 25 information scrap tasks we analyzed were chosen from among the most common information scraps that Bernstein, et al. [3] discovered.

We did not perform this analysis, however, to find out exactly how often people perform these tasks, as participants' memories are faulty and degrade rapidly over time. Rather, we wanted to rank these tasks based on how often people perform them. Obviously, participants' memories are still suspect, but we are confident in people's abilities to bin the tasks they perform into these coarse task frequency choices. In translating our results into relative rankings, we created a simple formula that, when applied to the totals in each bin for a particular task, results in a frequency score for that task. For a particular task T, *a* is the number of *monthly* responses, *b* is the number of *weekly* responses, *c* is the number of *daily* responses, *d* is the number of *multiple times per day* responses, and *n* is the total number of responses, the frequency score of that task is:

$$f(a,b,c,d,n) = \frac{a + 2b + 3c + 4d}{n}$$

Equation 4.1: Frequency score equation

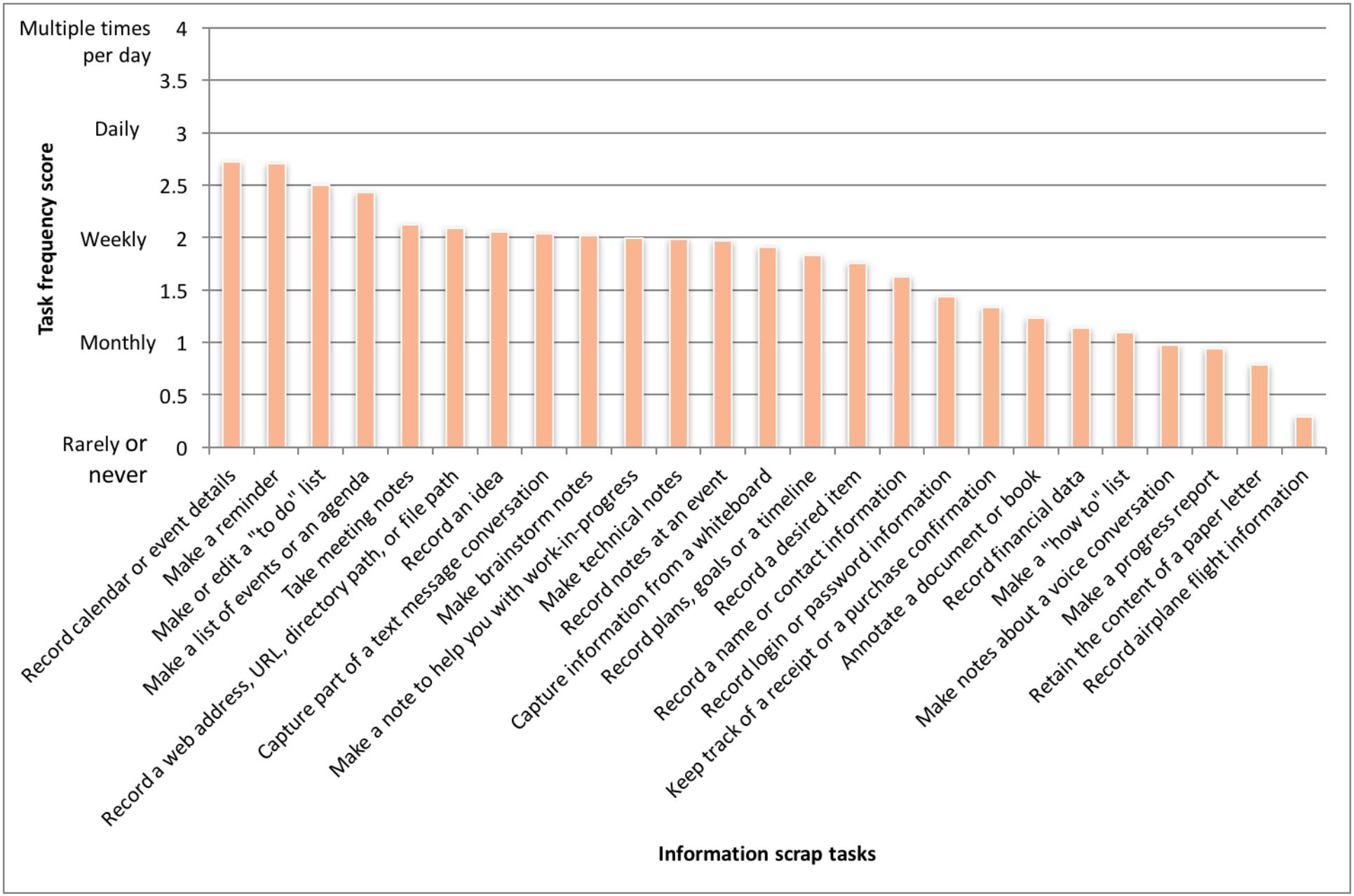

Figure 4.4: Task frequency rankings based on responses to the question, How likely are you to do the following tasks on paper vs. on your smartphone?"

The result lets us approximate the average frequency, in terms of our Likert scale answers, for each task as shown in Figure 4.4. Again, this is not useful as a measure of how often participants actually perform a task, but it is useful for seeing the tasks in terms of their perceived frequency. The ordering of the tasks in Figure 4.4 is from most frequent to least frequent.

At the far left of the graph, we find the most frequently reported information scrap tasks. Surprisingly, the 4 highest scoring tasks are of the *prospective memory* set we identified earlier. These tasks, which hover around the midpoint between *daily* and *weekly* on our graph, include *Record calendar or event details*, *Make a reminder*, *Make or edit a "to do" list*, and *Make a list of events or an agenda*. No other obvious task groupings emerge from this visualization, as paper-preferred and smartphone-preferred tasks are distributed throughout the rest of the graph in Figure 4.4.

4.1.3 Frequency of Smartphone Tasks

We now attempt to shed some light on the question, "Are smartphone information scrap tasks the information scrap tasks that people are doing most often?" The graph in Figure 4.5 is a scatterplot of the information scrap tasks with scrap medium likelihood along the X-axis and task frequency along the Y-axis. The X-axis is centered at 0, at which there is an equal likelihood of people using smartphone or paper for a particular task. We arrived at X values for tasks by assigning the responses *Very likely to use paper*, *More likely to use paper*, *Equally likely to use paper or smartphone*, *More likely to use smartphone*, and *Very likely to use smartphone* to the values -1, -0.5, 0, 0.5, and 1 respectively and averaging the value of responses for each task. Similarly, the Y-axis is centered at 0, at which the average frequency for a task is Weekly. We arrived at Y

values for tasks by assigning the responses *Rarely or never*, *Monthly*, *Weekly*, *Daily*, and *Multiple times per day* to the values -1, -0.5, 0, 0.5, and 1 respectively and averaging the value of responses for each task.

Looking at this graph, we cannot say that tasks are being performed much more often using smartphones than paper or vice versa. However, considering the state of smartphone scrap making in Bernstein, et al. [3], we may say that the use of smartphones has made serious inroads against paper into many common information scrap tasks. This figure provides a snapshot into a clear trend toward smartphone over paper for such tasks. The tasks on the paper side of the graph hover much more closely to the center than tasks on the smartphone side of the graph, which more often hew toward the far edge. Further, the two most frequent smartphone tasks are much greater in their smartphone tendency than the two most frequent paper tasks are in their paper tendency. Again, these 4 most frequently performed tasks, for which there seems to have been much smartphone adoption, all have *reminding* aspects. The most frequently performed tasks for which smartphones appear to have made the fewest inroads are tasks for taking notes that provide cognitive support and/or support retrospective memory, such as technical notes, brainstorm notes, document annotations, etc. This cluster of similar, semi-frequent tasks suggests important information scrap categories for which paper is still better suited than the smartphone.

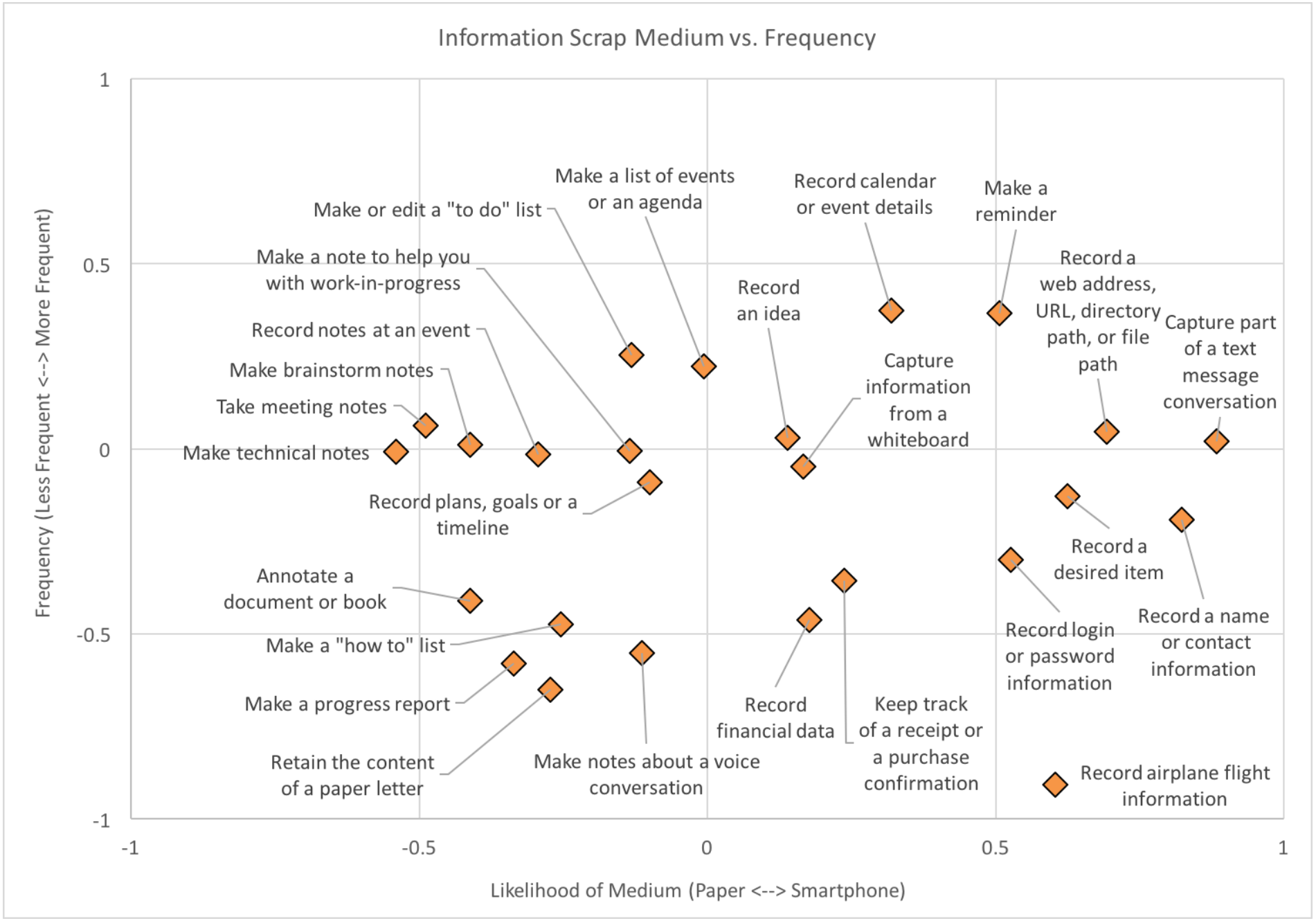

Figure 4.5: Information scrap task medium likelihood vs. frequency

4.2 ISSE Study Part 2: Diary Study

In the diary study portion of our investigation of *Information Scraps in the Smartphone Era*, we recruited fourteen participants from among Virginia Tech's students, faculty and staff in order to document some of the information scraps they made over a two-week period. Nine participants were female, and 5 were male. Eight of the participants were between 18 and 25 years old, 4 were between 26 and 35, none were between 36 and 45, 2 were between 46 and 60, and none were 60 or older. Six of the participants had completed education up to a high school level, 5 had completed education up to a college level, and 3 had completed education up to a graduate level. Prior to beginning each participant's diary recording period, we conducted a semi-structured interview to introduce the participant to the concept of information scraps as well as to explore the information scraps participants had on their smartphones.

4.2.1 Semi-structured Interviews

Our semi-structured interviews were similar to Bernstein, et al.'s [3] semi-structured interviews, however, they differed in some important ways. In Bernstein's interviews, researchers searched for information scraps along three axes—*tool*, *location* and *type*—for later analysis and categorization. Our interviews focused not on finding participants' information scraps but on finding participants' information scrap behaviors. As such, instead of searching participants' smartphones along Bernstein, et al.'s [3] three axes, we searched along the five roles identified by Bernstein in which information scraps may serve. These roles include *temporary storage*, *reminding*, *cognitive support*, *archiving*, and *unusual information storage*. The figures in this section show the most common behaviors that we documented for each information scrap role among our 14

participants. Similar to the "long tail" of uncommon information scrap types that Bernstein, et al. [3] found, we found a number of unique behaviors for each information scrap role that only a single participant practiced.

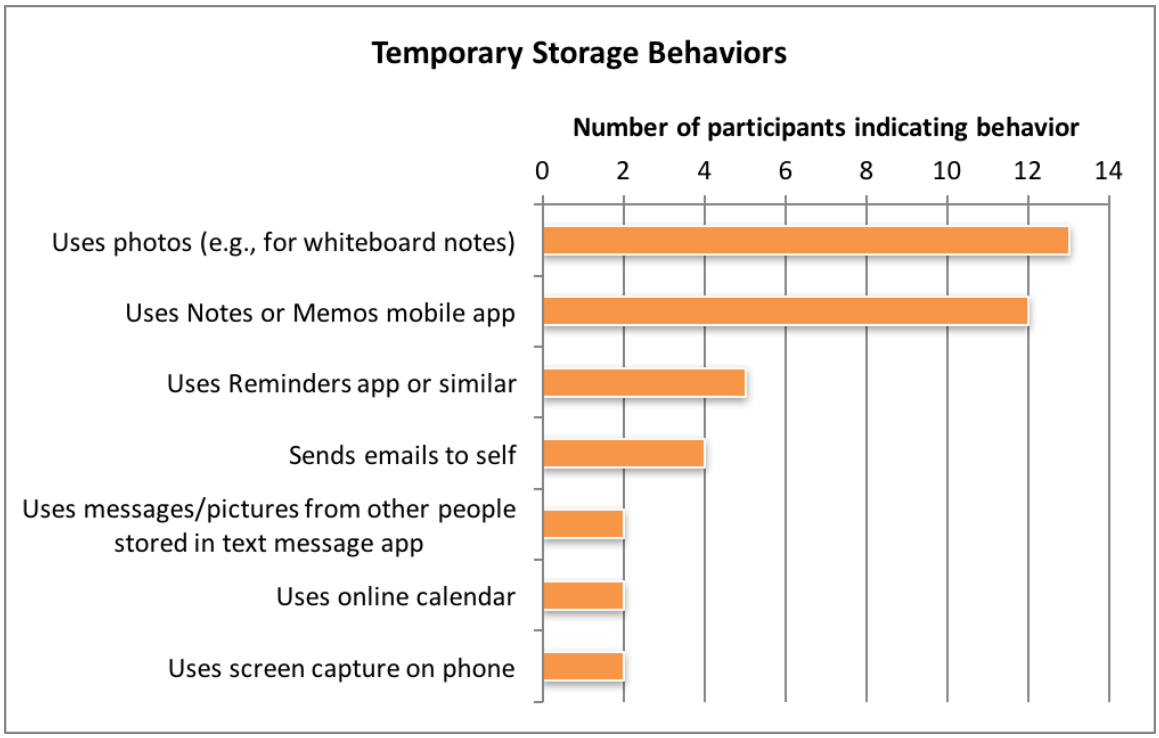

Figure 4.6: Documented 'temporary storage' behaviors in semi-structured interviews

Participants described 22 unique *temporary storage* behaviors in total. This was the second highest counted, after *reminding*, for an information scrap role. Figure 4.6 shows all of the *temporary storage* behaviors exhibited by at least 2 participants. The most ubiquitous behavior for this role—or any other role—was using the camera embedded in each participant's smartphone to create an information scrap by taking a picture. This was followed closely by using the free-form text entry apps *Notes* and *Memos* to create temporary information scraps. Commonalities in this area dropped off quickly as participants seemed to adopt more specialized and idiosyncratic behaviors for their temporary storage needs.

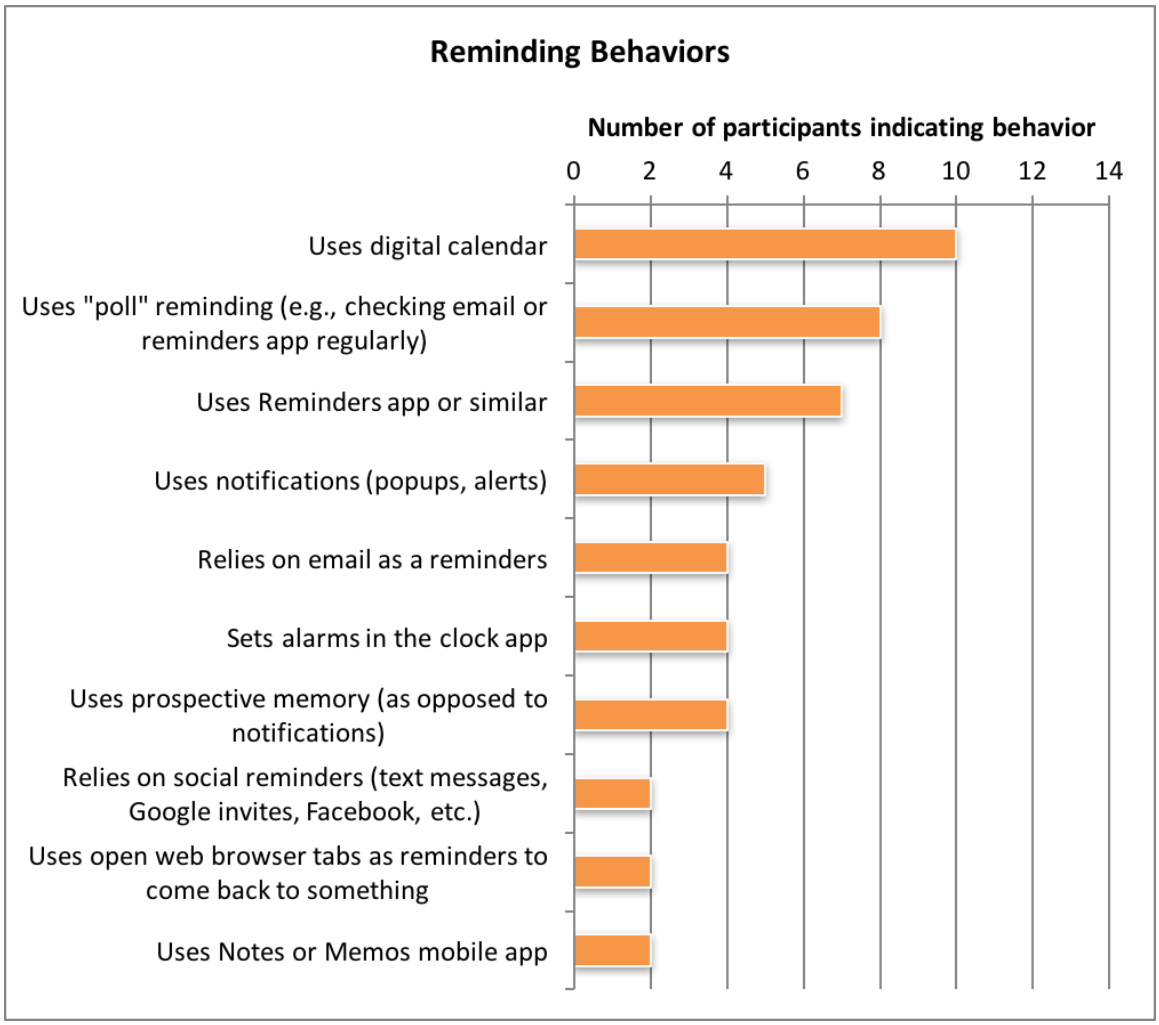

Figure 4.7: Documented 'reminding' behaviors in semi-structured interviews

Participants displayed the widest variety of behaviors for the *reminding* role with 24 types in total. Figure 4.7 shows all of the behaviors exhibited by at least 2 participants. A majority of participants used some kind of digital calendar for reminding on their smartphones. Half also used a dedicated *Reminders* app. A smaller set utilized the alarm capability of their phones' clock app for reminding. We also see a variety of prospective memory reminding strategies employed. While less than half relied on some kind of notification such as pop-ups or alerts, a majority claimed to check their reminding apps quite often for the things they wanted to be reminded of. A smaller set claimed that just

the act of recording a reminder was enough to help them remember it, a behavior documented by Lin, et al. [2]. One of the more distinct impressions we get from this data is just how varied the methods of reminding can be. Participants used email, browser tabs, and social media channels in addition to more conventional reminding apps.

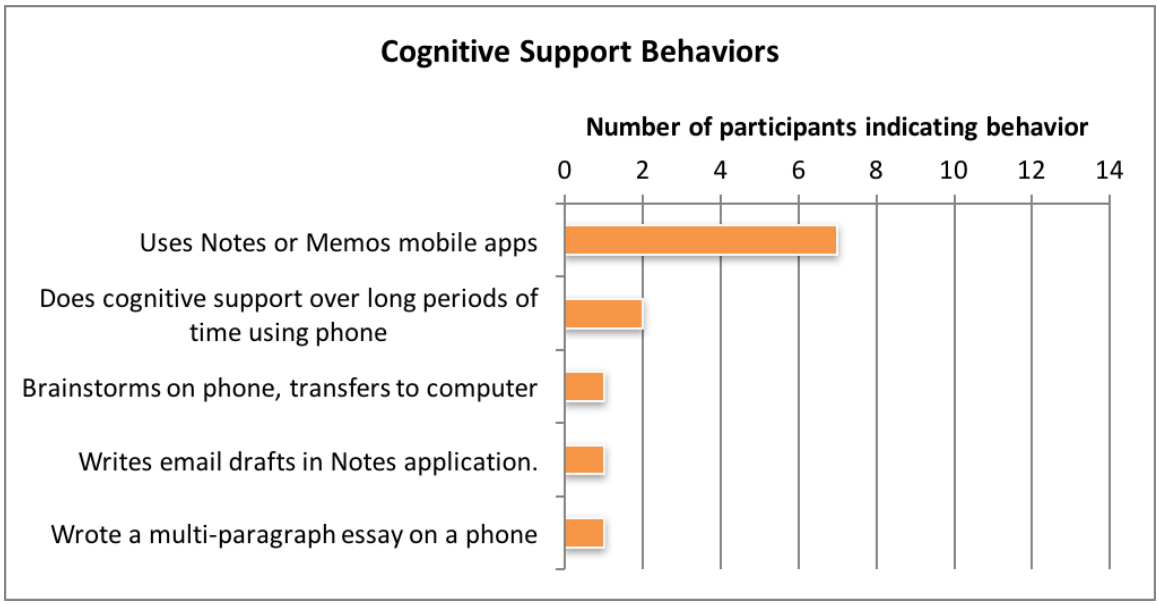

Figure 4.8: Documented 'cognitive support' behaviors in semi-structured interviews

At only 5 in total, participants showed few *cognitive support* behaviors in connection with their smartphones, as illustrated in Figure 4.8. Further, only 2 behaviors had any commonality among participants. The most common behavior was using the free-form text entry app, either *Notes* or *Memos*, included with each participant's smartphone. The other recurrent behavior, which we saw only twice, was maintaining scraps for cognitive support over long periods of time. For example, Participant ISSE103 was maintaining a list of graduate schools. Regarding scraps for cognitive support, he said, "I guess that would primarily be that list of grad schools that I jotted down, because that I go to every few days and I edit it, and I'll make additional notes and things like that." Most participants, however, said that when they do work requiring cognitive

support, such as making brainstorm notes, they like to use a computer or pen and paper more than their smartphones.

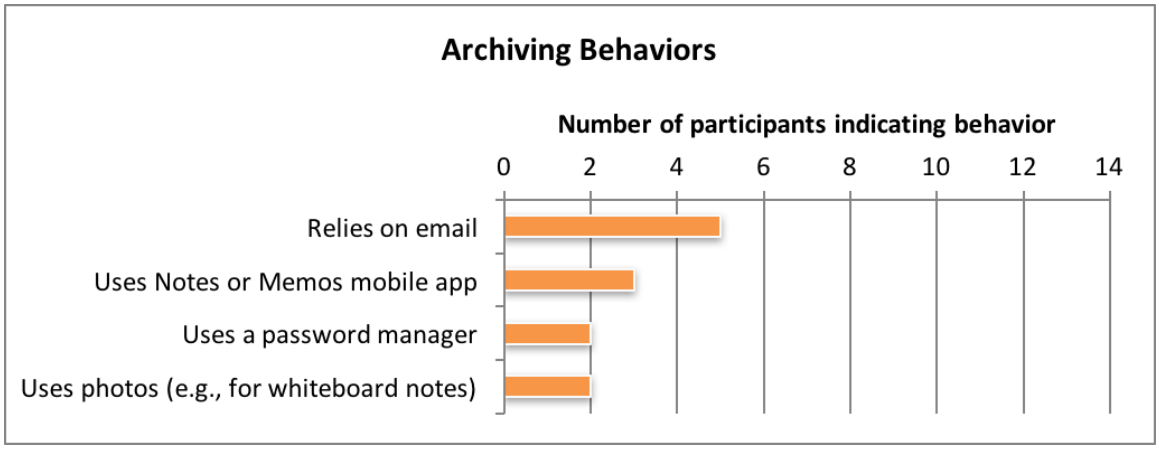

Figure 4.9: Documented 'archiving' behaviors in semi-structured interviews

Participants described 15 different smartphone *archiving* behaviors, however none of them were done by more than 5 participants. Figure 4.9 shows all of the behaviors exhibited by at least 2 participants. Interestingly, the most common *archiving* information scrap behavior that participants exhibited was the retention of email. Archiving email is not an information scrap activity that is particular to smartphones, but smartphone email apps seem to make it easy to extend email saving, curating, and re-finding activities to the medium. Some participants also used either the *Notes* or *Memos* app for long-term storage of information scraps. Indeed, it appears that *Notes*/*Memos* information scraps that are meant to serve as temporary storage transition very easily into the archive role simply by their owner taking no action to remove them. In addition, we see more evidence of smartphones' cameras being repurposed for information scrap storage. Again, temporary information scrap photos appear to transition easily to long-term archives without action from their creator.

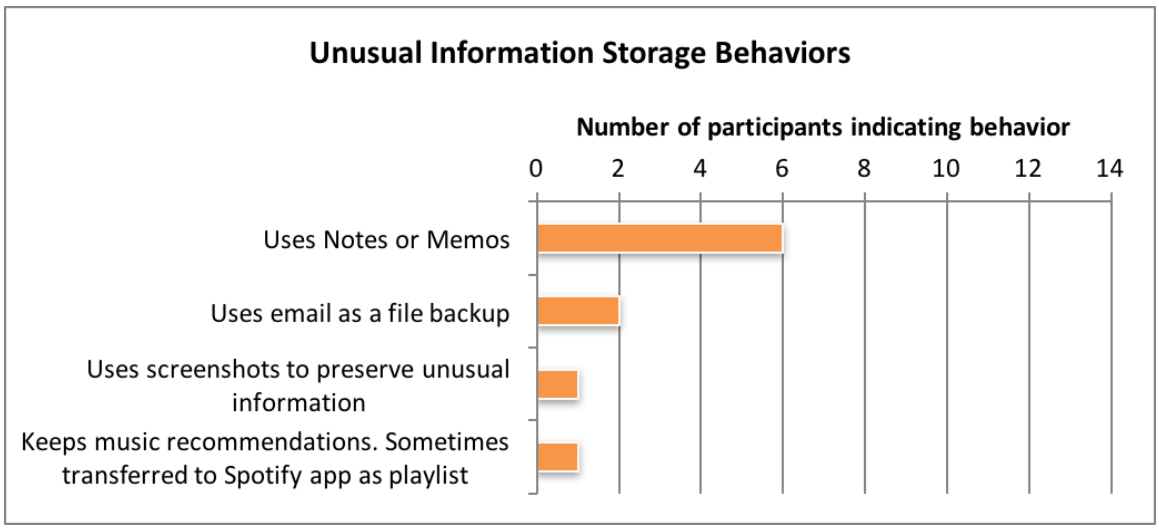

Figure 4.10: Documented 'unusual information storage' behaviors in semi-structured interviews

At only 4 in total, participants showed the fewest types of unusual information storage behaviors, as illustrated in Figure 4.10. Perhaps owing to this role's nature as a catchall for hard-to-manage information scrap data, participants who did try to manage such data on their smartphones tended to use their phone's freeform text app. Two participants also used their email as a backup for files containing unusual information. For one of these individuals, Participant ISSE112, an email he sent to himself containing an important attachment acted as a failsafe against other file storage systems, such as a USB stick, being unavailable. For the other individual, Participant ISSE113, email acted as a passive store of files attached to emails, which might be needed at some point in the future.

4.2.2 Diary Entries

For the diary collection portion of our diary study, we wanted to capture information similar in type to what we had solicited in our interviews. However, we wanted to capture it with little delay between the times when participants created an

information scrap and the times when we asked for their information scrap descriptions. This way, an information scrap would be fresher in a participant's mind when describing it. Further, we would be more likely to capture data about short-lived information scraps that might not have been captured in prior studies such as Lin, et al. [2] or Bernstein, et al. [3]. We collected 82 diary entries in total from 14 participants with no participant submitting fewer than 4 (out of 7 solicited) diary entries.

4.2.2.1 Medium

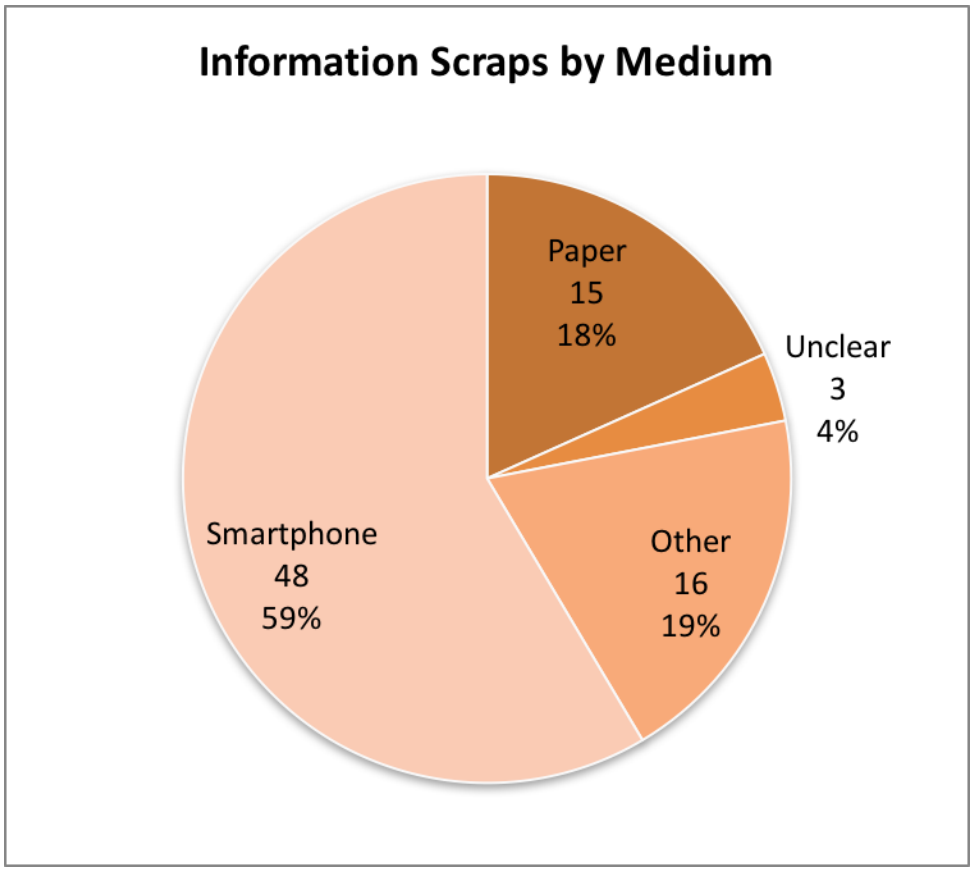

Figure 4.11: ISSE diary study information scraps by medium

While we only selected participants who currently used a smartphone, we instructed them to record diary entries about the most recent information scrap they made regardless of medium. Figure 4.11 shows a breakdown by medium of all recorded

information scraps. Participants reported making smartphone information scraps over 3 times as often as paper information scraps. They also favored using their smartphone more than 3 times as often as all mediums in the *Other* category combined. On the diary entry survey, the *Other* answer selection had a text entry field where participants could report the specific medium they used. Responses included "Tablet", "Laptop", "Computer", and "Whiteboard". The *Unclear* category in this diagram represents confusing or inaccurate answers that we were unable to otherwise categorize. These data provide significant support to the notion that information scraps are moving to smartphones.

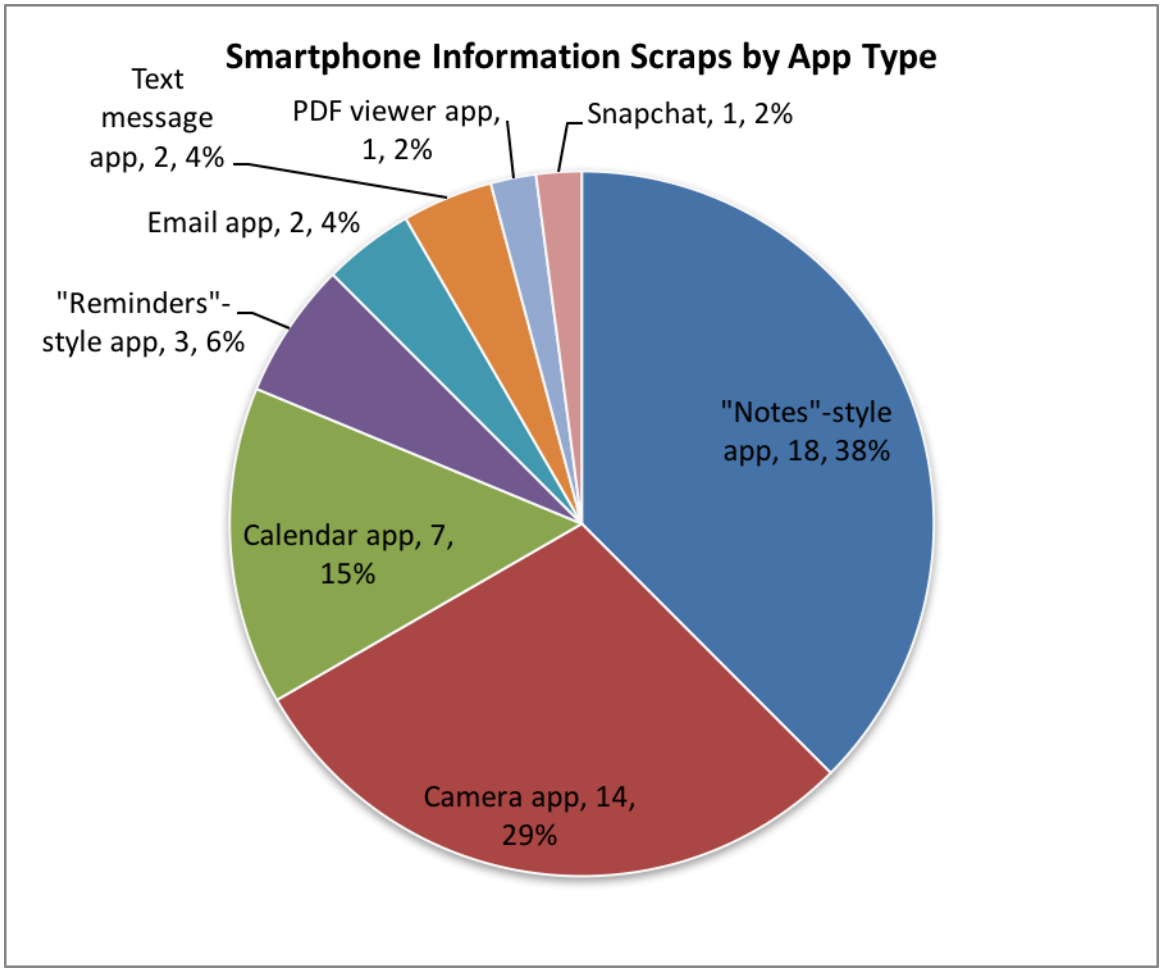

Figure 4.12: ISSE diary study smartphone information scraps by app type

In Figure 4.12, we break down the smartphone information scraps by the types of app that were used to make them. Most popular were freeform text entry apps in the style of the iPhone's *Notes* app. In fact, since the majority of participants were iPhone users, nearly all of such scraps were made using *Notes*. That participants used *Notes*-style apps the most is not surprising considering the versatility and ready availability of such tools. *Notes*, for example, can be ready to accept arbitrary text input for a new scrap in as little as three steps: 1) unlock the phone, 2) tap the app icon, and 3) press the + (new note) button. Next most popular, were camera apps, which accounted for 29% of smartphone information scraps. While *Notes*-style apps are an obvious analog to paper information scrap mediums, camera apps have few similar pre-smartphone mediums with which to compare. Bernstein, et al. [3] found only 2% of analyzed information scraps to contain pictures, whereas information scraps made with just smartphone camera apps make up 17% of all information scraps in our study. Calendar apps were the third most popular tool for smartphone information scraps, while *Reminders*-style apps were fourth most popular. Between these two groups, 21% of smartphone information scraps were made using tools with obvious prospective memory features. However, over half of the information scraps we analyzed serve as prospective memory aids, as will be illustrated in the *Information Scrap Roles* section.

4.2.2.2 Information Scrap Roles

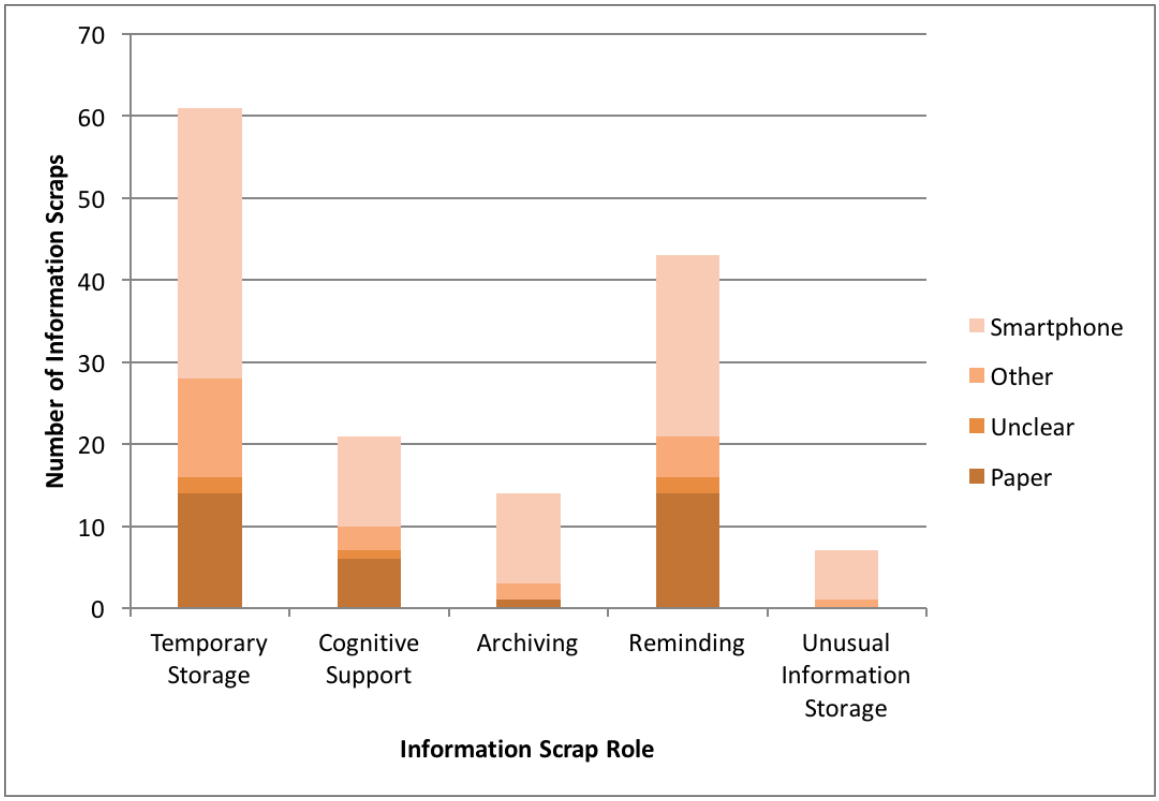

Figure 4.13: ISSE diary study information scrap counts by role [3], broken down by medium

As part of each diary entry, we asked participants to report which roles an information scrap served, as shown in Figure 4.13. The most reported information scrap role was *temporary storage*, followed in descending order by *reminding*, *cognitive support*, *archiving*, and *unusual information storage*. It is worth noting that the three most reported roles correspond to the three "most common types of notes usage" (temporary storage, prospective memory aid, and immediate use) described in Lin, et al. [2]. Consistent with Figure 4.11, participants most often reported the smartphone as their medium of choice for each role. We notice some variation from the ratios apparent in Figure 4.11, and, if we remove the scraps with *unclear* mediums from the data set, a chi-squared test reveals correlation between information scrap medium and role ($p<0.05$).

Specifically, the *smartphone* medium has outsized representation in *archiving* and *unusual information storage* roles, and it has undersized representation in the *temporary storage* role. This, of course, does not diminish the fact that *smartphone* scraps make up the majority of information scraps in all of these roles.

When running pilot interviews for our study, it became clear that, from the perspective of participants, information scraps often served in more than one of the roles reported by Bernstein, et al. [3]. As such, when asking participants to categorize their information scraps according to role, we allowed them to select more than one. Figure 4.14 is a Venn diagram showing the role overlap of information scraps reported by participants. For clarity, only the 3 most frequently recorded roles—*temporary storage*, *reminding*, and *cognitive support*—are shown, but the other two roles show a similar degree of overlap. Indeed, the degree of overlap between these roles is quite remarkable.

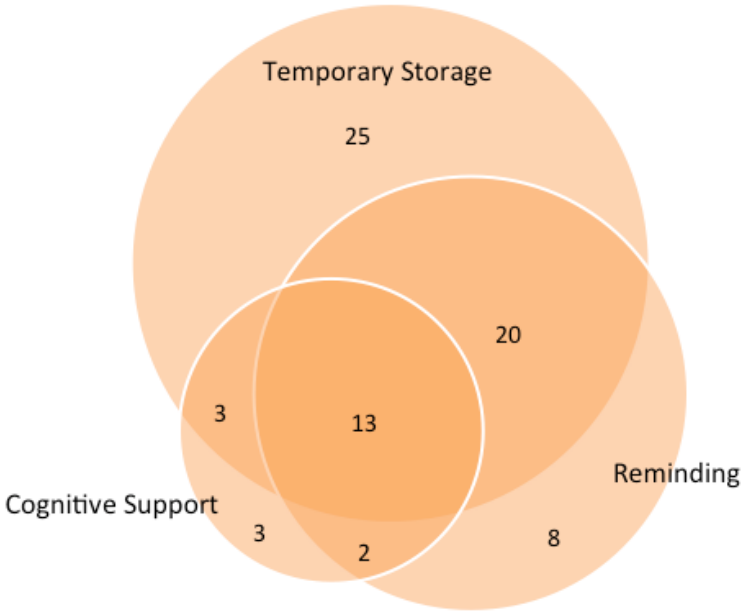

Figure 4.14: Venn diagram of role overlap of ISSE diary study information scraps

Recall that the five roles we discuss are a superset of the roles in Lin, et al.'s [2] micronote lifecycle in which a micronote is made for *temporary storage*, aiding prospective memory (*reminding*), or immediate use (*cognitive support*). While Lin, et al. [2] considers these roles to be along divergent paths in the micronote lifecycle, our data show otherwise. Participants consider nearly half of their *temporary storage* information scraps to also serve as *reminding*, and more than a third of that subset to also serve as *cognitive support*. In fact, *cognitive support* is so taken up by the other two roles that it hardly describes an independent role at all in this data set. Rather, it seems to be a sometime-benefit of making a *temporary storage* or *reminding* information scrap. As well, it seems that *reminding* is closely tied to *temporary storage* with 33 out of 43 of

reminding information scraps also serving in that role. This makes sense considering that many common reminder mediums, from Post-It notes to calendars to reminder apps, encourage encoding of information beyond simple memory triggers. In this light, it may be more helpful to think of these mediums as *temporary storage* mediums with reminding capabilities. In this diagram, only the *temporary storage* scrap set contains a large proportion of scraps not contained in the other sets. Considering that this set also contains, at 74%, the largest majority of recorded information scraps, the *temporary storage* role may be the most important role to participants and thus the one that most embodies the concept of information scraps.

4.2.2.3 Location

For each diary entry, we solicited a short answer response to the question, "Where were you when you recorded this information scrap?" Many answers seemed to group easily into two broad categories: *where one lives* and *where one works*. We named these *home* and *office* respectively. We noticed, however, that about half of the answers seemed to fall into an assortment of smaller categories, for example, "In the car", "in class", "Moe's [restaurant]", and "At the bus stop". We decided on grouping these into a third category we called *mobile*. We believe this category is significant as more than just a catchall for information scraps that aren't made at *home* or at *work*. Rather, this category is for all the scraps made when one does not have access to the personal information management tools available in their own workspace, which is most often when mobile. The restricted set of PIM tools that one does have when mobile must necessarily be portable. To illustrate this point, we disregard the distinction between *home* and *office* and group these sets of information scraps together in Figure 4.15.

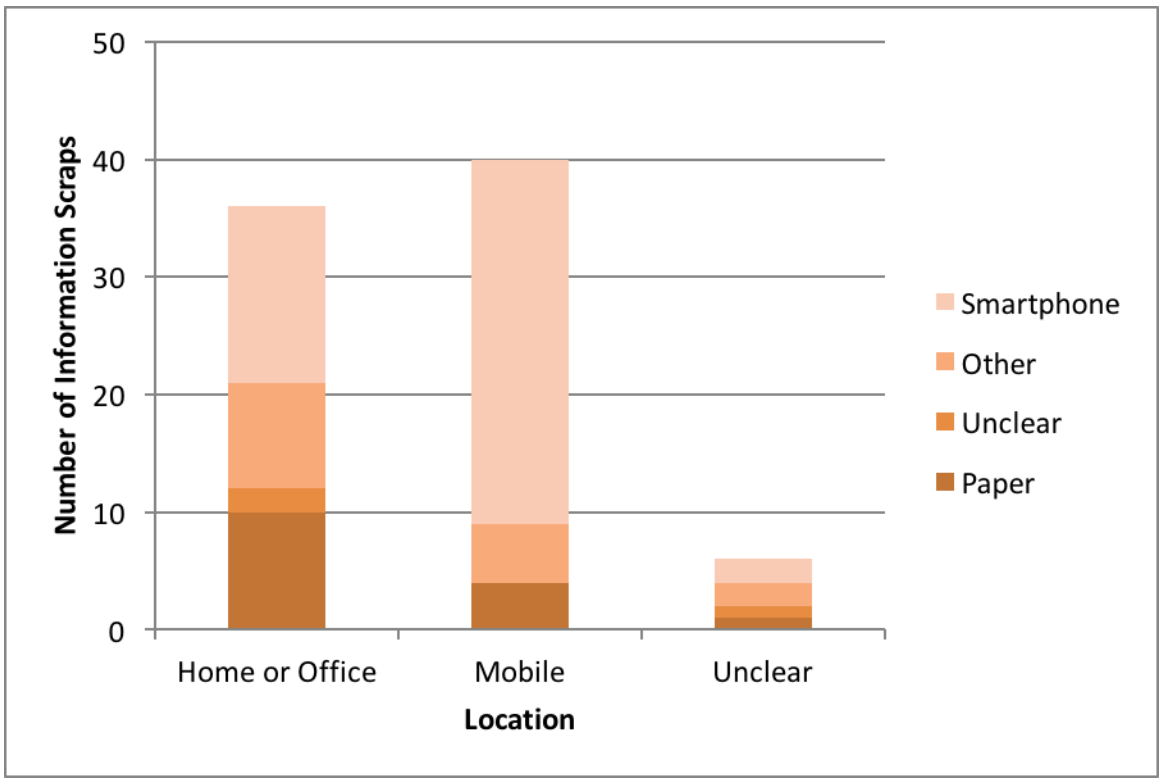

Figure 4.15: ISSE diary study information scrap counts by location, broken down by medium

In this figure, we can see the breakdown of the *mobile* and *home or office* categories along information scrap medium. Information scraps made while *mobile* are a slim majority over *home or office*. A two-proportion z-test reveals that the difference between *home or office* and *mobile* for smartphone use is significant ($p < 0.05$). Another such test shows the difference between *home or office* and *mobile* for paper use is significant as well ($p < 0.05$). The *Other* mediums, which are mostly reported as "tablet" or "computer", appear to be better represented in scraps made at *home or office* locations than *mobile* ones, however these results are not significant. The breakdown along medium seems to indicate that participants use different tools depending on whether or not they are mobile. Smartphone use is highly represented in *mobile* information scraps while paper is hardly represented at all. The comparison between smartphone and paper

is much closer among *home or office* information scraps. However, even with presumably more access to PIM tools in their homes and offices, participants still made a substantial amount of information scraps using smartphones.

Interestingly, we did not find any evidence that location and the information scrap roles are themselves correlated. A chi-squared test for correlation between these two variables in our information scrap data did not reveal any statistically significant relationship. This hints that, quite apart from an information scrap's intended use, location is an independent factor in a person's choice of information scrap medium.

4.2.2.4 Triggers

Lin, et al. [2] describe the first step in the micronote lifecycle as the *trigger*, the event that causes someone to feel the need to jot down a micronote. Their research shows that trigger events are quite varied and can occur anywhere [2]. To gain more insight into what triggers people to record information scraps, we asked participants, "What were you doing when you recorded this information scrap?" for each diary entry. As indicated by Lin, et al. [2], this produced all manner of answers, including "Watching a tv show (Star Trek)", "Reading my emails", and "I had just finished decorating my cake and was about to cover it with aluminum foil". Unfortunately, the question itself seems to have been worded too broadly to elicit many informative answers. While some answers, "In class trying to copy down notes," for example, illustrate activities that were clearly causative of their associated scrap—"Picture of notes in class," in that case—many more answers left such relationships obscured. One interesting result we do observe, however, is how rarely scrap-making seems to be triggered by the smartphone. Consider that a majority (59%) of recorded information scraps were made with smartphones. Consider also the many

avenues of communication that smartphones possess including phone calls, text messaging, email, app notifications, web browsing, social media, and so on. We might expect triggering through smartphone communication channels to occur at a relatively high rate. However, we could count only 6 information scraps that participants wrote due to smartphone triggers. Further, most of these were along the lines of "Contact information" recorded while "Making a phone call". Such triggers and scrap content were entirely typical before the widespread adoption of smartphones [2][3]. Do triggers originating with the smartphone really occur so infrequently? Are there really so few new smartphone triggers? Are triggers just more likely to originate through other channels or internal mental processes? Our original question was too broad to provide satisfying answers, and further research is warranted.

4.2.2.5 Completion, Deletion and Archiving

Once a micronote has fulfilled its purpose, it moves to the "Complete" stage in the micronote lifecycle, according to Lin, et al. [2]. From there, its owner either discards it or archives it. In order to better understand this process with regard to smartphone information scraps, we asked three questions about the state of the information scrap participants described in each diary entry.

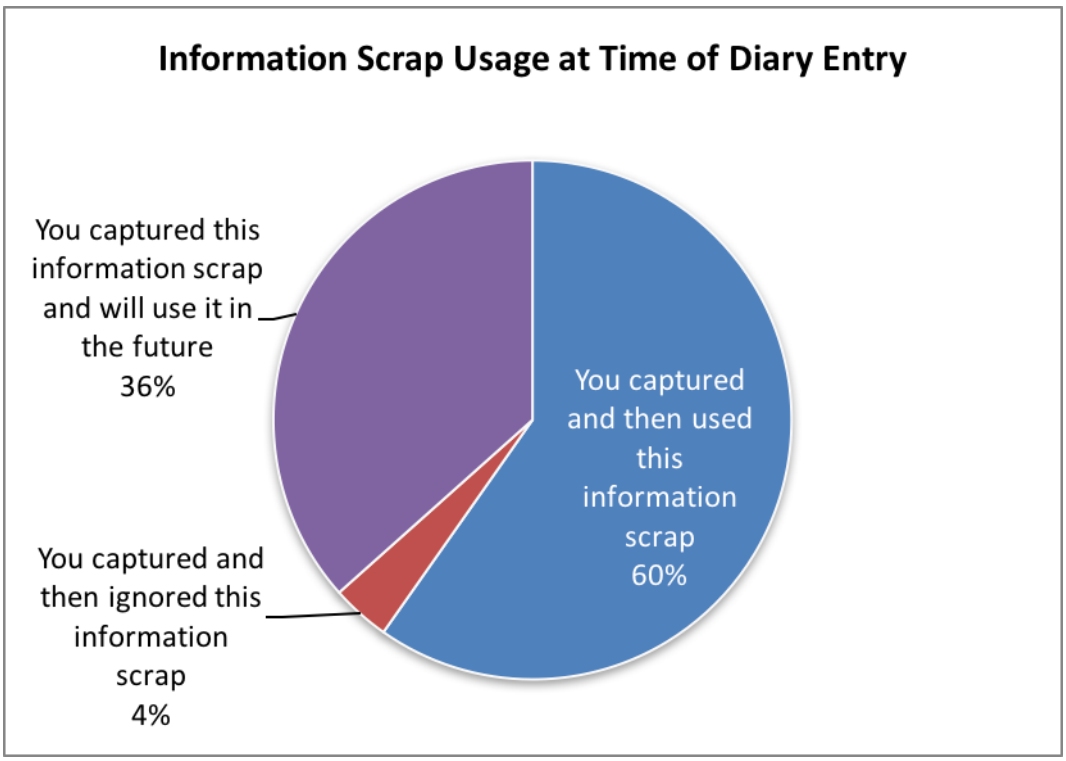

Figure 4.16: ISSE diary study information scrap usage at time of diary entry

The first question, which was multiple choice, asked, "Which of the following statements is most accurate? A) You captured and then used this information scrap. B) You captured and then ignored this information scrap. C) You captured and then lost this information scrap. D) You captured this information scrap and will use it in the future." This question lets us bin the "will use" information scraps into a state we refer to as pre-*complete*, which includes the micronote lifecycle stages after *record* but prior to *complete*. Doing so helps us analyze scraps from the micronote lifecycle perspective. The results of this question can be seen in Figure 4.16. These data show that in the short term, i.e., the two-day window that participants had to make scraps before being asked to report on their latest one, 60% of those reported scraps had already been used, 36% were awaiting future use, 4% were ignored, and none were lost. This high rate of used information scraps in the short term indicates the immediacy with which scraps are

needed after their creation. Interestingly, very few scraps were ignored after their creation. If this question were asked again about the same scraps after a longer period of time, we might expect the proportion of ignored scraps to increase as "will use" scraps age. A chi-squared test among information scraps between these categories and medium groupings (paper, smartphone, and other) shows no statistically significant dependence. Thus we cannot show that scrap medium has any bearing on how information scraps are used in the short term. It would be interesting to know if using smartphones to record information scraps affected how often scraps were lost, but since participants recorded no lost scraps, a different type of study may be needed to answer this question.

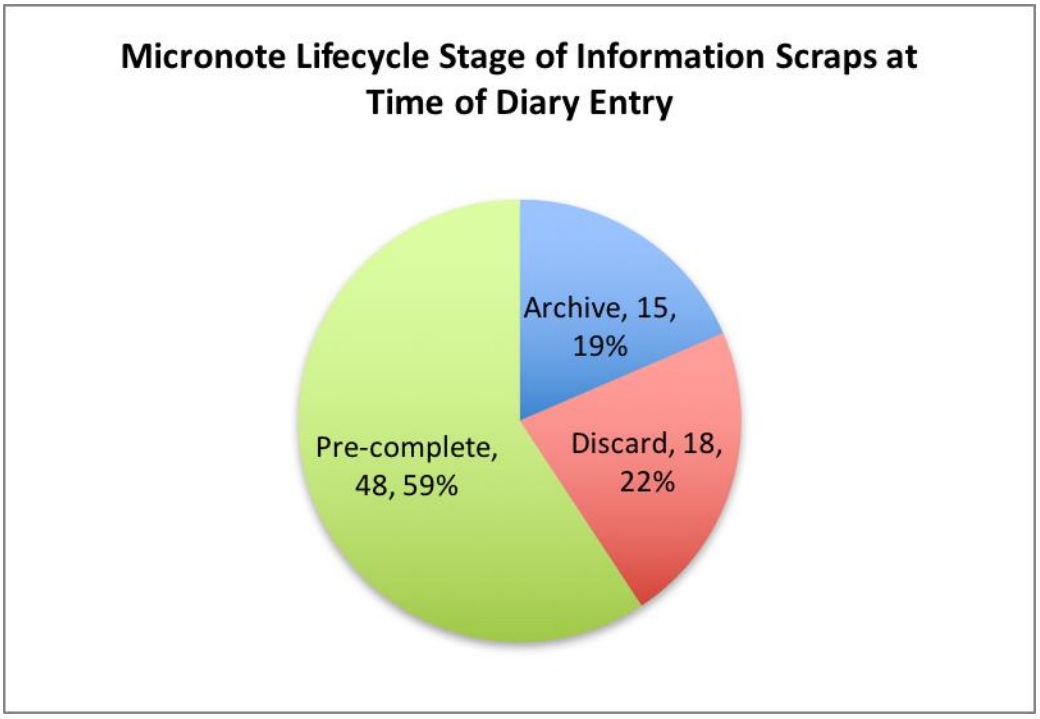

Figure 4.17: Micronote lifecycle stage of ISSE diary study information scraps at time of diary entry

The second question was only presented to those who answered, "You captured and then used this information scrap," or, "You captured and then ignored this information scrap," to the first question. It asked, "If you are finished using this

information scrap, have you kept it? A) Yes. B) No. C) Not finished using it yet." This question let us categorize the "used" and "ignored" information scraps into pre-*complete*, *archive*, and *discard* stages along the micronote lifecycle. The responses included 12 scraps reported as "not finished using it" (pre-*complete*), 15 reported as "kept" (*archive*), and 18 reported as "did not keep" (*discard*). Figure 4.17 shows the result of our categorizing all reported information scraps into micronote lifecycle stages based on answers from this question and the previous question. This figure makes it apparent that the majority of recorded information scraps had not yet passed the *complete* stage of the micronote lifecycle by the time they were recorded. While we suspect scrap medium is a factor in whether scraps are archived or discarded, our samples of archived and discarded scraps in this study alone are too small to draw any firm conclusions. However, it is interesting that 12 out of the 21 post-*complete* smartphone scraps were kept while only 1 out of the 5 post-*complete* paper scraps were kept.

The third question was only presented to those who indicated in the previous question that they were finished using the information scrap but had kept it. It asked, "What, if anything, have you done with this information scrap now that you are finished using it?" Responses were collected as short answer text. Of the 15 kept information scraps 12 of them were made with smartphones, 1 was made with paper, 1 was made on a computer, and 1 had a medium that was not totally clear (either smartphone or tablet). As such, most responses pertain to smartphone information scraps, and all but 1 pertain to scraps made with a digital medium. Eight of the answers indicated that participants simply left the information scraps where they were. Some of these answers indicated intent for future use, e.g., "It is still on my computer, I will use it in the near future," and,

"Kept it to remind myself what is done." Others indicated no such intent with answers like, "Nothing," or, "Kept it in my pictures." Three other answers indicated that participants kept their information scraps through their use of communication tools. These answers were, "Sent it to someone [as a text message]," "Sent it in a text," and, "Posted it on Instagram." Common in these examples, except for perhaps the Instragram post, is that participants spent no effort in archiving their information scraps above that needed to accomplish the original goals of their information scraps. The ease with which participants archived smartphone information scraps indicates the need for further research into this activity.

4.3 Information Scraps in the Smartphone Era Crowd

In our *Information Scraps in the Smartphone Era Crowd* (ISSE Crowd) study, we attempted to duplicate the diary study portion of our *Information Scraps in the Smartphone Era* study using Amazon Mechanical Turk (AMT) crowdworkers. As discussed in the Methodology section, we made some important changes from the previous study in order to facilitate our research with this new population. The most significant of these changes were the elimination of semi-structured interviews prior to diary entry collection and the removal of the option for participants to receive diary entry notifications through SMS text messaging. We recruited 20 crowdworkers in total, however, 5 of these failed to complete any diary entries. As such, we only consider 15 participants in this study. Seven participants were female, and 8 were male. Four of the participants were between 18 and 25 years old, 6 were between 26 and 35, 2 were between 36 and 45, 3 were between 46 and 60, and none were 60 or older. Three of the participants had completed education up to a high school level, 11 had completed

education up to a college level, and 1 had completed education up to a graduate level. In general, this group of participants is older and bit further educated overall than the group in the previous study. We collected 79 diary entries in total with some participants submitting as few as 1 but many submitting the full 7 out of 7 solicited diary entries. As such some participants have undersized representation in the diary entry data pool compared to the previous study.

4.3.1 Medium

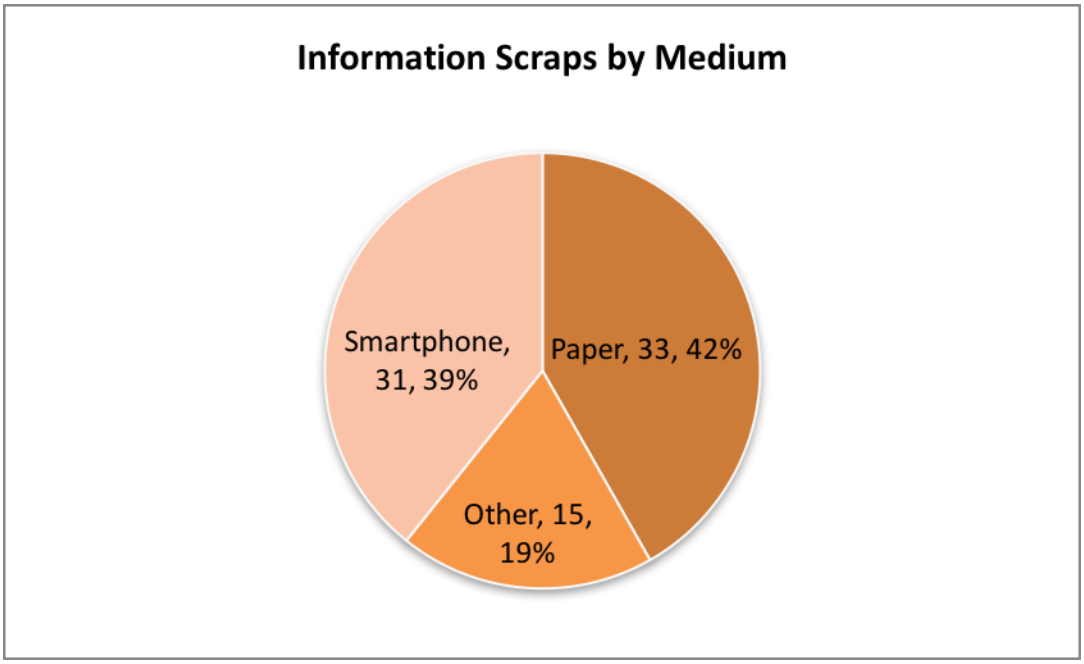

Figure 4.18: ISSE Crowd diary study information scraps by medium

Figure 4.18 shows the same kind of breakdown between information scrap mediums as seen in Figure 4.11 of the previous study. While the amount of information scraps made with tools in the *Other* category has stayed roughly the same, the percentage of scraps in the *Paper* category has more than doubled. That increase has mostly come at the expense of the *Smartphone* category, which only contains 39% of reported scraps. A two-proportion z-test reveals that the difference between *ISSE* and *ISSE Crowd* for

Smartphone use is significant ($p < 0.05$). Another such test shows the difference between *ISSE* and *ISSE Crowd* for *Paper* use is significant as well ($p < 0.05$). We may suspect that these differences are due to age differences between the two samples, however, no obvious trend in scrap medium emerges from our coarse age groupings. In any case, we still see strong support for the notion that information scrap activity on smartphones has greatly increased from the time Bernstein, et al. [3] conducted their study.

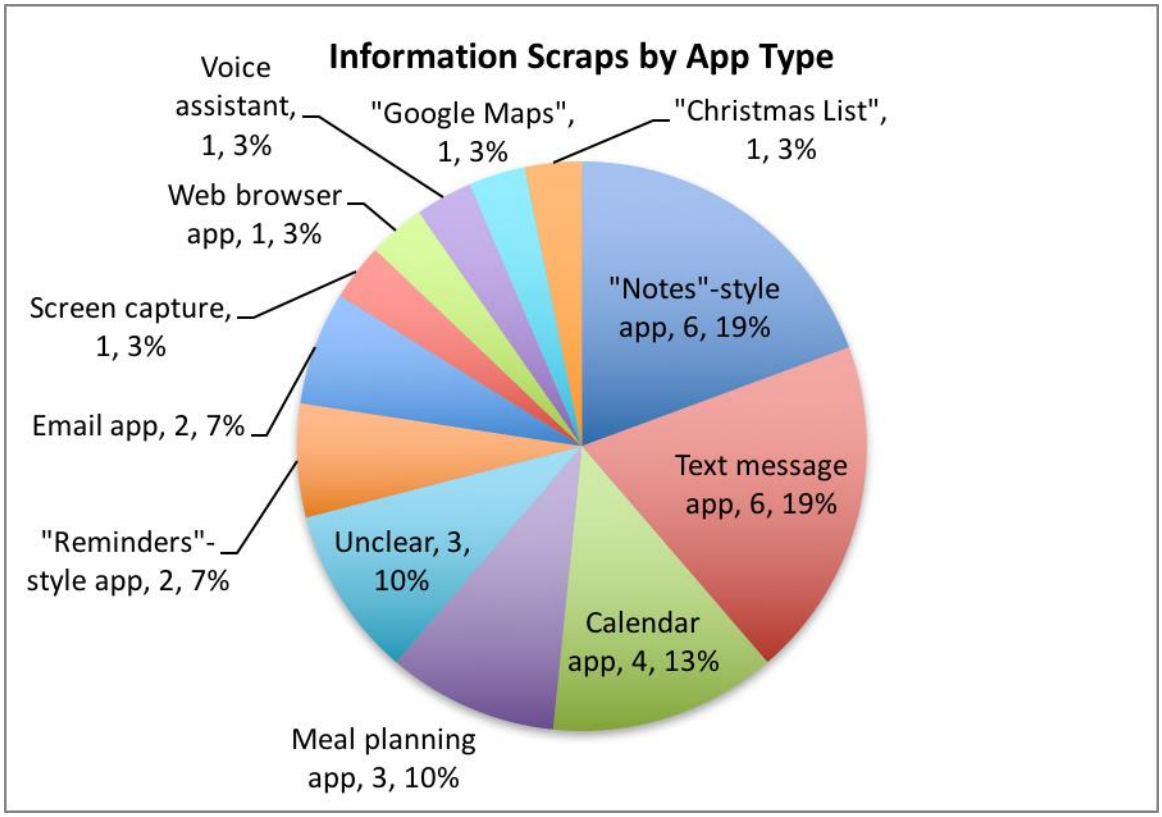

Figure 4.19: ISSE Crowd diary study smartphone information scraps by app type

Figure 4.19 shows the breakdown by app or app-type of the smartphone information scraps participants made. Like the previous study, *Notes*-style freeform text entry apps were the most popular medium. However, this time it is tied with text messaging apps at 19% of smartphone information scraps. Some of these text message scraps were ultimately used to communicate information to other people, while others

were used as just another kind of freeform text storage similar to scraps made with *Notes*-style apps. We find scraps made with calendar apps in third place again but scraps made with *Reminders*-style apps tied for 6th most prevalent. Interestingly, participants reported making scraps using a handful of meal planning apps named *Dinner Spinner, Our Groceries*, and *Plan to Eat*. These offer a variety of functionality including meal calendars, recipe searching, grocery list creation, and grocery list sharing. The presence of this app type, which serves *temporary storage* and *reminding* information scrap roles but centers around the specific activity of meal planning, suggests the domestic priorities of the *ISSE Crowd* study participants. This makes sense considering the group is markedly older than the previous study's participants thus more likely to need to plan meals for a family. Contrast this with the prominence of smartphone camera use in the *ISSE* study and the complete lack thereof in this study. Such a difference hints at *ISSE* participants' greater need for tools that facilitate quick scrap capture from physical space artifacts, e.g., whiteboards and notebooks.

4.3.2 Information Scrap Roles

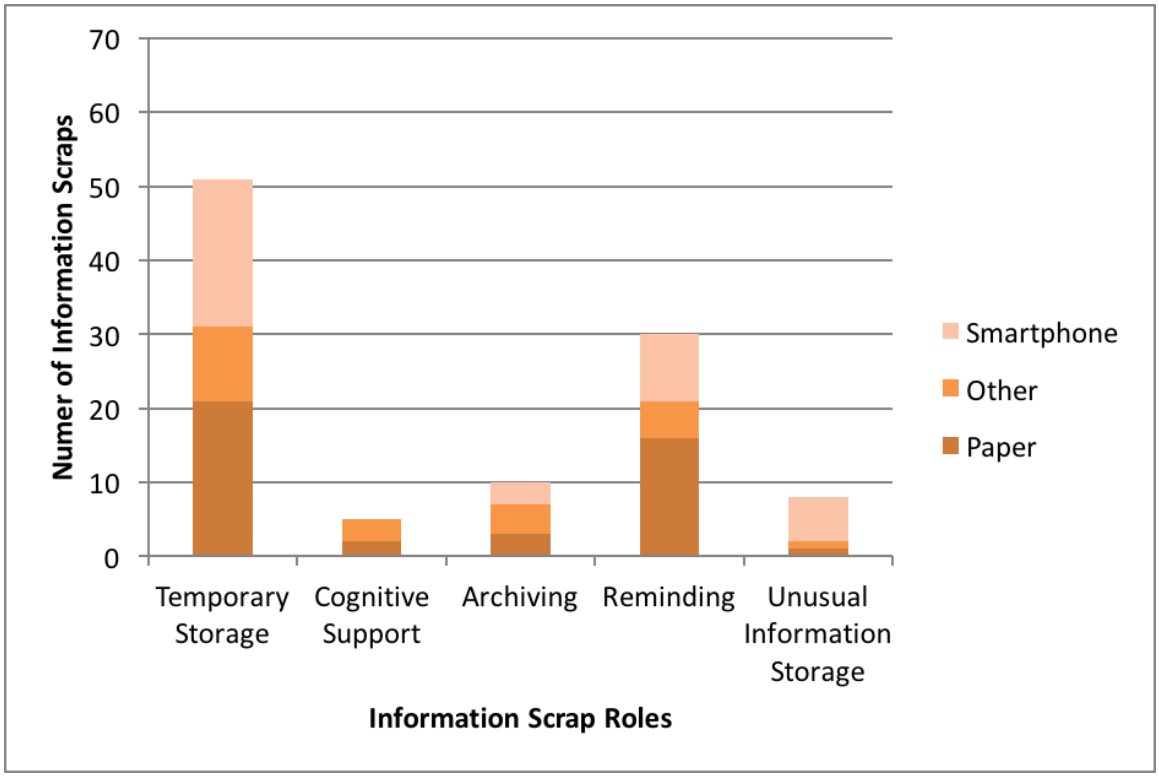

Figure 4.20: ISSE Crowd diary study information scrap counts by role [3], broken down by medium

Figure 4.20 shows this study's breakdown of information scraps between medium and role. Like the *ISSE* study, *temporary storage* was the most reported role with *reminding* coming in second. However, the *cognitive support* role fell to last place behind *archiving* and *unusual information storage*. A two-proportion z-test reveals that the difference between *ISSE* and *ISSE Crowd* for the number of reported *cognitive support* information scraps in each study is significant ($p < 0.05$). In comparing each study's *cognitive support* scraps, they do not seem to differ much in kind. Both studies' participants, when they did report cognitive support scraps, tended to report multi-role scraps. For example, Participant ISSEC511 reported "Christmas gift ideas for friends", which served *temporary storage* and *cognitive support* roles. The difference seems to be

that participants in *ISSE Crowd* were much less inclined to report scraps as having multiple roles. Only 28% of *ISSE Crowd* scraps were reported to serve more than 1 role compared to 52% for *ISSE*.

We can see this difference more clearly in Figure 4.21, which is a Venn diagram like the one in Figure 4.14. It shows the overlap of *ISSE Crowd* information scraps in the *temporary storage*, *reminding*, and *cognitive support* scrap roles. This time, *temporary storage* and *reminding scraps* have less reported overlap, while *cognitive support* is just less reported in general. The *cognitive support* scraps that were reported are subsumed entirely by the other two roles shown in this diagram, similar to the *cognitive support* scraps in Figure 4.14 of which only 3 out of 21 are independent of the other 2 roles. The t*emporary storage* set once again contains the largest proportion of independent scraps, lending further support to the idea that it is the role that most embodies the idea of information scraps.

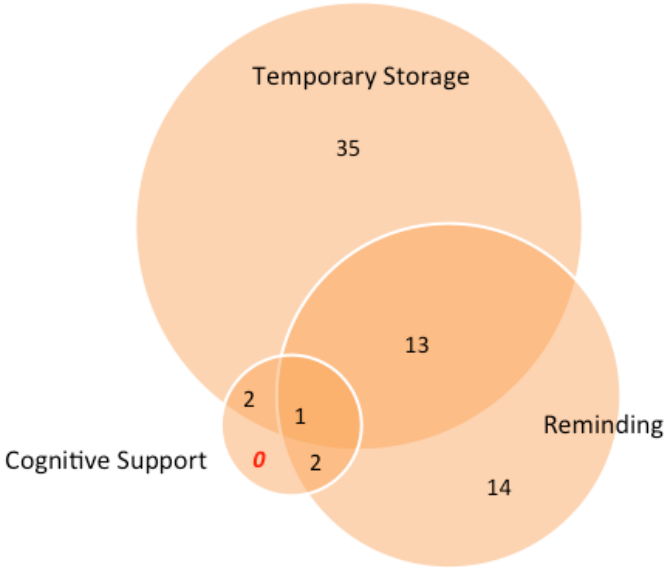

Figure 4.21: Venn diagram of role overlap of ISSE Crowd diary study information scraps

4.3.3 Location

In *ISSE Crowd*, we again looked at the role location played in participants' reported information scraps by asking the question, "Where were you when you recorded this information scrap?" Based on our findings from the previous study, we grouped answers into *Home or Office* and *Mobile* categories. This data can be seen broken down by medium in Figure 4.22.

The data's most obvious feature, especially when compared to Figure 4.15 of the previous study, is how few *mobile* information scraps that *ISSE Crowd* participants made. Participants made the vast majority of their information scraps while either at home or at their places of work. A number of plausible reasons, from experimental setup to population demographics may explain this difference. For one, *ISSE* subjects could easily

complete their diary entries through Qualtrics' mobile website, whereas *ISSE Crowd* subjects completed their Qualtrics diary entry surveys through an AMT portal with no proper mobile website. This could conceivably have led *ISSE Crowd* participants to complete diary entries on computers at home or at work much more often and thus report information scraps made in those places more often.

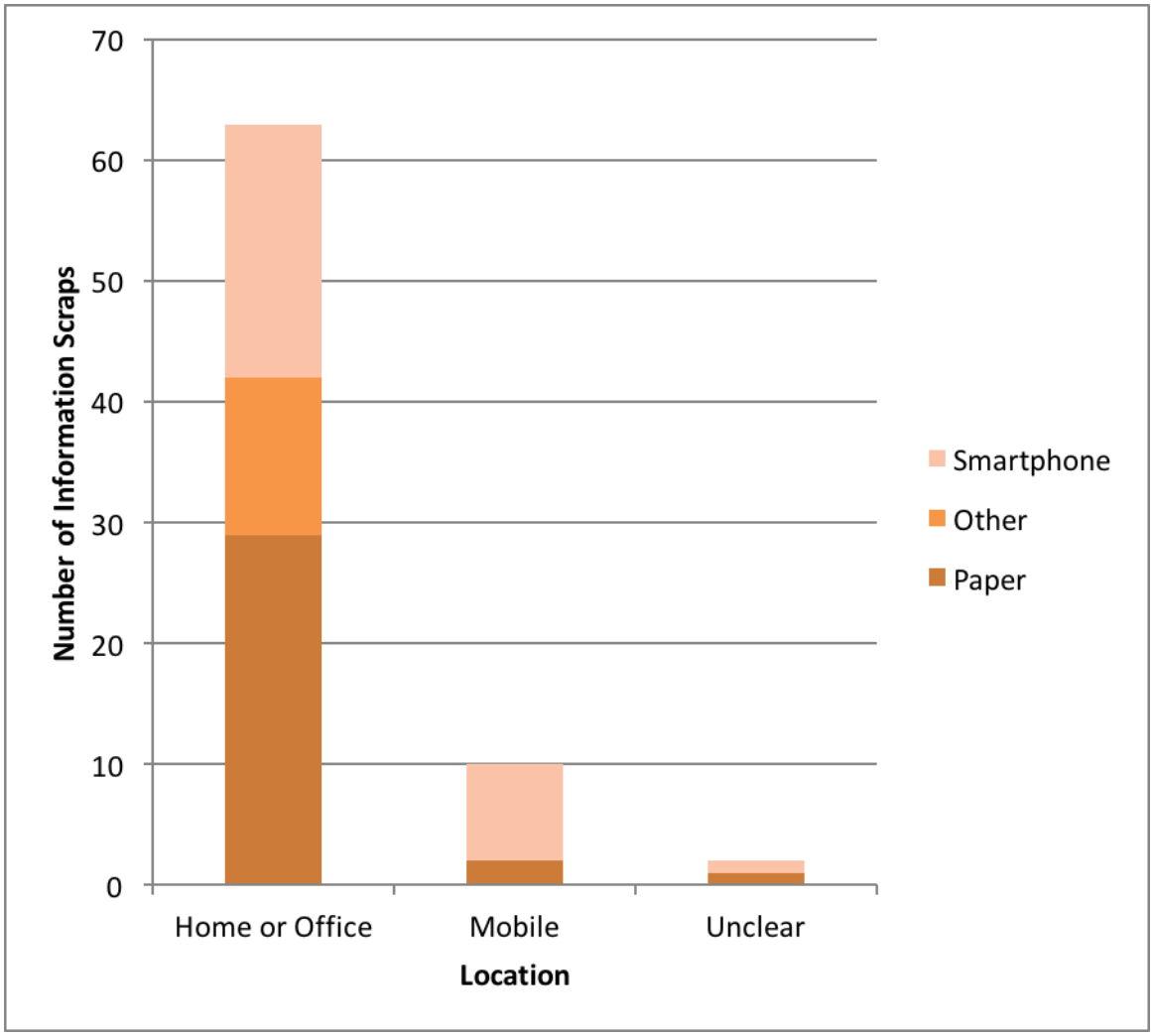

Figure 4.22: ISSE Crowd diary study information scrap counts by location, broken down by medium

While the location where participants completed their diary entries may be a factor, the information scraps reported in each study point more toward where these different populations spend their time. *ISSE* participants were mostly college students at

25 years of age and younger. For scraps we identified as *mobile*, participants often reported locations like "in class", "at the library", or "in the study lounge in my dorm" indicating they spend much of their time working in public non-configurable workspaces. Most *ISSE Crowd* participants, on the other hand, were out of college and 26 years of age and older. Their *home or office* scraps seem to indicate they spend most of their time in their personal configurable workspaces in these locations. Their much smaller proportion of mobile information scraps were made "in the car", "in the driveway", or "at a friend's house".

We speculate that *ISSE Crowd* participants made proportionally fewer *smartphone* information scraps than *ISSE* participants because *ISSE Crowd* participants may be spending much less time outside their homes and offices. Indeed, two-proportion z-tests reveal no significant difference between *ISSE* and *ISSE Crowd* for *smartphone* scraps or for *paper* scraps made at *home or office* ($p > 0.05$). In other words, both sets of participants made smartphone and paper scraps at nearly the same rates when they were at home or in their offices. Similarly, two-proportion z-tests reveal no significant difference between *ISSE* and *ISSE Crowd* for *smartphone* scraps or for *paper* scraps made while *mobile* ($p > 0.05$). As with *home and office* scraps, both sets of participants made smartphone and paper scraps at similar rates when participants were *mobile*. While our two studies show that *smartphone* information scraps make up a significant part of all scraps, our comparison of the two studies shows making *smartphone* information scraps to be highly correlated to being mobile.

4.3.4 Triggers

The original *ISSE* diary study unfortunately revealed very little about the *trigger* stage of the micronote lifecycle as it relates to smartphones. In our attempt to duplicate the conditions of the *ISSE* diary study in *ISSE Crowd*, we did not enhance our line of questioning in this area. Thus, we cannot say much about smartphone information scrap triggering here. We do find again, however, that the smartphone itself causes very little in the way of triggering. We count only 4 information scraps (5% of the total) whose creation appears to have been triggered by communication channels on the smartphone. These included "a note to remember a website and visit later to purchase something" triggered by "browsing the web" from Participant ISSEC615, "...appointment Monday 11AM" triggered by "...finishing up booking an appointment..." from Participant ISSEC593, "an address" triggered by "texting about borrowing chairs" from Participant ISSEC425, and "...the name of the disease the doctors said my dad has..." triggered by "talking on my smartphone with my step mom" from Participant ISSEC726. Considering the many communication channels supported by smartphones, it seems unlikely that triggering occurs so infrequently through smartphones, but we can provide no evidence to suggest otherwise.

4.3.5 Completion, Deletion and Archiving

In this study, we again sought information about the final stages of the micronote lifecycle with regard to smartphone information scraps. We did this by asking 3 questions in each diary entry survey about what participants ultimately did with their information scraps. The first of these asked, "Which of the following statements is most accurate? A) You captured and then used this information scrap. B) You captured and then ignored

this information scrap. C) You captured and then lost this information scrap. D) You captured this information scrap and will use it in the future." As in the *ISSE* diary study, this question lets us bin the "will use" information scraps into a pre-*complete* stage of the micronote lifecycle and thus helps us analyze scraps from that perspective.

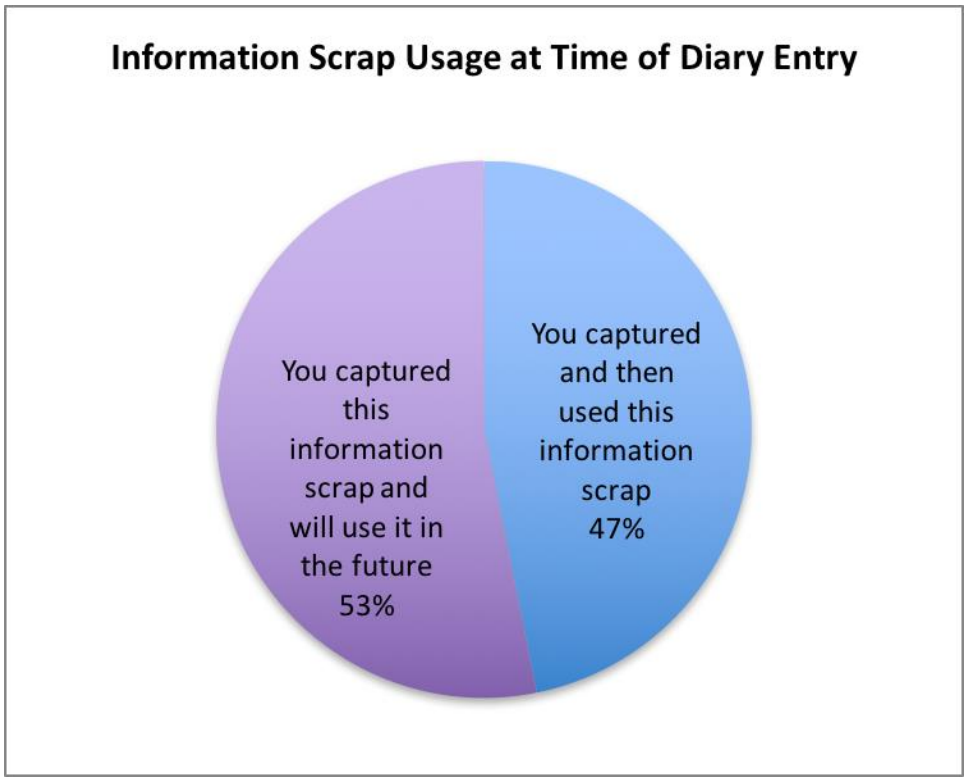

Figure 4.23: ISSE Crowd diary study information scrap usage at time of diary entry

Figure 4.23 shows the breakdown of participants' answers about how information scraps had been used at the time of each diary entry. Similar to Figure 4.16, our results in Figure 4.23 show that participants had used or planned to use the majority of their information scraps, while participants had not lost or ignored any information scraps they had made. Compared to the previous study, participants did report that, at the time of diary entry, they had used proportionally fewer of their information scraps but would use a greater proportion of their information scraps in the future. However, this difference in

kept and used information scraps between our two studies is made up in the answers to the second question.

The second question, which was only presented to participants who answered that they had either captured and used or captured and ignored a scrap, asked respondents, "If you are finished using this information scrap, have you kept it? A) Yes. B) No. C) Not finished using it yet." This question let us categorize the "used" and "ignored" information scraps into pre-*complete*, *archive*, and *discard* stages along the micronote lifecycle. The responses included zero scraps reported as "not finished using it" (pre-*complete*), 15 reported as "kept" (*archive*), and 18 reported as "did not keep" (*discard*).

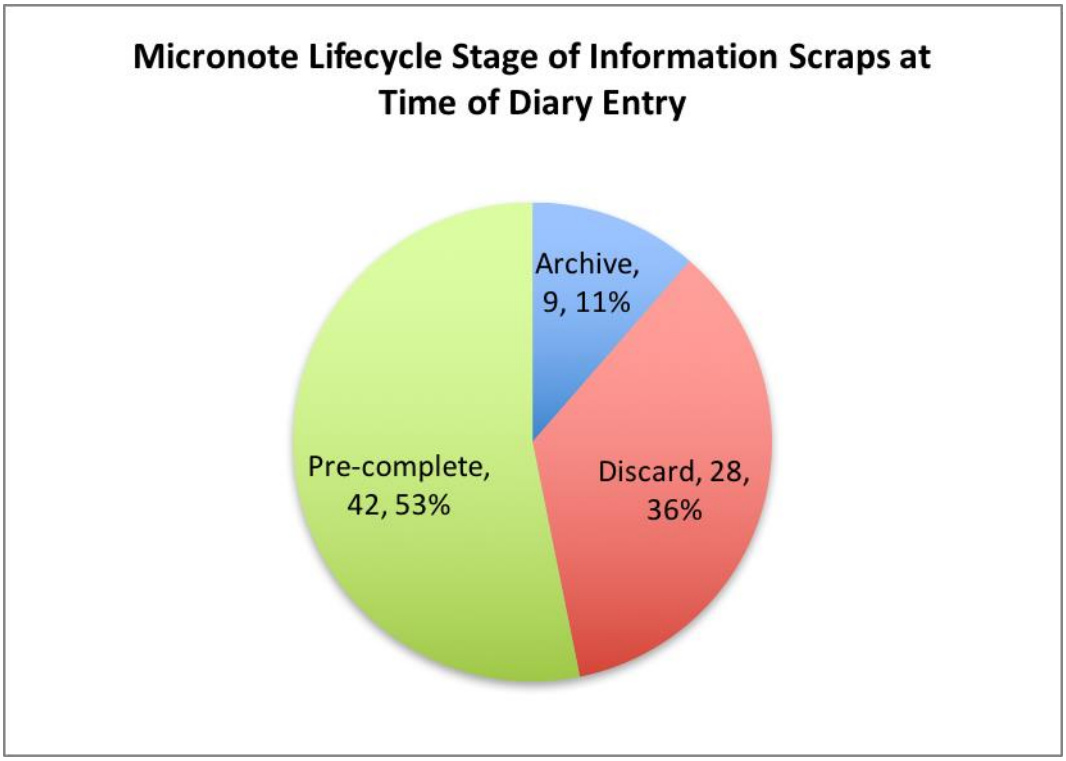

Figure 4.24: Micronote lifecycle stage of ISSE Crowd diary study information scraps at time of diary entry

Figure 4.24 shows the result of our categorizing all reported information scraps into micronote lifecycle stages based on answers from this question and the previous question. Proportions between the pre-*complete*, *discard*, and *archive* categories are

roughly similar to those in Figure 4.17 of the *ISSE* diary study. Once again, the majority of information scraps had not yet reached the *complete* stage in the micronote lifecycle. As a result, our samples of *discard* and *archive* scraps in this study alone are too small to see statistically significant correlation between a scrap's medium and a scrap's tendency to be archived. However, as in the *ISSE* diary study, we notice a higher proportion of kept smartphone scraps than kept paper scraps.

The final question each diary entry survey asked was, "What, if anything, have you done with this information scrap now that you are finished using it?" The question was only presented to participants who indicated in the previous question that they had kept their used information scrap. Of the 9 scraps for which we received responses, 5 were made with smartphones, 2 with paper, and 2 with other mediums ("recipe card" and "computer"). Most of the archived scraps in this study, such as the 4 scraps made using text messaging, were archived simply by leaving them where they were. In fact, for only the recipe card scrap did a participant seem to make special effort to store it when they were finished using it. This kind of no-effort archiving was common between this study and the *ISSE* study, and, considering how easily smartphone scraps are archived in this way, further analysis of our data is warranted.

Here, we take the unusual step of combining our post-*complete* information scrap data from both the *ISSE* and *ISSE Crowd* diary studies in order to have a large enough amount of such data to perform statistical analysis. In Figure 4.25, we can see both studies' archived and discarded information scraps across all mediums.

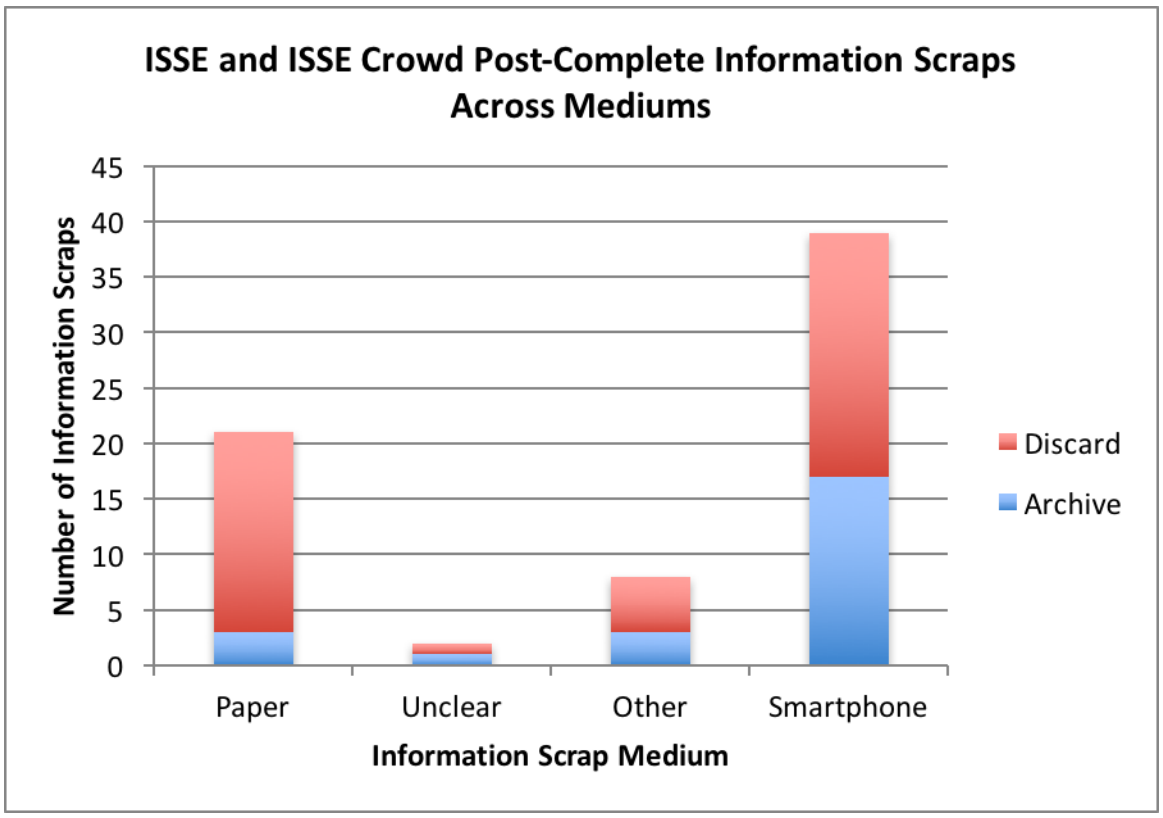

Figure 4.25: ISSE and ISSE Crowd post-complete information scraps across all mediums

Owing to the *ISSE* diary study's larger proportion of smartphone scraps, this graph displays a greater amount of completed smartphone scraps than paper scraps. More importantly, however, we can now visualize the difference in proportion between paper scraps that are archived and smartphone scraps that are archived. With our combined data sets, a two-proportion z-test reveals that the difference between paper and smartphone for archived information scraps is significant ($p < 0.05$). Of course, this correlation is not definitive. Its importance is necessarily weakened by our combination of data from two separate studies with slightly different methodologies. However, we take this as qualified confirmation of our suspicion that information scrap archiving is more prevalent when using smartphones than when using paper.

5 Discussion

We began this research with the goal of answering three questions: Which, if any, information scrap tasks are moving to smartphones? What factors influence people to make information scraps using smartphones? Finally, how can we better model people's information scrap behaviors on smartphones? Based on the results of our studies, we can begin to answer these questions.

Part one of our study *Information Scraps in the Smartphone Era* focused on discovering how and how often people carried out twenty-five specific common information scrap tasks identified by Bernstein, et al. [3]. Based on the data we collected, we saw a frequency ranking that placed *reminding* scrap tasks ahead of the *temporary storage*, *cognitive support*, and *archiving* scrap tasks that occupied most of the upper ranks of Bernstein, et al.'s list. Our cross-comparison of task frequency with task medium, visible in the scatterplot graph in Figure 4.5, showed that many of these high-frequency *reminding* tasks tended toward being done using smartphones over paper. If we consider the dearth of smartphone information scraps found in Bernstein's 2008 study, this is a remarkable change and provides strong evidence that *information scrap tasks are indeed transitioning to smartphones*. Furthermore, of the tasks that people do most often, *information scrap tasks having to do with prospective memory are the tasks for which people have transitioned the most to using smartphones*. This change can be explained, in part, by the fact that smartphones have become some of the most common tools at hand. In a November 2015 report, *comScore.com* puts U.S. smartphone penetration at 78.6% of the mobile phone market, or 195.6 million people [19]. However, our analysis of the kinds of information scraps people choose to make with smartphones indicates that

smartphones possess qualities that make them fit for certain kinds of information scrap tasks over others.

5.1 Smartphones and Prospective Memory

Many of the ways that people make smartphone information scraps are inherently *temporal*. That is, calendar apps, reminding apps, and even freeform text entry apps place a natural order according to time on the scraps they hold. Calendar apps, like paper calendars, arrange information scraps at specific times in the future and can deliver notifications of upcoming events. Reminding apps, which may double as to-do list apps, place scraps in order of their creation and, in doing so, create chronological queues of tasks. Freeform text entry apps such as *Notes* also order scraps chronologically, placing the most recently created scrap at the forefront where it is most accessible. The availability of these subtle differences between apps may account for the variety of reminding tasks for which people have taken to using smartphones.

Consider also that these apps' temporal capabilities do not exist by themselves but that these apps also store the semantic content of the scraps they embody. While a string tied around one's finger may serve as a reminder to do something, it contains little or no information about its meaning to "buy milk". However, a scrap stored in any of the aforementioned apps encodes not just the reminder but also text about its subject. For a calendar entry, that may be an event and its location. For a to-do list entry, it may be the name of an errand. For a freeform note entry, it may be this week's shopping list. The nature of these apps allows users to easily pair temporal and semantic meanings in their smartphone information scraps, which we believe is an important reason smartphones have grown so much in popularity for *reminding* information scraps.

As further evidence, consider again the Venn diagram in Figure 4.14, which shows the role overlap of information scraps collected in the *ISSE* diary study. At 61 reported scraps, *temporary storage* was by far the most popular role that information scraps filled. However, participants reported that over half of those scraps also served as *reminding* scraps. We see a similar phenomenon in the *ISSE Crowd* diary study, where over a quarter of the 51 reported *temporary storage* scraps also served in the *reminding* role. Of course, this plurality of purpose is not a new phenomenon when it comes to information scraps. Paper reminders, made with calendars or Post-It notes, may store the "what" as well as the "when" of their encoded data. In both of our studies, we see similar proportions between paper and smartphone information scraps that fill *temporary storage* and *reminding* roles simultaneously. If smartphone apps have become as good at this role combination as paper, it makes sense that smartphone users would often choose their smartphones for making *reminding* information scraps.

5.2 Smartphones and Mobility

In Bernstein, et al. [3], the authors identify the importance of mobility in the making of information scraps. They gathered evidence indicating that people employ a variety of tools, often dictated by social setting, to facilitate note capture. They also found that their subjects considered paper the most useful medium in these scenarios over digital tools. This is hardly surprising considering that only 8% of their recorded information scraps were in mobile digital formats. In light of our findings, such a low percentage seems indicative of the nascent state of mobile computing at the time. Their few smartphone-using participants, however, "used smartphones heavily for [information

scrap] capture," thus anticipating our findings in an era when smartphones are much more pervasive.

Mobility is, as Bernstein, et al. [3] discovered, an important aspect of information scraps in general, and it seems to be an important aspect of smartphone information scraps in particular. In our *ISSE* diary study, we found that fully 53% of information scraps (whose location we could determine) were captured in *mobile* contexts, i.e., in places outside of participants' homes or offices. Further, these information scraps had a statistically significant correlation to being made using smartphones over paper. While this does not indicate causality, it provides good evidence that *mobile context is a strong factor in people using smartphones to make information scraps*. While Bernstein, et al. [3] point to social considerations as playing a large part in whether one uses a laptop versus a notepad versus a PDA in mobile contexts, we believe that pure utility and convenience are the reasons we see such smartphone dominance in our *mobile* information scrap data. Participants snapped pictures of whiteboard notes, created reminders in the *Reminders* iPhone app, made calendar entries in calendar apps, sent text message reminders to themselves, wrote field notes in the *Notes* app, and so on. With smartphone ownership at 97% in our on-campus survey and at more than three quarters of the U.S. mobile phone market [19], it is difficult to imagine a social context outside of a movie theater where making notes on a smartphone would be less acceptable than other mediums.

Bernstein, et al. [3] identified two main barriers to information scrap creation on mobile devices: information fragmentation across PIM mediums as well as time and attention costs for data entry on mobile devices. To the first point, we saw little evidence

that information fragmentation has been solved to any extent for most information scrap types on mobile devices. To be fair, digital calendars can indeed be synchronized across devices, and some of our *ISSE* participants reported using such functionality, but others said they purposely chose not to do so. Information transfer was the critical functionality in this area that participants most used. Participants reported emailing and text messaging information scraps to themselves as well as to other people using their smartphones. They did this as needed and did not express any particular desire for automatic synchronization to their other devices. In effect, the built-in communication channels of the smartphone allowed participants to easily manage their information fragmentation through information transfer, obviating the need for true synchronization.

To Bernstein, et al.'s [3] second point, we did indeed see evidence that participants employed what that paper considered "new mobile capture modalities." Participants captured the majority of their smartphone information scraps with apps that use on-screen, error-correcting keyboards as their primary input method. Both iPhone and Android devices have voice dictation modes for their keyboards, though we have little data on how people use them. In only one instance—in our *ISSE Crowd* diary study—did a participant report creating an information scrap using dictation. We did not see any evidence that people use the digital pen products that Bernstein, et al. [3] foresaw, and we saw only a little evidence that people capture scraps using pen-like styluses. Participant ISSE107 made extensive use of their tablet and stylus to record information scraps, but this behavior was not seen in other participants. Perhaps the most interesting new capture modality, and the only one apart from keyboard entry to see wide use among participants, was taking pictures with the smartphone camera. Bernstein, et al. [3] reported some

instances of this behavior but did not predict how common it would become for smartphone users in capturing mobile information scraps. In our *ISSE* Part 2 participant interviews, nearly all of our participants reported using their cameras to capture information scraps. And, in *ISSE* Part 2's diary study, participants captured 14 information scraps (29% of all smartphone scraps) using smartphone cameras, 11 of which were made in *mobile* contexts. While Bernstein, et al. [3] did not predict the rise of this capture modality in mobile situations, smartphone cameras could be said to have overcome the time and attention costs that the paper identified. On both iPhone and Android devices, the camera can be used without even unlocking the device. Scrap capture is instantaneous with no manual transcoding of data on the part of the user. Further, phone cameras today are capable of producing much higher quality pictures in more variable conditions, which lets them consistently provide the detail needed for scrap capture. Finally, because of the camera's viewfinder, a user need not even take their attention away from the subject of their information scrap while capturing it. The ease with which smartphone users employ this unique capture modality and its great versatility appear to be a strong influence in people choosing to capture information scraps with their smartphones.

5.2.1 Mobility and Working Adults

When it comes to mobility, our findings in *ISSE Crowd* must necessarily temper our results from the *ISSE* diary study. We found that participants in *ISSE Crowd* made significantly fewer mobile information scraps than participants in the previous study and made significantly more information scraps at home and at work. Participants did make an amount of their mobile information scraps with smartphones that was proportional to

ISSE findings, but their overall lack of mobile information scraps is striking and could call into question the actual importance of mobility in this topic. Largely, we believe this difference in findings between our two studies boils down to the places participants spent their time, which seems, in part, a function of age. Most participants in the *ISSE* diary study were college students in the "18 to 25" age group. They necessarily spent much of their time in class, away from their apartments or dorm rooms or offices (if they even had offices). Conversely, most *ISSE Crowd* participants were in the "26 to 35" age group, had graduated from college, and had likely joined the workforce. Unlike college students, whose classroom obligations require them to spend a significant portion of time away from the home or office, working adults tend to split nearly all of their time between the home and office [20]. As such, it should not be surprising that *ISSE Crowd* participants made the vast majority of their information scraps in those places. Nor is it surprising that they reported no instances of scrap capture using smartphone cameras, a data capture modality we see closely tied to *mobile* contexts in *ISSE*.

If most working adults have little opportunity to make mobile information scraps, then what importance is there in the concept? For our purposes, the significance of *mobile* contexts is that people do not necessarily have access to all the PIM tools of their home and office workspaces, rather, only the ones that are convenient and necessary enough to bring with them. Bernstein, et al. [3], in documenting the information scraps of knowledge workers in their workplaces, took a more nuanced view of *mobile* contexts than we could with our studies' data. We labeled information scraps *mobile* if they were made outside of the home or office. Bernstein, et al. [3] labeled them *mobile* if they were made while participants were at work but away from the desk, like when in a meeting.

They also labeled scraps *mobile* if they were made with the intent of taking them from the workspace to another, perhaps *social*, space. Introducing these additional meanings to our definition of *mobile* would not break the definition, but they would give it a finer granularity than our data collection instrument could capture. Perhaps, then, it would be appropriate to develop better diary entry questions that could discover more detail in the area of *mobile* information scraps and then conduct further study with participants of working age.

5.3 Scrap Roles and the Micronote Lifecycle

We conducted our diary using two main theoretical lenses: Lin, et al.'s [2] micronote lifecycle and Bernstein, et al.'s [3] five information scrap roles. To synthesize our findings from these perspectives, we must understand how they are related. The micronote lifecycle describes the workflow that a person follows as they create and use a micronote. Something stimulates the user to make a micronote, and the user then captures the note. What happens next depends on the needs of the user, i.e., the *role* they intend the scrap to fill. If the user needs the micronote to temporarily store information, i.e., the *temporary storage* role, the user should eventually transfer it to a medium appropriate for that information type. If the user needs the micronote to serve as a prospective memory aid, i.e., the *reminding* role, the user should refer to and update it throughout its useful life. If the user needs the micronote for immediate use, i.e., the *cognitive support* role, they should make use of its content at the time of scrap creation. After such activity, the micronote is then considered to be complete. The user discards the micronote, or, if they may need it in the future, they store it long term, thus imbuing it with the *archiving* role. The aforementioned roles are 4 of the 5 information scrap roles promulgated by

Bernstein, et al. [3]. However, that paper did not relate the roles to the micronote lifecycle in this way. Bernstein, et al. [3] arrived at these roles through analysis of extant information scraps discovered in people's workspaces but without consideration of where those scraps might be along the path of the micronote lifecycle. In this light, the alignment of information scrap roles and micronote lifecycle paths is remarkable but, we feel, too constraining when taken together.

In our diary studies, we investigated participants' own understanding of their information scraps' roles. We gave participants short, relatable definitions along with common examples and allowed them to assess their information scraps with that understanding. The roles themselves are not complex, and we found in our interviews that participants easily grasped them. The amount of role overlap participants reported in their scraps was surprising, especially between the roles that correspond to divergent paths in the micronote lifecycle. Our findings effectively unbox the neat divisions between Bernstein, et al.'s [3] roles as well as the micronote lifecycle's divergent paths. To be clear, neither paper claimed their respective roles or paths to be mutually exclusive, but our findings make apparent the messy reality in how people think about and use their information scraps. Consider Participant ISSE102, who made an information scrap with the contents, "Church at 5." She classified this scrap as having *temporary storage*, *reminding*, and *cognitive support* roles. In section 5.1, we have already described how a scrap can serve both *temporary storage* and *reminding* roles. In this example, we see evidence that a scrap may serve as *cognitive support* as well. Though the participant provides no explanation for how the scrap does so, it is simple enough to imagine. Perhaps writing down the time for church was an act of cognitive offloading while

Participant ISSE102 planned her day around that event. Or consider Participant ISSE108, who made an information scrap with important dates and other information about "the house I just leased." He classified this scrap as both *reminding* and *archiving* but, strangely, had not used it yet. In other words, this scrap appears to be in both pre-*complete* and post-*complete* stages of the micronote lifecycle simultaneously. Perhaps this merely signifies intent to archive the scrap once it had been used, but it could also indicate that the participant considered the scrap at the time of creation to be an artifact with long-term relevance—one that he would find and refer back to over the course of his housing lease as needed. Bernstein, et al. [3] in fact observed this immediate archiving behavior, noting that, "a group [of information scraps], including meeting notes, was archived immediately without a period of active reference." From this perspective, it seems there is little difference between pre-*complete* and post-*complete* stages in the micronote lifecycle unless a scrap is actually discarded after it is used.

Smartphones only increase this muddying of roles and lifecycle stages. Nearly every kind of information scrap one can make with a smartphone may be automatically archived, and we saw evidence that this was happening in our diary studies. There is no "graceful degradation", as Bernstein, et al. [3] remarked, of aging smartphone scraps. Barring a change in platform or catastrophic device failure, all scraps may be stored perfectly forever. In fact, some interviewees in *ISSE* Part 2 had carried information scraps in the iPhone *Notes* app across multiple devices over the course of years, claiming to update and refer to them regularly. However, apart from their longevity, these scraps seemed entirely ordinary. Participant ISSE114 had kept and maintained a note titled "Baby Names" since middle school. Participant ISSE108 brewed beer as a hobby and had

maintained a list of beers he had drunk—a list he claimed that he would "keep forever." Participant ISSE106 kept a list of expenses he had paid on behalf of his brother, which he used to stay "even" with his brother whenever his brother bought him something. Because "unintentional archiving" [2] is the de facto behavior in app design and use, even disused scraps persist over time from one device to the next. In our interviews, participants only described regular *spring cleaning* behavior [21] in reference to information scraps made with the smartphone camera or screen capture feature. Their reason for sometimes cleaning out such scraps was that, similar to physical scraps that clutter a workspace, photo scraps eventually fill up the phones' available storage space. Textual smartphone scraps, on the other hand, need comparatively little space and, thus, were rarely subjected to spring cleaning. Consequently, we believe the *archive* stage may not be an entirely accurate component of the micronote lifecycle, at least with respect to smartphone information scraps.

Figure 5.1 illustrates our new *information scrap lifecycle for mobile devices*, a revision of Lin, et al.'s [2] micronote lifecycle (Figure 5.2), which we believe reflects how people make and use information scraps on mobile devices. Because archiving occurs automatically without deliberate action from the user, and because users consider some scraps to serve in an *archiving* role even before they make use of those scraps, we have renamed the *archive* stage of the original lifecycle to *keep*. Doing so serves 2 purposes. First, *keep* implies a more passive or default activity on the part of the user, as opposed to *archive*, which suggests an explicit action. Second, it disambiguates the *archiving* role from the *archive* lifecycle stage, which we understand to have an orthogonal relationship. For smartphone scraps, the *archive* stage in the original lifecycle

would mostly describe the ubiquitous automatic archiving of scraps, but it would fail to describe users' intentional creation of scraps that have an *archiving* role.

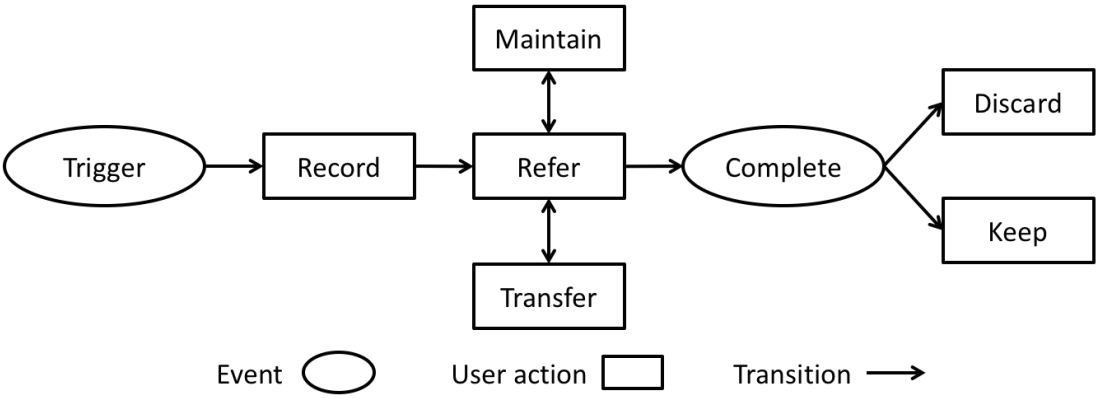

Figure 5.1: Our new information scrap lifecycle for mobile devices

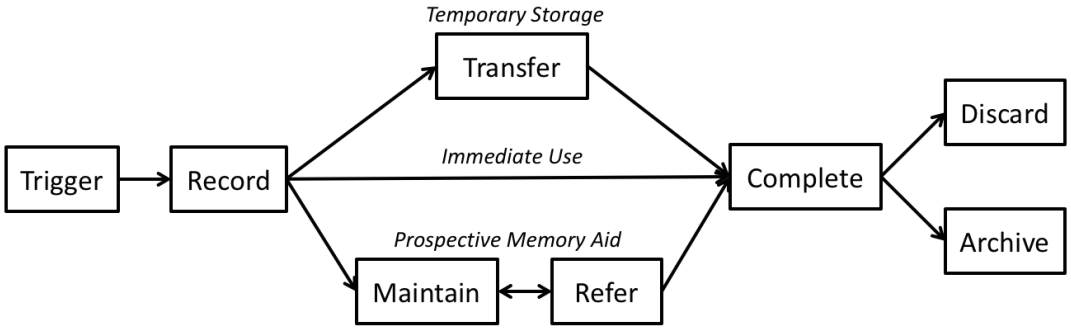

Figure 5.2: The original micronote lifecycle [2]

In addition, we have clarified the *trigger* and *complete* stages, taking care to indicate that they are not user actions but events that occur along the information scrap lifecycle that stimulates the user to take an action. The *trigger*, as before, prompts the user to *record* an information scrap. The *complete* event, which only occurs when the

user realizes they no longer need the information scrap, prompts the user either to *discard* the scrap or *keep* it where it is.

We have also eliminated the role-specific usage paths from the micronote lifecycle. We believe there exists too much overlap between information scrap roles in real-world information scraps to be able to accurately describe usage patterns exclusive to those roles. Further, we see no reason why one could not *maintain* or *refer* to a *temporary storage* or *cognitive support* scrap, behaviors which are not permitted in the original micronote lifecycle. Nor do we see why a *temporary storage* scrap is obligated to undergo *transfer* to another medium before *completion* while other scrap types are not permitted to do so. We have thus grouped the *refer*, *maintain*, and *transfer* stages in our diagram to illustrate that an information scrap, no matter its role, may optionally move back and forth between these stages.

We believe it especially important that the *transfer* action be optional. Information scraps made on paper are often, by their very nature, short-lived. Scraps of paper get lost in pockets or bags or cluttered workspaces. They are also easily discarded. A scrap owner must often transfer any information on a paper scrap if they intend it to outlive its medium. This is not so with digital information scraps. A smartphone user may leave a digital information scrap on their smartphone, if that is where they find it most useful, with no more possibility of it being lost than of the phone itself being lost. This changes the purpose of the *transfer* action to an extent, a fact illustrated in our interviews. While participants such as ISSE105 said they *transfer* some information scraps from their smartphones to what they considered their canonical repositories, e.g., a wall calendar or a day planner, many also claimed to perform *transfer* of smartphone information scraps

to other people using the platform's communication channels. Thus *transfer* is not just an action carried out to preserve or organize information scrap data. On a smartphone, *transfer* is an action sometimes done to share that data with others.

6 Conclusions

Beginning with Lin, et al. [2], the goal of research into information scraps has ultimately been to bring computing into this PIM practice. In moving to mobile digital platforms, Lin, et al. [2] foresaw advantages in scrap organization, re-finding, and synchronization, if only the challenges of those emerging technologies could be overcome. They uncovered challenges facing digital information scrap tools and developed the micronote lifecycle to help technology makers understand and overcome those challenges. New technologies would need, "the ubiquitous convenience of paper, the intuitive writing process of a digital pen, and the computational functionality of a PDA." Bernstein, et al. [3] echoed that work's sentiments, backing up its stance with a great deal of real-world data and extremely insightful analysis. To succeed, they said, digital information scrap tools would need to eliminate burdensome creation processes in favor of lightweight capture modalities. They would need to introduce flexibility in the structure of their data to allow for the innumerable ways people may choose to represent it. They would also need flexibility in the kinds of data that could be represented, acknowledging that people adopt and adapt tools for their own needs. Such tools would also need to become more visible, allowing users to "trip over" their scraps to more easily facilitate reminding. Finally, digital information scrap tools would need to grow in synchronization capabilities in order to support mobile scenarios Bernstein, et al. [3].

We consider these predictions in the aftermath of the smartphone revolution. The face of mobile computing changed rapidly with the introduction of the iPhone in 2007 and with the proliferation of the iOS and Android devices that followed. For proof, we need look no further than our *ISSE* Part 1 survey results. Nearly all of our 248 respondents claimed to use smartphones. For our sample population, this is a ubiquity that must surely rival paper. In that survey and our diary studies, we see the impact that widespread mobile computing has had on people's information scrap behaviors. People are now doing many of the most common information scrap tasks on smartphones at rates comparable to paper. As such, we can look back and see which predictions have come to pass, which ones have not, and which developments have been important factors in the rise of smartphone information scraps.

Digital pen technologies seem to have been largely inconsequential to people's shift toward smartphone information scraps. We believe the important part of Lin, et al.'s [2] prediction is that mobile digital platforms would need an "intuitive writing process." Writing is only intuitive because people learn and hone the skill over years. In the short time that people have had smartphones with on-screen keyboards, they have developed a new intuitive writing process. They use their thumbs to quickly tap out emails, text messages, status updates, and tweets. It is no surprise that such a skill also serves as a lightweight capture modality for information scraps. Of course, typing with one's thumbs lacks the full expressive range of writing and drawing with a pen. We do not know to what extent smartphone users miss the circles, arrows and ad-hoc pictograms that are only possible with pens. However, our data indicate that the affordances of typing-based,

touch-navigated smartphone apps such as *Notes* are sufficient for people to use those apps in place of pen and paper.

Bernstein, et al. [3] makes much of the need for flexibility in information scrap tools, both in terms of content and purpose. When one considers the myriad types of information scraps that their study documented, it is easy to see why. However, most of their information scraps fell into a handful of categories that smartphone makers have since targeted with their included apps. These apps are flexible enough to handle many uncommon scrap types, and third-party apps such as *Dinner Spinner* provide additional flexibility by targeting niche categories like meal planning. No single app on its own duplicates the flexibility of paper. However, each app adds its own particular combination of features to a platform that, when taken as a whole, provides the flexibility needed in an information scrap tool.

We have shown that people are using smartphones for information scrap types that support prospective memory. We have argued that the time-oriented nature and chronological organization of smartphone apps make them especially suitable for recording such scraps, including reminders, shopping lists, appointments, and so on. Bernstein, et al. [3], however, emphasized the need for scrap owners to be able stumble upon their scraps in opportune moments and places. We do not disagree, nor do we think this need is entirely obviated by the smartphone's ability to produce timed or location-based notifications. In fact, many of our interviewees did not use such notifications. However, many of them did indicate that they refer to their prospective memory apps so often throughout the day that they were likely to encounter their smartphone reminders anyway. We could view this as a novel behavior that is distinct from—yet serves the

same purpose as—placing scraps in the way of movements in physical spaces. However, it may be worth exploring the idea of the smartphone as a virtual space through which people move and serendipitously encounter the reminders they leave for themselves. Regardless, it seems clear that the frequency with which smartphone users refer to their smartphones is a crucial factor in users' comfort in choosing to make and maintain reminding information scraps with them.

We have also argued that mobile contexts influence smartphone scrap creation. Their correlation comes despite participants' apparent apathy toward information synchronization features on smartphones. This raises the question of why information synchronization has not been an important factor in the rise of mobile information scraps. We said before that information transfer through the smartphone's various communication channels has been sufficient for users to accomplish their synchronization tasks. Perhaps there is more to it though. The rise of mobile information scraps tracks the rise of mobile computing in general. As mobile platforms overtake traditional desktop and laptop computers in terms of both sales and engagement, one might argue that mobile platforms become the new nexus of people's digital lives. At the time of Bernstein, et al. [3], the desktop or laptop computer was the center of a person's digital life. It made sense that one would need to synchronize data from a peripheral device like a smartphone. If the smartphone now occupies that position, then the need for information synchronization is greatly diminished; the information is already present where it is most needed.

With these finding in mind, we have also reformulated the *micronote lifecycle* as the *information scrap lifecycle for mobile devices*, as shown in Figure 5.1. We did this in order to better model people's information scrap behavior on smartphones. Our new

lifecycle eliminates the old lifecycle's role-dependent usage paths, thus acknowledging the role overlap we saw in our studies. It also recognizes smartphone users' routine behavior of *keeping* a digital information scrap past the completion of the scrap's purpose while distinguishing such behavior from Bernstein, et al.'s *archive* information scrap role. Our lifecycle also shifts the meaning of *transferring* an information scrap. It recognizes that, like a paper information scrap, a smartphone scrap may be *transferred* to mitigate information fragmentation. But unlike a paper information scrap, a smartphone scrap is not usually *transferred* to evade its medium's transitory nature. Further, our lifecycle acknowledges that smartphone information scraps may be *transferred* to other people through the medium's built-in communication channels. We believe this updated information scrap lifecycle will prove useful in understanding people's behavior as research continues on information scraps in the smartphone era.

7 Implications for Design

This thesis is largely an exploration of people's information scrap behavior as it exists today. We had a goal, in this era wide smartphone adoption, to learn how and why people use smartphones to record information scraps. As discussed in Section 6, prior research points out many problems thought at the time to be in the way of digital information scrap tool adoption. Some of these problems, we argue, have been solved, while others proved not as obstructive as originally thought. However, we do observe challenges that remain in the design of digital information scrap tools.

In each of our diary studies, we found that participants made the vast majority of smartphone information scraps using apps that came standard on their smartphones, only

some of which, such as *Notes* and *Reminders*, could be said to be designed with information scrap making in mind. For smartphone manufacturers, this should serve as an indication that while information scrap support is desirable to their users, the current standard information scrap tools do not fully satisfy their users' information scrap needs. Consider the various information scraps in our studies that were recorded using email, text message, screen capture, a PDF viewer or, especially in our first diary study, the smartphone camera app. The camera was used to capture 29% of smartphone information scraps in *ISSE* Part 2, which is remarkable considering built-in camera apps such as the iPhone's *Camera* do not appear to have been designed with any information scrap purpose in mind. To better support photographic information scraps, smartphone makers could add features to camera apps that acknowledge their utility for information scrap capture. This could be automatic scrap tagging for easy spring cleaning or special image compression for scraps to save phone memory. Alternatively, smartphone makers could add photo-taking capabilities to their dedicated information scrap apps, giving users greater ability to organize their scraps by purpose than by capture modality.

Our findings present a different set of challenges for third party app makers than for smartphone manufacturers. While smartphone makers may simply improve information scrap support for their built-in apps, third party information scrap app makers must first convince smartphone owners to actually install and use their apps. Part of this issue no doubt has to do with the realities of doing business in current smartphone app marketplaces, a topic we will not address here. However, another part of this issue is the tendency, first noted by Lin, et al. [2], of people to make information scraps using whatever medium is readily available. No matter how good an information scrap app is, a

person will not likely reach for it, let alone download and install it, if there are suitable, familiar options already available, i.e., built-in apps.

While we saw few examples in our *ISSE Part 2* diary study of participants using third-party information scrap apps, we did see a few such examples in our *ISSE Crowd* diary study. There is not enough data to say with any certainty when and why smartphone users do use third-party apps for making information scraps. However, the cases we did see—three different meal planning tools and one Christmas list tool—lead us to speculate that people may be more apt to seek out task-specific apps as needed rather than seek out more general purpose information scrap apps. Thus, the goal for app makers may be to design appropriate information scrap features as value-adds that strengthen their other app or service offerings.

8 Future Work

We have sought to understand and explain the topic of smartphone information scraps within the frameworks of Lin, et al.'s [2] micronote lifecycle and Bernstein, et al.'s [3] information scrap roles. At the same time, we have tried to redefine those frameworks to better reflect the reality of smartphone information scraps. Through our experimentation, we have answered our overarching questions. However, we have left some smaller questions unanswered for want of data. How do smartphones affect the *trigger* stage of the information scrap lifecycle? At the least, we need better, more nuanced diary entry questions to help answer this. How prevalent are *mobile* contexts to different populations of working adults? We need diary entry questions that can solicit more detailed answers about *mobile* contexts in home or office environments. In addition,

office workers are not the only segment of working adults we should be targeting. Smartphones could enable digital PIM practices in many work environments, and future research should attempt to uncover it.

Our diary studies provided us with insight into how people make smartphone information scraps to fill the *archiving* role as well as how people retain—or *keep*, as we described in our information scrap lifecycle—their smartphone information scraps after they've fulfilled their purpose. However, future work is needed to flesh out our conclusions about the role automatic scrap retention plays in smartphone information scraps. By the same token, future work should put our information scrap lifecycle to the test. Such research should attempt to verify our information scrap lifecycle's utility as a descriptive analytical tool for smartphone information scraps.

Our work has also revealed some new information scrap questions worth investigating. Our initial survey showed paper is still preferred over smartphones for a cluster of common tasks, but it did not answer why. In Section 4.1.1, we pointed out that many of these paper-preferred types of information scrap tasks support retrospective memory. It could be that people prefer the organizing structure of paper notebooks over smartphones for such tasks, or perhaps these kinds of information scraps tend to be of a longer form that lends itself better to paper. On the other hand, many of these tasks, such as *Take meeting notes*, can often be anticipated well in advance. It could be that people choose paper over smartphones for these tasks because they are given the chance to plan for them. Future research should continue the work of investigating people's tool preferences for these information scrap tasks.

Finally, future research should investigate people's information scrap making behaviors on emerging "wearable" computing devices. As we have mentioned before, a hallmark of information scraps is that people make them with whatever tool is readily available. As user adoption grows for smartwatches and other always-on, always-present computing devices, there exist opportunities for researchers to study how people adapt these devices for information scrap work. These devices, whose input methods are often even more constrained than smartphones, also present new challenges in the design of scrap capture modalities. Smartwatches have screens that are likely too small to support the keyboards that are the standard text entry method on smartphones. Other kinds of wearables, like rings and clothing, may not even have screens. It will be interesting to see if people accept, for example, speaking aloud to their wearables as an appropriate keyboard alternative. Technology makers have the opportunity now to design novel information scrap creation methods for the coming wave of wearable devices.

9 References

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Appendix A – ISSE Part 1 Survey

"Information scraps" are small, informal notes that people write to themselves to help them remember something (e.g., a reminder written on a Post-It note) or to help them complete a task (e.g., a grocery list). While many information scrap activities are often done with pen and paper, some can also be done with smartphones. In this survey, we are interested in learning how people record and use information scraps in their day-to-day lives.

Do you currently use a smartphone?

__Yes

__No

How likely are you to do the following tasks on **paper** versus on your **smartphone**? (Doing a task on your smartphone could involve any kind of smartphone app or feature, including the camera, audio recording apps, note-taking apps, calendar apps, etc. If you do not use either paper or smartphone for a task, or if you do not do a task at all, you may select "Not applicable". Select one.)

	Very likely to use paper	More likely to use paper	Equally likely to use paper or smartphone	More likely to use smartphone	Very likely to use smartphone	Not applicable
Make or edit a "to do" list						
Take meeting notes						
Record a name or contact information						
Make a "how to" list (a list of steps to accomplish some task)						

Make a note to help you with "work-in-progress" (for example, a note relevant to a current project)						
Record a web address, URL, directory path, or file path						
Record a desired item or a thing you are thinking of buying						
Record login or password information						
Make brainstorm notes						
Record calendar or event details						
Record notes at an event						
Make a progress report						
Keep track of a receipt or a purchase confirmation						
Make notes about a voice conversation (in person, over the phone, Skype, etc.)						
Capture part of a text message conversation (SMS, iMessage, WhatsApp, etc.)						
Make a reminder						
Record financial data						
Make a list of events or an agenda						
Retain the content of a paper letter						
Make technical notes (math calculations, engineering notes, debugging notes, etc.)						
Record an idea						
Annotate a document or book						
Record plans, goals, or a timeline						
Record airplane flight information						
Capture information from a whiteboard						

How **often** do you do these tasks?

(For this question, it does NOT matter if you do the tasks with pen and paper or a smartphone or any other tool. We are only interested in how often you do these tasks. Select one.)

	Rarely or never	Monthly	Weekly	Daily	Multiple times per day
Make or edit a "to do" list					
Take meeting notes					
Record a name or contact information					
Make a "how to" list (a list of steps to accomplish some task)					
Make a note to help you with "work-in-progress" (for example, a note relevant to a current project)					
Record a web address, URL, directory path, or file path					
Record a desired item or a thing you are thinking of buying					
Record login or password information					
Make brainstorm notes					
Record calendar or event details					
Record notes at an event					
Make a progress report					
Keep track of a receipt or a purchase confirmation					
Make notes about a voice conversation (in person, over the phone, Skype, etc.)					
Capture part of a text message conversation (SMS, iMessage, WhatsApp, etc.)					
Make a reminder					
Record financial data					
Make a list of events or an agenda					
Retain the content of a paper letter					

Make technical notes (math calculations, engineering notes, debugging notes, etc.)					
Record an idea					
Annotate a document or book					
Record plans, goals, or a timeline					
Record airplane flight information					
Capture information from a whiteboard					

What is your age group?

__25 and under

__26 – 35

__36 – 45

__46 – 60

__Over 60

__Prefer not to respond

What is your gender?

__Male

__Female

__Prefer not to respond

What is your highest level of education completed?

__Less than high school

__High school

__College

__Graduate school

__Prefer not to respond

Appendix B – ISSE and ISSE Crowd Diary Entry Questionnaire

Thank you for your continued participation in the "Information Scraps in the Smartphone Era" study. Please answer the following questions about the last "information scrap" you recorded.

What was the last information scrap you recorded? (Short answer)

What were you doing when you decided to record this information scrap? (Short answer)

Where were you when you recorded this information scrap? (Short answer)

What was the purpose of recording this information scrap? (Short answer)

Information scraps can serve in the following roles. Please check all that apply to this information scrap?

__**Temporary storage** - meant to help you remember something over a short period of time (for example, driving directions)

__**Cognitive support** - meant to aid your thought process (for example, brainstorm notes)

__**Archiving** - meant to hold onto important information for long periods of time (for example, website passwords)

__**Reminding** - meant to remind you of something by notification or by being placed in the way of future movements and activities (for example, a to-do on a Post-it note placed where you will see it)

__**Unusual information storage** - meant to hold information that does not easily fit into your normal personal information management tools

How did you record this information scrap? (Select one. If other, please specify.)

__Smartphone

__Paper

__Other _____

If applicable, what app or apps did you use to record this information scrap? (Short answer)

Which of the following statements is most accurate? (Select one)

__You captured and then used this information scrap.

__You captured and then ignored this information scrap.

__You captured and then lost this information scrap.

__You captured this information scrap and will use it in the future.

If you are finished using this information scrap, have you kept it? (Answer only if previous answer was either "You captured and then used this information scrap" or "You captured and then ignored this information scrap". Select one.)

__Yes

__No

__Not finished using it yet

What if, if anything, have you done with this information scrap now that you are finished using it? (Answer only if previous answer was "Yes". Short answer.)