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Automation of Personal Information Management

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Abstract. In this thesis, I examined how an automated digital solution could facilitate the user experience within PIM by examining how users acquire, organize, manage, and retrieve their personal information on digital devices using photos and screenshots. I conducted an online survey to validate findings from the literature review and an exploratory contextual study to understand and improve the user experience. Using descriptive statistics and thematic analysis, I discovered specific patterns and indicators of how screenshots and photos are used on PIM. Participants welcomed automatic PIM, but there were concerns about the automatic deletion and trusting external parties with access to private information. The prototypical solution showed that it should be a personalized, adaptive, and automatic retrieval system.

Keywords: personal information management, automatic solution, smartphones,

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1 Introduction

Personal information management (PIM) refers to the study and practice of people's activities in acquiring, organizing, maintaining, and retrieving information (Barreau, 1995). According to Shirazi et al. (2021, p. 120), PIM controls the distribution of information such as documents (both paper and digital), web pages, and email messages to accomplish tasks and fulfill various roles. For example, screenshots of travel plans or maps for the trip could be used to fulfill different roles or tasks.

According to Jones et al. (2017), one of the goals of PIM is to have the appropriate information at the right time, in the proper format, and in sufficient quantity and quality to fulfill current demands. For most people, this ideal is far from reality. It comes with numerous complications. According to Jones et al. (2017), people may not find the correct information at the right time to meet their needs. The information they need may not be available or arrive too late to be helpful. The information may also arrive too early and be misplaced or forgotten before the opportunity to use it arises. People may forget to use the information even if they have taken the trouble to save it for later use. For example, many of us have taken a photo or screenshot to use later and then forgotten about it. We also felt the frustration of scrolling through the tons of photos and screenshots on our phones and not finding the item we were looking for.

Academics in the field of information science have expressed serious concerns that the new applications of PIM, despite their usefulness, lead to an increase in overall complexity (Jones & Bruce, 2005). Jones & Bruce (2005) further explain that a new system for managing personal information does not interact with existing systems, forcing users to deal with yet another system for collecting, organizing, maintaining, and retrieving data.

Various research has been conducted on how digital devices are used for PIM. However, according to Müller et al. (2015, p. 427), only a limited amount of research has been conducted on handheld devices. Traditionally, PIM has been conducted on paper, desktop, and laptop computers, but technological advances in handheld devices, such as digital cameras and apps for note taking, are better suited for PIM (Buttfield-Addison et al., 2012). In limited handheld research, photos and screenshots have been the primary types of information managed on handheld devices (Jensen et al., 2017, p. 148). Handheld devices referrers to smartphones, tablets, smartwatch etc. For this thesis, I will focus on smartphones.

1.1 Problem statement

As mentioned earlier, PIM fails when the information needed is never found or arrives too late to be useful (Jones, 2007). Therefore, in this thesis, I will explore how people manage, create, and use memories on smartphones while designing a digital solution to facilitate users' experiences from a PIM perspective. Based on this, I formulate the following problem statement:

How to design a digital solution to ease the user experience in finding the necessary information at the right moment, focusing on photos and screenshots on smartphones within the scope of PIM?

1.2 Research questions

To support the problem statement, I decided to explore the following research questions (RQ):

1.2.1 Research question 1 (RQ1):

It is important to understand how users acquire, organize, maintain, and retrieve the information and what type of information, such as screenshots, photos, etc.. The user uses to accomplish the various tasks such as shopping lists, travel plans, etc., in the context of smartphones. Once I understand the management and nature of the information and the intended roles of the users, I can further explore the current challenges facing the users to develop a digital solution.

1. How screenshots and photos are being used in relation to personal information management, and what challenges do the users experience on their smartphones?

1.2.2 Research question 2 (RQ2):

To design a digital solution, I need to study the current smartphones to understand the possible features and functionalities and design a better solution.

2. How can our existing smartphones' different features & functionalities be re-designed to better support PIM?

1.2.3 Research question 3 (RQ3):

Once the solution is created, I need to test it to see if it provides a better user experience and allows for easy use of PIM.

3. How likely is the digital solution prototype that benefits the users and eases their experiences?

2 Theory

The first following section consists of the main principles of Personal Information Management (PIM) to define the term *personal information* in the context of PIM. The

second part deals with the theory of Prospect Memory, where I will explore different characterizations of prospect memory and choose an appropriate framework to fit the scope of the thesis.

2.1 Personal information management (PIM)

PIM is commonly used in information science (Feng & Agosto, 2019, p. 1352). However, it originates from Lansdale's (1988, p. 55) research describing the procedures people use to manage, classify, and retrieve information daily. The research was based on his psychological viewpoint to understand better people's motivations for office activities (Feng & Agosto, 2019, p. 1354). Over the years, researchers expanded the scope of PIM, merging information behavior and information systems research (Feng & Agosto, 2019, p. 1353).

PIM stands for Personal Information Management. According to Boardman (2004, p. 15), information in a person's possession and under his or her direct control is referred to as *personal*.

According to Henderson (2009, p. 7), the term *personal* can be interrupted in two ways:

1. A type of personally identifiable information could be sensitive, which could be a date of birth, credit history, or address. These types of information are often not controlled or managed by the individual about whom the information is being collected and therefore are often the source of privacy concerns.

2. The second type of information is owned and controlled by the individual. This type of information can be changed, rewritten, and deleted by the person who owns it.

The context I will use in this thesis is the second type of personal information, where personal refers to information in the possession and control of the individual, and information refers to data that is significant to the individual.

According to Henderson (2009, p.8), *management* in the context of personal information refers to the act of controlling or maintaining personal information. Throughout the literature review, there are differences in the definition of PIM. According to Lansdale (1988, p. 55), PIM refers to the strategies and processes users use to accomplish their daily tasks by managing, categorizing, and retrieving information. Lansdale sees PIM primarily in using information most efficiently after it has been obtained.

According to Boardman & Sasse (2004, p. 583), PIM is a broad term that defines an individual's collection, storage, organization, and retrieval of digital information in his or her personal digital environment. According to Barreau (1995, p. 327), PIM includes the individual's techniques and rules for gathering information, being part of the system

for organizing the information, rules, and processes for maintaining the system, tools for retrieval, and procedures for creating various necessary outputs. Unlike Boardman & Sasse (2004), Barreau (1995) considers storing and organizing a single characterization in PIM.

In addition to Lansdale's (1988) and Barreau's (1995) definition, Jones (2007) defines a broader perspective of PIM. According to Jones (2007, p.5), the practice and study of the activities users undertake to acquire, create, store, organize, maintain, retrieve, use, and distribute the information they need to achieve specific goals and fulfill specific goals roles and responsibilities. According to Jones (2007, p.5), a specific goal can be short- or long-term, while specific roles and responsibilities can be parents, spouses, friends, or community members. According to Jonas (2007, p.5), PIM focuses on organizing and managing personal information, and the information stored should be for future use and reuse.

Barreau's (1995, pp.328-330) research characterizes personal information management in five steps: Acquisition, Organization, Maintenance, Retrieval, and Output.

2.1.1 Acquisition

The initial input of PIM is where the user enters his or her problems, requirements, and requests into the system (Barreau, 1995, p. 328). This information is either created by the user or collected from another source in PIM (Barreau, 1995, p. 328). There are various methods for gathering data. Previous research on PIM has mainly focused on personal information commonly stored on a desktop or laptop, such as files, emails, and bookmarks (Jensen et al., 2018, p. 143). However, in recent years, the rise of handheld devices has shifted researchers' focus to the forms of handheld devices such as photos and screenshots (Buttfield-Addison et al., 2012), (Jensen et al., 2018), (Zhang & Liu, 2015).

2.1.2 Organization

The organization is the next step in PIM, which refers to ordering and categorizing information, such as naming, grouping, and classifying the information in one place for later retrieval (Barreau, 1995, p. 328). Barreau (1995, p. 328) refers to this as the access point for retrieving the needed information. According to Henderson (2009, p. 9), an organization is a process of classifying, categorizing, and applying metadata to the information.

2.1.3 Maintenance

According to Khoo et al. (2007), maintenance occurs once information is acquired and organized, and the focus of this step is to improve the retrieval process and avoid

overload. According to Henderson (2009, p. 9), the primary maintenance activities are deleting documents that are no longer needed, making backup copies of information, and moving documents that are no longer frequently used. According to Barreau (1995, p. 329), maintenance of PIM system is a critical role that is often overlooked in the development of PIM systems. According to Henderson (2009, p. 9), it is theoretically possible to manage a single piece of information. However, in practice, management efforts focus on collecting information as documents may be work-related, personal, or even recreational. According to Barreau (1995, p. 329), at this stage, a user can delete information, change the organizational structure, update outdated or erroneous information, rename folders and documents, move information, and back up information. In contrast to Barreau (1995), Jonas (2007, p. 65) includes maintenance activities in which the user updates, reorganizes, and deletes acquired information that he or she must be able to retrieve after maintenance. According to Kljun & Carr (2005, p. 1), PIM has a few solutions that maintain information automatically, such as removing things after a certain period; otherwise, the user is responsible for maintenance.

2.1.4 Retrieval

According to Henderson (2009, p. 8), information is retrieved from the collection for various functions, including reading, editing, sharing with others, and archiving. According to Barreau (1995, p. 329), retrieval in PIM systems is dependent on user-defined queries, the system's access capabilities, and the system's ability to fulfill the user's request. Information retrieval depends on the previous steps. For an effective PIM, it must be able to quickly retrieve information that also regularly meets users' needs (Deng & Feng, 2011, p. 324). According to Song and Ling (2011, p. 763), the biggest problems in retrieval are caused by the cognitive process of retrieving and recognizing information. Deng & Feng (2011, p. 324) argue that users can often clearly remember what they have retrieved or created in a short period. However, users may have difficulty retrieving their long-term information due to blurred memories.

2.1.5 Output

From the user's point of view, the output is one of the most important aspects of organizing PIM systems. Barreau (1995, p. 329) argues that users come to the PIM system to solve a problem or get an answer and that the system's ability to do so depends heavily on the quality of the output. In the context of photos and screenshots, both iOS and Android-based handheld devices use optical character recognition solutions to improve the accessibility of information to users.

Optical Character Recognition (OCR).

OCR technology became popular during the digitization of historical newspapers in the early 1990s, and in recent years the technology has improved almost to perfection while being available to the public (IBM, 2022). The technology separates the

information into dark and light areas in a digital image based on the identified potential characters (Sravan et al., 2015). It analyzes the dark area to identify it using pattern or feature recognition (Sravan et al., 2015).

The iOS system has developed its text recognition feature called *live text*, where the technology can recognize multilingual digital and handwritten text. It uses machine learning models to recognize individual characters and neural networks to work as humans read (Apple, 2022). Google created OCR with Cloud Vision API using machine learning models focused on image recognition and formatting them in a simple REST API interface (Chan, 2019). Users of both systems use OCR extensively in their daily activities, such as in Google Translate, in their camera, and in their system.

2.1.6 Personal information type

According to Whittaker (2011, p. 11), personal information has several characteristics, such as how information is distinguished between action-oriented and informative-oriented . To understand how users process information, I need to understand the difference between action-oriented and informative-oriented information. Action-oriented information requires an action, e.g., many email messages require the recipient to take any action, whether it is answering a question, making an appointment, or providing information (Whittaker, 2011, p. 11). Informative-oriented does not require an action; for example, information on the Internet is potentially informative-oriented but does not usually prompt the user to take action (Whittaker, 2011, p. 11). Furthermore, according to Whittaker (2011, p. 12), the uniqueness of a piece of personal information influences how the user interacts with it.

2.1.7 Summary

I adopt Henderson and Boardman & Sasse's definition of personal information management, in which the term *personal* refers to information owned and controlled by the individual, *information* refers to data that is meaningful to the individual, and *management* refers to the maintenance of personal information. I chose to omit the *acquisition* from Barreau's (1995) characterization of the five steps of personal management because photos and screenshots predefine my problem statement. I adopt the rest of the four steps: organization, maintenance, retrieval, and output, to explore the rest of my research questions. To support my research question 3, I use Whittaker's (2011) information types to understand whether users interact with action-oriented or informative-oriented.

2.2 Prospective memory

To understand how information is used in personal information management, we need to understand the process of prospective memory. According to Ratnam et al.

(2020, p. 28), prospective memory is a type of memory required for everyday cognition, such as remembering an intended and planned action, remembering the action in the future, required for everyday cognition, such as remembering important dates. It means remembering future actions (Einstein et al., 2008, p. 867). According to Einstein et al. (2008, pp. 868-869), prospective memory became a research focus in the late 1980s to address the fundamental questions. It increased over time as theoretical research on the cognitive processes that support prospective memory, curiosity about how these processes change over time, and the development of neuroimaging tools to study the brain basis of prospective memory increased (Einstein et al., 2008, pp. 868-869).

Einstein et al. (2008, pp. 871 - 872) divided prospective memory into time-based, event-based, and activity-based.

2.2.1 Time-based

Time-based prospective memory refers to remembering to do something at a particular time. According to Ratnam et al. (2020, p. 28), the user must form an intention of what he or she wants to remember and then establish a schedule of when he or she wants to act. According to Einstein et al. (2008, p. 872), the intention is based on time measurement, e.g., answering a phone call in 10 minutes or attending a meeting at a particular time.

2.2.2 Event-based

Event-based prospective memory refers to remembering to do something when a particular circumstance occurs. According to Ratnam et al. (2020, p. 28), users need to store memories in retrospective memory (memory of recalling past memories) when they are busy with other tasks. According to Einstein et al. (2008, p. 871), performance on an event-based task is measured by the proportion of specific or general cues recognized and responded to when the intention was formed.

2.2.3 Activity-based

Activity-based prospective memory refers to remembering one activity after another activity. According to Einstein et al. (2008, p. 872), there is not much experimental research on activity-based prospective memory. It is theoretically unclear whether it is just a variant of an event-based task in which the completion of a task acts as the event that indicates the response (Einstein et al., 2008, p. 872).

According to Einstein et al. (2008, p. 872), although all three formulations are prospective memory tasks, success rates differ depending on the individual and the circumstances under which the task was performed. According to Ratnam et al. (2020, p. 29), it is essential to consider the intention of the task because prospective memory

refers to the recollection of intentions, and the most important aspect of intentions is the connection to the individual's daily activities and duties.

2.2.4 Summary

In this thesis, I will apply Einstein et al.'s (2008) approach with the three types: time-based, event-based, and activity-based, to investigate RQ1. By splitting the photos and screenshots into these three approaches, I can analyze the participants' memories and the indicators that underlie the habit of creating memories.

3 Literature Review

A literature review is a critical summary and analysis of relevant previous research on the topic under study (Cronin et al., 2008, p. 38). Zobel (2014, p. 21) argues that every research project builds on the work of previous papers. A literature review aims to identify literature that will help me answer the research questions and problem statement. According to Rowley & Slack (2004, p. 32), a literature review helps select a research topic, research question, and hypothesis and develop theoretical concepts and terminology. This section describes the process and key findings of the literature review.

3.1 Systematic Review

Traditional and systematic literature reviews are the two types of reviews (Jesson et al., 2011, p. 14). According to Jesson et al. (2011, p. 15), traditional reviews provide a general overview of a study topic without a defined scientific approach. Systematic reviews use a straightforward, methodological approach to find, critically evaluate, and summarize the results of primary research studies (Jesson et al., 2011, p. 16). I will choose a systematic literature review approach because it contains a well-defined search strategy for my clear problem statement. According to Xiao and Watson (2017, p. 94), a systematic review should be conducted before conducting empirical research. A subset of the literature from the systematic review closely related to the empirical study can be used as background for the empirical research (Xiao and Watson, 2017, p. 94).

3.1.1 Search

There are two basic approaches: Query expansion and thinning strategy (Rowley & Slack., 2013, p. 31). In query expansion, I start with a few results and expand the results as the search progresses, while in the thinning strategy, we start with many results and narrow it down to specific results (Rowley & Slack., 2013, p. 31). Due to the variety of different literature results on PIM, I decided to use the thinning strategy.

To gain a brief understanding of the topic, I began with a simple approach using the Boolean operator's method from AND & OR (Cronin et al., 2008, p. 40). First, I used the problem statement to guide me through the process. I also used Google Scholar and the AAU library to overview the field.

Then, I used building blocks, i.e., the structural search type, by expanding the search with synonyms and related terms from PS (Rowley & Slack, 2004, p. 35).

I used the PQRS method to summarize the results, which is commonly used to conduct systematic reviews using building blocks. According to Cronin et al. (2008, p. 40), the PQRS begins with a preview, where the abstract of the literature is skimmed to identify the relevant literature in question and read, and the relevant features of the literature are captured in summary.

3.2 Related work

In the first part of this section, I will present the literature most relevant to this thesis. In the second part, I will consider the related work based on Barreau's five characters in the second part.

3.2.1 Most relevant literature

Jensen et al. (2018) presented the results of an exploratory contextual study of personal handheld devices PIM, according to which screenshots and photos of digital and non-digital information are among the most common types of information managed on smartphones. According to Jensen et al. (2018, p. 148), action-oriented information focuses on using photos and screenshots to create reminders for things to do or things to buy, while regular screenshots and photos have design implications. Information on smartphones was deleted when a task was completed or lost its usefulness, except for personal attachments such as photos (Jensen et al., 2018, p. 149). Flagging and favoriting were commonly used to create reminders. The users relied heavily on their memories of location, time, and visual features to retrieve information (Jensen et al., 2018, p. 149).

In my 1st semester project, we explored digital devices in managing users' personal information through photos and screenshots to enhance their prospective memory (Ratnam et al., 2020). Data were collected through a mixture of online surveys and contextual inquiries. Afterward, the results were analyzed using descriptive statistics and contextual survey analysis (Ratnam et al., 2020). According to Ratnam et al. (2020), users use handheld devices in PIM to store digitally but often forget the existence of the photos or screenshots. The information is unorganized, and many photos and screenshots are stored.

Zhang & Liu (2015) used mixed methods (questionnaires and focus group interviews) to study college students' behavior PIM. The result was that sending self-addressed emails and messages and screenshots was the common practice on handheld devices (Zhang & Liu, 2015). Zhang & Liu (2015, p. 4) concluded that smartphone users are storing more and more personal and work-related information, while there are no suitable methods for smartphone PIM. The information is overlaid in the applications created or accessed, as smartphone operating systems lack a folder system for resource management (Zhang & Liu, 2015, p. 5).

Leino et al. (2010) combined a survey and a dairy/interview study on smartphone use in PIM. According to Leino et al. (2010), smartphones are increasingly used to handle personal information because users carry them with them. As a result, users use active reminders on their phones, which has become the default when users need to remember things, especially when they are on the go (Leino et al., 2010, p. 267).

Buttfield-Addison et al. (2012) conducted a questionnaire survey followed by a semi-structured interview among employees of medium to large organizations in different countries to understand the role of handheld devices within PIM. This study's findings suggest that the impact of handheld devices on PIM should be investigated.

According to Blažica et al. (2013), the rise of digital photography has increased the number of photos in personal collections that need to be managed. Blažica et al. (2013) designed an experiment to observe how people behave when editing photos on a handheld device to analyze the interaction.

3.2.2 Barreau's five characters

The following section will go through the related work with Barreau's five characters.

3.2.2.1 Acquisitions

Since I am focusing on screenshots and photos as memory aids in this thesis, I have filtered the literature and related works so that they do not go beyond the scope. According to Zhang & Liu (2015, p. 5), one of the most common memory information in practice is PIM photos and screenshots, with screenshots being the most common acquisition strategy. It is also evident in the study by Jensen et al. (2018). According to Jensen et al. (2018, pp. 143 - 144), screenshots and photos are two of the five types of information managed on handheld devices. For photos, a distinction can be made between long-term and short-term photos, where long-term photos are primarily informational, and short-term photos could be classified as action-oriented (Jensen et al., 2018, p. 143). According to Jensen et al. (2018, p. 144), different photos serve different purposes, with users distinguishing between informative-oriented long-term photos and action-oriented short-term photos. Screenshots often serve as a reminder of planned activity in the future or as action-oriented information. (Jensen et al., 2018, p.

144). These can be screenshots of a Snapchat, screenshots of websites to revisit later, or screenshots of emails as reminders (Jensen et al., 2018, p. 144).

According to Ratnam et al. (2020, p. 63), action-oriented photos and screenshots can be classified into social information activity and self-reminders. The social information activity consists of sharing their photos or screenshots with others. Self-reminders were remembering a particular action. However, the self-reminders did not fulfill the expected potential because their photo album was too messy (Ratnam et al., 2020, p. 63). According to Buttfield-Addison et al. (2012, p. 66), information such as notes and photos are easily kept on handheld devices and, therefore, often replace paper for note taking.

3.2.2.2 Organization

According to Leino et al. (2010, p. 262), the large amount of information stored on the smartphone was not easy to organize. Zhang & Liu (2015, p. 5) suggested several strategies for smartphone organization:

1) Categorization, where the user uses folders as category holders to classify apps.
2) Frequency of use is a common strategy for finding and organizing by frequency.
3) Location, where the user remembers where the information was placed.
4) Visual clues, where the information is organized according to the visual.

Blažica et al. (2013, p.) proposed a different strategy, where photos are organized according to the user's affinity rather than time, to evoke the user's memories or by the photo's aesthetics. Indratmo and Vassileva (2008, p. 2) classified organizational structure approaches into five categories: hierarchical, flat, linear, spatial, and network.

Hierarchical

Hierarchical approaches use a tree structure to organize information, which can be one file at a time or a group of items such as a file folder (Indratmo & Vassileva, 2008, p. 2). Users tend to organize information according to the task at hand and the value of the items to the users (Indratmo & Vassileva, 2008, p. 2). According to Indratmo & Vassileva (2008, p. 3), a hierarchical structure requires significant cognitive effort to organize and classify information hierarchically. To make classification, administration, and retrieval more accessible, many software systems utilize a hierarchical structure to organize data and allow users to create folders and subfolders (Indratmo & Vassileva, 2008, p. 2).

Flat

Users assign tags or features to information objects in a flat structure. These tags summarize or retrieve the items, providing associative access to the items (Indratmo & Vassileva, 2008, p. 4). Also known as tagging, users can divide an information item into multiple categories by assigning multiple tags to the item. Thus, tagging is a versatile approach to arranging information items (Indratmo & Vassileva, 2008, p. 4). According to Indratmo & Vassileva (2008, p. 5), the ability to assign multiple tags to an information item leads to inconsistencies in tag assignment, which prevents users from finding all relevant items in a collection simultaneously. Another problem with

tagging approaches is that users are generally reluctant to annotate their information items extensively (Indratmo & Vassileva, 2008, p. 5). According to Indratmo & Vassileva (2008, p. 5), attributes can be automatically extracted from the content of text files. However, automated tagging of images is complex due to the difficulty of analyzing the content of such documents.

Linear

In a linear structure, information is arranged in a list in a specific order, which can be alphabetical (e.g., the order of words in dictionaries) or chronological (e.g., incoming messages in email inboxes) (Indratmo & Vassileva, 2008, p. 6). According to Indratmo & Vassileva (2008, p. 6), this depends on users knowing the attributes of the information they are looking for. A sorted list allows them to navigate through the list in a meaningful way, which helps them search. According to Indratmo & Vassileva (2008, p. 7), only one dimension of an information collection can be displayed at a time to be sorted either chronologically or alphabetically.

Spatial

Spatial structure is used daily to organize things at home and work to be easily retrieved, separate important files from unnecessary ones, and place regularly used objects in easily accessible locations. Therefore, locations are the primary technique for arranging information in spatial methods (Indratmo & Vassileva, 2008, p. 7). According to Indratmo & Vassileva (2008, p. 7), using only spatial memory to retrieve information leads to poor results, especially when the number of items increases.

Network

A network structure allows information to be freely connected (Indratmo & Vassileva, 2008, p. 8). According to Indratmo & Vassileva (2008, p. 7), it is not easy to have a comprehensive picture of an information network and properly move across it since networks are less ordered than other organizational systems. Broken connections are a typical problem in network structures and occur when data objects are removed from their old places on servers (Indratmo & Vassileva, 2008, p. 8).

Automatic

Automatic organizing has increased in recent years due to technological advances. According to Indratmo & Vassileva (2008, p. 9), a successful organizational structure must consider individual needs, and technologies should aim to automate and simplify development procedures. According to Whittaker (2011, p. 42), users in the organization prefer effective semi-automated methods over ineffective automated models. This study dates back to 2011, and today, technologies have evolved in automation.

Summary

According to Zhang & Liu (2015), organizational structure can be divided into four main strategies: Organization by categorization, frequency of use, position, and visual cues. According to Indratmo & Vassileva (2008), they can also be categorized as hierarchical, flat, linear, spatial, and network. In addition, I would like to investigate

whether handheld device users prefer automatic or manual organization (Whittaker, 2010).

3.2.2.3 Maintenance

According to Henderson (2009, p. 2), after the information is acquired and organized, maintenance takes place to maintain order and optimize the retrieval process. The literature review revealed that most maintenance processes are performed manually by users. According to Kljun & Carr (2005), only a few solutions from PIM maintain information automatically, e.g., by deleting it after a certain period; otherwise, the user is responsible for maintenance.

According to Barreau (1995, p. 329), maintenance can be categorized into deleting items, changing organizational structure, renaming items, and updating or removing items. In order to perform it, it is essential to understand the value of the information. According to Jensen et al. (2018), the value of information depends on the following factors: Information value, personal value, storage capacity, and information overload.

Information value

According to Khoo et al. (2007), one of the reasons users resist deleting information that may be useful is the fear of destroying information that may be valuable in the future. In Kirk et al.'s (2006) study, users have difficulty deleting digital photos even if the photo is very similar to a copy of another photo in their collection. According to Jensen et al. (2018), individuals leave all options open when deciding which photo to keep.

Personal value

Users retain this information for emotional or sentimental reasons (Bergman et al., 2007). According to psychologists Kahneman and Tversky (1979), the reference point was already established when the user decided to acquire the information in the first place, and users measured the pros and cons of retaining or deleting information. Loss aversion in prospect theory explains that the pain of losing something is twice as great as the pleasure of gaining something (Harley, 2016). This argument is also found in the thesis of Jensen et al. (2018).

Storage capacity

According to Whittaker (2011), users prefer to keep the information they do not need to delete because it does not consume space, is readily available, and is cheap. The same result is observed when participants rarely delete their digital information due to their large storage capacity (Diekema & Olsen, 2014). However, with limited storage capacity, users need to delete information manually (Zhang and Liu 2015).

Information overload

According to Boardman and Sasse (2004), it is not easy to delete photos taken by users that convey a strong sense of ownership. According to Krik et al. (2006), users' number of photos has increased in recent years. This argument can be corroborated by

Whittaker et al. (2011). Participants kept almost all photos, while the deleted photos were of poor quality or failed to convey the desired message (Whittaker et al., 2011).

Summary

According to Zhang and Liu (2015), users have to manually delete information regularly due to the smartphone's storage capacity. According to Kljun & Carr (2005), only a few solutions from PIM can manage the information automatically. According to Jensen et al. (2018), the value of information depends on the following factors: Information value, personal value, storage capacity, and information overload.

3.2.2.4 Retrieval

Retrieval refers to the practice of retrieving and reusing stored information. According to Whitaker (2011), retrieval refers to the re-access and re-finding of information. According to Goren-Bar (2004), users prefer adaptive and automatic retrieval systems, while personalization is crucial for retrieval on handheld devices. According to Jensen et al. (2018), PIM retrieval on handheld devices seems to be undervalued and divides retrieval strategies into Search, Navigation, and Hybrid.

Search

According to Jensen et al. (2018), search-based retrieval of photos and screenshots is complex because they are not text-based and cannot be found with a content-based search. In the study by Kirk et al. (2006), it was found that direct search is not an activity that many home digital photo users engage in. A similar result was shown in Whittaker's (2010) study. Users indicated that searching for photos was difficult because they had not labeled the individual photos and therefore had no idea what to search for (Whittaker's, 2010).

Navigation

According to Bergman et al. (2010, pp. 166 - 167), navigation requires less verbal attention to visual cues and is much faster than search. In a study by Bergman et al. (2010), users had difficulty accessing long-term archives. Over 40% of photo retrievals were unsuccessful due to the ease of acquisition and a large amount of storage. Users attempted to remember the number of photos by remembering the exact day they were taken to obtain photo folders labeled with the specific date. Unfortunately, most labels did not contain date information or proved inaccurate, making the retrieval process difficult (Bergman et al., 2010). Users also reduced the number of photos their autobiographical memory used for memories to facilitate visual identification when navigating through thumbnails of photos with rough shooting dates and associated events.

Hybrid

A Hybrid system is a combination of navigation and search query. According to Jensen et al. (2018), hybrids are not considered a retrieval method in the literature due to unknown user habits and the memory process. Most information retrieval methods aim to facilitate the retrieval of information rather than retrieve it (Jensen et al., 2018).

Summary

According to Jensen et al. (2018), there are three main strategies: search, navigation, and hybrid. There are few studies on the retrieval of hybrids compared to search and navigation in the literature. According to Bergman et al. (2010), navigation is the best strategy compared to searching for visual content such as photos and screenshots. In this thesis, I will investigate which retrieval strategies users use on handheld devices and under what conditions concerning visual cues to understand retrieval and recognition memory processes.

3.2.2.5 Output

Output is the final step in Barreau's PIM model. According to Barreau (1995), the outcome for users is essential because the users came to the PIM system with a goal rather than a solution. Literature shows that users prefer automatic output (Barreau, 1995), (Boardman, 2004), (Krik et al., 2006), (Jensen et al., 2018). According to Krik et al. (2006), users were interested in a system where the process is automatic and uses intelligent tools to display a solution automatically. However, not many studies have been conducted on automatic results within PIM.

3.2.2.6 Summary

Most studies focused on qualitative and quantitative data collection (Zhang & Liu, 2015), (Jensen et al., 2018), (Leino et al., 2010), (Ratnam et al., 2020), (Buttfield-Addison et al., 2012), (Leino et al., 2010). They consist of a survey followed by a semi-structured interview. The survey focused on either validating their hypotheses or collecting data on general usage of PIM. The semi-structured interviews focused on the details behind the *why*. These were studies in the area of handheld devices. Following Jensen et al. (2018), the qualitative interview was divided into six steps: general information, acquisition, organization, maintenance, retrieval, and output. Inspired by Jensen et al. (2018), I looked to the related work of Barreau (1995) to characterize PIM. Since this work is about photos and screenshots, the focus was not on acquisition. Zhang & Liu (2015) categorized the organizational structure into four strategies, while Indratmo & Vassileva (2008) subcategorized it into four structures. In addition, the automatic organization should investigate whether handheld device users prefer automatic or manual organization (Whittaker, 2010). In the maintenance phase, literature has shown that users need to delete information manually due to the storage capacity (Zhang & Liu, 2015). Retrieval steps indicate three main strategies, while the navigation should be considered when dealing with visual content such as photos and screenshots (Jensen et al., 2018). Not many studies have been conducted that explicitly address the output steps in Barreau's PIM. However, it was mentioned that users preferred automatic output. In the next section, I will describe the methodology.

4 Methodology

This section will explain the consideration of methodologies to address the RQs and PS. I will describe the user involvement, philosophy of science, project management, design framework to approach this thesis, materials, and analysis methods.

4.1 User involvement

From the literature review, there was a clear indication of potential users that could be involved in the empirical study. The participants in this study should be smartphone users. Their smartphones should be able to execute computer-like operations, such as having an interface, taking photos and screenshots, internet access, and an operating system such as iOS or Android. Gender seems irrelevant because, according to Poushter (2016), owning a smartphone in Europe and the United States is normal. For the user research, I will conduct both quantitative and qualitative research.

4.1.1 Quantitative vs. qualitative research methods

Quantitative vs. qualitative research methods are two strategies for gathering knowledge to understand the field of study. According to Bryman (2012, p. 470), the quantitative research method was developed to increase the consistency and validity of core ideas. Since the researcher has a well-defined set of study questions to investigate, it is often more systematic (Bryman, 2012, p. 470). According to Goodman et al. (2012, pp. 95-96), qualitative research methods such as interviews and observational research can explain why people do what they do. Under design thinking in phases, I will explore what tools are applicable for this thesis in quantitative and qualitative research.

4.1.2 Sampling in quantitative research

For quantitative research, how many respondents are enough depends on the sampling (Goodman et al., 2012). According to Goodman et al. (2012), a population includes all elements with the characteristics one wishes to understand. However, since the population is dynamic, I cannot send it to everyone. Therefore, sampling is essential to select a representative subset of elements from the population. There are two main categories of sampling probabilistic sampling and non-probabilistic sampling (Goodman et al., 2012). The most crucial criterion for probability sampling is that everyone in the population has an equal chance of being chosen (Bryman, 2012). Since there is a financial constraint, I will use non-probabilistic samples. According to (Bryman, 2012), there are four types of samplings.

Convenience sampling relays on available elements to which the researcher has access (Bryman, 2012). However, the location, time of day, and other factors may produce a biased sample. *Snowball sampling* is a strategy in which respondents are asked to forward additional people who might be interested in responding to the

questionnaire (Bryman, 2012). *Snowball sampling* is a convenience sampling in which respondents are chosen based on their ease of access (Bryman, 2012). *Purposive samplings* select respondents with characteristics (Bryman, 2012). *Voluntary-response sampling* requests a set of populations to respond to in quantitative research (Bryman, 2012).

Since this thesis focus on smartphone users, I will use snowball sampling to generate responders. I will use my network to recruit individuals as a quick and low-cost method (Bryman, 2012).

4.1.3 Sampling in qualitative research

According to Nilsen (2010), recruiting just five participants is adequate to uncover 80% of the issues. According to Faulkner & Trotter (2017), the phrase *data saturation* is used to characterize the point in the testing phase when no new information is discovered, or the data begins to repeat itself. I will aim to locate at least 5 participants.

4.2 Philosophy of science

According to Bryman (2012, p. 5), what is studied and how the research results are interpreted are influenced by the theories social scientists use to understand the social environment. There are two types of approaches: the deductive approach, which theory guides research, and the inductive approach, in which theory emerges from research (Bryman, 2012, p. 19). This thesis emerged from theory, which is a deductive approach. However, according to Bryman (2012, p. 20), before conducting social research, the researcher must think about epistemological and ontological issues and the research approach to data collection. The epistemological question is one of the essential aspects in determining whether a paradigm of the natural science research process is appropriate for studying the social world (Bryman, 2012, p. 19). The ontological issue is whether the social world is viewed as something external to social actors or as something that individuals themselves create (Bryman, 2012, p. 19). According to Goldkuhl (2012, p. 136), pragmatism is interested in action and change and the interaction between knowledge and action. Pragmatism seems to be a clear choice, as the focus of this thesis is to examine users' activities concerning PIM in photos and screenshots as memories. According to Goldkuhl (2012, p. 142), pragmatism allows researchers to combine qualitative and quantitative methods. Pragmatism works effectively when the researcher studies the world and makes changes or analyzes actions (Goldkuhl, 2012, p. 142).

In terms of pragmatic epistemology, knowledge is formed through activities and considered a reflection of reality (Goldkuhl, 2012, p. 140). In terms of the ontology of pragmatism, knowledge is equally related to actions and changes (Goldkuhl, 2012, p. 139).

4.3 Project management

There are two main approaches in project management: waterfall and agile. After the requirements phase, a waterfall approach is a linear approach that does not require interaction with the user (Dix et al., 2003, pp. 228-230). The agile approach is characterized by its adaptability, allowing frequent user testing (Preece et al., 2015). Due to the ability to go from and back and involve users in different phases, the agile approach seems to be a clear choice for this thesis.

4.4 Design framework

According to Batterbee (2020), a framework is a design and development method that fosters creativity and learning and provides tools and techniques for solving problems, aligning solutions, and creating better experiences. According to Verschoor (2016), there are several frameworks, but they all focus on understanding users' needs and goals. According to Batterbee (2020), a design framework helps structure the process, develop new ideas, and foster collaboration. Therefore, it is a necessary component for aligning design solutions. In the following section, I will present three design frameworks that can be considered for this thesis. I will look at their pros and cons before deciding on a design framework for this thesis.

4.4.1 Double diamond

It was popularized by the British Design Council in 2005 (Design Council, 2019) and consisted of four phases: discover, define, develop, and deliver. It starts with understanding the users through empirical data collection, analyzing the data, developing solutions, and testing it as the final phase (Design Council, 2019). The users will also be co-designing and testing before the solution is delivered. According to Tasi (2019), the clarity and flexibility of the double diamond is a practical approach to communicating the model. One of the exciting aspects of the double diamond is limiting the alternatives by searching for fresh ideas through a divergent thinking process (Verschoor, 2016).

4.4.2 Co-design

Participatory or co-design focuses on co-creating the design with users. (Ferguson & Candy, 2014, p. 1). It does not necessarily have to be the users, but co-design emphasizes the collaboration of different teams, users, and stakeholders, bringing their skills to the design (Verschoor, 2016).

4.4.3 Design thinking

According to Cross (2018), the first Design Thinking symposium took place in 1991, where the framework was introduced. In contrast to the double diamond, design thinking has five phases according to Dam & Siang (2020b): Empathize, Define, Ideate, Prototype, and Test. It is an iterative and non-linear process (Dam & Siang, 2020b), meaning the researcher can complete the phases in any order, repeat them, or return to an earlier phase during the process.

4.4.4 Selecting a design framework

All three design frameworks mentioned above focus on end-user understanding. However, the differences lie in their approach. The participatory or co-design framework focuses on co-creating the solution with the end users. Therefore, this framework will not be helpful for this thesis. Both Double Diamond and Design Thinking have similar approaches. Both start with understanding users, then creating and testing solutions before delivery. However, Design Thinking is a non-linear process, meaning I can move back and forth between steps. Unlike design thinking, which focuses on the testing portion of the diagram, the double diamond indicates less of an iterative process, and the end of the second diamond shows *the completed and produced project*. (Tasi, 2019). Unlike Design Thinking, the Double Diamond does not provide space for rapid prototyping (Verschoor, 2016). Since this thesis will use a non-linear process (by returning to each phase) and gets to know the users by testing the prototype, I will use the Design Thinking framework.

4.5 Design thinking in phases

According to Lewrick et al. (2018, p. 96), design thinking is a problem-solving approach that is both practical and creative. Design thinking is user-centered (Meinel & Leifer, 2022, p. 5). According to Luchs (2015, p. 4-7), it starts with empathizing with the users, defining the information gathered to identify the problem the researchers are trying to solve, developing ideas to solve the problems, turning the ideas into prototypes, and finally testing the prototype (Dam & Siang, 2020b).

According to Dam & Siang (2020b), the researcher can perform these steps in parallel, repeat them, or return to an earlier stage during the process. In contrast to the double diamond, which is a linear process, design thinking only works if it is iterative (Luchs et al., 2015, p. 8).

According to Brown & Wyatt (2010, p. 32), it is a human-centered methodology. The methodology is based on insights about how users interact with a product or service rather than how someone thinks they will interact. According to Luchs et al. (2015, p. 3), it is an iterative process, meaning the researcher studies how users use a product or service and adjust it to improve the user experience. According to Brown & Wyatt (2010, p. 32), design thinking promotes impactful ideas from below rather than being

imposed from above. It also prioritizes rapid prototyping over lengthy research or deliberation (Luchs et al., 2015, p. 3).

In the section below, I will explore different approaches and tools I will consider in each Design Thinking phase.

4.5.1 Phase 1: Empathize

According to Köppen & Meinel (2015, p. 16), in this first step, the researcher examines the users to understand how users interact with the product or service or how a product or service influences users. In this step, the researcher must study the user with empathy (Köppen & Meinel, 2015, p. 16), not pass judgment (Köppen & Meinel, 2015, p. 23), and not assume what the user needs (Luchs et al., 2015 p. 5). Empathy-based research is effective because it can uncover issues that the customer was unaware of or could not express themselves (Kouprie & Visser, 2009, p. 440).

There are different methods to understand users. In the section below, I will explain the different steps, advantages, and disadvantages to assess which methods are most suitable for this thesis.

4.5.1.1 Focus group

According to Bryman (2012, p. 501), a focus group is a group of interviewers who come together to talk about a particular product or concept. Although focus and group interviews are similar, they are different. According to Bryman (2012, p. 501), focus groups concentrate on a single topic, while group interviews cover many topics. Another difference is that group interviews are often conducted to save time and money compared to 1-on-1 interviews; however, focus groups are not conducted (Bryman, 2012, p. 501). According to Freitas et al. (1998, p. 4), the focus group is one of the low costs among other methods. However, it is impossible to tell if he thinks about group interaction or individual conduct. It is time-saving, but it is not as in-depth as other research methods (Freitas et al., 1998, p. 9).

4.5.1.2 Eye tracking

Eye tracking is a research method for determining visual attention. According to Khachatryan & Rihn (2017), eye tracking technology that records actual eye movements has become very popular. When participants in consumer behavior studies know they are being watched, they change their behavior (Khachatryan & Rihn, 2017). Eye-tracking technology alleviates this concern because participants are generally unaware that their eye movements are recorded (Maughan et al., 2007). According to Khachatryan & Rihn (2017), eye-tracking technologies cannot record contact lenses, glasses, or pupil colors.

4.5.1.3 Diary studies

Diary studies typically run over a period and allow participants to self-report their experiences with a product, service, or task (Fernandez, 2020). According to Fernandez (2020), diary studies have the potential to capture influential external factors; however, researchers cannot observe participants. According to Salazar (2016), it is a longitudinal method, which means that an efficient result can only be obtained in a long-term study. Diary studies will not function due to the restricted time allowed for this thesis.

4.5.1.4 1-on-1 interview

According to Martin & Hanington (2012, p. 54), 1-on-1 interviews allow us to gain a comprehensive understanding of the situation and explore specific perspectives, values, behaviors, and decisions. 1-on-1 interviews can be divided into three types: structured, unstructured, and semi-structured interviews (Ratnam et al., 2020). According to Bordens & Abbott (2010. Pp. 272-273), a structured interview contains prepared questions (typically referred to as an interview guide). It tends to be rigid, whereas an unstructured interview has only a rough concept of the topics to be discussed. According to Bordens & Abbott (2010. P. 273), an unstructured interview is recommended for exploratory research because a structured interview can exclude essential information. According to Bordens & Abbott (2010. pp. 272-273), in an unstructured interview, it is possible to digress from the topic and discuss anything unrelated, making it difficult to code and analyze later. Semi-structured interviews have a base of researched questions, but the interviewer can further elaborate on specific topics as the interview progresses (Bryman, 2012. p. 471).

4.5.1.5 Contextual inquiry

Contextual Inquiry (CI) is a combination of in-depth interviews and observation. According to Raven & Flanders (1996, p. 2), CI emerged from psychological, anthropological, and sociological research. One of the main differences between a structured interview and CI is that CI involves dialog rather than just asking questions, which can help uncover previously hidden or unnoticed details about the user's practice (Holtzblatt & Beyer, 2014, p. 51). The purpose of CI is to find out how and why users act the way they do. CI is done through observations and interviews in the context of the research topic (Raven & Flanders, 1996, p. 2). For CI, the researcher and the user must establish a relationship. This allows for a shared consideration of the topic and gives the user an equal voice in the discussion (Holtzblatt & Beyer, 2014, p. 51). Unlike structured interviews where questions are asked, in CI, the researcher should seek to engage the user in a discussion. This can help reveal information about the user's practice that was previously hidden or unseen (Holtzblatt & Beyer, 2014, p. 52).

According to Raven & Flanders (1996, p. 1), the three main principles are:

1. Data must be collected in the context of the user's actions.

2. The user and the researcher must establish a working relationship in which the user feels comfortable revealing his or her true feelings.
3. The study should be narrowed down and focus on specific topics rather than general questions.

According to Raven & Flanders (1996, p. 4), the most common approaches to using CI are the work-based interview, the post-observation interview, and the artifact walkthrough. In user studies, artifact walkthrough is also the most common method for conducting contextual inquiry (Raven & Flanders, 1996, p. 2). I choose to use an artifact walkthrough in this study because the activities I want to study repeatedly occur over time. It allows users to talk about their actions using the relevant artifacts. According to Raven & Flanders (1996, p. 3), the researcher can confirm previously found assumptions by experiencing the user in action and conversing with the user during the CI session.

4.5.1.6 Selecting tools or methods

Emphasis is gaining a better understanding of users (Dam & Siang, 2021a). The eye-tracking research method is helpful, but I will not choose eye-tracking based on Covid and the online empirical data collection for this thesis.

Dairy studies are a longitudinal method (Salazar, 2016), which means that an efficient result can only be obtained in a long-term study. Due to the restricted time allowed for this thesis, this method will not work.

A focus group is a cost-effective method to gain users' understanding (Freitas et al., 1998, p. 9). Compared to 1-on-1 interviews, focus group interviews are not in-depth. Focus groups also cannot reflect an individual's honest and personal opinion on a topic, especially if their ideas conflict with another participant's opinions (Bryman, 2012, p. 502). Therefore, I will not use a focus group.

1-on-1 interviews are efficient with a semi-structured interview guide. Rather than simply asking questions as in a structured interview, semi-structured interviews will make the session more of a conversation that could uncover previously hidden or ignored facts about the user's practice (Holtzblatt & Beyer, 2014, p. 51). Contextual Inquiry is ethnographic fieldwork that incorporates in-depth interviews to gain comprehensive knowledge about attitudes and practices (Salazar, 2020). For this thesis, I need to observe and understand the process that participants use in acquiring, organizing, maintaining, and retrieving their personal information management. Therefore, I will choose contextual Inquiry with artifact walk-throughs and semi-structured 1-on-1 interviews.

4.5.2 Phase 2: Define

The define phase is where the researcher uses observations from the empathy phase to define the problem the researcher wants to address. According to Dam & Siang

(2019), the define phase is about stating the users' needs and the problems, where the researchers find out the perspective of this problem and what they are working on. The define phase includes identifying the problems users experience and the ongoing conflict they face and summarizing the results on how the problem impacts them. According to Dam & Siang (2019), the designer summarizes their observations about the users in this step.

Synthesis reveals cohesion and a sense of continuity (Kolko, 2010, p. 5). It shows how things are connected and how they are related. According to Kolko (2010, p. 5), it provides order, reduces complex problems to something I can address, and creates clarity. So, it is a way of making something out of chaos. According to Kolko (2010, p. 17), synthesis is an abductive sensemaking process. Sensemaking is an action-oriented process that aims to make sense of the world by integrating experiences into understanding the world around us (Kolko, 2010, p. 17). According to Kolko (2010, p. 17), through induction, the researcher attempts to learn from the data; through deduction, the researcher develops hypotheses or theories and applies them to the world; and through abduction, the researcher attempts to infer what might be. In abductive research, the researcher is not trying to find the truth but the best explanation (Kolko, 2010, p. 17). In this phase, I will explore different tools in the define phase and select tools that will define the problems I want to address.

4.5.2.1 Literature review

A literature review is a detailed review of academic material about the topic. According to DSS (2020), it is a reliable method to support assumptions about the concept, building on previous academic work. The output of this method should contain in-depth information about the problem.

Unlike literature review, secondary research is a simple internet search to understand the context. According to Vianna et al. (2011, p. 32), the term *desk* is derived from *desktop* and is used because most modern secondary research is based on reliable online sources.

4.5.2.2 Service blueprint

The Service Blueprint is mainly used in the context of the Service Design Methodology. According to Gibbons (2017), it is a mapping tool for visualizing organizational processes. Service blueprints are a collection of service elements such as actors, physical or digital evidence, and procedures associated with the touchpoints of a journey (Stickdorn et al., 2018, p. 54). According to Stickdorn et al. (2018, p. 54), service blueprints can take a more balanced approach to service by depicting the many levels of coordination needed to make it work. The service blueprint can be compared to customer journey mapping (Stickdorn et al., 2018, p. 54). However, according to Gibbons (2017), the Service Blueprint starts with the Customer Journey. Gibbons (2017) divides the Service Blueprint into different stages: The front Stage includes the

actors and actions immediately before the customer experience. The Back Stage: consists of processes and activities behind the scenes to support what happens on stage.

4.5.2.3 Personas

According to Liedtka & Ogilvie (2011, p. 59), personas are a potentially abstract notion of *users* that help the researcher develop an empathic knowledge of the product or service user. According to Goodman et al. (2012, p. 492), the goal of a persona is to create a sense of familiarity and empathy for users. *Personas* are tools used to understand better the many forms of user interactions (Liedtka & Ogilvie, 2011, p. 70). Researchers use personas as a summary tool to create various forms of representations based on user research (Goodman et al., 2012, p. 480). According to Laubheimer (2020), there are three personas for different purposes: proto-personas, qualitative personas, and statistical personas.

Proto-personas

According to Laubheimer (2020), proto-personas are a simplified version of quick personas created based on current user data and researchers' assumptions about who users are and what they want. Proto-personas can also serve as the basis for future studies if the researcher views them as hypotheses that can be tested through research (Laubheimer, 2020).

Qualitative personas

According to Laubheimer (2020), qualitative personas are ideal for developing personas by conducting exploratory qualitative research with a small to medium sample size and segmenting people based on shared attitudes, goals, pain points, and expectations. Qualitative personas are accurate and provide critical insights into users' motivations, expectations, and desires that are difficult to glean from analytics data, demographic information, or assumptions alone (Laubheimer, 2020). It also means that they are a time-consuming process.

Statistical Personas

According to Laubheimer (2020), statistical personas are the most time-consuming method of persona creation. It involves collecting data from a large sample of the user base via a survey and then performing statistical analysis to identify clusters of similar results. This persona form requires some exploratory qualitative research to determine which survey questions should be included (Laubheimer, 2020). Creating statistical personas requires a mix of qualitative and quantitative research methods.

Selecting a persona type

The goal of personas is to provide an abstract representation of the end users (Liedtka & Ogilvie, 2011, p. 59). Both statistical and qualitative personas require empirical research. Proto-personas do not require empirical research based on literature review rather than user research (Dam & Siang, 2020). Therefore, I will choose proto-personas.

4.5.2.4 User stories

According to Lucassen et al. (2016), User Stories are used in software development to specify needs from the user's perspective. User stories are part of an agile methodology that helps focus on user requirements (Lucassen et al., 2016). They streamline the requirements definition process by focusing on the business needs rather than the solution to those needs (Lucassen et al., 2016).

4.5.2.5 Journey mapping

According to Gibbons (2018), a journey mapping visual represents a person's path to achieving a goal. Creating a map encourages everyone involved to discuss and create a shared mental model. The shared artifact created by the mapping can be used to provide knowledge about the user or service to all stakeholders (Gibbons, 2018). According to Gibbons (2018), a journey map and a user story map have some of the same components but are used at different stages of the process. Since I am using user stories, journey mapping will not be appropriate as a visual representation for this thesis.

4.5.2.6 Activity mapping

UML (Unified Modeling Language) is a software development modeling language used to visualize software (Whitten & Bentley, 2005, p. 244). According to Whitten & Bentley (2005, p. 246), an activity diagram shows how the system interacts with users. It graphically represents who will use the system and how the user expects to interact with the system. It illustrates the flow of the activity from beginning to end and highlights the multiple decision paths that occur during the activity (Whitten & Bentley, 2005, p. 247). It is used to iterate the visions of the proposed platform and visually represent the platform's concepts (Whitten & Bentley, 2005, p. 252).

4.5.2.7 Empathy mapping

According to Vianna et al. (2011, p. 83), it is a tool for synthesizing information about the user by visualizing what they say, do, think and feel, allowing the data from the immersion phase to be organized to understand situations arising from the user's context, behavior, concerns, and ambitions. According to Dam & Siang (2019), CI makes it easy to determine what users have said and done. However, to find out what they thought and felt, it is necessary to closely observe how they acted and reacted to various activities, ideas, and conversations.

4.5.2.8 Selecting tools and methods

The information obtained will be reviewed and synthesized to define the central questions in this phase. An extensive literature review should provide me with a problem definition. I will create proto-personas based on the literature review rather

than user research personas (Dam & Siang, 2020). It should give me a good indication of who my users are and their needs. Based on the proto-personas, I will create user stories to understand users' perspectives (Lucassen et al., 2016). Activity mapping will show how users interact with the system. This thesis will use an activity diagram to visualize the interaction flow and connection between the system and the user.

The Service Blueprint is a mapping tool to visualize the entire process (Gibbons, 2017). It is a good tool for a larger organization. However, there are not many actors in this thesis, and therefore, this is not a tool for this thesis.

Empathy mapping is a highly recommended tool for Design Thinking (Dam & Siang, 2021a). Empathy mapping aims to visualize what users say, do, think, and feel (Vianna et al., 2011, p. 83). Since both proto-personas and user stories are based on literature review, there is no concrete data to map what users feel and think. Therefore, I will not use this tool.

4.5.3 Phase 3: Ideate

In this phase, the researcher should solve the previously mentioned problems. According to Dam & Siang (2021), in the ideation process, the researcher should be able to develop ideas and solutions in different sessions. According to Dam & Siang (2021), this phase is more about quantity than quality, meaning that the researcher should develop many ideas, which are then filtered in the next phase.

4.5.3.1 Conceptual design

According to Preece et al. (2015, p. 553), the conceptual model is critical to interaction design, but defining it can be not accessible due to the many different conceptual models. The underlying idea of conceptual design is to go from the abstract to the tangible. Exploring and experimenting with numerous techniques to develop a tangible idea is the best way to capture a conceptual design (Preece et al., 2015, p. 553).

4.5.3.2 Future workshop

Like the co-designing framework, the future workshop is an idea generation process involving participants in the decision-making process. According to DSS (2020), this is a beneficial method for children and youth to learn about an ideal future. This method is not very useful due to its nature as co-designing.

4.5.3.3 Brain writing and mind map

According to BHP (2011), this is an approach to creative thinking developed by a German design institution in the late 1960s to discuss fresh ideas, stimulate innovation, and develop unique concepts. According to (DSS, 2020), this method is used when the design team is not comfortable with sketches and drawings, which could limit idea

generation. I will use sketches for idea generation. Like brainwriting, a mind map is a diagram that is a collection of ideas or objects that visually represent knowledge and relationships (DSS, 2020).

4.5.3.4 Sketch

According to Preece et al. (2015, p. 543), low-fidelity prototyping relies mainly on hand-drawn sketches, which can be difficult for many people who are uncertain of their drawings' accuracy. Sketches are meant to be quick and easy to create. Sketches are used to explore and propose ideas by providing a concrete visual representation of those ideas (Buxton, 2007).

4.5.3.5 Selecting tools and methods

This phase is about generating ideas. The future workshop method will not be helpful due to its nature as co-designing. The conceptual design will be an appropriate tool to create ideas by moving from abstract to tangible ideas (Preece et al., 2015, p. 553). In addition to conceptual design, I will also use brainwriting and mind-mapping as basic tools that will help me brainstorm ideas. Like mind mapping, sketching will help me draw ideas because it is quick and easy to create (Preece et al., 2015, p. 543). I will use these tools to develop ideas and help create the prototype in the next phase.

4.5.4 Phase 4: Prototype

At this stage, the researcher should make tangible ideas so that they can solicit feedback, filter the ideas, and negotiate them. According to Walker et al. (2002, p. 2), prototyping is a tool for designing, developing, and constructing ideas. The development of a model of the final design that guides the design process and decisions is called prototyping (Buchenau & Suri, 2000, p. 1). According to Preece et al. (2015, p. 540), prototypes provide solutions to questions and assist designers in decision making. According to Jerry et al. (2015, p. 14), conceptual ideas become actual concepts during prototyping. According to Preece et al. (2015, p. 538), users cannot always verbalize what they want, but once they see or feel something, they quickly know what they do not want. Instead of just *guessing* what the result would look like, prototypes anchor in user reality by offering actual feedback (Jerry et al., 2015, p. 14). According to Preece et al. (2015, p. 540), prototyping is used for several purposes, including determining the technical feasibility of a concept, clarifying requirements, and conducting user testing and review.

According to Walker et al. (2002, p. 1), there are different prototypes, with high-fidelity and low-fidelity prototypes being predominantly used. Below I will explore different prototype methods and choose applicable methods for this thesis.

4.5.4.1 Low-fidelity prototype

Low-fidelity prototypes are intended for experimentation rather than preservation and integration into the final product (Preece et al., 2015, p. 542). According to Jerry et al. (2015, p. 33), the main benefit of a low-fidelity prototype is that it may be produced quickly and inexpensively while maintaining minimal aesthetics and functionality and then rejected or adjusted readily. According to Preece et al. (2015, p. 542), low-fidelity prototypes are used in the early stages of development during conceptual design for exploration and change using simple, low-cost, and quick-to-create methods. A low-fidelity prototype can be anything from a paper storyboard to a cardboard mockup to a cast model (Preece et al. 2015, p. 538). According to (Jerry et al., 2015, p. 77), low-fidelity prototypes are excellent for representing conceptual or abstract concepts in the early stages of design.

4.5.4.2 Paper prototype

According to Jerry et al. (2015, p. 33), a paper prototype is an excellent example because it is easy to construct and can be used to answer structural and functional problems. A paper prototype is one of the approaches for usability testing to discover and identify missing features in an application (Lancaster, 2004, p. 335). According to Miao et al. (2009, p. 82), a paper prototype is a step in product development that helps to understand the design and find deficiencies and enables change recommendations. According to Thornton (2019), a paper prototype is a user-centered design that involves users in the design process and receives feedback rather than expecting them to be the designers. Paper prototypes have several advantages. A paper prototype does not always require programming or technical knowledge (Jerry et al., 2015, p. 38). If user feedback is received early in the development process, content and functionality can be changed in response to user feedback (Lancaster, 2004, p. 335). According to Jerry et al. (2015, p. 74), there is no need to include or test graphics, colors, written text, or anything else because it is a low-fidelity prototype.

4.5.4.3 Storyboard

According to Preece et al. (2015, p. 542), a storyboard is a collection of sketches representing how a user might use the product. According to Dix et al. (2003, p. 320), it is a flexible evaluation method. When used in conjunction with a scenario, the storyboard adds depth to the written scenario and allows stakeholders to role-play the prototype by walking through it (Preece et al., 2015, p. 243).

4.5.4.4 High-fidelity prototype

Prototypes close to the final version of the system are called high-fidelity prototypes. According to Preece et al. (2015, p. 246), high-fidelity prototypes develop prototypes that closely match the final product, excellent for users. User-driven high-fidelity prototypes look and feel like the final product. They are often used for exploration and testing (Preece et al., 2015, p. 246). High-fidelity prototypes are often produced in the

same way as the final product, with the same interaction approach and presentation, which can be more expensive and time-consuming (Walker et al., 2002, p. 1). According to Preece et al. (2015, p. 246), creating high-fidelity prototypes is time-consuming because of the many intricacies involved, and testing early in the design process is also inefficient.

4.5.4.5 Selecting tools and methods

This phase is about exploring the ideas developed in the previous phase. There are two main prototyping tools: Low Fidelity and High Fidelity prototypes (Preece et al., 2015). Low-fidelity prototypes are suitable for experimentation and exploration, while high-fidelity prototypes are good for product definition and estimates (Jerry et al., 2015, p. 27). According to Preece et al. (2015, p. 545), a high-fidelity prototype is more practical and/or more similar to the final product than a low-fidelity prototype. Since I will conduct a usability test in this thesis, I will use a low fidelity prototype to test the ideas. Once the test is complete, I will use high fidelity. Both the storyboard and paper prototype are helpful in creating low fidelity prototypes.

4.5.5 Phase 5: Test

This phase is about testing the prototypes. Design thinking is iterative, even though this is the final phase: teams often use the results to redefine one or more additional challenges (Dam & Siang, 2021a). According to Dam & Siang (2021a), it is best to create a natural environment while conducting user testing with the prototype.

Two types of data can be obtained in a user testing study: qualitative and quantitative data. According to Budiu (2017), qualitative usability tests provide information for the design process, while quantitative usability tests serve as a basis for benchmarking and ROI calculations. The main differences between qualitative and quantitative usability tests are summarized in figure 01

	Qual Research	Quant Research
Questions answered	Why?	How many and how much?
Goals	Both formative and summative: • inform design decisions • identify usability issues and find solutions for them	Mostly summative: • evaluate the usability of an existing site • track usability over time • compare site with competitors • compute ROI
When it is used	Anytime: during redesign, or when you have a final working product	When you have a working product (either at the beginning or end of a design cycle)
Outcome	Findings based on the researcher's impressions, interpretations, and prior knowledge	Statistically meaningful results that are likely to be replicated in a different study
Methodology	• Few participants • Flexible study conditions that can be adjusted according to the team's needs • Think-aloud protocol	• Many participants • Well-defined, strictly controlled study conditions • Usually no think-aloud

Figure 01: Qualitative and quantitative usability testing differences (Budie, 2017)

The primary purpose of this usability test is to identify and address usability issues. For this thesis, I decided to conduct qualitative usability tests. Qualitative usability testing is excellent for identifying important design issues (Budie, 2017). The researcher can ask follow-up questions and adjust the course of the study during the usability testing phase to gain insight into particular difficulties the participant encountered (Budie, 2017). I used a combination of semi-structured interview procedures to keep the data consistent. The *evaluator's effect* explains where different participants notice different problems in the same usability testing session (Budie, 2017). It could be prevented by recruiting people who match my personas.

4.5.5.1 Usability testing

According to Goodman et al. (2012, p. 344), usability testing is significant to creating a successful user interaction that addresses all product elements, and the range of tasks can vary widely. Usability testing can be conducted in various ways, both online and offline, with a small or large group of people (Goodman et al., 2012, p. 344). According to Hotjar (2021), usability testing evaluates the usability of a product and helps evaluate specific features or functions for a representative of the personas. Usability testing allows the researcher to immediately see how users will understand and use the designs in their current state (Goodman et al., 2012, p. 344). According to Hotjar (2021), the role of the researcher is to ask questions and guide the discourse by setting tasks for the participants. Usability testing ensures that the user has a smooth transition through Hotjar (2021). Although testing can be done at any point in the production process, it is most effective when done early to identify potential problems and make changes (Goodman et al., 2012, p. 344). Consider resources, personas, and study objectives when planning usability testing before deciding on a usability testing

method (Hotjar, 2021). There are four forms of usability testing (Goodman et al., 2012, p. 345):

- Exploratory (testing the concepts and seeing how promising they are)
- Evaluation (testing the features during implementation)
- Comparison (comparing one design to another)
- Validation (validating the features to see if they meet the requirements)

In user-based testing, a group of representative users is presented with representative tasks (Lazar et al., 2010). According to Lazar et al. (2010), user-based testing can be divided into formative and summative testing. Formative testing is exploring options, evaluating early prototypes, and supporting the final product's design early in the design cycle. Summative testing is when a formal prototype is ready, and high-level design decisions have already been made.

4.5.5.2 Task scenario

According to McCloskey (2014), observing how users use an interface is the most efficient approach to learning what works and what does not. The action that the designer asks the participant to perform on the test interface is called a task scenario (McCloskey, 2014). The designer should also know how many steps the user must take to achieve a goal (McCloskey, 2014). A task scenario is best known as a tool that expresses the participant's purpose by providing context and necessary elements to achieve the goal without being overly directive. It can also determine if a user story is effective, efficient, and satisfies the user's needs.

4.5.5.3 A/B testing

It is a user experience research method that compares two versions of a single variable (Kohavi et al., 2008). It usually involves comparing a subject's response to variant A with variant B and deciding which variant is more successful (Kohavi et al., 2008). However, it can only consider two variables and only works well for specific goals (Kohavi et al., 2008).

4.5.5.4 Survey

A survey can be conducted in both the empathy and test phases. I will use it in this phase because I will use the survey to validate the literature review results. A survey is qualitative research (Bryman, 2012, p. 184). According to Bryman (2012), a survey is easy and quick to create and can reach a broad audience. A cost-effective way to evaluate and discover market trends is to conduct an online survey (Goodman et al., 2012, p. 327). However, non-response (Bryman, 2012, p. 187) and skipping responses or stopping the survey in the middle of the survey could lead to inaccurate data (Bryman, 2012, p. 676).

A survey can contain both open-ended and closed-ended questions. Closed-ended questions produce numerical responses (Bryman, 2012, p. 249), but open-ended

questions elicit free-flowing text responses (Bryman, 2012, p. 247). However, open-ended questions are time-consuming to answer, have lower response rates, are difficult to compare, lead to irrelevant information, and are difficult to analyze (Bryman, 2012, p. 676).

A closed-question survey provides a bird's eye view of the topic, with specific response options that are easy to compare and analyze (Wolff, 2021). It is simple and quick to answer (Goodman et al., 2012, p. 328), and responses are consistent (Bordens & Abbott, 2010, p. 259). It is a good tool for validating hypotheses (Goodman et al., 2012, p. 180). However, a survey with closed-ended questions cannot be created without previously researched topics because the respondent's answer choices must reflect the possible answers (Bordens & Abbott, 2010, p. 259). It can be helpful and concerning, as the designer may not always know the possible answers (Wolff, 2021). It could be addressed by including an open-ended *other* option as one of the choices (Bordens & Abbott, 2010, p. 263).

4.5.5.5 User engagement scale (UES)

The user engagement scale (UES) is a frequently used tool for determining a user's subjective perception of a product's user engagement (Schrepp et al., 2017). It was proposed initially with 26 questions. However, Hinderks et al. (2018) proposed a shorter version with eight questions. Proposed by Laugwitz et al. (2008) to cover six aspects of user experience, which are:

- Efficiency (Can users solve tasks without unnecessary effort? Does it react fast?),
- Perspicuity (Is it simple to become acquainted with the product and learn how to utilize it?),
- Dependability (Does the user feel in control? Is it secure and predictable?),
- Attractiveness (The product's overall impression. Is it liked or despised by users?)
- Novelty (Is the product's design creative? Does it catch the users' interest?)
- Stimulation (Is using the product exciting and motivating? Is it entertaining?)

4.5.5.6 Selecting tools and methods

This phase is about testing the prototype (Dam & Siang, 2021a). It is not only about testing the prototype but also about checking if I have formulated the problem correctly (Dam & Siang, 2021a). Usability testing is significant for successful user interactions and can be conducted online and offline with a small or large group of people (Goodman et al., 2012, p. 344). I will use this tool since my user interactions will occur online.

Furthermore, I will use the survey to validate the results from the literature review section. Since this is a validation survey, I will use closed-ended questions with an additional open-ended option called *other* (Bordens & Abbott, 2010, p. 263). Since it will be a low-fidelity prototype, UES will not work because UES evaluates an existing system. UES will be helpful upon testing high-fidelity testing.

I will use the task scenario approach to test the prototype to learn what works and does not (McCloskey, 2014). Since I will be using other testing tools, A/B testing seems irrelevant to this thesis at this stage. In the future, A/B testing may be helpful once I have tested the concept and developed two different design variations.

4.6 Materials

Due to the covid pandemic, I will approach online data gathering. I will use google forms for the survey, and to spread the survey, I will rely on my social media accounts. For the CI sessions, I will use Teams, Zoom, and Facebook messenger to conduct interviews and usability testing. I will also record the sessions and use Microsoft transcripts and Descript to transcribe the interviews. To analyze the quantitative data, I will use R. I will use Figma to analyze the qualitative data and develop the prototypes.

4.7 Procedure

This section will describe how I intend to collect the data. In the first part, I will describe the procedure of creating and distributing an online survey. In the second part, I will describe the procedure of creating CI.

4.7.1 Survey

According to Bryman (2016, p. 220), a survey is a research method where data is collected using questionnaires. The survey will be used as an introduction tool to validate the findings from the literature review section. A questionnaire is a collection of questions administered to respondents and is often used synonymously with *survey* (Bryman, 2016, p. 220).

As mentioned in the above section, a survey is a quantitative research method (Goodman et al., 2012, p. 327). The survey will be based on SURGE (Grimshaw, 2014). According to Grimshaw (2014, p. 207), SURGE is used to ensure that methodical issues relating to a survey and detailed, easy-to-understand questions are systematically sent to the researcher. SURGE addresses procedure, sample, survey distribution, analysis, and methods to deal with the results (Grimshaw, 2014, p. 211).

The questionnaire can contain both open and closed questions. According to Bryman (2016, p. 221), closed questions are typically analyzed using descriptive statistics or inferential statistics. Descriptive statistics describe patterns from the sample. Inferential

statistics conclude the population from the patterns in the sample. Because the goal of this survey is to confirm the literature review findings, I will use closed-end questions and descriptive statistics to analyze afterward.

4.7.1.1 Procedure of survey and questions

The survey will be an online self-completion survey, with respondents reading and answering each question independently (Bryman, 2012, p. 231). According to Bryman (2016, pp. 222 – 236), online questionnaires are cheaper, quicker to administer, and convenient for respondents as they can fill the survey wherever and whenever they want. The survey will be designed where each respondent will be asked the same question in the same order, resulting in comparable data that will be easy to analyze later on (Bryman, 2012, p. 210). I will group the survey questions into seven sections.

In the introductory text, I will explain the purpose of the survey, the importance of the survey, confidentiality assurance, the duration of the survey to complete, the period the survey will be running, and the contact information of the responsible parties (Goodman et al., 2012, p. 342) & (Bryman, 2016, p. 225).

I will use predominately multi-choice and multi-choice tick box questionnaires in this survey. In a multi-choice questionnaire, the respondent can choose a single answer, but in a multi-choice tick box questionnaire, the respondent can choose more than one answer. I will add the *other* option at the end of each question. According to Goodman et al. (2012), even though the options in multiple choices were based on the literate review, an open *other* option can always provide new insights.

Questionnaire

I will start the questionaries with general questions. See appendix 1 for the entire survey questions. SQ1 is to know the digital devices they use, SQ2 is the operating system type, and SQ3 is the cloud base question. The cloud-based solution question is based on Ratnam et al. (2020). Questions SQ1 and SQ3 were multiple-choice ticks boxes, and SQ2 were multiple-choice questions.

I will group the following questions into five primary categories as Barreau's five characteristics of personal information management (Barreau, 1995, pp.328-330): Acquisition, Organization, Maintenance, Retrieval, and Output.

Question SA1 is a multiple-choice tick box in the acquisition section to know how many of the respondents were taking screenshots and photos as a reminder. The options on this multiple-choice tick box are taken out from the literature review.

Question SA2 is to see what information the participants took in the form of screenshots and photos. I will divide the answers into action-oriented and informative-oriented information (Whittaker, 2011). Action-oriented information requires an action (Whittaker, 2011). *Appointments and to-do lists* were one of the repeated acquired information (Leino et al., 2010); (Henderson, 2009). *Shopping lists and wish lists* are highlighted in the research (Jensen et al., 2018); (Leino et al., 2010). *Meal plans and*

job-related information are emphasized in the research, Jensen et al., (2018); Ratnam et al., (2020). *Social events, such as meeting with friends, appointments, and restaurants,* are significant events in the research by Müller et al. (2015). Whittaker et al. (2010) suggest that *important dates such as birthdays, anniversaries, and deadlines* are essential acquired information. Informative-oriented information does not require an action (Whittaker, 2011). *Something you like* could be something the respondents see on their social media, ect. This option does not require the respondents to take action later.

I will focus on how the respondents organized their information in the organization section. Question SO1 is based on the literature by Zhang & Liu (2015) and Ratnam et al. (2020). According to Whittaker (2010), the users prefer automatic organization, which I will include as one of the options (Appendix 1, SO1). Question SO2 is based on Indratmo and Vassileva's (2008) literature to validate the structure of the screenshots and photos.

In the maintenance section, I would like to see if the respondents deleted the screenshots and photos (Kljun & Carr, 2005) and, if so, when they deleted them (Appendix 1, SM1). It will be a multiple-choice question with the respondent who could choose a single answer. According to Diekema & Olsen (2014), the users do not delete the information due to a large amount of storage capacity. Therefore I will include *I do not delete, I have enough storage space* as one of the choices (Appendix 1, SM1). However, according to Zhang and Liu (2015), the users delete information once they reach a limited capacity, which I will include *Once my phone is full* as one of the options (Appendix 1, SM1).

In the retrieval section, I would like to know how often the users return to their screenshots and photos, based on Ratnam et al. (2020) (Appendix XX, SR1).

In the demographic section, I will ask about their age (Appendix 1, SD2) and the country they are from (Appendix 1, SD3). According to Bryman (2016, p. 227), these questions are background questions, and I will place them at the end of the questionnaire. Placing these in the beginning, will reduce stereotype threat bias (Bryman, 2016, p. 227), which means the respondents will unconsciously conform to the stereotype and not provide valid answers. These questions will also minimize drop-out representativeness at the end of the questionnaire (Bryman, 2016, p. 227). According to Bryman (2016), background questions help describe the sample, making it possible to compare the sample with other studies.

4.7.1.2 Replicability, reliability & validity

According to Bryman (2016, p. 397), when the survey includes predetermined answer possibilities, it is possible to replicate it. As a result, I would rate this survey as relatively reliable because respondents will answer the same questions in the same order. It will also increase the internal validity of the research by ensuring that I measure what was intended (Bryman, 2016, p. 397).

I will aim to achieve external validity by reporting the survey methodology through SURGE since I attempt to be upfront with the process (Grimshaw, 2014).

According to Bryman (2016, p. 397), the respondent's circumstances at the time of the survey can impact their answers. There is also a possibility that internal validity might be affected by misunderstandings and misinterpretations of terms, especially among respondents who do not speak English as their first language.

4.7.2 Contextual inquiry

According to Raven et al. (1996), a contextual inquiry methodology is a qualitative approach that relies on sociology, psychology, and anthropology. CI seeks to comprehend and offer information about how participants accomplish certain activities in real life (Raven et al., 1996).

I will use CI in three steps. Starting with a semi-structured interview and artifact walkthrough, then ending with testing the prototype. I will create an interview guide (Appendix 2) as a preliminary step in conducting the semi-structured interviews to assist the participants and verify that all data will be gathered under the same conditions (Goodman et al., 2012, p. 130). The interview guide will be developed with a list of clearly defined open-ended questions that let participants react freely rather than from established answer possibilities and allow the interviewer to ask follow-up questions (Bryman, 2012, p. 219). According to Goodman et al. (2012, p. 129), the structure of an interview should start with general information and then move to specific questions and then wrap up with a summary.

4.7.2.1 Procedure of CI session

The CI sessions will happen through Teams and Zoom. Following the interview guide, I will moderate the dialogue and ask follow-up questions while the whole session will be recorded on Teams or Zoom. Prior to the CI session, I will ask the participants to bring 10 of their recent photos and screenshots that they took as reminders. English is the primary language throughout the CI sessions. I will also use the participants' native languages, Danish and Tamil, to support when English is not applicable. I will start the procedure like the following:

- Before the CI session, I will send out an invitation letter to the participants (Appendix 3).
- Prior to the CI session, I will ask the participants to sign a participant consent form from Aalborg University (Appendix 4).
- During the CI session, I will present the introduction, ask the semi-structured interview questions combined with the artifact walkthrough, test the prototype, and wrap up.

4.7.2.2 Pre-session preparation and interview guide

Preparation

As a preparation for the interview, I will ask the participants to bring ten recent photos and screenshots that they took as a reminder (Appendix 2), as proposed by Jensen et al. (2018) and Ratnam et al. (2020). It will be later used in context to answer RQ1.

Introduction

According to Goodman et al. (2012, p. 130), an introduction establishes the interviewer's stance as a neutral yet sympathetic observer. As suggested by Bryman (2012, p. 138), I will ask the participants to sign a consent form (Appendix 4) in which they will be assured anonymity and what I am going to use the gathered data. I will use the Aalborg University Consent Form template. The consent form is based on permission to use their statements in this thesis, which I will create from audio recordings to ensure that the data is as precise as feasible (Bordens & Abbott, 2011, p. 223). I will further explain to the participants the purpose of this session, and if there are any complications, they can stop me at any time.

Interview guide

I will create a semi-structured interview guide for the sessions (Appendix 2). According to Bordens & Abbott (2011, p. 223), there are three types of interview guides: structured, unstructured, and semi-structured. In a structured interview, there is no space to explore the topic in depth with follow-up questions (Bryman, 2012, p. 227). An unstructured interview can go outside the topics (Bordens & Abbott, (2011, p. 272). Therefore, I will create a semi-structured interview guide. With a semi-structured interview guide, I will be able to go in depth with follow-up questions (Bryman, 2012, p. 487) as well as not go off topics (Bordens & Abbott, (2011, p. 272). The purpose of the interview guide is to gain a depth perspective, and the questions are based on the concerns that I found from the literature review. According to Raven & Flanders (1996, p. 3), not sticking to a precise list of questions but being more flexible in the inquiry might lead to discovering intriguing and surprising information. It will also enable the researcher to take a route that has not been explored before. When it comes to CI, according to Raven & Flanders (1996, p. 3), an essential component of CI is to ask broad questions in order to gain comprehensive knowledge of the topic of research.

Questions

The interview guide's questions were derived from a literature study and the theory and related work section. I will code the questions to be easy for me to analyze in the later thematic analysis stage (Bryman, 2012, pp. 578-580). See appendix 2 for the CI interview guide.

Similar to Zhang and Liu (2015) and Jensen et al. (2018), I will start the session with general questions to warm up the participants for the main section and to understand their general usage of smartphones (Bordens & Abbott, 2011, p. 342). Similar to Ratnam et al. (2020), questions CIQ1 & CIQ2 will identify the participant's smartphone. Question CIQ3 & CIQ4 are to know the participant's smartphones.

Question CIQ5 is to learn the participant's knowledge and usage of a could base solution. Due to the cheap and readily available storage, the users keep the information they do not find necessary to delete (Whittaker, 2011). According to Ratnam et al. (2020), cloud-based solutions are easy and cheap.

For the main section, I will group the questions into five primary categories as Barreau's five characteristics of personal information management (Barreau, 1995, pp.328-330): Acquisition, Organization, Maintenance, Retrieval, and Output. A similar approach can be seen in Zhang and Liu (2015) and Jensen et al. (2018).

In the acquisition part, I will use task scenarios (McCloskey, 2014) to understand how the participants take screenshots and photos (RQ1). These task scenarios will be based on the user stories.

In the organization part, I will focus on Zhang & Liu's (2015) different strategies of organization: Categorization, frequent use, Position, and Visual clues, as well as Indratmo and Vassileva's (2008) classification of organizational structure: hierarchical, flat, linear, spatial, and network. The results from the pilot testing indicate that the participants did not understand the vocabulary mentioned above. Therefore, I rephrase the questions as a conversation (CIO1) and follow-up question (CIO2). They are also artifact walkthrough questions, as I will ask the participants to demonstrate through Teams or Zoom. Question CIO3 is to understand the organization's structure, as Indratmo and Vassileva (2008) suggested.

According to Whittaker (2011, p. 42), users prefer successful semi-automated solutions over ineffective automated models when organizing. To investigate this, I will ask the question CIO4.

I want to understand how the participants maintained their information in the maintenance section. Question CIM1 is to understand the participants' process of maintaining their information. If there are any maintenance actions, I will ask the participants to demonstrate how they will maintain the information, which is the artifacts walkthrough part. To understand the information overload according to Bruce (2005), I will ask question CIM2. Questions CIM3 to CIM6 will focus on understanding the information value (Bruce, 2005) and personal value (Bergman et al., 2007). Like the previous step, Question CIM7 to see if the automatic maintenance would work.

Question CIR1 will focus on how the participants retrieved the acquired screenshots and photos in the retrieval section. Question CIR2 will focus on the preferred process for the participants. Here I focus on the search (Whittaker, 2010), navigation (Bergman et al., 2016), and hybrid (Jensen et al., 2018) structure. According to Goren-Bar (2004), the users prefer adaptive and automatic retrieval systems, which I will ask in question CIR3.

In the outcome section, I will investigate the automatic solution as preferred (Barreau, 1995), (Boardman, 2004), (Krik et al., 2006), (Jensen et al., 2018). I will also test the prototype in this section.

4.7.2.3 Replicability, Reliability, and Validity

In the CI session, I will use semi-structured and follow-up questions. According to Bryman (2012, p. 389), the research may be hard to replicate, which reduces its reliability. According to Bordens & Abbott (2011, p. 130), different factors might have altered the research's internal validity. Conducting the sessions in English, which is neither the interviewer's nor the participants' first language, might be one of the explanations. Therefore, it may cause problems in conveying both questions and responses. It may have resulted in misunderstandings and misinterpretation of words, affecting internal validity. To prevent this, I will ask the participants to express themselves in their native language at the time. I will also summarize the participant's key points or statements and ask them to correct me if I am wrong. Additionally, the partnership approach will allow me to ask clarifying questions about a specific observation, which will increase internal validity.

According to Bordens & Abbott (2011, p. 130), one factor affecting internal validity is access to the data. I will have access to information that the individual participant feels comfortable showing me, which may impact the internal validity.

4.8 Analysis methods

The analysis method will be described in the next section. I will start with a descriptive analysis for the survey and a thematic analysis for CI.

4.8.1 Descriptive analysis

According to Bordens & Abbott (2011, p. 391), the descriptive statistics approach helps researchers in exploratory data analysis and identifying trends, which is helpful for this exploratory study. The researcher can obtain numbers using descriptive statistics, but the numbers do not give the complete picture. Therefore, the simplest way to present the results is to use the appropriate forms of visualizations (Smith et al., 2019). There are different ways to visualize the data, such as bar charts and pie charts. The most common method is the bar chart. Whenever the data relates to categorical independent variables, the bar chart is visually easy to understand (Bordens & Abbott 2011, p. 405). The goal of a bar chart is to make data correlations easier to see (Bordens & Abbott 2011, p. 406). In a bar chart, the length of each bar, especially in an ordered bar chart, indicates the value of the dependent variable (Bordens & Abbott 2011, p. 401).

I will save the data as a CSV file from Google Forms. I will import it into R Studio, where I will perform data cleaning to convert the raw data into consistent data before running the analysis.

4.8.2 Thematic analysis

According to Bryman (2012, p. 579), qualitative research is thought to generate significant, messy data sets that are difficult to work with. When working with qualitative data, it is critical to find a method of analysis, and one such approach is thematic analysis (Bryman, 2012, pp. 578-580). Thematic analysis is a method for discovering patterns and themes in a collection of qualitative data (Maguire & Delahunt, 2017, p. 3352). According to Bryman (2012, pp. 578-580), some researchers confuse themes with codes, while others believe themes are constructed from codes. Therefore, according to Maguire & Delahunt (2017, p. 3352), it is a flexible method. Inductive and deductive coding are two methods of identifying patterns and themes in thematic analysis (Bryman, 2012, pp. 578-580). In inductive coding, also called open coding, I will build themes based on the identified patterns that emerge from the data (Maguire & Delahunt, 2017, p. 3354). Deductive coding is a top-down method in which the researcher fits code into pre-existing themes (Maguire & Delahunt, 2017, p. 3354). Therefore, before beginning the analysis, I must think about these factors.

5 Results

In the following section, I presented the descriptive analysis and thematic analysis results. I divided the section into user involvement, acquisition, organization, maintenance, retrieval, and output. The results were based on data from the survey, design thinking phases, and contextual inquiries. In each section, I described the outcome of the tools I used previously and presented the key findings from each tool.

5.1 User involvement

User involvement happened through surveys and CI. Based on the survey and the literature review, I created personas.

5.1.1 Survey pilot testing

For the pilot study, I recruited three users within the personas to test the survey if it was easy to understand. I administered the pilot testing and asked the respondents to talk aloud to understand the respondents' thought processes. According to Bryman (2016, p. 260), pilot testing estimates questionnaire duration, Clears up if any questions can be misunderstood or are challenging to answer, and identify any questions that have too little variability in their answers to be of interest.

According to Bryman (2016, p.260), a pilot test ensures that the survey is understood and interpreted in a preferred way by sending it out to pilot testers for feedback before distributing it to the general population. Initially, I added a user engagement scale. However, the pilot tester seemed not to understand the questionnaire because of the system's and questions' nature. So I decided to delete the user engagement scale.

According to Bryman (2016, p. 251), there are a few common mistakes that need to be tested, such as asking double-barreled questions, not skipping irrelevant questions based on previous answers, asking two questions in one, asking leading questions, including answer options that are not mutually exclusive, and failing to include all relevant answer options. During the pilot test, I was conscious of the above-mentioned common mistakes.

5.1.2 Survey

The survey was conducted online for two weeks, from May 2nd, 2022, to May 20th, 2022. I shared the survey on several of my social media platforms. It is a convenience sampling because I used social media as the primary distribution channel (Bryman, 2016, p.187). I shared the survey on my Facebook, Instagram, and LinkedIn, which have different audiences to spread more comprehensive than my network (Berg, 2014).

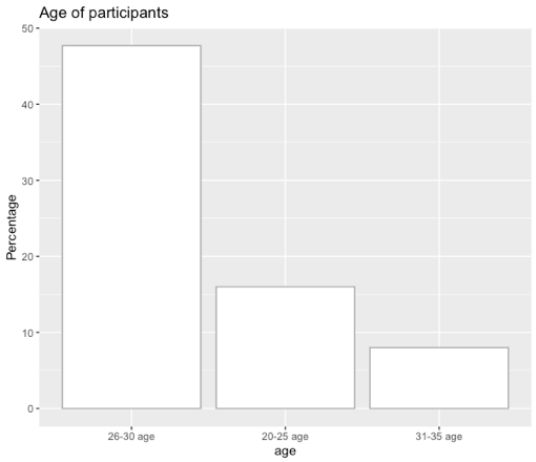

Figure 02: Top three age respondents.

Within 20 days, I gathered 90 respondents for the survey. Over 40 % of them were between the age of 26 – 30 years old, and 17% of the respondents were between the age of 20-25 (Figure 02).

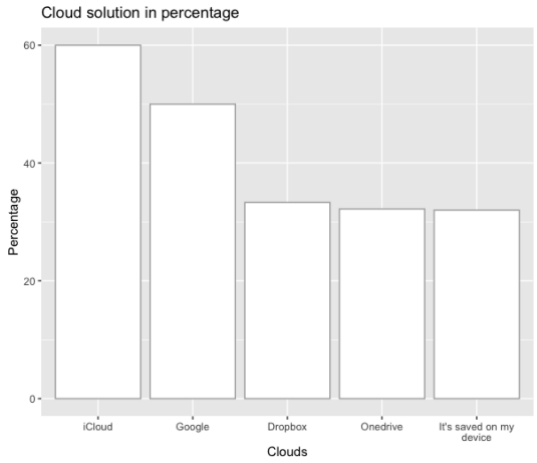

Figure 03: Cloud base solution in percentage

Everyone from the survey owned a smartphone. One of the first questions from the survey was about the usage of cloud solutions. The responses were broad, as the respondents used the other option. The survey received several responses on whether the respondents are using cloud-based solutions (Appendix XX, SQ3) and, if so, which. 27% of the respondents said that the information is saved on their device, while 60% of the respondents save their information on iCloud, and 45% use google (Figure 03).

5.1.3 Proto-persona

I built proto-personas based on the findings from the survey and literature review. There were two clear clusters of personas that I identified from the literature review:

1. Taking screenshots for the reminder
2. Taking photos for reminders.

See appendix 5 for final proto-personas

5.1.4 CI session pilot study

Before conducting the CI, I carried out two pilot studies to fine-tune the interview guide and see if the questions would provide me with the necessary information about the participant's behavior. According to Bryman (2012, p. 263), a pilot study can help identify un-understandable and unanswered questions. The pilot study also provides how well the questions flow and whether any of them need to be rearranged to improve for the CI session (Bryman, 2012, p. 264).

I conducted the pilot test on members of my network who matched my personas. I began with the general questions and artifact walkthrough in the first pilot study. In the second pilot study, I began with the interview questions and then moved on to the

artifact walkthrough. I decided to go with a similar approach to the second pilot study following the pilot testing.

According to Bryman (2012, p. 264), a pilot study can also identify the questions that make participants feel uncomfortable or lose interest (Bryman, 2012, p. 264). During the pilot test, I realized how important it was to explain the context of the CI session because it was their personal information.

I also grew more aware of how to broaden and restrict my emphasis throughout the interview and how to make the participants feel at ease so that a partnership could be formed.

5.1.5 Contextual inquires

For the contextual inquiries, I interviewed five participants between the ages of 25 to 46. they were recruited through my network. One out of five used the iOS operating system (Table 01). Three of them saved their files on the computer, while the rest used a cloud-based solution.

Table 01: CI participants' involvement

	Age	Experiences	Mobile system	Where they save
CI-P1	46	Beginner	Andriod	Computer
CI-P2	31	Beginner	Andriod	Computer
CI-P3	25	Medium	iOS	OneDrive & iCloud
CI-P4	26	Advanced	Andriod	Google
CI-P5	34	Medium	Andriod	Computer

5.1.6 Summary

For the survey, the primary age group respondents were between the age of 26 to 30 years old, and for the CI sessions, the participants' age groups differed from 25 to 46. Three of them were between 25 to 31 years old. Demographically, my primary respondents from the survey were from Denmark, same with CI sessions. From the survey, most of the respondents used iCloud and google to save their information. Just two of the participants used a cloud-based solution from the CI sessions.

5.2 Acquisition

To understand how the screenshots and photos are used with PIM, I examined what type of information the respondents and the participants gathered.

5.2.1 Survey

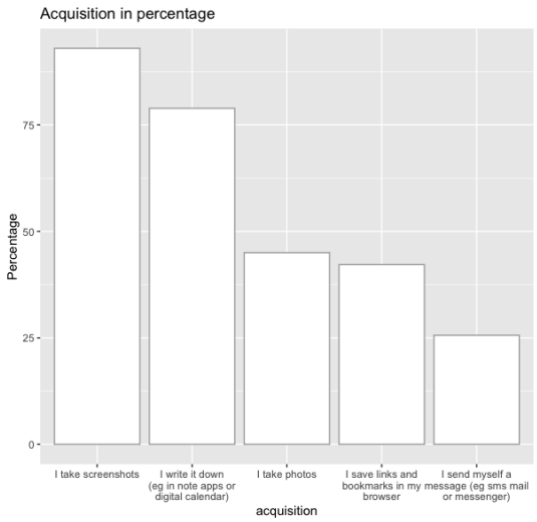

Figure 04: Acquisition in percentage

When gathering the information (Appendix 1, SA1), 93% of the respondents took screenshots, 78% wrote it down on note apps, and 45% took photos (Figure 04).

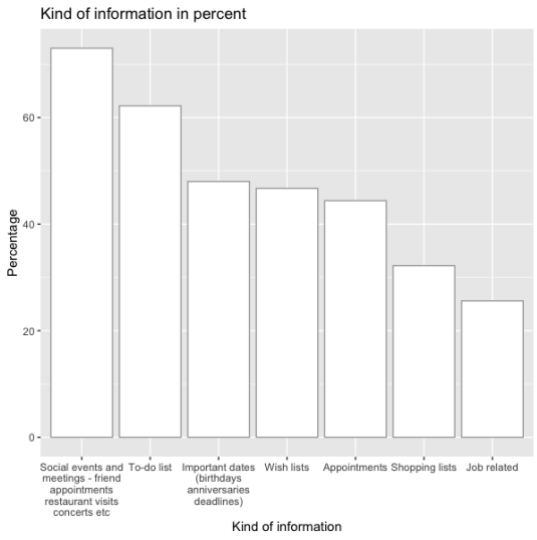

Figure 05: Kind of information in percentage

The kind of information the respondents took screenshots or photos of (Appendix 1, SA2) were social events and meetings 73%, to-do- lists 62%, essential dates 48%, wish lists 46%, appointments 44%, shopping lists 32%, and job-related 25% (Figure 05).

5.2.2 CI session

The acquisition part of the CI session was focused on screenshots and photos as reminders. Through inductive coding, I understood why the participants take photos and screenshots, how many reminders they acquire a day, and what type of information they take screenshots of as a reminder. See appendix 7 for a full overview of the affinity diagram of acquisition.

"If it's something I meet just randomly at this street when I'm doing something else, I'm going somewhere else and I see that I'll probably take a picture of it. Because at that point I don't know if I have time to read the poster or remember what was said about it or something like that. So that's why I will take a picture of it and look at the picture when I have time to it." (Appendix 6, CI-P3, p. 70)

Information through photos was acquired when the participants needed to remember non-digital information such as a concert poster they saw on the street (Appendix 6, CI-P3, p. 70) and remember something from the computer screen (Appendix 5, CI-P4, p. 93).

"if I have something, if I'm working on the computer and there is something that I want to remember, and I don't want to save it on the browser or writing on paper, I just take a photo." (Appendix 5, CI-P4, p. 93).

The results from the CI sessions indicate that screenshots are used with digital information, while photos are used for non-digital information.

Participants CI-P3 and CI-P4 took 5-20 screenshots on a day, which is more than photos as a reminder.

"It can vary, I think Sometimes I don't do it, you know. It's not necessary, but other times it can be from.5 to 20. The most of them will be reminder." (Appendix 6, CI-P3, p. 74)

Participants CI-P1 took a screenshot of a photo because it was easy to save.

"That's a photo isn't? that's your children? I took a screenshot of the photo that was send to me to keep it for myself." (Appendix 6, CI-P1, p. 16).

Participant CI-P5 took screenshots as reminders based on emotions or specific event.

"it has a reminder, but it's based on your emotions or based on a specific event that a specific period it's based on the intention." (Appendix 6, CI-P5, p.97)

5.2.2.1 Action-oriented vs informative-oriented

Screenshots are frequently used to provide action-oriented. The majority of the screenshots in the CI session are action-oriented. 29 out of 36 information provided by

the participants were action-oriented. Below are two pieces of information from the CI session of action-oriented. See appendix 8 for full filtered action-oriented and informative-oriented. The below screenshot was a bus ticket that participant CI-P2 took a day earlier.

"I took a day before. 'cause, I just need that time and. I want to know the pick up point so I should take." (Appendix 6 CI-P2, p. 23)

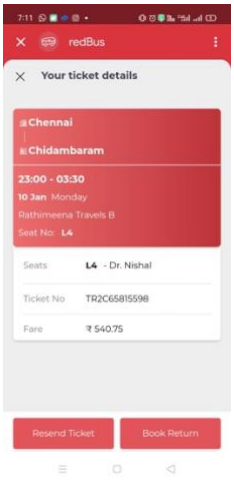

Figure 06: Action-oriented screenshot

Figure 07 was a photo of a computer screen that participant CI-P4.

"it's a picture cause I took it on my laptop cause it was on a website." (Appendix 6 CI-P4, p. 83)

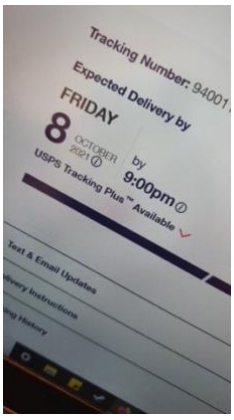

Figure 07: Action-oriented photo

5.2.2.2 Type of information

Based on their interviews, I divided the type of information into three categories based on the literature by Einstein et al. (2008).

Time-based information

Based on the interviews and the participants' recent photos and screenshots, the information within time-based were bus tickets, train tickets, time-table, work schedules, expected parcel deliveries, personal and professional appointments, and bus plans. The below figure was a screenshot of information taken by CI-P4 (Figure 08). See appendix 9 for full filtered *time-based information.*

> *"that's I took it when. It was probably the day before I had to go to the job center or something like that… when I was logged into job-center and I took it because I have to login user name ID.. to get that information…. When I screenshot it, I just have it there and I have the address and time." (Appendix 6, CI-P4, p. 79)*

Figure 08: Time-based information

Event-based information

The participants also took screenshots of event-base information that were evidence-based records with time constrain and screenshots of social events. The below figure was a screenshot by participant CI-P4 of an university event (Figure 09). See appendix 10 for full filtered *event-based information.*

> *"that's actually because I found it interesting… it's about and upcoming, seminar or anything like that.. So I found it interesting and I don't know if I do have time to attend this lecture or something but I will look at it" (Appendix 6, CI-P3, p 65)*

Figure 09: Event-based information

Activity-based information

The participants' activity-based information was learning and emotional support information. The below figure was a screenshot by participant CI-P2 of a university event (Figure 10). See appendix 11 for full filtered *activity-based information.*

"I think I will not delete this because actually I'm not that much fluent in English. So I just saw this in Instagram. I just took screenshot but I didn't try that. What they have said so I will keep that." (Appendix 6, CI-P2, p.29)

Figure 10: Activity-based information

5.2.3 Summary

93% of the respondents took screenshots from the survey, and 45% took photos to acquire the information as a reminder. The participants preferred screenshots over photos from the CI sessions and took, on average, 5-20 screenshots a day. The respondents' top five types of information taken screenshots and photos as reminders were social events and meetings, to-do lists, important dates, wish lists, and appointments. Based on the prospective theory, I divided the CI-sessions type of information into time-based, event-based, and activity-based information. Time-based information was bus tickets, train tickets, time-table, work schedules, expected parcel deliveries, personal and professional appointments, and bus plans. Event-based information was evidence-based records and social events. Activity-based information was learning-based and emotional support information.

5.3 Organization

To understand what challenges the users' experiences and to study the limitation of the smartphone from the users' perspective, I needed to understand their current organizational process. I examined how the users organize and structure their information.

5.3.1 Survey

To the question SO1 on how they organize the photos and screenshots (Appendix 2, SO1), 80% said that the phone does it automatically, 56% said through folders, 48% said through labels or tags, and 34% said through favorites (Figure 11).

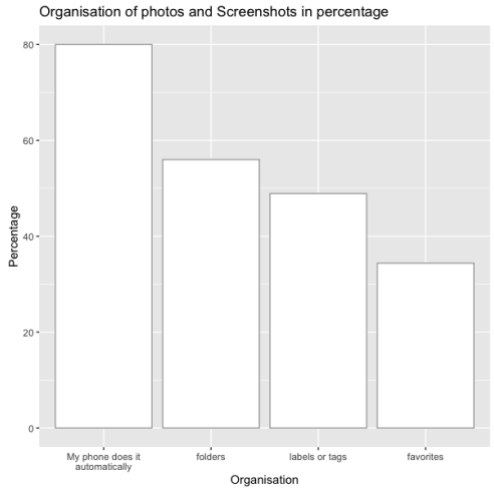

Figure 11: Organization of photos and screenshots in percentage

In the responses for how they structure their photos or screenshots (Appendix 2, SO2), 98% said automatically, 94 % said hierarchically, 26 % said linear, 17% said flat, and 16% said through the network (Figure 12).

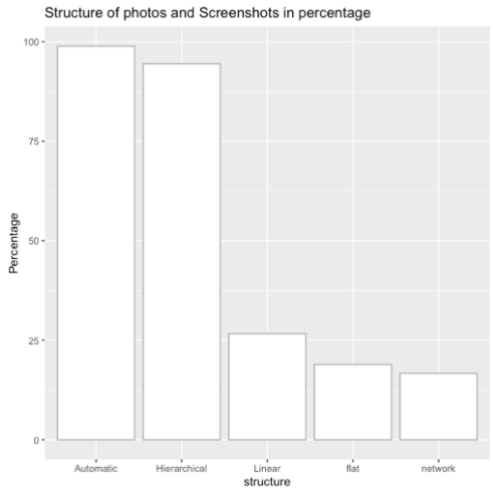

Figure 12: Structure of photos and screenshots in percentage

Figure 13 illustrates the side-by-side comparison of the respondents' organization on iOS and Android devices. More than 45% of the android respondents' smartphones automatically organized their information. More than 30% of the iOS respondents' smartphones automatically organized their information. 27% of the iOS respondents' used labels or tags, while 20% of android respondents used labels or tags.

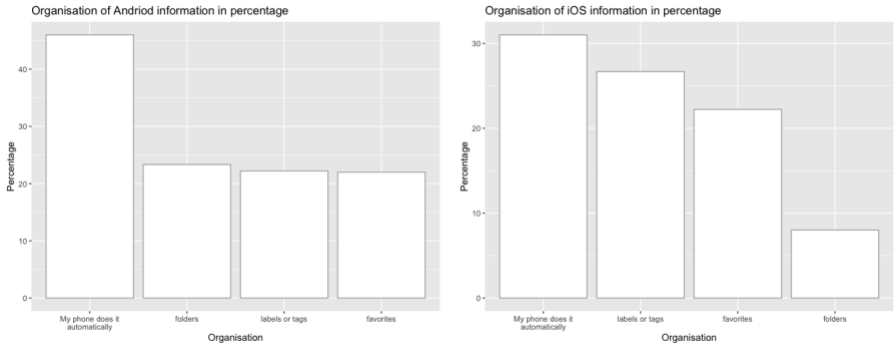

Figure 13: Organization of iOS and Android in percentage

5.3.2 CI session

The participants' smartphones automatically organized their screenshots and photos primarily. Four out of five participants expressed that their smartphones automatically created folders and organized their information.

"No, I will not arrange the photos... it automatically saves it by date and year" (Appendix 6, CI-P2, p. 21)

The smartphones automatically created the folders, but the folders were apps-based.

"they organized by themselves. I do not remember ever creating a folder myself a gallery of Samsung creates folders, uh, by itself. Like it knows, which is screenshot knows who has downloaded. It knows what it is photos it is. Yeah, it is automatic..... because I do not think about it. It is there it is, pre-made. It is exactly what I need. So it is just using it and goes," (Appendix 6, CI-P5, p. 87)

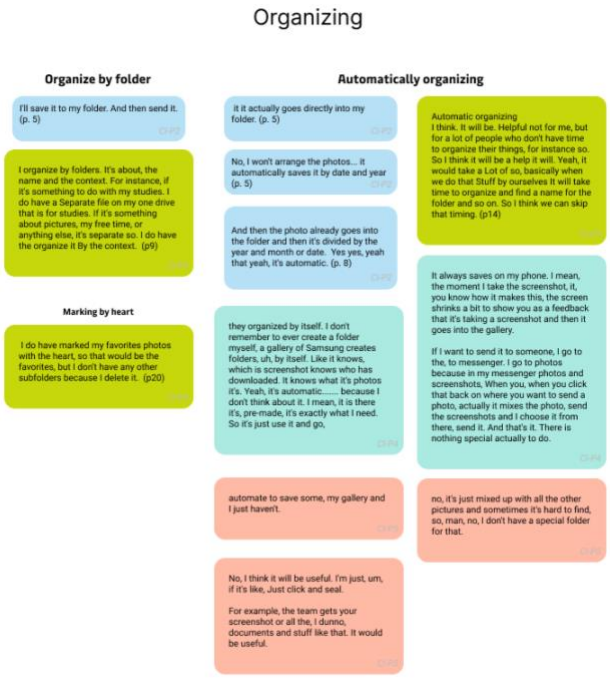

Figure 14: Affinity diagram of organizing information

Participant CI-P3 used the heart option from iPhone to indicate the important pictures. Participants CI-P2 and CI-P3 organized their information through folders (Figure 14). Their smartphones organized the folders in a flat structure, where the participants did not rename or reorganize the folders.

"I do not know how to rename on my phone. I do not even know if I can remain renamed the photos on my phone." (Appendix 6, CI-P5, p. 89)

When organizing on the computer, participants CI-P3 and CI-P5 preferred hierarchical folder structure with subcategories (Appendix 12). CI-P3 uploaded the screenshots and pictures on OneDrive that she shared with her close relatives, which was network structure.

> *"And that's actually a shared folder with my brother because he took some pictures and my mom took some and I would also take someone. So we just just uploaded all of our pictures to have it at one place." (Appendix 6, CI-P5, p. 43)*

Participant CI-P1 did not know where the screenshots were, so she forgot about them most of the time.

> *"I take the screenshot and then it goes to somewhere. I do not know where it is, and mostly it goes to somewhere. mostly I forget where it is going to" (Appendix 6, CI-P1, p. 15)*

Participant CI-P3 also said that she does not trust automatic organization due to doing things by herself.

> *"I am the kind of person I need to do it by myself..... So if the phone had that application, by doing it by itself, I would probably check if it is correct..... if it is correct. I will allow it, but I will check." (Appendix 6, CI-P3, p. 39)*

See appendix 12 for an affinity diagram on the organization.

5.3.3 Summary

The primary answer from the survey was that the respondents' smartphones automatically organize and structure their information. The same results were founded from the CI session as well. During the CI sessions, the participants' smartphones organized the folders in a flat structure, where the participants did not rename or reorganize the folders. However, they preferred a hierarchical folder structure with subcategories and network structure.

5.4 Maintenance

To understand the challenges the users experience while maintaining PIM, I examined what actions they performed on their current PIM maintenance and what challenges they came across.

5.4.1 Survey

Regarding how they delete their screenshots or photos (Appendix 1, SM1), 50% said they would delete once their phone is full, 36% said they have enough storage, and 13% said every few months (Figure 15).

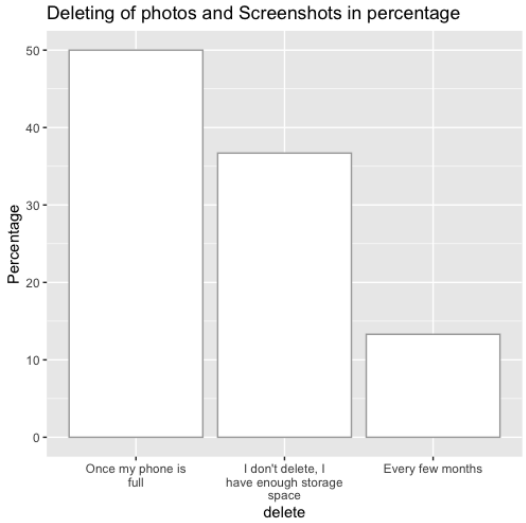

Figure 15: Deleting of photos and screenshots in percentage

5.4.2 CI session

The participants do not update the screenshots or the photos on their smartphones. Deleting was the only maintenance they did on their smartphone. Three out of five participants said they delete the information once every few months (Appendix 13). However, the last time they deleted the information was early this year because their phone was full. All five said that they would manually delete the information once they transferred it to their computer or on the cloud (Appendix 13). See

Storage capacity

Participants CI-P1, CI-P2, and CI-p5 often forgot to delete the information, which led to storage capacity problems.

> *"I continue stuffing my phone until the point where the phone does not want to take a photo anymore" (Appendix 6, CI-P5, p. 91)*

Participant CI-P3 deleted the information once she reached around 100 pictures due to not trusting her phone.

> *"I mean privacy also included, but also because I have experienced sometimes that my phone freezes or the connection goes down or something like that. Since I have*

experienced that multiple times, I do not feel like I trust my phone that much."
(Appendix 6, CI-P3, p. 53)

Participants CI-P3 and CI-P4 used cloud-based solutions, which often resulted in not running out of space. However, due to the limited smartphone storage, they are still required to manually upload to the cloud and delete manually on their phone.

"And the deleting process is a.. I have to do it manually. When I say manually, that means I have to delete by myself from phone, when I uploaded to computer."
(Appendix 6, CI-P3, p. 49)

See appendix 13 for an affinity diagram on the maintenance.

5.4.3 Summary

The participants did not update or rename their information on their smartphones. Deleting was the only maintenance they did on their smartphone, and they did it manually. From the survey, 50% of participants deleted their phone once is full, and 13% deleted it every few months. Three out of five participants deleted the information from the CI session once every few months. However, the last time they deleted the information was when their phone was full. Three out of five participants often forgot to delete the information, which led to storage capacity problems. The rest of the two participants used cloud-based solutions, but because their smartphones had limited storage capacity, they too ran out of storage and required manual delete on their smartphones. One of the participants deleted the information from the smartphone due to a trust issue. From the survey, 36% of the respondents did not delete the information because they had enough storage.

5.5 Retrieval

According to the literature review, retrieval was one of the major issues in PIM. This section examined how often the users returned to their screenshots and photos and how they would retrieve the information.

5.5.1 Survey

Regarding how often they get back to their screenshots or photos (Appendix 1, SR1), the responses were 60% said that they would return frequently, 20% said occasionally, 11% said always, and 7% said rarely (Figure 16).

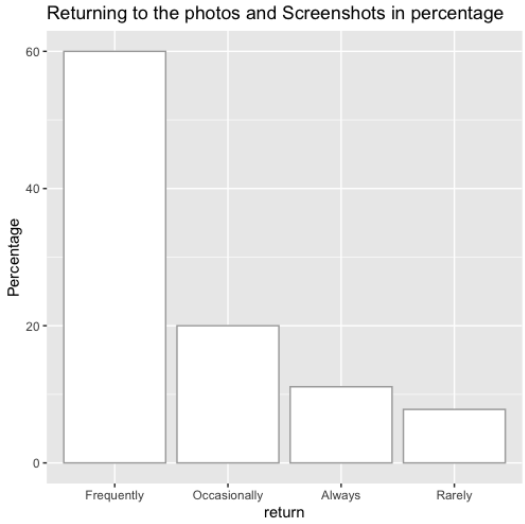

Figure 16: Returning of photos and screenshots in percentage

5.5.2 CI session

Participant CI-P1 said she does not know how to find screenshots or photos again.

"I do not even know how to find the screenshots. They go into this picture folder" (Appendix 6, CI-P1, p. 13)

Participants CI-P2 and CI-P3 searched for the information by year and remembered where it was placed. They used the *recent* feature to retrieve the information if it was not found.

"I do remember the files and the names. If I do not, uh, I look at them at the side you have a. Something called senest," (Appendix 6, CI-P3, p. 54)

Participant CI-P2 tried to remember through the event and others forgot about the information altogether.

"I usually forget. I do not go back there sometimes if I accidentally remember something, I just go through the screenshot and try it, try to find it." (Appendix 6, CI-P2, p. 20)

See appendix 14 for an affinity diagram on the retrieval.

5.5.3 Summary

The survey indicated that 60% of the respondents returned to their information frequently. The CI session suggests differently. Two out of five participants forgot about the information or did not know how to find it again. Two participants used the *recent* strategy to retrieve their information. One of them would search for the information by remembering the event.

5.6 Output

I built user stories and activity diagrams based on the personas. Furthermore, I developed prototype 1, which I tested during the CI session. Along with the prototype testing, I examine the challenges the participants face within the automation scenario on each step. Based on their responses, I improved the prototype.

5.6.1 User stories

Based on the personas, I developed user stories to assist me in developing prototypes.

User story 1
As a worker, Erik wants his phone to remind me automatically of the screenshots that he took as a reminder so that he would like to be remembered for the intended event.

User story 2
As a student, Emma wants her phone to automatically organize and maintain the photos she took as a reminder so that she does not waste time on PIM.

5.6.2 Activity diagram

I created an activity diagram using the persona as a reference to see how the personas would interact with the system and what happens within the system (Figure 17). I created the process to be:

Emma takes photos of the information, and Erik takes a screenshot of the information (Figure 17). The information gets filtered based on the type of the information, if it is action-oriented or informative information (Whittaker, 2011, p. 11). The system then sends the informative information to the folder and action-oriented screenshots or photos to the next filtering stage. The system filters the action-oriented information into self-reminders and social information activity (Ratnam et al., 2020, p. 63). The filtered self-reminder follows through to the next step to be filtered based on prospective memory (Einstein et al., 2008, pp. 871 - 872). Emma and Erik then will get the opportunity to fill the desired time that they want the reminder to be reminded on the filtered event-based and time-based information, which is then saved in a separate

folder called reminders. As per the requested time, Emma and Erik will get a notification.

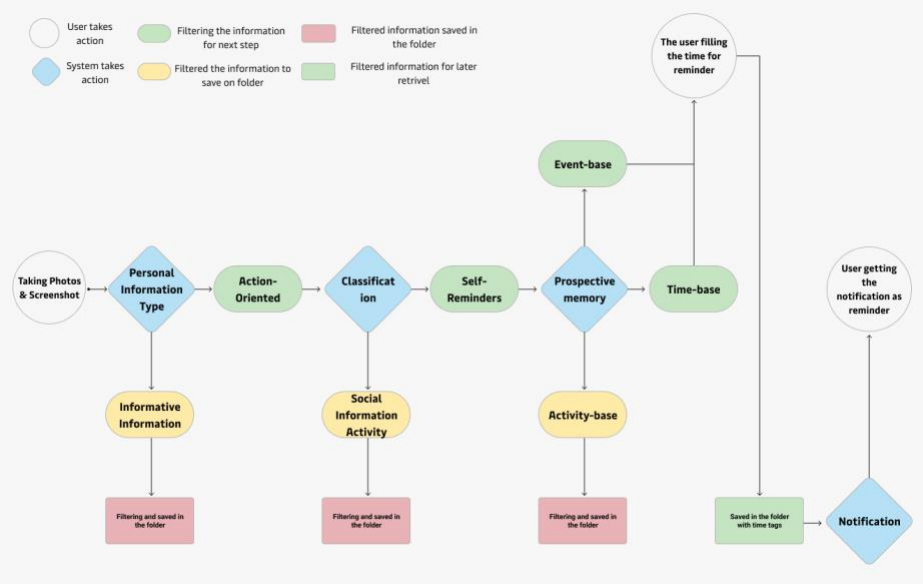

Figure 17: Activity diagram

5.6.3 Prototype 1

I created a simple prototype based on user stories and activity diagrams to test the process and the concept. I decided to use the iOS design system (iOS Design system, 2022). There were four steps. According to Kaley & Gibbons (2022), the purpose of UX is to simplify the user experience, which includes as few steps as possible. Since Emma and Erik had a similar process except for acquiring, I created one prototype for testing.

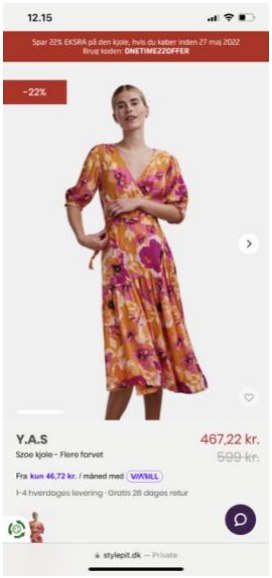

Figure 18: Step 1

Step 1 on was acquisition. Finds a dress online, and they should save it as a reminder

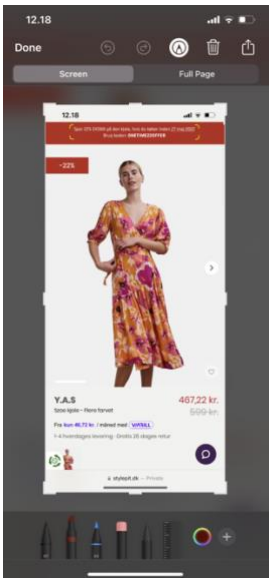

Figure 19: Step 2

Step 2 was the system identifying the date and time through text recognition technology (Sravan et al., 2015).

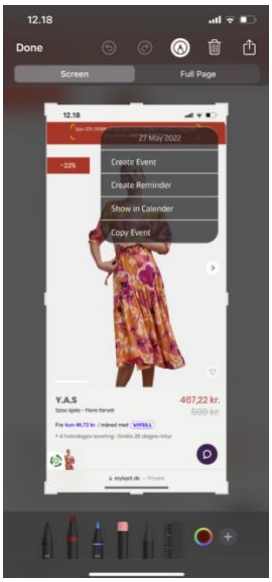

Figure 20: Step 3

Step 3 showed the options to create a reminder. I used an iOS design system template to create the options (iOS Design system, 2022).

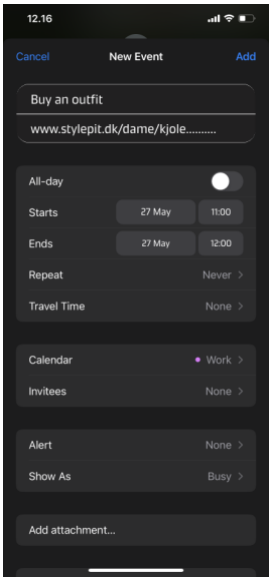

Figure 21: Step 4

Step 4 was creating an event with options. Again I used the components from Apple (iOS Design system, 2022).

Since this was an interactive prototype, the link can be seen in the following: https://www.figma.com/proto/3Avmsf0U1JIBa5dIQ0q95S/Prototype-PIM?page-id=0%3A1&node-id=2%3A862&viewport=685%2C-591%2C0.17&scaling=min-zoom&starting-point-node-id=2%3A887&show-proto-sidebar=1

5.6.4 CI session prototype

To retrieve later the dress for step 1, four out of five participants stated they would take a screenshot. In step 2, every participant understood the yellow mark.

> *"The yellow corners. It might be a link. You can click on or. Something you can copy." (Appendix 6, CI-P5, p. 91)*

In step 3, they found it confusing with the four options. *create an event* and *show in calendar* sounded similar to participant CI-P4. They preferred to have one or two options.

> *"showing calendar and so I can see it there….. cause I would imagine the calendar would have an overview and I would see it there….. Then I can look at the calendar" (Appendix 6, CI-P5, p. 92)*

> *"Create reminder or. Create a reminder or sharing calendar because I do also use my calendar very often." (Appendix 6, CI-P3, p. 72)*

> *"Copy event will not work, too many choices to choose" (Appendix 6, CI-P4, p. 81).*

She found it useless to copy an event.

In step 4, they found it helpful to customize the date and time personally. The participants were also pleased to see the URL.

See appendix 15 for an affinity diagram on the prototype.

5.6.5 Automatic PIM

When asked about how automatic PIM will be useful, the participants responded positively to automatic PIM. However, there were concerns about the specific organization, maintenance, and retrieval.

5.6.5.1 Automatic organization

Participants CI-P3 and CI-P4 expressed that having an automatic organization will save them time (Figure 22).

"Automatic organizing, I think. It will be helpful not just for me, but for many people who do not have time to organize their things, for instance so…. It will take time to organize and find a name for the folder and so on. So I think we can skip that timing." (Appendix 6, CI-P3, p. 38)

The rest of the participants said that their smartphone was already organizing the information by year and date. However, they ran into a capacity limit, and therefore hierarchal folders with sub-folders will be helpful in an automatic organized system (Figure 22).

"Automatic organizing will work if the system can categorize by itself when I take the photo.... is there any technology that could do that" (Appendix 6, CI-P4, p. 85)

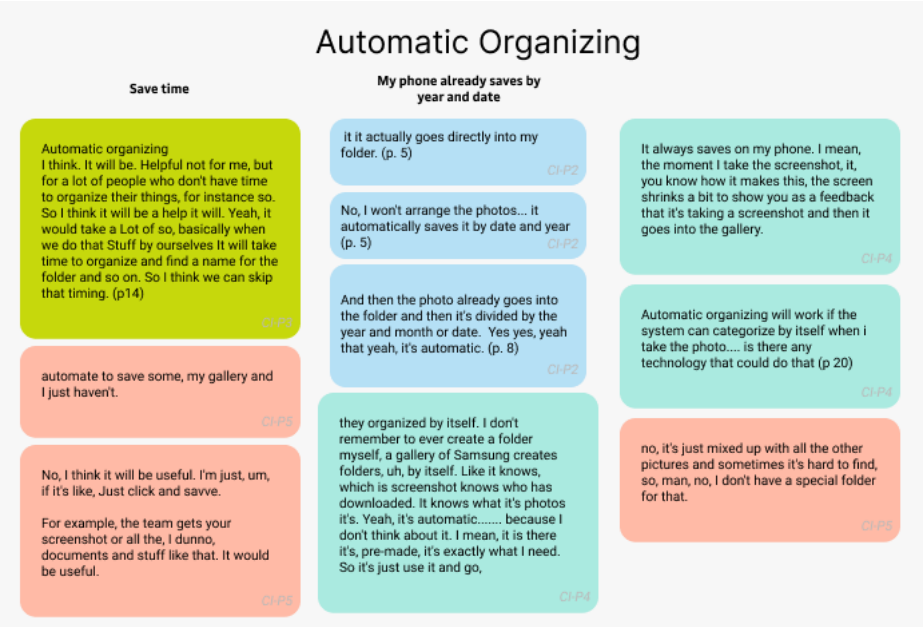

Figure 22: Affinity diagram on automatic organization CI answers

5.6.5.2 Automatic maintenance

Three out of five participants expressed that automatic deleting of information will be helpful (Figure 23).

"If the app deletes it automatically. I feel happy because I usually forget to delete." (Appendix 6, CI-P4, p. 85)

Participant CI-P1 smartphone already does this based on the quality of the photo or screenshot (Figure 23).

"After a while, my phone suggests to clear up space to delete something. If I have not opened, then that would be one of the suggestions." (Appendix 6, CI-P1, p. 14)

Participant CI-P3 did not like the idea of automatic deleting (Figure 23).

"That will not make me happy because the phone does not know which photos or videos or documents on my phone that I prefer to be deleted. I do not think the phone will be able to understand when a picture is capable of being deleted. That is my preference, and that is my decision, not the phone." (Appendix 6, CI-P3, p. 49)

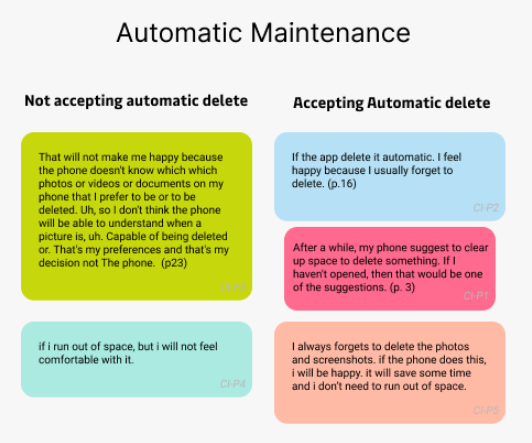

Figure 23: Affinity diagram on automatic maintenance CI answers

5.6.5.3 Automatic retrieval

All participants said that an automatic reminder would be helpful, but there were a few concerns. Participant CI-P3 was concerned about the number of notifications that she would receive (Figure 24).

"Too much reminder at this point. I think it will be quite annoying, to be honest, at a point, but it depends on how much and how many times you get the same reminder…… About five is the maximum." (Appendix 6, CI-P3, p. 73)

Participant CI-P4 was worried about an external app receiving her private information (Figure 24).

"That will be good, but also be worried that external app has access to all that information, you know, cause It could be a lot of personal stuff too, with some documents or reminders." (Appendix 6, CI-P4, p. 78)

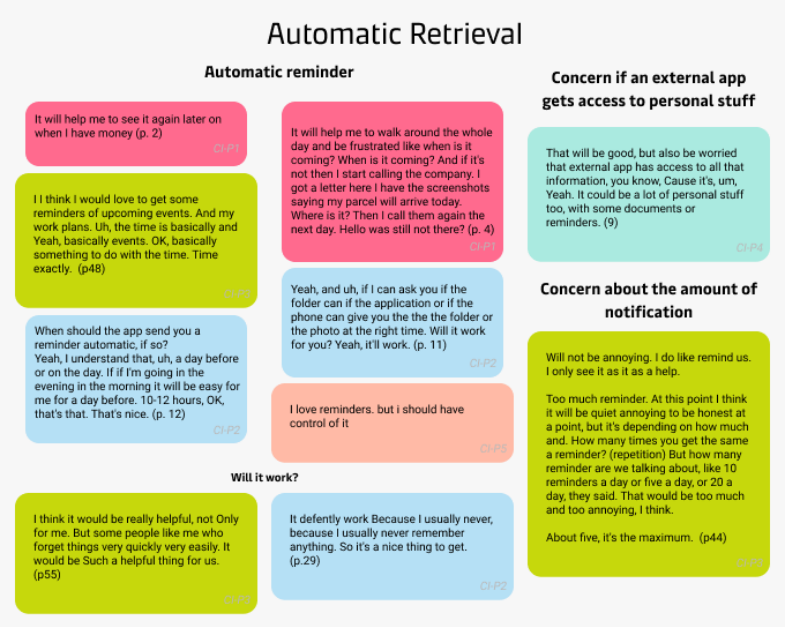

Figure 23: Affinity diagram on automatic retrieval CI answers

5.6.5.4 Prototype 2

Based on the results from the CI session, I improved the prototype design. I added two scenarios, one for taking photos and another for taking screenshots with a better scenario with date, time, and address (Appendix 16).

There was not necessary to change the steps from prototype 1. However, in step 3, I reduced the options into two: create a reminder and show it in the calendar (Figure 24).

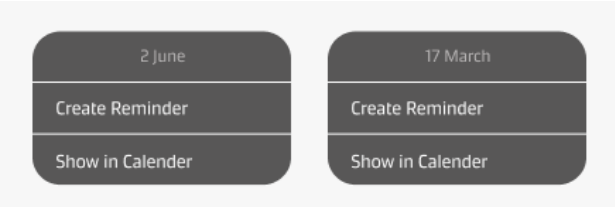

Figure 24: Improved prototype removing options

In step 4, I included a switch for automatic delete with a drop-down row called *delete* (Figure 25).

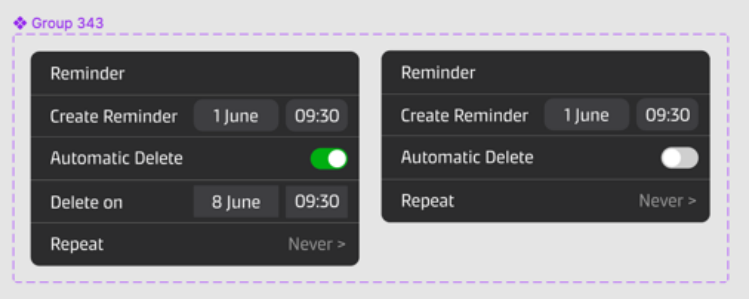

Figure 25: Improved prototype including deleting options

Since this was an interactive prototype, the link can be seen in the following:

Scenario 1 – photo
https://www.figma.com/proto/3Avmsf0U1JIBa5dIQ0q95S/Prototype-PIM?page-id=0%3A1&node-id=2%3A369&viewport=527%2C-39%2C0.13&scaling=min-zoom&starting-point-node-id=2%3A369&show-proto-sidebar=1

Scenario 2 – screenshot
https://www.figma.com/proto/3Avmsf0U1JIBa5dIQ0q95S/Prototype-PIM?page-id=0%3A1&node-id=2%3A421&viewport=527%2C-39%2C0.13&scaling=min-zoom&starting-point-node-id=2%3A421&show-proto-sidebar=1

5.6.6 Summary

I created prototype 1 with the help of both user stories and the activity diagram. There were four steps in the prototype. Steps 1 and 2 were well-understood by the participants. They had confusion about step 3. They preferred two options as create an event and show it in the calendar. In step 4, the participants found it helpful with customized the date and time and the provided URL.

Two out of five participants expressed that having an automatic organization will save time. The rest of the participants found no differences as their smartphones already automatically organized the information by year and date.

Three out of five participants liked the idea of automatic deleting of information. However, one of the participants had concerns about how the phone would know what to delete. Deleting should be her own decision and not the phone.

All participants agreed that automatic reminders would be helpful with concerns raised. There were concerns about the number of notifications they would receive in a day and worries about the external app gaining access to all their personal information.

Based on the CI session results, I improved the prototype by including a scenario for a screenshot and one for a photo, decreased the number of options in step 3, and included an automatic delete option in step 4.

6 Discussion

In this section, I will discuss the findings from the result section. This section is divided into three main segments based on my RQs.

6.1 Research question 1

RQ1: *How screenshots and photos are being used in relation to personal information management, and what challenges do the users experience on their smartphones?*

I will discuss this question based on Barreau's (1995), five PIM characters.

6.1.1 Acquisition

Upon acquiring information, screenshots and photos are the most common method of obtaining digital information. 93% of the respondents took screenshots from the survey, and 45% took photos to acquire the information as a reminder (Figure 04). A similar result can be seen in Jensen et al. (2018) and Zhang & Liu (2015). The results from the CI sessions indicate that screenshots are used with digital information, while photos are used with non-digital information. The participants from the CI session took, on average, 5-20 screenshots a day. According to Zhang & Liu (2015), one of the most common memory information in practice is PIM photos and screenshots, with screenshots being the most common acquisition strategy.

When investigating between action-oriented and informative-information information, the survey indicates that the top five information were action-oriented. According to Jensen et al. (2018, p. 144), screenshots are commonly used as action-oriented information. It can be seen in the result from the CI session, where the majority of the screenshots are action-oriented.

Unlike screenshots, photos can be divided into long and short terms. According to Jensen et al. (2018, p. 143), a distinction can be made between long-term and short-term photos, where long-term photos are primarily informational, and short-term photos could be classified as action-oriented. A similar result can be seen in CI session results, where the participants took photos of computer screens and specific events. The specific event photos are no longer used once the event is over. Computer screen photos can be classified as both action-oriented and informative-oriented information. For the

app to identify quickly when there is a date and time, it can be considered action-oriented.

According to the theory of prospective memory, prospective memory is a form of memory necessary for everyday cognition, such as remembering an intended and planned action, remembering the action in the future, and remembering significant dates (Einstein et al., 2008, p. 867). The survey results show that the top five information the respondents acquired were social events and meetings, to-do lists, important dates, wish lists, and appointments.

Upon dividing the information based on the prospective theory, the result from the survey indicates: Time-based information were bus tickets, train tickets, time-table, work schedules, expected parcel deliveries, personal and professional appointments, and bus plans. Event-based information was evidence-based records and social events. Activity-based information was learning-based and emotional support information.

6.1.2 Organization

The primary answer from the survey was that the respondents' smartphones automatically organize and structure their information. The same results were founded from CI sessions as well. It is currently saved linearly by year and date. Blažica et al. (2013) proposed a different strategy, where photos are organized according to the user's affinity rather than time, to evoke the user's memories or by the photo's aesthetics. No participants talk about this strategy. Both iOS and Android have folder creating options, yet no users create any folders on their smartphones. The reason could be the participants do not organize on their smartphones due to the screen size. According to Jensen et al. (2018, p. 163), the information is often not organized due to the smartphone's small screen.

The CI session result indicates that the participants do not rename or reorganize their folders or the information. The participants' smartphone also creates automatic folders based on applications, but all the photos go directly into the gallery folder and screenshots into the screenshot folder. Their smartphones automatically categorize the folders in a flat structure. A similar strategy can be seen in the literature by Zhang & Liu (2015).

Blažica et al. (2013) proposed a different strategy, where photos are organized according to the user's affinity rather than time, to evoke the user's memories or by the photo's aesthetics. Participants' smartphones do not use this strategy. It could be why their smartphones cannot understand the type of information.

Upon organizing on their computer, the participants seem to flavor a hierarchical folder structure with subfolders. According to Indratmo & Vassileva (2008, p. 2), users tend to organize information based on the task at hand and the value of the items to the users. However, a hierarchical structure requires significant cognitive effort to organize and classify information hierarchically (Indratmo & Vassileva, 2008, p. 3). It seems to

be accurate as participant CI-P1 uses an average of 30 minutes every few months to organize the information on her computer.

According to Leino et al. (2010, p. 262), the large amount of information stored on the smartphone was not easy to organize. A similar perspective has participant CI-P1 has expressed.

Except for participant CI-P3, no one else uses tags or labels to categorize their information. Participant CI-P3 uses heart function to indicate essential information. Participants CI-P3 uses iOS, while others use Android. It could be the result of using differences in the operating system. It can be seen in the differences between the iOS and Android systems in Figures 13.

Participant CI-P3 also uses network structure as she shares the information on OneDrive with her family. It can be seen in the literature by Indratmo & Vassileva (2008).

The participants' smartphones automatically organize their information. This and the size of the screen lead to mostly the users cannot organize the information by themselves, so they cannot use any of the strategies.

6.1.3 Maintenance

Jonas (2007, p. 65) includes maintenance activities in which the user updates, reorganizes, and deletes acquired information that he or she must be able to retrieve after maintenance. However, deleting manually was the only maintenance the participants did on their smartphones from the CI sessions. According to Henderson (2009, p. 9), the primary maintenance activity is deleting documents that are no longer needed.

According to the survey, 50% of participants deleted their phone once it was full, and 13% deleted it every few months. Three out of five participants in the CI session deleted the information once every few months. However, due to the time efficiency, they deleted the information once the phone was full. Three of the participants had a habit of forgetting to delete information, resulting in storage capacity issues. A similar result can be seen in the literature by Zhang and Liu (2015).

According to CI-P1, android smartphones show automatic deleting suggestions based on the quality of the information. It seems okay for the participant CI-P1 but not for others. Whittaker et al. (2011) suggest that participants kept almost all the photos, while the deleted photos were of poor quality. Participant CI-P3 uploaded the information manually on her computer and deleted it from her smartphone due to the trust issue.

According to Whittaker (2011), users prefer to keep the information they do not need to delete because it does not consume space, is readily available, and is cheap. The same

result is observed when participants rarely delete their digital information due to their large storage capacity (Diekema & Olsen, 2014). From the survey, 36% of the respondents did not delete the information because they had enough storage. However, the participants who use cloud-based solution also runs out of storage and manually upload to their cloud-based system and delete it on their smartphone. Even though a cloud-based solution seems to solve the storage capacity problem, the users still need to manually delete the information from their smartphones due to the limited storage capacity. This result can be seen in research by Zhang and Liu (2015).

6.1.4 Retrieval

According to the survey, 60% of respondents frequently returned their information. Two of the participants in the CI session said they had forgotten about the knowledge or did not know where to look for it. According to Song and Ling (2011, p. 763), the biggest problems in retrieval are caused by the cognitive process of retrieving and recognizing information. Deng & Feng (2011, p. 324) argue that users can often clearly remember what they have retrieved or created in a short period. However, users may have difficulty retrieving their long-term information due to blurred memories. Respondents from the survey might misinterpret the question SR1 with short- and long-term information returns. It could also mean that the respondents from the survey answered based on action-oriented information.

Jensen et al. (2018), search-based retrieval of photos and screenshots is complex because they are not text-based and cannot be found with a content-based search. Upon retrieving the information, two of the participants used the *recent* strategy to retrieve their information if they could not search the information by year or remember where it was placed. It is a navigation strategy. A similar can be seen in the literature by Bergman et al. (2010). Users had difficulty accessing long-term archives. Users attempted to remember the number of photos by remembering the exact day they were taken, making the retrieval process difficult (Bergman et al., 2010). Participant CI-P2 would search for the information by remembering the event.

6.2 Research question 2

RQ2: *How can our existing smartphones' different features & functionalities be re-designed to better support PIM?*

OCR

Both iOS and Android use Optical character recognition technology on a daily bases (Sravan et al., 2015). However, the participants have no clue about what it is. The activity diagram describes the steps information goes through after being acquired and filtered through OCR.

Automation PIM

With the assistance of OCR, automatic PIM is achievable. When asked about it during the CI session, they welcomed the idea of automatic organizing. A similar approach can be seen in the literature by Indratmo & Vassileva (2008). According to Indratmo & Vassileva (2008, p. 9), a successful organizational structure must consider individual needs, and technologies should aim to automate and simplify development procedures. According to Participant CI-P3, the automatic organization saves time. However, OCR can only read the text on the picture, but it cannot know the users' intention behind the information. The AI behind the technology could read if it is action-oriented information, event- or time-based information. Perhaps as Whittaker (2011) suggested, effective semi-automated methods could work here.

When it comes to automatic delete, similar to the literature by Kljun & Carr (2005), three participants from the CI session expressed that automatic deleting of information will be helpful. However, two of the participants were against automatic delete. According to Khoo et al. (2007), one of the reasons users resist deleting information that may be useful is the fear of destroying information that may be valuable in the future. Participant CI-P3 expressed the same argument.

"I do not think the phone will be able to understand when a picture is capable of being deleted or not… That is my preference, and that is my decision, not the phone." (Appendix 6, CI-P3, p. 49)

According to Boardman and Sasse (2004), it is not easy to delete photos taken by users that convey a strong sense of ownership. This argument can also be seen in CI-P3. According to Jensen et al. (2018), individuals leave all options open when deciding which photo to keep.

When it comes to the automatic deleting of information, the owner should be considered. Kljun & Carr (2005, p. 1), PIM has a few solutions that maintain information automatically, such as deleting things after a certain period. Therefore, on my prototype 2, I have included automatic delete with a certain period to choose as an option.

6.3 Research question 3

RQ3: *How likely is the digital solution prototype that benefits the users and eases their experiences?*

The result from prototype 1 indicates that the users understand steps 1 and step 2. In step 2, the participants recognize the yellow mark as a link. In step 3, the participants were confused about the different options. This design was adapted from the iOS design system. After a brief discussion with the participants, I decided to create a reminder and show it in the options in the calendar.

In step 4, the participants found it helpful to customize the date and time personally. According to Goren-Bar (2004), users prefer adaptive and automatic retrieval systems. According to Jensen et al. (2018), personalization is crucial for retrieval on handheld devices. All participants from the CI session said that an automatic retrieval/reminder would be helpful. Literature shows that users prefer automatic retrieval (Barreau, 1995), (Boardman, 2004), (Krik et al., 2006), (Jensen et al., 2018). However, there was a concern with the number of automatic reminders the user will receive, especially if they take 5-20 screenshots a day as reminders.

Another concern was the trust of external apps. Participant CI-P4 was worried about an external app receiving her private screenshots and photos. It could be solved if the solution is not an external app but an integrated functionality of the system.

7 Conclusion

Based on the results and knowledge gained from my investigation, I have concluded my problem statement. The problem statement reads

How to design a digital solution to ease the user experience in finding the necessary information at the right moment, focusing on photos and screenshots on smartphones within the scope of PIM?

The results of the survey and CI studies on the practices of PIM with smartphones are presented and discussed in this thesis. Due to the small sample size, especially for the CI, I cannot draw any conclusions. However, there are undoubtedly common, significant features in PIM 's behaviors among my small sample of participants that could serve as inspiration for future, more extensive studies.

Through the survey and CI sessions, I answered RQ1. When obtaining information, screenshots and photos are the most common method of obtaining digital information. Screenshots and short-term photos are commonly used as action-oriented information. For non-digital information, photos were used as reminders. The most common information for the survey and CI session was social events, important dates, and personal and professional appointments.

Both iOS and Android offer the ability to create folders, but no user creates folders on their smartphone. The small screen of the smartphone could mean that information is often not organized. Participants' smartphones organize their information automatically. Their smartphones automatically organize their information based on the folders created by each folder. Participants do not rename or reorganize their folders or information. A large amount of information stored on their smartphones was not easy to organize or navigate.

Manual deletion was the only maintenance activity that participants performed on their smartphones. The majority of them deleted the information as soon as their

smartphones were full. Participants using cloud-based solutions must manually upload the data to their cloud-based solution before they can delete it on their smartphone. Even though a cloud-based solution seems to solve the storage capacity problem, users still have to manually delete the data from their smartphones.

The biggest problems with information retrieval are caused by the cognitive process of retrieving and recognizing information. Users may have difficulty retrieving their long-term information because their memories are fuzzy. Participants attempt to retrieve the information by navigating through the year or remembering where it was filed. When the navigation strategy fails, participants use *recently*. There are no other strategies, which complicates the retrieval process.

I answered RQ2 through CI sessions and literature review. Both iOS and Android use optical character recognition technology. OCR can only read the text on the image, but cannot identify the user's intent behind the information. The AI behind the technology could learn whether the information is action-oriented, event-based, or time-based. A successful automated PIM should organize information based on individual needs, and technologies should aim to automate and simplify development procedures. One of the reasons users resist automatic deletion of information is the fear of destroying information that may be valuable in the future. The decision should be theirs, not the phone's. When automatically deleting information, the owner and ownership should be considered.

I answered RQ3 by testing the prototype. Personalization is critical for smartphone search. Participants also prefer adaptive and automatic retrieval systems. Another concern was the reliance on external apps, which could be prevented by integrating the solution as an integrated functionality of the system.

In summary, a digital solution with automatic organization, personalized maintenance, and custom search combined with OCR technology makes it easier for users to find the information they need at the right moment.

8 Future work

Due to time restrictions, several possibilities for improving and widening the scope of this thesis have been postponed indefinitely. More profound assessments of specific areas of interest and ideas for new methodologies to use will be part of future studies. The following are some of the suggestions:

1. Prototype two was an improved version of the result of prototype one testing. The delete function was developed based on the result. It will be interesting to observe if the solution is beneficial or unpleasant to the users.

2. Participant CI-P4 mentioned that a certain amount of notification would be annoying. It will be interesting to test how self-creating notifications will be received.

3. The most rewarding option for future work would be to replicate our investigation on a more significant sample, either using CI or other approaches more suited to gathering larger-scale data.

4. Quantitative validation of the findings is recommended to determine whether differences and similarities in attitudes and behavior are evident on an individual level or apply to a broader group of people.

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