Design Process of a Social Network System for Storage and Share Files in the Workplace

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Abstract. This paper explores the design process of a social network based storage and share application in the workplace. One of the big challenges of our era is to handle the amount of data available. This may result in a high cost with additional servers to store the data and guarantee availability and reliability. We interviewed ten employees to understand better their share and storage practices in everyday life, and also identify opportunities to inspire the design of storage applications. As a result, we provided 20 recommendations to develop social network storage systems. Additionally, we created personas and scenarios inspired by interviewed participants. We envisioned how the system should work and we illustrated it by interaction cycles with a low-tech prototype. Finally, we provide lessons learned towards the design of storage and share files in the workplace leveraging the social relationship amongst co-workers.

Keywords: Design process · Social networks · Distributed storage systems

1 Introduction

Social networking has been adopted in different contexts inside the enterprises not only to improve the relationships among co-workers across different departments but also to allow them to share ideas, documents and information. With such systems, workers can connect with each other, create and participate in several communities related to projects, teams and subjects they are interested in. One possible solution to store these documents is to have a dedicated storage. However, with the rapidly increasing number of files produced by the user, the dedicated storage may become a bottleneck: single point of failure and high bandwidth consumption.

In addition, the expectation of employees in the organizations, as attested by our study, is that storage needs to expand continually. Thus, this storage should be elastic and increase with the amount of data since users hardly erase old versions and documents that are no longer relevant. This may result in a high cost with additional servers to store the data and guarantee availability and reliability. According to a SpiceWorks[1] report, the organizations have in average 55 percent of the storage in laptops and desktops that are unused. So, leverage unused storage may lead to solution with no additional cost. In this paper we wanted to understand the user experience of current ways of storage and share files in the workplace to gather insights and look for

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[1] http://www.spiceworks.com.

opportunities to build a new mobile storage tool that might overcome some storage problems in the workplace. Our main research questions are:

- What are the everyday practices of storage and share files in the workplace?
- What are the practices to deal with storage and sharing files in the workplace?
- In which ways a future mobile storage tools may improve practices of storage and share files in workplace?

We followed a Design Research methodology. The preliminary research was a semi-structured interview with 10 employees working in the same company. Afterwards, we provided 20 recommendations to develop social network storage systems. Additionally, we created personas and scenarios inspired by interviewed participants. As a result, we proposed a decentralized storage and share system based on social network and illustrated it by interaction cycles with a low-tech prototype.

2   Methodology

In this work, we follow a Design Research Methodology with the intent to have a distributed system to store and share files in the workplace, and doing so minimizing the cost of a centralized structure and to take advantage of unused space in worker's devices and their social relationships. Design research aims to improve the design process of manmade artifacts and extend the knowledge acquired to projects with a similar approach. Several authors contribute with definitions of Design Research [6, 8, 14]. Some of them explore design research applied to the Human Computer Interaction field [22]. There is a lack to apply this approach to the design of mobile systems. Most writers emphasize the lessons learned in the design process as a contribution to knowledge. Methods, theories and better development of certain artificial products are carefully studied to improve the design process, solve problems and extend the knowledge generated to other similar artifacts. Additionally, in their opinion, previous research is necessary to boost new achievements in developing objects. In [8], Design Research (also referred to as the design experiments approach) was developed as a way to carry out formative research to test and refine educational designs based on theoretical principles derived from prior research. In general, authors agree that design research process consists of three main stages: Preliminary Research, Prototyping phase and Assessment phase [6, 12, 14] add one more stage: reflection and documentation.

The prior research phase [8], also known as preliminary research [12] and predictive research [16], may be an investigation of literature and main principles existent in the field; similar products that are already in the market and/or field studies to understand better the target users. In [6], the authors suggest that the designer has to start by analyzing human behavior, from which he could derive "quantities, qualities, and relationships". Empirical research is essential to this first stage.

The stage of refinement is also called the prototyping phase. Elements identified in the preliminary research are implemented in the prototype in order to test their validity and improve the artifact. The designers implement some elements as intended, some are adapted to circumstances and others will not be implemented due to their lack of

relevance in the context. This approach is described as progressive refinement in [8]. This implies bringing the first version of a design into the world to see how it works. Therefore, the design is constantly revised based on experience to solve possible problems. Expert evaluations or user evaluation with early prototypes might be applied. From these studies, design principles are indicated. Prototype designs represent a specific framing of the problem, and are compared to other research artifacts that emphasize the same problem. They provoke a discussion in the community of methods and approaches employed to solve common problems [9]. Those artifacts become design exemplars, providing an appropriate conduit for research findings to easily transfer to the HCI research and practice communities [22].

Reference [19] suggests that while design researchers do focus on specific objects and process in specific contexts, they try to study these as integral and meaningful phenomena.

The last stage, the assessment phase, is more usually named the evaluation phase. The outcomes of this stage are: identification of main problems occurring; confirming design issues and principles emerging in the experimental phase with the prototype; and recommendations for artifact and design process improvements [14]. The result of the whole process, after a systematic reflection and documentation of each phase, will be the production of theories or/and validated design principles [12].

In this paper we show the preliminary research step (user research and conceptual design) and the prototyping phase.

3   Preliminary Research

In our study, we decide to interview workers to understand better the practices of storage and share in the workplace. We also reviewed the main literature in the field.

3.1   Related Work

In this section we situate our study of investigating work practices of sharing and storage files among the field of research surrounding to social network activities in the workplace. We begin by reviewing related research. Then, we describe some market applications that aim sharing and store files.

Research on management of information in work environments has been explored for the last three decades [1, 3, 4]. Technology has been changing over since, and new challenges emerged in the workplaces. Workers normally adopt several tools in their everyday practice and those tools not always work as expected. As a consequence workers found themselves diverted from their tasks because of missing information, broken tools, or needed expertise [2]. Current practices in file sharing are studied in [20] and the authors examined tools used to share files. They noted that people shared a wide variety of file types, that they determine their sharing practices with respect to a combination of individual users and groups, and that they typically select from a small number of mechanisms for sharing, most commonly sending files by email due to its simplicity and universality. The breakdowns in sharing that were reported were often

related to the poor visibility of sharing settings in the user interface. Users identified a set of characteristics of file sharing mechanisms and push and pull activities. Users chose which sharing modality to use based on the affordances of this sharing modality. Based on it, they developed a tool – sharing palette – that supports interaction for a variety of file sharing styles that allow users to select a sharing modality based on the affordances of that modality.

One common tool example is the e-mail application. Reference [3] investigated "e-mail overload" in-depth fieldwork and uncovered six key challenges of task management in e-mail: threaded task-centric collections, equality for all content, task-centric meta-information for all items and aggregations of information for an overview.

Other studies have been proposed with attempt to understand how users organize their files. In [1] the authors interviewed managers and employees to understand how the information is used. This results in how they will be organized and stored in the file systems. Reference [4] interviewed 27 employees from 5 different organizations in order to understand the information scraps life cycle. Jones [10] investigated how users organize information in support of projects. The study suggests that users continuously reorganize the folder's structure to reflect with the projects completion. Reference [5] investigated personal information management across several tools and over time. Results showed that users devote little time to maintain their information.

Another study points to the way people think about and use shared folders. Questions of ownership and privacy are highly discussed in this work. Even though people can modify, delete and modify other people's files in shared folders, there are implicit rules and assumptions guiding their behaviors. Access permissions affect how people incorporate share folders to their personal management. Reference [21] identified it in cases involving sharing between just two people. More studies are needed with large group of people sharing folders. Reference [15] did an online experiment related to understand if information management tasks are governed by the same communication processes as conversation. The study suggested that people think of labeling and organizing not just as storage and categorization, but as a communicative activity.

In [13], the authors asked 30 people to describe instances of when they shared something that they later regretted sharing. As a result, people do not want a transgression made public or their e-mail to be widely shared, but are comfortable with people having their work e-mail address and desk phone number. Additionally, authors discovered that people willingness to share depends on who they are sharing the information with. Reference [7] proposes a Facebook-based social storage cloud. The integration with Facebook application allowed users to discover and trade storage contributed by their friends, taking advantage of preexisting trust relationships. A credit-based trading approach has been adopted to discourage free loading.

In [17] the authors studied how workers store and manage their files in the workplace. They have examined what files the users have in common and they found an aggregate redundancy of 54 % in number of files and 32 % of total storage space. Moreover, the study showed a tendency to share files is more common on people

sharing same or similar role. So, these characteristics can be considered to create a distributed storage system where files are stored in people working in similar role or project in order to minimize the network and storage overhead. Another aspect that should be taken into account while designing such systems is to avoid free riding or lurking behavior, i.e., avoid users that uses the system's resources (store files only) without contributing to the system (provide resources for other users). For example, studies done on Cattail, a social file sharing system of an enterprise showed that 72 % of users presented a lurking behavior [11].

Reference [15] studied users' multi-device utilization in workplaces. Users use multiple storage and share solutions and the choice depends on the type of the file.

Systems such as CrashPlan, Symform and SpaceMonkey are relatively recent distributed storage services that allow data to be stored and retrieved among peers. Even that most of these systems can be deployed inside the organizations, they do not take into account the co-workers relationship such as participating in the same projects or communities. Other distributed storage systems tries to leverage the social network relationships between friends. Friendbox [18] is a hybrid friend-to-friend personal storage system that combines friend's storage with cloud storage.

3.2 Semi-structured Interviews

Occasionally, the time available to carry out experiments is not enough for users to write long answers. At other times, users do not feel encouraged to write their own opinions. An alternative is to use semi-structured interviews that are employed to support users in answering questionnaires and to give users opportunities to share their experience in a more natural way.

In our study, participants answered a semi-structured interview. The interview was audio recorded. Participants signed a consent form. The interviews took place in a cafe inside the company, to add an informal atmosphere to the study, and to let participants get confortable. The study lasted about one hour and participants answered in average twenty questions. The questions covered issues of everyday life at work; experience with share and storage tools at work; organization of files in their computers and management of digital files. The results of interviews gave us directions to user modelling and insights of a storage and share prototype features.

3.3 Participants

A convenience and snowball sample was used to collect the data. Ten participants were interviewed. Four participants have been working at the company from 9 months to 4 years. Three participants have been working at the company from 6 to 8 years and three from 13 to 27 years. Participants had different job roles: Sales out report analysts (2 participants); Supply Chain analyst (1); Project manager (1); Research scientist (1); Problem analyst (1); Contractor Manager Specialist (1); Business control (1); Credit and Invoice executer (2). All the participants had a smartphone and work at the same company.

3.4 Data Analysis

The data sets available were audio transcriptions of semi-structured interviews. The method selected to examine the interviews was content analysis, in which the data was analyzed using a categorization scheme. The categorization scheme arose from the data itself and the research questions also guided the study to find new relations and categories. The researchers wanted to identify opportunities, advantages and drawbacks of having a distributed way of sharing and storage files in the workplace. Therefore, a set of research questions were formulated to guide the study:

- How do people organize, share and storage files in the workplace? Why?
- What are the drawbacks and opportunities to improve sharing and storage practices in the workplace?

3.5 Findings

With the purpose of presenting the findings, categories were classified but also dissolved in the text, as the boundaries among them are not so clear. Findings were described according to the research questions in sections.

How Do People Organize, Share and Storage Files in the Workplace? Participants use a number of tools in everyday work to communicate and share files with co-workers. Most participants usually start their day checking their calendars and e-mails. They use the company chat service to communicate with co-workers and share files. The size of the file determines which tool will be choosing to transfer files. If the file is important and relevant to the topic of the chat conversation, the files are send in the same time to the chat partner. If the file is not relevant in the moment, or/and people are not online, or even if they want to register/track the receive file they transfer it by e-mail. When the file is big, they use USB flash drivers or a storage app to transfer it. Some official tools were created to share files, but were not fully adopted for this purpose, were used as a file repository instead. Problems with storage space were common problem using these tools. Participants were not aware of limit storage and limit of size files for sharing using company official tools. The drawback of using the chat tool and e-mail to share files is the tracking of the file. When they shared their files through a cloud system or the social network official tool it was possible to recover it. On the other hand, storing files in a server/cloud and send the hyperlink, sometimes takes more time (uploading and downloading) and affect computer performance than sending files via chat and e-mail.

   Generally they store their files in their computer and an external hard drive. Three participants store files on cloud systems and two on social networks apps. Only one person store her files in an external hard drive and does not have a copy of them in her computer. More than half of the participants do not backup their files often, normally only when they need space or remember of it. The same happens related to the frequency to erase old versions of files in their computers. To save file versions is a common practice in the workplace. We identified several practices related to file versions and replicas. Some save relevant files versions on the desktop. Hence, they are

aware that those files are temporary and means that actions have to be done. They group the files in a folder, when the desktop has many files saved, and then later they decide to erase them or not. Others save file versions in the same folder, and keep them in the backups. Despite of doing versions, sometimes they override files by mistake and cannot recover the previous version. To avoid this, others have original version of the files in a server/cloud, shared or not with their team co-workers. Half of the participants do not use any tool to synchronize their files.

Participants reported that they do not use the entire storage space of their device. As aforementioned, usually people use about 40 % of the storage space. In our study, most of participants have the impression they use between 50 % and 75 %. This shows the opportunity to use unused storage space. Only one participant thinks he uses more than 75 % of storage availability. Some of them have difficulties to manage their own files; they try to find a pattern for labeling them - including the date in the name; the name of the person who sent the file. Additionally, they save versions files by numbering (1, 2, 3…) or lettering (A, B…). Folder was a metaphor people are used to in other applications. In their view, it is important to keep the same folder name in the backups, otherwise you cannot find the files you need in the backup easily.

Not all the participants use mobile phones for work purpose, but they mentioned interest of using it if the company gave them the device. The ones who use mobile phones for work, they usually review, edit and share files from their devices.

What are the Drawbacks and Opportunities to Improve Sharing and Storage Practices in the Workplace? It is clear that participants use numerous software alternatives to share and store files in the workplace. And also the residual space in their devices might be availed. The study suggested an integration of tools to share and storage files in the workplace. Additionally, it is clear that social network structure is used for safety and recovers files. In order to recover files, they ask co-workers to send them last versions, in case they do not have anymore. Even though, most of them have personalized way to organized files in their computer, most of the interviews already share a server space with their team to save files. The main problems are many similar versions of files available, each team member store in their machines. Moreover, not always they are aware of who has the updated version. Furthermore, some participants have not only the computer machine but also mobile phones for work purposes, which gives room for use the unused space of those devices and avoiding servers.

Our study expands findings described in the literature review. We confirm common sharing and storage practices unveiled before, such as usage of many tools at work and their drawbacks [2]. They do not clean files when they do not need them anymore [5]. People label their files in an intuitive way for better search [15]. People duplicate files in their devices to assure they will not be corrupted; lost according to files importance or they saved it in a shared folder or cloud. The preferred mode of sharing files in our study was a Chat service not e-mail as previous studies pointed out [20]. File size was the main factor to choose tools to use to share and storage files.

Thinking of those practices, tools constraints and cost of storage we suggest design requirements for developing storage systems for the use in the workplace.

4   Recommendations

The interviews gave us a better view of people's behaviors of sharing and storing files in the workplace. We examined the findings and listed the main drawbacks employees mentioned. From that, a list of recommendations was formulated.

We describe 20 design recommendations for storage and share files systems based on the literature review and the findings of our data analysis interviews.

1. The system should be integrated to other tools such as e-mail and chat.
2. The system should work in diverse platforms, mobile or not.
3. The system should provide more flexible storage space avoiding limiting the space size
4. The system should assure safety, when stores files in other people computer.
5. The system should allow chat between users if they wish to ask for permission to store a file and also send files anywhere, anytime.
6. The system should have transparence/people awareness of who has permission of editing files.
7. The system should be customizable to let user to import contacts from other social networks.
8. The system should be available 24/7 or during work period.
9. The system should not affect the performance and storage (available space).
10. The system should provide mechanism to share files and folder. The owner may give access to other people.
11. Provide some access control: e.g., password.
12. The system should protect the files (guarantee redundancy, automatic backup) in case there is a problem with the local storage or laptop.
13. The files should be encrypted.
14. Guarantee that there is always a safe copy in case someone deletes or the file is corrupted.
15. Automatic backup and restore.
16. The system should trace the transfers (who sent to whom) and the versions (who has the last version).
17. Access to people outside the enterprise: clients or business partners.
18. The system should guarantee that at least one copy of the file is available remotely or locally as a backup. The system should have copies of the files, in case the file is corrupted.
19. The system should allow to create the structure of storage similar to the structure of the project.
20. Provide incentives for people to give more space. e.g. Users may have space from the system proportional to the amount of space he/she provides (available x times the space provided).

We applied those recommendations to develop a new storage and share system based on social network. For better envision of the new system, we created personas and scenarios based on real situations described during the interviews.

5   Personas

Personas' characteristics were envisioned based on our interviewees, as well the scenarios exemplifying the personas using the future system. Vanessa, Laura and Ricardo our personas, are co-workers in the same company. Vanessa is a financial analyst, works in the company for two years and is very keen on social network tools. One of the tools she uses, is an internal social network that helps her to share files with her peers and create private communities. When she is storing files on her own computer, she usually keep several versions of the same file with different names, so she does not lose milestones of the work she is doing. Her philosophy is: Personal is personal, company is company. Therefore, she does not mix personal documents such as pictures to work documents. Laura is a manager and works for 8 years in the same company. Uses the corporative chat system to talk with people from her team. She is very competent and cautious in his work. She does backups every week and does not save many version of the same file in his hard disk. She only erases files if she needs space in her machine. Ricardo is a team leader and has been working in the same company for 15 years. He is a member of public social networks, but did not use the corporative social network. He tried to use, but does not see value to be apart of a social network environment as he can share, store his files in other corporative applications. He can talk with his team and share files by the corporative chat system. The only community he is a compulsory member, he adopts a lurking behavior. Additionally, he asks members of his team to save files in their computers to assure they will not be corrupted. He prefers store files in his machine and in the hard drive than use a dedicated system, a cloud to save his files. He uses 75–100 % of space in her laptop hard drive.

6   Scenarios

We describe here, one scenario that highlights a task in the system using the social network. Laura is interacting with 'Ruy' a co-worker.

Laura arrives at work and checks her priorities for the day. She opens her e-mail and the Storage system pops up appears. It is her colleague Ruy asking permission to save a file in her device. She sees in the pop up screen her storage capacity and remembers she has to backup her hard-drive. So, she types: Good Morning Ruy. How was the weekend? - He answers -Great and yours? She says - Good. About store your file, I'm sorry Richard, Im afraid I wont be able to do, as you know, even I have space to store it, I don't really like to store personal files in my work machine. I can indicate some people the company that is part of my Storage system network to you. Ruy - No problem, I was suspecting you wouldn't store for me. Laura select back up settings, change Weekly by Now, and the backup files process start.

7   Low-Tech Prototype

After identifying the system requirements based on the use-case scenarios and basic functionalities that the system should fulfill, we have developed a low tech-prototype. Our system is multiplatform, for personal computers and mobile devices as the working
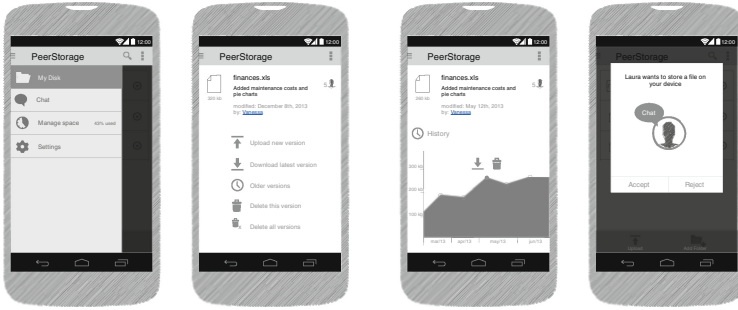
Fig. 1. Low-tech prototype (a,b,c and d).

environment is changing to a more collaborative, social and mobile workplace. It uses unused space in hard-drive machines to store files of people working together. The edges or workers will have a direct communication in order to share resources that can be content such as file. Each worker acts both as a server providing resources and as a client requesting services. Thus, in contrast to the traditional client-server architecture, this system has no centralized control. The files will be encrypted and the host will know who is storing information in their machine. Primary files and also backup copies will be stored; the number of copies stored will be proportional to the importance owners will rate to the file. Files that are more important might have more copies. In Fig. 1 we illustrate some of these functionalities according to the developed scenarios.

Figure 1(a) illustrates some of the system's settings where the user can access his storage, chat with other users, manage his storage space and configure the system. In the low tech-prototype we have assumed that the system has a limited storage, but with the possibility to increase if the user provides more available space in his/her disk. The Fig. 1(b) shows a selected file and the user can easily upload a new version, download, delete or access old versions. In addition, the user can share the file with other users in the social network as illustrated by a person and the number 5. The idea is that the system stores the replicas of the files in these people storage in order to minimize the overhead of storing and downloading the file. The old versions of the file can be accessed in a separate screen, as shown in Fig. 1(c). In this screen the user visualizes a timeline of the versions and the size of the files and the user can click on a version in order to download or delete and old version it. When the user wants to upload a new file or version, the system will provide a list of users based on the social network where the user can interact with via chat (see Fig. 1 (d)). So, when the other user receives a request to store a file, he can decide to chat with this requesting user.

8   Discussion and Future Work

Interesting facts are not only the ones that appeared more during the interviews. Due to our sample (ten people), any issue raised by interviewees is interesting to examine. In addition to practical factors (integration of tools, possibilities of convergence of tasks to the same system) and subjective factors (sense of privacy,

safety, confidence) concerns of basic tasks also appeared in the study. In participants view, if the company requests them to use a system they will use it, they will learn and will accept it as it occurred with many other tools they use with similar functionality. The problem is that using many tools to do similar tasks (e.g. depending on the file size they choose the tool to share it) affects their work performance. Sending or sharing a file might turn out a time-consuming activity and a cognition overload. As any tool has to use machine performance to work and people have to learn and remember diverse ways to do the same task. It might be a solution to use a social network approach to help in the action of sharing and storage files. It provides a low cost solution to the high cost of additional servers to store the data and guarantee availability and reliability in the workplace. As they aggregate storage from edge devices such as laptops, desktops and smart-phones.

Our solution, distributed social network storage, still has to be investigated very carefully. It intents to use the spaces unused in employees devices, therefore cautious with safety and privacy are matter issues. Also issues such as backup management, redundancy and duplication of files and performance will be addressed in this project follow up activities. According to the literature and our interviews, people do not use the whole space available in their machines and generally save duplicate files. For example, in a team of 15 people we could have 2 files duplicate instead of 15, it would save storage. Otherwise, those 2 copies should be available for the team whenever they need, at least in the work hours.

We are planning to run user evaluation sessions, assessment phase, with a group of employees in order to refine the prototype. We expect this process will also generate recommendations to develop similar systems, documentation and reflection phase.

9   Conclusion

Our studies aimed to find opportunities for supporting work through appropriate design and technology. For this purpose, we applied a Design Research methodology. The use of a Design Research methodology leads us to think about the design process and insights that might emerge from it. We interviewed 10 employees about their everyday sharing and storage activities. Our main findings are (1) collaboration was a primary activity among employees; (2) employees worked with many tools to do similar tasks; (3) employees save many versions of the same file in their computers (4) the residual space in employees devices might be availed; (5) integration of work tools would save time. Furthermore, (6) the tools available to employees do not fulfill their work practices in these areas. They have to use several tools to storage and share files according to the size of the file or their real time priority for someone to see it.

We propose twenty recommendations for developing social network storage systems based on the interviews and literature review. Those recommendations were applied to develop a social network storage tool. Conceptual design was also inspired by the interviews. We created personas and scenarios to envision a new share and storage system based on social network. A social network storage tool might overcome some employee's issues while storing and sharing files in the workplace and decrease

cost of storage servers in the workplace. The follow up activity will be to evaluate the prototype and identify lessons learned for similar approaches (reflection and documentation).

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