Supporting the Design of Sharing Economy Services: Learning from Technology-Mediated Sharing Practices of both Digital and Physical Artifacts

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ABSTRACT

Sharing personal digital information online has been a common activity for many years. However, the recent rise of *sharing economy* services has since expanded the set of "things" one can share. How does the sharing of such physical artifacts differ from "traditional" sharing practices of photos and status updates? This paper attempts to consolidate the existing body of work on both sharing personal digital content (e.g., social networking) and personal physical artifacts (e.g., apartment, car sharing), and attempts to identify both commonalities and differences between them. We summarize existing research on the diversity of shared content, users' motivations to share, audience management, privacy & trust issues, and user experience requirements. We also conduct 16 semi-structured interviews with both design practitioners and sharing economy domain experts to formulate a set of design implications for devising novel sharing economy services.

Author Keywords

Online Sharing; Sharing Economy Services; Literature Survey; Qualitative Inquiry; Design Implications.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

With the advent of social, mobile, and cloud computing, sharing details of our everyday lives online has become a routine for many of us. The wide adoption of social networking sites (SNS), instant messaging services, and personal fitness applications has enabled sharing a wide range of digital content; initially mostly in the form of textual information (e.g., status updates), then increasingly pictures and videos. Today, dedicated platforms allow us to share

our personal preferences in music and food, or details of workouts, with wide audiences [23]. Scholars in various disciplines, from social psychology to consumer research, have highlighted the motivations and the relevance of such sharing for supporting social relationships [7,36,40]. For example, John describes sharing as a fundamental and constitutive activity of Web 2.0 in general, and SNS in particular [34]. He positions such sharing as a form of speech and argues that it follows an underlying *communicative* logic ("to let the world know") [36]. Research in HCI has extensively examined such digital sharing practices through designing and evaluating various content sharing systems that support the sharing pictures [30,80], videos [43,70], music [72,79], location information [13,15], generic files [73,81], and textual "status updates" [49,78].

Although online sharing is a widespread practice nowadays, prior research has outlined a number of issues end-users face, such as (a) managing access to shared content [81]; (b) self-presentation to multiple audiences [78,79]; (c) larger concerns of privacy [2,67]; (d) trust in a sharing service [46]; (e) security [15,43]; and (f) avoiding information oversharing [16]. A number of research efforts have suggested different ways to address those challenges, e.g., by reducing user interface complexity, introducing granular access controls mechanisms over shared content, and targeting selective audiences [43,74,79,84]. However, such solutions were often put in a specific sharing context (e.g. workout communities, media collections at home) and largely non-systemized throughout today's diverse online sharing landscape.

The recent rise of "sharing economy" services now sees people increasingly share *physical* artifacts, such as apartments and rooms (e.g., Airbnb), vehicles and rides (e.g., Uber), and, more broadly, everyday objects (e.g., Peerby). In contrast to the communicative logic of online sharing, John argues that sharing physical artifacts often represents an act of *distribution* [36]. Prior work has described practices and motivations for the sharing of apartments [29,31], cars [4,29], tools [48,75], toys [64], personal devices [32], everyday objects [33], as well as peer-to-peer service exchanges [9,41]. We argue that many of the challenges and issues that are present in digital online sharing are also highly relevant for the distributive sharing of real world artifacts, especially when they have digital representations

and/or are mediated by an online platform. In contrast to online sharing, however, distributive physical sharing has received less attention from design research. This gap will become even more apparent once everyday objects become increasingly networked (e.g., the Internet of Things).

Note that the term *sharing economy services* today is often used to refer to commercial endeavors that are accused of unethical labor practices (e.g., Uber) or associated with negative social impacts (e.g., Airbnb). However, an increasing number of community groups and organizations have formed networked-driven collections of shared things (e.g., books, tools) and other resources (e.g., woodworking spaces, fab labs) that explicitly aim to benefit local communities. Scholz [71] calls this emergent phenomenon "platform cooperativism". We envision that these resource sharing organizations and collectives will see increased use in the future. The designers of such platforms and services could not only leverage the empirical knowledge on how to adequately *communicate* the information about available resources through an online platform, but also to support an organization's environmental, social, and cultural values in the digital sphere at large.

Our research goal is thus twofold: (1) to better understand current sharing practices of both digital and physical artifacts; and (2) to address common challenges end-users face in those contexts – with a view towards supporting platform cooperatives. In order to reach the goal we attempt to compare and contrast these two sharing spheres. Our point of departure lies within John's conceptual classification of different sharing practices into *distributive* and *communicative* logics of sharing [36]. Sharing economy services combine both of these logics: acts of distribution of physical resources, and acts of communication by sharing artifact details and availability through an online platform.

Specifically, we address the following research questions:

RQ1: What are the key design themes that constitute technology-mediated sharing practices?

RQ2: What are the commonalities and differences between sharing digital and physical artifacts?

RQ3: What are the design implications for sharing economy services (i.e. technology-mediated physical sharing)?

We address these questions by surveying previous studies of digital and physical sharing. We have systematically reviewed 87 papers published in major HCI venues throughout the last 15 years. We additionally conducted 16 semi-structured interviews with design practitioners and domain experts in the sharing economy to develop a deeper understanding of specific design challenges of such services. We offer three main contributions: (1) a comprehensive account of sharing practices of both digital and physical artifacts; (2) a mapping of the design space for both physical and digital sharing; and (3) a set of design implications for future sharing economy services.

Note that, throughout the paper, when we refer to digital or physical sharing practices (and services), we always imply *technology-mediated* sharing of digital or physical artifacts. Non-digital "offline" sharing (e.g., sharing a power drill with a neighbor) is outside the scope of this work.

BACKGROUND
Related work falls into three main areas: (i) research in HCI that investigates online content sharing practices; (ii) studies of sharing and *sharing economy* services; (iii) intersecting research in interaction design and domestic computing that looks into bridging digital and physical artifacts.

Sharing Digital Content Online
Early work on digital sharing phenomena outlined the practices of file sharing, mainly for supporting group work [16,35,52,74,81,84]. Studies described the heterogeneity of various file-sharing methods (e.g., E-Mail, instant messaging, blogs) [84] and classified motivations to share files not only around efficiency and productivity at work [16,74,84], but also outlined social factors characterizing peer-to-peer sharing [52]. Later, with a boom of online photo sharing services, researchers started to look at the actual experiences surrounding sharing practices [30,80]. Self-presentation [27,30,72] and self-expression [12,27,30,44] along with the social motives to create and maintain relationships [27,43,70] became important factors to motivate digital content sharing. However, digitally stored personal photo, video, and music collections allowed wide, often unknown, audiences to access them [12]. Naturally, this aggravated privacy concerns [2,43,54] around proper audience management for shared content [38,43,79]. Collectively, these studies on media sharing practices deepened our understanding of *why* people share online. Our work summarizes these motivations and categorizes privacy concerns across different sharing contexts.

As previous studies in SNS confirm, managing the audience of shared content is one of the key factors in service usage. Acquisti and Gross [1] explained the "privacy paradox" – the dichotomy between users' privacy concerns and their online disclosures. Despite concerns, active social network users often reveal large amounts of personal information on SNS. In particular, these concerns neither affect how users adjust their profile visibility [77] nor their posting behavior on SNS [69]. Furthermore, previous research identified how people address audience challenges on social media: they think of more general abstract audiences or imagined targeted audiences [49]. In fact, these ambiguous audiences in SNS raised the issue of "context collapse", where self-presentation and the distribution of information to distinct social groups (e.g. personal, professional) became difficult: "people from different contexts become part of a singular group of message recipients" [78]. Social media scholars identified several coping mechanisms to address context collapse through boundary regulation [85] and audience segmentation [83], and concluded that control over the audience to access personal information is critical to address

privacy concerns in SNS [20]. These works informed our study articulating *to whom* sharing takes place, emphasizing the audience as a constitutive factor to classify contemporary sharing practices.

With the rapid adoption of GPS sensors on smartphones, people started to share their locations [82] not only with family members (e.g., through specialized apps) but also to strangers (e.g., on SNS), which naturally aggravated issues of privacy and security [6,15]. Furthermore, research pointed out that people can infer one's activity from a shared location and, subsequently, make judgmental conclusions about one's behavior [13,82]. We leverage the dynamic *context* that location-sharing research revealed as a factor to compare digital and physical sharing practices.

Recent research on personal informatics [47] discussed emergent digital sharing practices. People share their physical activity data with tracking devices and smartphone apps to motivate themselves [57,76], to create and maintain social ties [14,55,57], to compete with peers [3,63], and to get guidance and feedback [63]. Similar to location sharing, the sensitivity of personal biophysical data (e.g., heart rate) raises issues of safety and security, especially when disclosed indiscriminately [57,63,66,67]. Researchers seem to agree that designing granular, easy-to-use controls over such content would address the challenges of disclosure and thus would improve the sharing experience [56,63,66]. Epstein et al. [21] introduce a corresponding design framework that is composed of six dimensions: (i) the type of data collected and shared; (ii) the transformations applied to the data prior to sharing; (iii) events that causes the data to be shared; (iv) persistence of shared content; (v) the presentation of the shared data; and (vi) the audience as a recipient of the shared data. We extend this framework in order to adequately compare and contrast digital and physical sharing practices.

In summary, prior research on sharing digital content online looked at *what* people share, *how* the share, *to whom* they share, and outlined *motivations* for sharing. Note that the aforementioned online sharing practices (with the exception of file sharing) are examples of the *communicative* logic of sharing [37]. Next, we turn to physical sharing practices, where sharing is seen as an act of *distribution*.

Technology-Mediated Physical Sharing Practices

The recent development of sharing economy platforms and services enabled people to temporarily access and experience underutilized physical resources, such as housing [31], vehicles [4], household objects [64] and spaces [75]. Researchers empirically illustrated that participation in popular commercial sharing services (e.g., Airbnb, Uber) are often driven by practical needs (e.g., get a service, increase convenience, receive monetary benefits) [8,31]. However, nascent research shows a growing interest in fostering local sharing cooperatives and collectives, such as maker spaces [75], libraries of things [24,64], and community gardens [48], which prioritize social values over economic gain.

In contrast to digital sharing online, sharing economy services largely adhere to the *distributive* logic of resource sharing [36]. However, interactive technologies and systems actively *communicate* the availability of those resources on dedicated sharing platforms (e.g., Airbnb) or simply on SNS (e.g., Facebook). Attending to the fact that physical and digital sharing practices may at first glance seem to be semantically different, they not only use similar pro-social rhetoric [37], but also share mutual values of cooperation and participation [40].

The challenges identified in digital sharing such as access control, self-presentation, and privacy and security concerns, are also present in physical sharing practices. In particular, prior research outlined concerns of trust [31,50], joint ownership [48] and reciprocity [4,41] as emergent challenges in physical sharing. Developing trust within a community is a key challenge for designers of sharing economy services [50]. Prior work demonstrated that the sharing of detailed online profiles can contribute to decision-making [22] and help establish perceived trustworthiness of a peer [51], e.g., when sharing rooms through a sharing economy service. However, it may also entail negative consequences (e.g., racial discrimination) [18]. We take this into account by incorporating *trust* as a key factor when comparing physical and digital sharing.

Bardhi and Eckhardt [4] constructed an analytical framework to describe access-based consumption of shared resources. We include their *temporality* and *consumer involvement* dimensions in our comparison of physical and digital sharing practices. Raval and Dourish [68] looked at emotional aspects of participation in the sharing economy among Uber and Lyft drivers. We frame these dimensions within the broader concept of *user experience* that influences sharing. Dillahunt and colleagues [17] conducted an extensive literature review of the sharing economy in computing and identified several directions for future research. Their work guided our choice of methodology and informed our higher-level themes, namely, *privacy and trust* and *motivations* (see the Results section for the full list of themes).

Contrasting Physical and Digital Artifacts

Drawing on research in interaction design that looks into bridging personal physical and virtual artifacts (e.g., collections of digital photos, music and movies) in domestic environments [28,58,61,65], e.g., digital vs. framed pictures, we tried to understand how their sharing practices differ. For instance, studies of personal photography [25,58] demonstrated that practices created around material forms of media were still present in the digital ephemera. Odom offers an extensive inquiry of "virtual possessions" [61]. He contrasts them to personal physical artifacts and proposes three distinctive qualities [62]: (i) placelessness – an absence of place where digital things can be found; (ii) spacelessness – they do not intrude into people's physical space and can thus grow invisibly; and (iii) formlessness – the fact that they do not have a clear form, and thus can be easily repro-
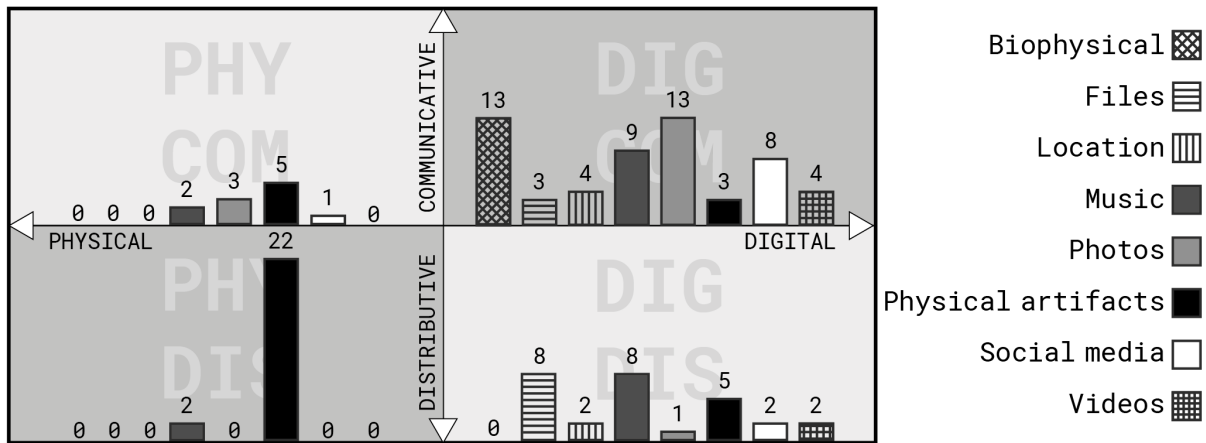
Figure 1. The overview of our data corpus. Each paper is classified within digital and physical medium where sharing occurs, and communicative and distributive logics of sharing. The detailed list is hosted at https://doi.org/10.6084/m9.figshare.6960509

duced, replicated and remixed. The accrual of metadata is another defining aspect of virtual possessions: it supports personalization, linking multiple types of virtual possessions together, and creating social stories [59].

Research that investigated virtual possessions in domestic environments provided four insights that distinguish them from personal physical artifacts. First, virtual possessions are fragmented across different services (e.g. desktop, cloud storages, smartphones), which complicates one's sense of ownership [59] and control over them [60]. Second, digital belongings often lack symbolic associations and lasting value in comparison to their physical counterparts [65]. Third, the more effortful access to digital artifacts at home [65] often inhibits serendipitous opportunities for social engagement [58], which physical artifacts allow (e.g., displayed souvenirs and framed photographs). Finally, virtual possessions play a lesser role in identity construction in comparison to personal physical artifacts [39,45].

While these studies represent an important point of departure for our work, we note the lack of a shared understanding to describe both differences and commonalities of such cross-domain sharing practices, in order to inform the design of new physical sharing services and platforms. We aim to fill this gap by (i) mapping the design space between physical and digital sharing and (ii) synthesizing a set of implications for design in order to support building future sharing economy services.

METHODOLOGY

To understand the key design themes that constitute technology-mediated sharing (RQ1), we performed a literature survey across eight broad domains identified in prior art: (1) file sharing; (2) photo sharing; (3) sharing videos; (4) music sharing; (5) sharing in social media; (6) sharing locations; (7) sharing personal biophysical information; and (8) sharing physical artifacts in the context of sharing economy services. In our study, we aimed to include both seminal and nascent works on sharing (a subset of which we dis-

cussed in the prior section) within the HCI and CSCW communities and beyond.

Following a methodology suggested by Dillahunt et al. [17], we conducted a systematic literature review of 87 papers to build a data corpus of various contemporary sharing practices of both digital and physical artifacts. Initially, we identified the most cited papers on "sharing" using both the ACM digital library (http://dl.acm.org) within key conference proceedings (e.g., CHI, CSCW, Ubicomp) and journals, as well as Google Scholar (http://scholar.google.com). Next, we excluded articles that were not aligned to our RQ1, or which had no clear methodology or data collection process described. For the remaining articles, we additionally included studies that cited those works. We then classified articles along two dimensions: the principal medium of sharing (physical vs. digital) and the logics of sharing (*communicative* vs. *distributive*) [36]. It is important to note that after performing this process iteratively, the studies of digital sharing practices were dominant in our data corpus. Figure 1 presents an overview of the included publications in our data corpus. Note that some articles cover multiple dimensions, hence the final count is greater than 87.

Next, following Epstein's et al. [21] design framework, we reviewed each paper from the corpus focusing on *what* people share, *to whom*, *why*, and *how* sharing takes place. Two researchers on the team employed open- and axial-coding techniques from grounded theory [26] to analyze the data thematically. The process was iterative: the team met every week to discuss the emergent sharing dimensions, going back and forth between the data and the researchers' notes, which we developed through recurrent reading of the material [53]. Subsequently, we identified 5 top-tier themes and 8 sub-themes (see Figure 2 on the next page) that served as our point of comparison between sharing digital and physical artifacts (RQ2). To this end and drawing on content analysis methodology [26], we counted occurrences in our set of papers that corresponded to our coding tree.

To further our understanding of these numerical findings, and to develop a richer account of physical sharing practices, we engaged with 5 sharing economy domain experts and 11 design practitioners (16 people in total, 11 were female, all used sharing economy services actively) in semi-structured interviews. We were particularly interested in recruiting designers and domain experts not only to elicit their personal experiential accounts of participating in popular sharing economy services, but also to collect their professional reflections on developing and running such services. The goals of the interviews were twofold: (1) to better understand nuanced characteristics of contemporary sharing economy services within the previously identified five top-tier themes; and (2) to identify challenges end-users face while interacting with such sharing services to inform the design of future physical sharing services.

We recruited participants through our extended professional networks. After collecting participants' demographic information and establishing a common frame of reference around the "sharing economy" phenomena, we then inquired about one sharing economy service that participants have had most experience with. We first wanted to elicit their personal experience with this service, therefore we asked for instance "Can you describe what have you shared in this platform? Have you had any concerns about sharing this?". We subsequently seek their professional feedback about that service. For example, we have challenged designers: "According to you, what are the key user experience requirements in this platform? How have designers tried to meet them?". For sharing economy experts, we asked: "Can you describe the main motivations to participate in this sharing economy service for both peer-producers and peer-consumers?" For those who had experience running a service we further inquired about the biggest challenges they had faced to establish a new service. The interviews were conducted using Skype, taking about one hour each and were transcribed verbatim. We adopted a deductive coding approach [53] in order to distill a set of design implications for sharing economy services (RQ3).

The results reported below, firstly, describe the 5 main themes and 8 sub-themes that emerged from the analysis, and secondly, outline similarities and differences between digital and physical sharing practices. In each section, we present illustrative examples that help capture detailed
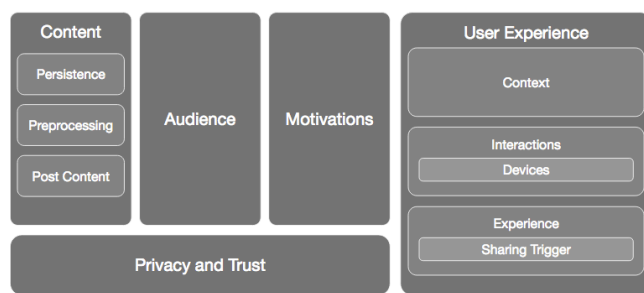

Figure 2. Sharing dimensions emerged from the analysis.

characteristics of contemporary sharing economy services and illustrate their ongoing design challenges using participants' quotes from the interviews. In the remainder of the paper, we use pseudonyms to describe study participants.

RESULTS
Our systematic review of the literature across eight broad sharing domains identified five main themes within our data corpus: (1) shared content; (2) audience management; (3) motivations to share; (4) privacy and trust issues; and (5) user experience requirements. Despite their simplicity, we argue that these themes are useful to unpack digital and physical sharing practices. Furthermore, they can serve as a point of departure to understand similarities and differences between sharing digital and physical artifacts. Drawing on Epstein at al.'s work on social sharing in personal informatics [21] we identified several sub-themes within both the *Content* and the *User Experience* theme. Collectively, our themes and sub-themes constitute 13 dimensions of sharing (see Figure 2).

To arrive at these dimensions, we clustered a total of 1212 codes into 68 groups that uniquely describe one aspect of sharing (e.g., "sharing for self-expression"). For each sharing dimension we report the most representative groups with its relative values counts (in percentages within their respected sharing sphere, i.e., digital or physical). Due to space constraints, the detailed results (per each distinctive group) of the analysis are included in an online annex[1].

Content
Content refers to the type of the shared artifact. It addresses the question: "What is being shared?"

Sharing practices for digital and physical artifacts may involve content of diverse nature. We distinguish three levels of materiality for shared artifacts: (i) material with a physical presence; (ii) immaterial with defined representation or form (e.g., digital files); (iii) immaterial and abstract types of artifacts with no defined physical form (e.g., knowledge). Sharing digital information involves only immaterial content with defined representation, usually files in the form of digital imagery (50% of all digital shares in our data corpus) and status updates in social media or in instant messaging apps (50%). In physical instances of sharing, material artifacts are the most frequently shared (60% of all physical shares). These include houses, cars, personal goods, electronic devices, and their digital representations. Worden, 32 explained the diversity of content shared using Airbnb: "*On the one hand it is a physical space that is being shared that is makes flat or house accessible or the room within a flat, on the other hand it is the whole data layer about the users themselves and the byproduct of their interaction with the platform*". Julie, 27 pointed out that Airbnb since extended

their offerings to different types of services (23% of all physical shares): "*Airbnb launched other kind of products besides accommodation, they are expanding the things they offer. It's a new category called 'experiences' where you can find other stuff, not houses, you can book tours, excursions, dinners, maybe even a yoga class at the Himalaya, it's a different type of content.*"

Persistence

Persistence refers to the lifetime of an artifact. It addresses the question: "For how long is a shared artifact visible or available?"

While both sharing practices can be time-constrained, the enforcement mechanisms can be different. For instance, 80% of the digital instances of sharing can be regulated by a system's capabilities, such as the maximal display time of a piece of content on top of the personal timeline in a social media platform. In contrast, the practice of sharing physical artifacts is frequently determined by a sharer (62%), such as in the case of renting apartments through Airbnb, as illustrated by Julie, 27: "*Some* [flats] *are available for immediate booking, but on others you have to indicate you are interested in booking the place and the host evaluates it, and you exchange comments or messages with each other* [to reach an agreement]".

Preprocessing

Preprocessing describes the amount and the type of work done on the content prior sharing it, and outlines how much a platform assists in performing these tasks. It addresses the question: "Which transformations are being applied to the content before sharing it, and have they been carried out automatically by a system or manually by its users?"

In our data corpus, there is a large amount of manual preprocessing work involved in sharing physical artifacts and services (e.g., rides), suggesting lack of automatic tools to accomplish the most frequent tasks (92% of all physical sharing). Pierre, 37 listed few manual tasks to find a companion for a ride: "*App is not the main communication tool after you establish a contact with your passenger, I used SMS, phone or another messenger to sync on certain details. The service did a great job to find a travel buddy. Basic conditions were agreed within the app: I tried to get people who speak same language, but small details were arranged on the phone… at 5am I prefer to call* [the] *person directly to confirm the pick-up*".

In our data corpus we observed a prominent difference in the type of manual preprocessing that takes place in physical and digital sharing. For example, the main form of manual processing in the context of photo-sharing is related to naming, tagging and captioning pictures (55%). With physical artifacts, common tasks are instead related to their maintenance (25%), grouping and linking supporting digital content (e.g., making announcements or creating albums) (50%), as well as editing it (17%). Danny, 31 recalled his recent experience with Airbnb: "*Sometimes the owners do a good job in describing the place with text and pictures. Sometimes those pictures are too good, I think this* [indicates that] *something could be wrong with the property, if the pictures have being photoshopped or they used wide-angle camera... if the text is too well-written*". This observation suggests that an overly polished description may be interpreted as suspicious or non-reliable.

Post Content

Post Content refers to the format of the shared information. It addresses the question: "What form or shape does the content take in order to be shared?"

In our data, this sub-theme illustrates a similar characteristic among the sharing of digital and physical artifacts. In the digital sphere, people not only share digital "things" such as images or music (51%), but also digital information *about* real-world events, such as free-form status updates (29%) and contextual activity information e.g., workout summaries, or GPS tracks (20%). Sharing of physical artifacts or services, e.g., home repairs, IT support, or tutoring, always involves such digital descriptions about an object (e.g., an address where it is located) or a service. Note that while in some popular platforms, including Airbnb, the content of those listings are carefully curated, Jehanna, 31 mentioned that information does not even need to be explicitly advertised at all in order to get a service, like a city tour: "*I got in touch with another Couchsurfing user who didn't offer his house, instead he offered a tour of the city. That's another way to use Couchsurfing, users don't necessarily need to offer their houses, they may offer social encounters. I met this guy who paints, I was interested because I paint as well, it was a good experience, he took me to dance salsa, he showed me his studio, and told me facts about the city, we shared a one day experience*".

Audience

Audience refers to the recipients of the shared content. It addresses questions like "To whom is the content being shared and how is it being communicated?"

In our data, we found a visible difference between digital and physical sharing: most instances of digital sharing are targeted towards friends and family (43%) or with their extended circles, which include co-workers and classmates (25%). Conversely, physical sharing practices in the sharing economy typically target unknown people (43%). While sharing physical artifacts (e.g., tools) sometimes happens within interest groups such as makers (32%), Morten, 33 criticizes the lack of community when interacting with a typical sharing economy platform: "*Airbnb somehow seems like making a strong connection between an owner of the apartment and the user, but currently it misses the community dimension between users who rent those apartments*".

Unlike in the digital environment where sharing is usually targeted to multiple users at once (73%), most of the time people share physical artifacts or services to one individual at a time (73%). Although there are examples of physical

sharing with more than one receiver (such as the sharing of tools, or spaces).

When it comes to *communicating* the information about the shared artifact or service, Dacie, 35 emphasized the importance to involve multiple stakeholders to support a transaction on a sharing economy platform. Especially when their involvement is crucial to the outcome of that transaction: "*I had an excellent experience communicating with our host (Lilly). However, since she is not fluent in English she has to ask her daughter to reply* [to our messages]*, so there was some waiting involved in the process (half day or a day).* [The platform] *may also CC our conversation to her daughter* [in order] *to get her involved directly*".

What is more, Delora, 32 reaffirmed the importance of community-building by maintaining multiple communication channels based on her own experience running a sharing economy service: "[In our platform] *a user buys meals that someone else is cooking. We have different communication channels, one of them is* [a] *chat with a cook, Q&A... We're trying to create a cooking community and let users to create new discussions through our platform*". Danny, 31 reflected on the aspect of temporality regarding post-transaction communication: "*The owner was trying to identify who had smoked in the unit, by sending messages through Airbnb. The property was checked-out ok, nothing was broken. I don't think that's OK to send messages after our departure. There should be something like a* [departure] *contract: as soon as you sign it, we are done. I should not take responsibility for someone else*". This quote illustrates the potential of ephemerality of the shared data to play an important role in managing online disclosures at large.

Motivations
Motivations are what drive people to share. It addresses the question: "Why is the content being shared?"

One of the most notable differences between digital and physical sharing practices lies in its motivations. Motivations for sharing physical artifacts are highly instrumental, such as to earn money or to get things done (41%). Thus, economic and practical needs are the most common reasons to engage in this type of sharing, which is usually not the case in the purely digital context (7%). Worden, 32 elaborated on reasons to engage with Airbnb from a supplier and a consumer side: "*For those hosts that are doing it full-time professionally it is clear — monetary incentives are the most important motivations, especially if they are renting an entire apartment. If they are renting a room within a place, it may be more about the community and experience. On the guests' side, it can be more diverse*".

Purely digital instances of sharing are largely motivated by self-expression and enjoyment needs (24%). Sharing for the purpose of social connection is a strong motivating factor in digital sharing (23%), but it has a limited presence when it comes to sharing physical artifacts and services (10%). De-

spite that, Rebecca, 26, used ride-sharing as an example of a physical sharing practice that may create new social ties: "*There's also the social bond that one is able to build in these practices, I believe it's a different idea, another culture of transportation, you may meet really interesting people, not the usual taxi driver*".

In addition to that, both physical and digital sharing practices are motivated by aspirations of self-development. However, these pursuits often have different meanings. In digital sharing, they are largely related to identity construction (21%), whilst in physical sharing they relate to personal and community development (28%). Gladys, 30 reflected on the importance of both based on her own experience using a bike sharing service: "*I want to be a user and personally I would like to participate in their organization from some other angles as well: for example to clean the bike and to protect it a bit* [from being stolen]*... also to say 'Look, that's a bike I use, it is my bike', not really mine but you know... I would feel much happier... somehow this aspect of community*[-making] *around bikes is missing there* [for me]".

Privacy and Trust
Privacy relates to people's desire to control information dissemination. It addresses questions like: "How do users feel about privacy and trust issues when deciding to share, and how does it affect their choices?"

People have a number of privacy concerns regarding sharing their personal information, most of them can be drawn around people's self-presentation online (43% of all digital sharing) and disclosures to the undesired audiences that could get access to the shared content as a result of sharing personal details too broadly (28%).

Within our data corpus, people that participate in sharing economy services were not broadly concerned about these issues (40%). In the same way, Worden, 32 suggested that convenience weighted over his privacy concerns when he decided to sign up to Airbnb: "*My biggest concern was when I had to scan my passport for verification purposes. I wanted to be a verified user, so I would have easier time finding a place if I needed one. That's a very personal document, it was the moment when I was quite skeptical... but in the end I just signed up and hoped for the best*".

What seems to be more relevant in sharing economy services is a trust in the recipient or the community where sharing takes place (40%). Bobby, 33 regarded the use of reputation review systems to improve the trust within a platform and its participants: "*I believe all these tools to build and show a reputation are there to mitigate potential issues of trust. If I see 300 people stayed in this house and everyone says 'it's OK' and they are all happy with the experience, well... if nothing bad happened to them, why would it happen to me?*" Furthermore, Aubrey, 30 reflected on the privacy trade-offs that users have to make when decided to participate in a sharing economy service: "*Consid-*

ering that you can link [your profile] *to the Facebook account, some people may not like it, but it is a way to make a person accountable and to be secure that you are that person... you can't be anonymous in this regard: one has to accept that the name and the age will be visible to others. You are part of the service. You have to be a part of the* [online] *community. It's hard to protect this kind of information in sharing economy. You're part of the transaction*".

User Experience
User Experience concerns aspects of a user's internal state, the characteristics of the *interaction*, and the *context* where interaction between the user and the system occurs. In addition to those upper-level categories, we also explore two sub-themes: *devices* that support sharing, and s*haring triggers* that initiate an interaction.

Context, Interactions and Experience
Context, Interactions and Experience examine how users share, and how they experience the activity. They address questions like: "What are the circumstances in which they are involved?" and "What is the state of a user before, throughout, and after using a sharing service?"

While user experience is a complex phenomenon, our participants (i) evaluated the role of positive and negative experiences with a sharing service; (ii) argued for the value of contextual feedback; and (iii) emphasized the importance of addressing users' information needs. Jehanna, 31 illustrated that by simply reading reviews of a host on a room-sharing platform could save her a lot of trouble: "*I created my Couchsurfing account during a trip, so I didn't look too much. I was heading to Amsterdam and I saw someone offered a place to stay, I got in touch with him and ended up staying at his place, but then I noticed he had a lot of bad reviews, I saw it at the end of my stay. My experience was not good*". Furthermore, our participants valued effective and efficient interactions with a platform when actual sharing takes place. For instance, Worden, 32 outlined the importance of the instant in-situ feedback feature: "*I think hotels.com, they send out these surveys immediately after you checked-in, asking how was it, how was the location— a very quick user survey. Airbnb does not provide that immediate feedback that you can give during the transaction while you are staying at the host's place, especially when he or she is physically not present* [there]... *like problems with electricity or noise*". Danny, 31, while reflecting on the Airbnb web interface, brought up the benefit of concierge-like personalized recommendations that is currently absent from commercial sharing economy services: "*The designers could leverage the available information on amenities and transportation through existing services out there: Google Maps and Yelp. Pull that and use it in a platform interface.* [One can show] *the most important aspects of this information and prioritize that for users, if there is a way to tailor it – better... like 90% of users care about transportation, 10% of users care about restaurants, can we give them that tailored experience?*".

Devices
Devices refers to the type of an electronic device that supports sharing. It addresses the question: "What devices are used to collect and to share the information or artifact?"

Digital content often needs to be collected and/or created, and this process requires an electronic device (e.g., fitness trackers or mobile phones to collect personal workout data, or, simply, a digital camera to take pictures of a shared room). In digital sharing practices smartphones and tablets are the most used companion devices for both collecting digital content (49%) and sharing it (56%). However, to facilitate sharing of physical artifacts and services the rapid adoption of mobile phones (35%) did not overcome the use of personal computers (39%). Dacie, 35 contemplated on the use of multiple channels when she had to book an apartment on her trip to Iceland: "*We started to communicate through the mobile* [app]. *However, when we were about to leave the place, we used email to agree about how to hand back the keys*".

Sharing Trigger
Sharing Trigger describes the event that initiates sharing. It addresses questions like: "What causes the information to be shared?" and "Is it automatically or manually shared?"

Users engaged in sharing digital content and physical artifacts behave similarly with respect to the triggers that drive them to share. Sharers often initiate the sharing activity and determine its conditions by themselves. One interesting difference between two contexts of sharing is a number of shares that are requested by a sharee. For instance, the aforementioned case of Jehanna (see the *Post Content* subsection), when she has proactively reached out to a "non-sharing" Couchsurfing user to give her a city tour. On the whole, "share-on-request" behavior is much more present in practices of sharing physical artifacts and services (32% versus 10% in digital sharing). Blanca, 30 explained the nature of the request mechanism in Airbnb and outlined potential challenges related to reliability and authenticity that can be associated with immediate responses: "*If you are the person who is looking for a flat, a host needs to approve* [your] *request... there are some hints* [in the interface of a platform] *like 'this person normally answers within a range of 6 hours...or even instantly'. However, this does not tell you if this "person"* [is] *just a bot or not*".

Automatic triggers are common in digital sharing (21%). For example, workout tracking apps can determine the exact time when a user finished her run and immediately after share detailed statistics (12%). Usually, sharing triggers in physical sharing are driven manually by the user (87%). Nevertheless, Morten, 33 suggested to consider some elements of automation in sharing economy platforms: "*One nice option would be, for example, when I am renting an apartment abroad,* [the platform] *could make me a reciprocal offer: 'Why would not you rent your apartment when you are away?' This* [approach] *can be used as enrolling process for new hosts*".

Collectively, these reflections not only outline the intricated boundaries of physical and digital sharing by mapping out the space for researchers in the area, but also establish frames of reference for designers who are working on sharing economy services.

DESIGN IMPLICATIONS FOR SHARING ECONOMY SERVICES

Our findings help to illustrate commonalities and differences of sharing of digital and physical artifacts. The five key differences between these two practices are: (1) the shared content: sharing physical artifacts often encompasses not only the shared material object itself, but also the accompanying layers of (meta)data; in digital sharing, content is exclusively immaterial; (2) the recipients of a shared artifact: unknown audiences in physical sharing vs. family members and friends in digital sharing; (3) the motivations for sharing: physical sharing is often driven by economic and practical needs (e.g., getting monetary benefits), while digital sharing is largely guided by self-expression; (4) the substantial concerns of trust in physical vs digital sharing; and (5) the sharing triggers: in physical sharing, a borrower/renter proactively needs to express an interest in a shared artifact, while sharing digital artifacts is often initiated by a sharer. In what immediately follows, we discuss the implications for design that these key findings offer for contemporary and future sharing economy services.

Worden and many of our other participants indicated the dual nature of content when sharing physical artifacts. Besides sharing "a thing" itself (e.g., car), there is a supporting layer of digital information that is shared along with it. This included both machine-produced forms of information and metadata captured by virtue or use of a platform's digital infrastructure, and human-produced digital records through directly taking and uploading the information (e.g., photos of a car, textual annotations). This information often affords opportunities to build a narrative around the artifact itself. Leveraging nascent research in HCI that aims to bridge the gap between physical artifacts and their digital representations through collecting metadata [61], provenance [33] and histories of use [10], we see the value for designers to use these strategies to communicate information about the ownership, duration of a share, provide contextual suggestions of use of an artifact, and preserve and share previous interactions with it. This not only can improve the overall user experience with the shared artifact itself, but also can afford opportunities for social interactions around it [24].

Our findings suggest that physical sharing is largely carried out with unknown people [31,42,64]. It can be partially explained by the advent of the sharing economy services, where people participate in an exchange for monetary compensation [8]. To effectively advertise and execute the sharing transaction, sufficient level of details must be provided about the shared artifact or service. Designers of sharing economy platforms should provide appropriate levels of controls for the user that help balance adequate level of disclosure of personal information and the details of a shared artifact. Modern sharing economy platforms incorporate progressive disclosure mechanisms [24] that reveal adequate amounts of content at a given stage in the transaction. In addition to that, service designers may want to consider *concealing information* upon the completion of a transaction, due to some possible negative consequences (as in the case of Danny, who was accused of smoking after having already departed from a rented property). One interesting option in this respect may be smart-contracting technologies [19], which can automatically enforce a "departure contract" by simply retrieving data from installed sensors at home (e.g., smoke detectors). While such technologies may offer straightforward evidence and minimize ambiguities when it comes to the issues of liability in sharing economy, the extent of their deployment and enforcement should take the larger social organization of the service into consideration, since it can influence social relationships among peers and the community at large. Finally, in contrast to digital sharing, where shared content can scale to reach multiple audiences at the same time [62,78], physical sharing limits people share to one individual (or small group) at a time, which may delay decision-making as in the case of Dacie. We suggest that designers of future physical sharing services explore viable user interface techniques (e.g., access control mechanisms) where the shared artifact (and their digital counterparts) can be ultimately accessed and maintained by a group of involved stakeholders.

When it comes to motivations to share, we want to get back to our framing of two different logics of sharing (Figure 1). We found that prior research in HCI has paid a lot of attention to digital sharing as an act of *communication*, while only few works explored this logic in the context of physical sharing practices [11,25,54,58]. Researchers explained that participation in online sharing stems from people's desires to create and maintain social ties [27,43,70], needs for self-expression [e.g. 27,30,38,44], and generally from the hedonic qualities of sharing experiences online [e.g. 1,5,46,54,86]. However, these social phenomena were less accentuated in prior research in physical sharing. This may indicate an opportunity for research to explore communicative aspects of physical sharing. In practice, designers of sharing economy services can explicitly emphasize the advantages of maintaining social relationships, for example through illustrating the benefits of reciprocity. As our participant Morten proposed, this can facilitate enrolling new users in a sharing economy platform.

Our findings identified that the main concerns of sharing physical artifacts are rooted in the lack of trust in a counterpart of the sharing transaction [31,50]. Given that sharing economy services (which account for most of physical sharing in our data corpus) are carried out broadly with unknown individuals, trust is something that strangers do not naturally have for each other. Therefore, we have emphasized that it is of crucial importance for designers of physical sharing services to provide mechanisms and tools to

build trust between potential exchange partners. Furthermore, we speculate that presenting accounts of successful exchanges may contribute to the overall endurance and growth of the sharing platforms and communities over time. Some commercial sharing economy services have already adapted various mechanisms to build trust within the community and the platform through reputation review systems, transparent profiling, and offline-identification for the providers of the shared resources. It follows that, in order to build attractive and trustworthy social profiles within platforms, designers need to explain the benefits and provide tools to de-anonymize participants within a sharing platform, as aliases, nicknames, or incomplete profiles are not considered trustworthy to engage in community building [4]. Note that while more disclosures are encouraged, owing to the fact that self-descriptive profiles can contribute to making informed decisions [22] and are perceived more trustworthy [51], there may be some negative consequences designers should be aware of, such as "digital" discrimination based on the aspects of appearance, e.g., race, gender [18].

During our analysis, we have encountered a difference between the triggers to share in physical and digital sharing. When sharing physical artifacts the number of shares that happen by request from the audience is much more represented than whilst sharing digital artifacts [9,41,64]. The difference may be explained by the motivations to share. While digital sharing is driven by self-expression and self-representation, in physical sharing motivations are largely instrumental and driven by inquires to borrow an object or provide a service based on the demand of the audience. Designers of future physical sharing platforms may proactively explore the needs of the audience to leverage these behaviors.

Note that the pro-social rhetoric of sharing (e.g., openness, trust, commonality and understanding between people) [37] are rarely placed at the center of attention in popular profit-driven sharing economy services. Nevertheless, we envision that the wider adoption of platform cooperatives [71], with their commitments to cultural and community values over economic gain, can empower service designers to develop and evaluate sharing triggers that follow from social interactions. Ultimately, in our data we found no instances of sharing 'determined by the system' in physical sharing. However, examples of such practices exist (e.g. Airbnb's 'instant booking' feature, which allows guests who meet predefined requirements to automatically book a space without an additional host's approval). Sharing economy services could take a step further in this direction and enable to, e.g., instantly share a WiFi password, provide an access code for a building, or even open a door or locker using some IoT-based technology (e.g. Slock.it) after a user confirms a reservation. Designers of physical sharing services could explore the opportunities to include automatic sharing capabilities, based on user needs and available infrastructure. For example, community owned lending librar-

ies of things (e.g., thethingery.com) may benefit from the computerized pick-up/drop-off stations (similarly to the self-service parcel lockers used by a number of European postal services) for their members to facilitate exchanges of tools and equipment, and to assist in emergency preparedness in neighborhoods.

LIMITATIONS

The results presented here, although organized and descriptive, are rather indicative and must be interpreted with caution. While we illustrate the results of the content analysis in the form of descriptive statistics, the method that we used is based on a qualitative account of a limited number of papers. In order to minimize this limitation, we have: (1) considered our results in the light of a recent survey of the sharing economy in computing [17], and (2) additionally conducted 16 semi-structured interviews with design practitioners and sharing economy experts to complement and develop our summaries and conclusions. Naturally, another set of implications can be developed by conducting a purely qualitative study and looking only into a single sharing domain i.e. sharing economy practices. Despite that our mixed method approach yielded not only a mapping between two sharing spheres, but also nuanced understanding of communicative logic of sharing within physical sharing context.

CONCLUSIONS AND FUTURE WORK

Based on an extensive literature review, we presented five main themes that characterize technology-mediated sharing practices: (1) the diversity of shared content; (2) audience management; (3) motivations to share; (4) privacy and trust issues; and (5) user experience requirements. Using these dimensions, we described commonalities and differences within digital and physical sharing practices within eight broad sharing domains. We also offered a mapping of the design space for researchers who are interested in examining this space further. Finally, we provided a set of design implications for devising future sharing economy services.

In future work, drawing on our empirically-extracted sharing dimensions, we plan to develop actionable recommendations for designers of sharing economy services. We also plan to conduct participatory workshops with designers and sharing economy experts to field test those recommendations with the goal to improve existing services and platforms, and to devise the new ones. Ultimately, future research could further examine the fuzzy boundaries between technology-mediated digital and physical sharing based on the works around materiality, and potentially contrast them against purely non-digital offline sharing practices.

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