

Reasons, Rewards, Regrets: Privacy Considerations in Location Sharing as an Interactive Practice

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ABSTRACT

Rapid growth in the usage of location-aware mobile phones has enabled mainstream adoption of location-sharing services (LSS). Integration with social-networking services (SNS) has further accelerated this trend. To uncover how these developments have shaped the evolution of LSS usage, we conducted an online study ($N = 362$) aimed at understanding the preferences and practices of LSS users in the US. We found that the main motivations for location sharing were to connect and coordinate with one's social and professional circles, to project an interesting image of oneself, and to receive rewards offered for 'checking in.' Respondents overwhelmingly preferred sharing location only upon explicit action. More than a quarter of the respondents recalled at least one instance of regret over revealing their location. Our findings suggest that privacy considerations in LSS are affected due to integration within SNS platforms and by transformation of location sharing into an interactive practice that is no longer limited only to finding people based on their whereabouts. We offer design suggestions, such as delayed disclosure and conflict detection, to enhance privacy-management capabilities of LSS.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous

General Terms

Design, Human Factors, Security

Keywords

Location sharing services, privacy, check in

1. INTRODUCTION

Socially-networked location-sharing applications have seen explosive growth in recent years. Until recently, however, such systems were limited in scope and purpose. Early

systems focused on enabling collaborators to locate each other (e.g., [25, 36]). Such systems typically required organizations to install their own location-mapping infrastructure, either developed in-house by the organization or purchased from companies such as Ubisense, which offers a 3D localization infrastructure. To scale globally without such custom infrastructure, services such as Dodgeball¹ allowed users to send their current locations as text messages to the service, which then alerted friends if they opportunistically happened to be near each other. Eventually WiFi and GPS-based localization built into smartphones led to the development of various stand-alone location-sharing services (LSS) such as Foursquare (<https://www.foursquare.com>), Gowalla (<http://gowalla.com/>), and Google Latitude (<http://latitude.google.com/>).

The recent widespread adoption of smartphones and social networking has led to an integration of LSS into social-networking services (SNS); just in the past two years major SNS, such as Facebook [11], Google [21], and Twitter [27], have incorporated location sharing into their platforms and smartphone apps, thus dramatically altering the LSS landscape. LSS now operate in various modes: (i) an 'always on' mode in which location is monitored and broadcast continually with no explicit user action, (ii) a 'check in' mode in which the user shares his or her location with an explicit action (e.g., by pushing a 'check in here' button), or (iii) some combination of the preceding two modes.

Much of the existing research on location sharing was conducted prior to the advent of smartphones and social networking sites. For example, one of the influential studies of location sharing [8] was conducted in 2005, before many of these services were in existence. Some studies examining the latest generation of LSS have indeed begun to emerge, although many of these focused solely on stand-alone LSS [16, 18, 23, 28, 33]. Moreover, these studies typically utilized small samples of tech-savvy early adopters and/or students. For instance, Tang et al. [31] studied issues related to our interest but included only 10 participants. Their study also predates the integration of LSS within SNS.

Given these recent transformations in the landscape of LSS, our goal is to examine the motivations and habits of today's LSS users. In particular, we seek to understand: (i) what motivates people to share their location, (ii) what modes of location sharing they prefer and why, (iii) how economic incentives, such as offers and rewards, influence

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¹Dodgeball was acquired by Google and reintroduced as Google Latitude: <http://www.google.com/latitude>.

their location-sharing behaviors, and (iv) whether and why they experience regret over sharing location. We believe that a deeper understanding of these issues can highlight salient privacy considerations and also inform better design of LSS in general.

Our Contributions. We conducted an online study ($N = 362$) that aimed to study contemporary LSS usage with a larger and more diverse population than in previous studies. More specifically, we investigated why people chose to share their location via LSS and which sharing features and modes they preferred. Further, given the well-documented concerns with user privacy in the context of location sharing [4, 7] and the regrettable experiences caused by disclosures in SNS [35], we sought to explore design opportunities for enhancing LSS privacy-sensitivity by examining privacy-impacting situations in LSS usage. The scenarios explored included social and professional interactions as well as situations involving external motivators like consumer offers and game-based rewards. In this paper we build on our preliminary insights [26] by significantly expanding our findings and discussion through additional statistical analyses of our data and detailed coding of open-ended responses. In particular, we coded the motivations for LSS usage, the external rewards that influenced many to share location, and the regrets that several individuals expressed regarding some instances of location sharing.

We include a detailed discussion of how our findings can inform privacy considerations in LSS. Further, we explore the implications of our findings by offering possible design suggestions for making LSS more sensitive to privacy issues faced by users. For example, if a user utilizes an LSS to share experiences or recommendations of places — as opposed to broadcasting his or her *current* location to their social contacts — these location updates could be delayed to provide better privacy. Depending on how people respond to rewards, privacy mechanisms could try to warn users of cost/benefit tradeoffs for revealing location for the sake of a coupon. Similarly, knowing how and why people regret sharing their location could yield better privacy controls to avoid such situations.

Paper Outline. In the next section we provide an overview of related work and describe how our study builds upon, adds to, and extends the literature on LSS privacy. We then provide details of our method in Section 3 and present our findings in Section 4. In Section 5 we discuss the relevance of our findings and analyses for privacy management in LSS. In Section 6 we offer a few design suggestions for enhancing LSS privacy management. We point out limitations of the work in Section 7 and conclude in Section 8.

2. RELATED WORK

The research described in this paper is related to three areas of prior work: user privacy consideration in LSS, impression management, and economic considerations in information sharing. We now survey prominent results in each of these areas and highlight key relations to the research described in this paper.

Privacy Considerations in LSS. Want et al. [36] described one of the first LSS, the Active Badge system, de-

signed to facilitate coordination and collaboration in an office environment. Many LSS — commercial as well as academic — evolved from these roots and spawned a great deal of research regarding privacy of location information. For instance, Anthony et al. [3] and Consolvo et al. [8] identified that people considered various contextual factors when managing access to their location by others. These included where they were, who wanted to access their location and why, and what level of detail and granularity will be included in the location information. Through a large survey of 587 respondents, Tsai et al. [34] explored the perceived benefits and risks of location sharing. Respondents noted that LSS were beneficial for ensuring the safety of friends, coworkers, and children, coordinating activities/meetings, finding people with similar interests, etc. However, they also pointed out several potential harms: being bothered by advertisements, exposing one’s home address, being stalked, being tracked by the government or bosses, etc. However, unlike our study, Tsai et al. did not require that study participants be LSS users. In contrast, our study was comprised of LSS users who described their *actual* preferences and experiences with LSS usage.

Researchers have incorporated some of these insights to build LSS with improved privacy management features. For example, the Peoplefinder [28] LSS allowed users to control who could see their location disclosures. Luccacino [33] added more granularity to recipient-based access controls by allowing specification of when and where accesses were permissible. Benisch et al. [4] found that LSS users were more comfortable with such time- and location-based access rules than with simple whitelists. Based on our findings, we offer additional design suggestions for further enhancements to LSS privacy management.

Impression Management. Privacy concerns in systems for interpersonal interaction have been shown to be connected to the desire for impression management (also known as self-disclosure), i.e., trying to convey an appropriate impression of oneself to others [17]. Goffman [12] described impression management using the metaphor of theater production; the social actor picks props and costumes appropriate to a specific audience. In LSS these costumes take the form of locations shared by a user, which are typically chosen with a specific audience in mind.

Nissenbaum [22] posited that two types of norms govern potentially private information: norms of *appropriateness* and norms of *information flow*. She proposed that together these two norms form the concept of *contextual integrity*. Contextual integrity is violated when information is shared beyond the expected norms, leading to a sense of compromised privacy. Failed attempts at impression management can thus be seen as violations of contextual integrity. For example, Wang et al. [35] found that many regretted posts on Facebook arose because a message meant for a subset of the user’s social circle was disclosed to a larger set and/or to a different subset, creating a mismatch between expected and actual audiences.

To examine impression management in LSS, Tang et al. [31] conducted a study that included 10 participants. They found that LSS users shared locations across multiple social groups with strong as well as weak ties. They classified sharing locations purely for impression management as “social-driven” location sharing (as opposed to the more

traditional conception of “purpose-driven” location sharing, in which location disclosure serves an immediate, tangible need). They also mentioned how attempts at impression management sometimes backfired when contextual integrity was violated due to differences in norms among different types of ties. Our study further expands upon impression management uses of LSS and includes a much larger and diverse sample of LSS users.

Economic Incentives to Share Information. Businesses are increasingly offering discounts and goods if a consumer uses LSS to ‘check in’ at their business location. As a result, it is likely that consumers, who may not normally use location sharing, could be nudged into sharing their locations through the use of such offers. Lindqvist et al. [18] noted that some users listed “discounts and special offers” as reasons for using Foursquare LSS.

Various studies have demonstrated that privacy concerns play a role in the value people place on their information when responding to such rewards and offers. For instance, Cvrcek et al. [9] found that people demanded higher compensation for the use of their personal information for commercial purposes than academic purposes. Grossklags and Acquisti [13] found that persons with higher privacy concerns demanded more money to disclose personal information. Huberman et al. [15] uncovered that the valuation of a piece of private information was inversely related to how much a person believed it deviated from what is considered “normal” (as determined by prevailing social norms). People placed higher valuation on personal information perceived to be different from what could be expected for most others.

These results suggest not only that people are likely to differ in the value they place on location information but also that the valuation may depend on social perceptions regarding the location and the purposes for which the location information is used. It is also conceivable that the changing landscape of LSS described above may alter — positively or negatively — the amount of information available for making informed privacy choices. As Bonneau and Preibusch [6] suggest, a service provider can achieve increased effectiveness by differentiating between user groups with different levels of privacy concerns. Therefore, a better understanding of the link between privacy and rewards in LSS could help shape the design of offers and advertising that can be effective for businesses, yet sensitive toward privacy concerns of LSS users. Toward this end we analyze the types of rewards and their influence on location sharing within the larger context of LSS practices.

Significance of this paper. Most past studies of LSS, including the ones described above, exhibit one or more of the following shortcomings: (i) the study reports on a system that is now outdated due to advances in technology and infrastructure and evolution in user adoption, (ii) the study is limited to a specific LSS (typically with a single mode of location sharing), (iii) sample sizes are small, and (iv) tech-savvy early adopters, undergraduate students, and/or young adults are oversampled. In contrast, we studied a large sample of LSS users drawn from the general population. The sample also covered a wide age range and included users of one or more of a variety of different LSS. In the section that follows we describe our method along with details of participant recruitment and data analysis. Our findings show that

many privacy insights from past work extend to a diverse sample of the general population. Additionally, our results suggest that SNS and smartphones have transformed location sharing into an interactive practice that serves a wide range of purposes. We discuss how this transformation exacerbates several privacy issues regarding location privacy.

3. METHOD

We used an online questionnaire to investigate the motivations, preferences, and practices of LSS users. In particular, we asked LSS users about reasons for using LSS, the features of LSS used, and experiences and comfort with these features. To explore the impact of individual privacy attitudes, we included the short form of the Internet Users’ Information Privacy Concerns (IUIPC) scale [19]. Our questionnaire is included in Appendix B. Note that the description of the research focus as well as the questionnaire itself were worded generally without explicit mention of the term “privacy.” This ensured that respondents were not primed regarding privacy. Further, this allowed respondents to *maintain their own mental models of privacy throughout the survey*, which enabled richer insight into their privacy considerations during LSS usage.

In a similar vein, the concept of location is also nuanced and malleable. It can be described spatially to be as specific as a geotagged point or as vague as to include an entire country or continent. Moreover, as Harrison and Dourish [14] pointed out: “We are *located* in ‘space,’ but we *act* in ‘place.’” They describe a place as “*a space which is invested with understandings of behavioural appropriateness, cultural expectations, and so forth.*” As a result, how a person describes the *same* location can vary depending on contextual and socio-cultural factors, such as the recipient(s) of the information and the purpose(s) for which the information is used [8]. Therefore, we framed the questionnaire to capture the diversity of ways in which “location” is conceived of and disclosed via LSS. Moreover, the questionnaire was not focused on a specific LSS or a specific technique for describing location, but rather on how location sharing is *experienced* by users. Therefore, we were also able to examine the relationship between location-sharing preferences and practices and the features offered by various LSS.

Recruitment and Validation. We sought participation via an announcement in the “Et cetera jobs” category of the online classifieds site Craigslist. Respondents were entered into a drawing for one of ten rewards of \$25. For breadth, we posted to the Craigslist sites for 10 cities covering a wide geographical area of the US: Atlanta, Boston, Chicago, Denver, Los Angeles, Miami, New York, Seattle, San Francisco, and Washington D.C. We screened potential respondents in order to limit participation to adults (persons 18 years and older) who reported having used LSS. To minimize impact of cultural factors, we also ensured that respondents had lived in the US for at least 5 years. We further chose to limit participation of those in the 18–22 age group (i.e., the typical age range of undergraduates) to no more than 35%² of the sample. This approach allowed us to capture responses from a broader spectrum of the population, unlike prior work that typically drew participation from student populations.

²We set the proportion such that this group will be no more than roughly 1/3rd of the sample.

The questionnaire used to screen respondents is included in Appendix A. This questionnaire was presented before revealing that our study was about LSS and was carefully worded to avoid disclosing our selection criteria. Yet, it is conceivable that some individuals could have inferred the criteria merely from the set of questions asked. We used two measures to minimize the likelihood of such false positives in the screening process: (i) we set a browser cookie to disallow multiple submissions from the same respondent, and (ii) we included questions regarding the specifics of LSS usage and practices in the main questionnaire that allowed us to identify those who did not use LSS.

In the main questionnaire we also included eight verification questions to check for attentive participation. The verification questions were interspersed inconspicuously among the other questions. The verification questions required respondents to perform basic mathematical operations (e.g., “Please choose the answer equal to seven minus two.”)³ Before beginning data analysis, we excluded the responses of those who did not answer all eight verification questions correctly. Next, we examined timestamps and excluded 32 submissions that were completed in less than five minutes. Timestamp-based filtering also ensured that we eliminated responses of those who rushed through the study (which likely includes most of those who provided false answers to the screening questionnaire merely for a chance to receive the reward for participation in the study).

Since tech-savvy individuals can circumvent cookie-based validation, we checked for duplicate submissions from the same IP address. A closer look at the three sets of duplicate IP addresses revealed one of these as a likely duplicate submission from the same individual while the other two sets appeared to be completed by different individuals sharing an IP address as part of the same household. The likely duplicate was excluded from consideration. We then checked respondent reporting of the LSS used and the frequency of usage. This check resulted in exclusion of six respondents as LSS non-users because their responses revealed that they never used LSS. Finally, we excluded an outlier for obvious fake reporting of the year of birth as 1900.

Respondents. Overall, we received 362 valid responses from 210 (58%) females and 152 (42%) males. The respondents covered a wide age range spanning 18 to 67 years, with fewer than 10% in the 18–22 range ($N = 30$). However, the sample is skewed toward the lower end of the age range, with a median age of 30 and a mean of 33.33. Nearly 80% of the respondents ($N = 289$) reported being LSS users for more than 8 months. Close to 90% of the respondents ($N = 323$) used a smartphone, and almost all indicated using it for more than an hour each day ($N = 321$) and using it for LSS ($N = 297$). The percentages of smartphone users among male and female respondents were roughly the same (92% vs. 87%, respectively). Almost 94% of the respondents ($N = 339$) had attended at least some college, with 61% ($N = 222$) having completed at least an undergraduate degree. Reported income was also well-distributed with 46% ($N = 167$) of the respondents reporting an annual income between \$20,001 - \$60,000. The rest were roughly equally distributed on either side of this range; 26% ($N = 95$) with an annual

income of \$20,000 or less and 28% ($N = 100$) earning more than \$60,000 per year.

In general, respondents reported high levels of privacy concern as measured by the IUIPC. The IUIPC scores were heavily distributed toward the higher end of the 7-point rating scale for privacy concern (mean: 5.9, median: 5.9, sd: 0.8). We, therefore, categorized respondents with IUIPC scores of 5 or lower as indicating low privacy concerns and those with IUIPC scores of 6 and 7 as expressing high privacy concerns. This resulted in 90 (25%) respondents being classified as those with privacy concerns rated as low and 271 (75%) as those with privacy concerns rated as high.⁴

Coding free-text responses. The questionnaire included a few questions that allowed respondents to provide detailed, open-ended answers. To analyze responses to these questions, we followed the procedure below:

1. The authors independently read through the responses and identified common themes.
2. The common themes were discussed and refined collectively and consolidated into a single list of themes per question with a label and detailed descriptions for each theme. The themes were not mutually exclusive, i.e., a given response could fall under more than one of the themes. The labels and descriptions of each theme are included in Appendix C.
3. These labels and descriptions were then provided to three coders of diverse backgrounds. The coders were native speakers of American English and unaffiliated with the research. Each coder independently coded each open-ended response using the theme labels and corresponding descriptions.
4. The authors compared the results of the independent coding and marked each instance where the coders were not in full agreement.
5. The three coders then collectively discussed each discrepancy until full intercoder agreement was reached. The primary author was present during the discussion to provide clarifications if needed.

Ethical considerations. Our user study was approved by the Indiana University Institutional Review Board (IRB).

4. FINDINGS

In this section we describe notable insights gained from the responses regarding why, when, where, and how people use LSS. The next sections will discuss how these observations are connected to privacy considerations in LSS and offer design suggestions for enhancing LSS support for privacy management.

Types of LSS used. Only about 13% of the respondents ($N = 45$) indicated that they used a dedicated, standalone LSS, such as Foursquare. In contrast, nearly 76% of respondents ($N = 275$) reported using an LSS embedded within a larger SNS, such as Facebook, or a microblogging service, such as

³These questions are excluded from the questionnaire included in Appendix B.

⁴One respondent’s IUIPC score could not be calculated due to a missing response on one of the scale items.

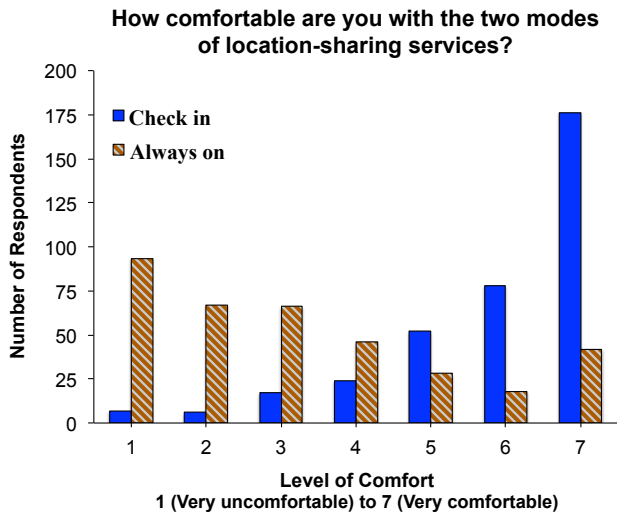


Figure 1: Levels of Comfort with the Two Modes of Location Sharing

Twitter. A further 11% ($N = 41$) used both embedded as well as standalone services almost equally.

Modes of sharing. Respondents exhibited different levels of comfort — on a 1–7 Likert scale — with the two common modes of location sharing: ‘check in’ and ‘always on’ (see Figure 1). While the mean level of comfort with the ‘check in’ mode was high (Mean: 5.9, Median: 6, SD: 1.44, Mode: 7), the opposite was the case for the ‘always on’ mode (Mean: 3.2, Median: 3, SD: 1.99, Mode: 1). A Wilcoxon rank sum test with continuity correction confirmed that this difference was statistically significant ($W = 1307.5$, $Z = -14.8$, $p \sim 0$, $r = 0.55$). At the same time, the two levels of comfort were positively correlated with each other ($r = 0.2$, $p \sim 0$), i.e., those who were highly comfortable with the ‘check in’ mode were also likely to be comparatively more comfortable with the ‘always on’ mode, even though the absolute level of comfort for the ‘always on’ mode was lower than that for the ‘check in’ mode. Further, the levels of comfort with each of the modes showed a statistically significant positive correlation ($r = 0.35$, $p \sim 0$) with the level of comfort for third parties sharing one’s location with others (e.g., by the ‘tagging’ feature of LSS). These correlations suggest that people harbor a baseline level of comfort with LSS in general, regardless of mode.

The level of comfort with the ‘always on’ mode was negatively correlated with privacy concern measured by the IUIPC ($r = -0.18$, $p < 0.001$). Interestingly, a linear regression indicated that parenthood was a tiny but statistically significant predictor of comfort with the ‘always on’ mode (adjusted $R^2 = 0.012$, $F(1, 358) = 5.54$, $p = 0.02$). The level of comfort with the ‘always on’ mode was higher among parents (Mean = 3.57, $N = 110$) compared with those without children (Mean = 3.04, $N = 252$). A Mann-Whitney’s U test also confirmed that the difference in means between parents and non-parents was statistically significant ($U = 15613$, $Z = 2.17$, $p = 0.03$, $r = 0.11$). This relationship is particularly noteworthy because the level of comfort with the ‘always on’ mode does not show a corresponding statistically significant

| Reason for sharing location | N | % |
|---|-----|--------|
| I wanted to tell my friends that I liked the place. | 207 | 57.18% |
| I like to keep my social circle informed of where I am. | 182 | 50.28% |
| I wanted to record and remember that I had visited this place. | 154 | 42.54% |
| I was visiting a different city and wanted local friends to know that I was around. | 152 | 41.99% |
| I wanted to appear cool and interesting by sharing where I was. | 151 | 41.71% |
| I wanted people to join me at the location. | 141 | 38.95% |
| I wanted geographically distant friends/family to feel that they were part of my day-to-day activities. | 128 | 35.36% |
| I was at a political/social/artistic event and wanted to promote it. | 90 | 24.86% |
| I was offered a coupon or some other financial incentive. | 72 | 19.89% |

Table 1: Common Reasons for Sharing Location using LSS (Researcher-provided Categories)

| Motivations for using LSS | N | % |
|--|-----|--------|
| Social interaction with friends | 228 | 64.77% |
| Finding/seeking others nearby in one’s home/work area | 77 | 21.88% |
| Social interaction with family | 59 | 16.76% |
| Recommending a location to others | 38 | 10.80% |
| Journaling one’s experiences for future recollection | 30 | 8.52% |
| Projecting a positive and interesting impression of oneself | 25 | 7.10% |
| Attending/taking part in an event taking place at the location | 24 | 6.82% |
| Visiting an unusual/non-routine location | 20 | 5.68% |
| Coordinating and collaborating with (work/school) colleagues | 17 | 4.83% |
| Sharing location with a provider of a location-based service | 16 | 4.55% |

Table 2: Common Motivations for using LSS (Open-ended Responses, $N = 352$)

association with age. The level of comfort with the ‘check in’ mode did not exhibit any of these associations.

Reasons for using LSS. Respondents indicated a variety of reasons for sharing location. Table 1 provides the number and percentage of respondents who chose each of the several common reasons that we provided (it was possible to select more than one), sorted in descending order. Interestingly, the table indicates that the most important reason for sharing location was interacting and connecting with one’s social circle by sharing a positive experience. Keeping contacts informed of one’s location appeared to be the second most important motive.

For additional insight we consulted the open-ended answers in response to the question: “Please tell us in detail why and how you use location sharing services?” ($N = 352$). Table 2 lists the ten most common themes in these responses from among those that we identified during the coding process described in Section 3. The table also provides the numbers and percentages of responses that the independent coders marked as containing each of the themes. Appendix C.1 provides a complete list of all themes along with coding results.

Tables 1 and 2 show that the the original purpose for which LSS were intended — finding others and/or being found by others in order to facilitate in-person meetings — is reflected in their usage. People mentioned using LSS to facilitate and coordinate face-to-face meetings in professional as well as social contexts:

“I use location services on my smartphone for both business meetings and social outings. It is a critical service to expedite my ability to invite clients/friends to my current location.”

“Co-workers know where I am during work hours and can ask for immediate assistance if I’m in their area.”

“I use location sharing to collaborate with coworkers and colleagues.”

“I usually check in at big events, school, work, or outings if I want my friends and family to be able to join me.”

“Great way to let people know where I am. Makes it easier to meet up with friends.”

“I can meet up with friends around me.”

“Friends can see my location and possibly meet me there.”

Respondents also mentioned LSS usage driven by other immediate benefits:

“Some places offer incentives for checking in, which is a big factor in my doing so.”

“I like to use these services to acquire special deals.”

“I use apps to find nearby establishments.”

“I use location sharing for navigation purposes in getting directions to various destinations.”

“I can look back someday and remember where I was.”

“I share my location to recommend to friends or to review the place.”

However, Tables 1 and 2 also reveal that location disclosures served a variety of other purposes beyond immediate needs:

“[I use LSS] to make others a part of my day when they cannot be physically present.”

“I live about 2000 miles away from my friends and family so it’s fun to be able to show them where I go around here.”

“I have family all over so I like keeping them informed of where I am and my news.”

“[I use LSS] to let out-of-town family know where I am.”

“I like to share with my family and friends where I am if it is something out of the ordinary, say a concert, show, or event.”

“It’s a great topic for conversation.”

“I do it just to incite commentary and participation of friends with whom I may not have spoken in a while.”

“It is a way of starting a conversation with friends. It lets people into my life and I learn new things from their comments.”

“[I use LSS] to let friends and family know where I am and how much I am enjoying myself. I like others to know about my happiness and travel destinations.”

| Type of reward received for sharing location | N | % |
|--|----|--------|
| Food | 49 | 36.30% |
| Discount | 44 | 32.59% |
| Coupon | 31 | 22.96% |
| Drink | 21 | 15.56% |
| Gift certificate | 12 | 8.89% |
| Clothing | 9 | 6.67% |
| Points or virtual objects in games | 9 | 6.67% |
| Raffle, lottery, or contest | 8 | 5.93% |
| Tickets or entry to a place or event | 4 | 2.96% |

Table 3: Common Rewards Received for Sharing Location using LSS (Open-ended Responses, N = 135)

“I share location to look cool and brag about the fancy places where I go.”

“I like using location-sharing services because it helps express my personality online.”

The above comments from respondents suggest that many of these purposes fall under one or both of two higher-level themes: (i) maintaining and strengthening bonds with family and friends and (ii) presenting an interesting impression of one’s identity and personality.

Responding to rewards. As a promotion strategy businesses and advertisers often offer external rewards for the use of LSS. In some cases location-sharing is turned into a rewards-based game or entertainment activity — by businesses and advertisers, LSS providers, or the users themselves. Although rewards rank lower in comparison with connecting and sharing experiences with one’s social circle, Table 1 suggests that they do encourage users to use LSS. About 1/5th of the respondents indicated receiving rewards as one of the main reasons for using LSS. Importantly, nearly 39% (N = 140) of the respondents reported that they had shared location in order to receive rewards.

Among the categories we provided, a discount was the most commonly received reward (N = 88), followed by free goods (N = 65) and free services (N = 25). We also gave respondents the opportunity to provide open-ended details regarding the rewards they received: “What specifically did you receive for sharing your location?” Table 3 shows the most common themes in the coding of these answers (N = 135). In addition, there were isolated mentions of other rewards such as cash, music, video games, magazines, etc. Appendix C.2 provides a full list.

We expected that those who reported higher privacy concerns would be less likely to respond to offers for rewards. This was indeed the case; those who shared location for rewards reported being slightly less concerned about privacy (IUIPC mean score of 5.73 vs. 5.96 on a 7-point Likert scale). A Mann-Whitney’s U test confirmed that the difference is statistically significant (U = 13101, Z = -2.45, p = 0.01, r = 0.13). More than half (N = 48) of those in the group who rated their privacy concerns to be lower reported responding to offers, while only about 1/3rd (N = 92) of those in the group with higher levels of rated privacy concerns did so. Fisher’s exact test confirmed that the difference is statistically significant (p = 0.002). Yet, 33% of respondents with higher levels of rated privacy concerns represents a rather large percentage of offer takers. This is especially noteworthy because IUIPC measures consumer privacy, which

| Reason for regret over sharing location | N | % |
|---|----|--------|
| Disclosing location to an audience broader than intended | 30 | 30.61% |
| Being caught lying | 21 | 21.43% |
| Dealing with an encounter with an unwanted party | 17 | 17.35% |
| Hurting feelings of others | 9 | 9.18% |
| Dealing with an encounter with an ex | 7 | 7.14% |
| Being stalked | 7 | 7.14% |
| Being judged negatively by others based one's visited location(s) | 7 | 7.14% |
| Leaking secondary information (beyond just the location) | 6 | 6.12% |
| Experiencing romantic repercussions | 4 | 4.08% |

Table 4: Common Reasons for Regrets over Sharing Location using LSS (Open-ended Responses, N = 98)

is precisely the larger context in which rewards are offered. We did not, however, find a statistical relationship between a person’s level of privacy concern and the specific types of rewards he or she responded to.

We also noted that a larger percentage of males responded to rewards: 44% (N = 67) of males reported doing so while the corresponding percentage for females was 35% (N = 73). However, Fisher’s exact test indicated that the difference was not statistically significant. Similarly, we did not find statistically significant gender differences in responding to different types of rewards with one surprising exception; all 9 respondents who mentioned receiving clothing as a reward were male (Fisher’s exact test indicated statistical significance of $p = 0.001$). We examined the responses for details of the clothing-related rewards and confirmed that the stores or items of clothing mentioned were not exclusively male.

Regrets. The use of LSS did sometimes lead to unexpected consequences. More than a quarter (27%) of our respondents (N = 99) had experienced regret over a previous decision to share their location. The gender split among those who had experienced regret was roughly in equal proportion of the overall sample: 27% (N = 57) of the females and 28% (N = 42) of males. On a 1–7 scale, with 7 indicating the deepest regret, the level of regret fell somewhere in the middle (Mean = 4.21, Median: 4, SD: 1.14, Mode: 5). Fisher’s exact test did not find statistically significant differences between those with high vs. low rated privacy concerns in terms of whether they reported experiencing regret. The rated level of privacy concern also did not exhibit a correlation with the level of regretfulness of the experience.

We included an open-ended question that allowed respondents to offer details regarding their biggest regret: “Think of your biggest regret. Why do you regret checking in/sharing your location on that occasion?” Table 4 shows the most common circumstances that led to later regret (N = 99). In addition to the themes in the table, there were isolated mentions of other reasons, such as exposing someone else’s lie and ruining a surprise (see Appendix C.3 for a full list of reasons for regret). Three respondents also mentioned that their moments of regret occurred because location was automatically disclosed via geotagging. While the percentages of females mentioning stalking (12%) and encounters with ex (12%) was higher than those for males (2.44% in each case), the sample size is too small to estimate statistical significance. None of the other themes exhibited notable gender differences.

It is to be expected that wrongful disclosure of any private information causes regret. However, the situations of regrettable disclosure for many types of private information (e.g.,

financial information, passwords, etc.) involve commercial entities and/or unknown third parties, such as spammers, phishers, and hackers. In such cases, the consequences are limited to the individual whose information was disclosed and future damage can often be prevented (via actions like closing accounts, changing passwords, etc.). In the case of unintended location disclosures, however, the consequences often result from *contextual* aspects and lead to *social* repercussions that can affect multiple parties and often linger on in the future. This is reflected in respondent comments like:

“I was out with some friends. I told my other friend, who wanted me to hang out with her, that I wasn’t feeling good (sick in bed) because I did not want to go to the place she was going. I checked into another bar that night forgetting what I had told my friend, who is on Facebook, that I wasn’t going out at all.”

“My boss saw where I was when I told her I was sick and I got fired.”

“It made my girlfriend jealous because I checked into a local restaurant with my female co-worker.”

Similar to regrettable Facebook messages [35], location-sharing regrets often involved disclosure to a broader audience than intended. As one respondent mentioned, *“I realized that this was going out all over the Internet and would be there permanently. Yikes.”* Inclusion of unintended parties could often expose inconsistencies between one’s words and actions:

“I RSVPed no to a birthday party and then checked in somewhere when I said I was somewhere else.”

“My wife saw that I was at the mall buying a gift when I stated I was somewhere else. It ruined the surprise.”

“I was supposed to be putting in more time with someone else rather than going to a bar.”

Notably, the social links maintained in LSS via friendship connections contributed to regrettable disclosures in a variety of ways:

- Disclosure of location to third parties by those with whom location was shared. (*“An ex-boyfriend showed up at the club I was at because a friend of his had access to my Facebook information.”*)
- Disclosure of location resulting in revealing the location or activities of others one is connected to. (*“I checked in at a friend’s party and it started an argument between the person hosting the party and someone who was not invited.”*)
- Disclosure of location as a result of the location-sharing act of other parties one is connected to. (*“I lied to some friend that I was sick because I promised another friend to hang out. Then the friend who was hanging out with me tagged me. My other friend found out and stopped talking to me for a few weeks.”*)

5. DISCUSSION

The findings described in the previous section provide notable insights that impact the privacy of users in LSS. In this section, we highlight several of these themes.

LSS are increasingly embedded in larger interactive systems. The wide age range of our sample suggests that the user base for LSS has moved beyond tech-savvy early adopters. Wider adoption appears to be enabled by two major factors: (i) growth in the number of smartphone owners and (ii) embedding of LSS within larger services like SNS that have become an integral part of everyday interactive practices. Our respondents showed an overwhelming inclination toward using LSS integrated within such larger interactive platforms. In addition to increased convenience and efficiency, an integrated solution also serves to contextualize the location-sharing act by leveraging connections to other interactive practices (such as photo sharing and status updates) on the host platform. This added context can enhance the richness and significance of location information in comparison to decontextualized, standalone LSS.

However, this integration comes with privacy costs. Firstly, sharing location is typically not the primary purpose of the host platform. As a result, location exposure can easily be overlooked and result in accidental disclosure of location. As described in the previous section, several respondents indicated regrets associated with accidental sharing in an integrated LSS (e.g., by automatic geotagging of status updates). Secondly, associating location sharing with the details of one’s personal information and activities maintained by the host platform enables richer and nuanced inferences beyond the solitary piece of location information. This association exacerbates the problem of ‘secondary information leakage’ that was mentioned as one of the reasons for location-sharing regrets (see Table 4). Thirdly, ‘friendship’ connections maintained and exposed by the host platform increase the probability and visibility of violating other people’s privacy due to one’s location-sharing decisions as well as of one’s privacy being violated due to location-sharing actions of other people in one’s social circle. Several examples of such situations were noted in the previous section, for instance, when location sharing by one party exposed another party’s lie, or when being tagged at a location by co-present parties revealed one’s location.

LSS are no longer simply about finding people. The analysis presented in the previous section highlights that conveying a physical location is often not the primary motive for LSS adoption and utilization. Many times, location sharing serves as a means toward achieving a higher-level interactive goal, such as sharing a positive experience at a place or ‘appearing cool.’ In this regard designers could consider offering and enhancing LSS features in a manner that takes into account the larger goals of connecting with people, promoting oneself, and receiving location-relevant benefits. It is also noteworthy that we found almost no gender differences regarding responding to external rewards. Traditional brick-and-mortar marketing efforts are increasingly geared toward females [32]. Our findings suggest that location-based incentives could also engage males equally, if not more. This opens up further opportunities for LSS providers to enhance their effectiveness as a location-relevant bridge between users and advertisers. Efforts to capitalize on these opportunities must however be balanced with the privacy concerns of targeted advertising [30], e.g., uncertainty over the entity or entities collecting and storing location information, the extent to which this information can be correlated with other personal information, etc.

Mode of disclosure matters. We found that LSS users were less inclined to favor modes in which location is recorded and shared constantly without explicit user action sanctioning each disclosure. At the same time, the results showed that there may be certain subgroups (e.g., parents) for whom such modes might be preferable and appealing. It may also be the case that such an ‘always on’ mode of location sharing is desirable in certain situations (e.g., while driving). This suggests that LSS modes need to be designed carefully to accommodate these special needs. When switching between these modes, proper care must be taken in order to avoid inappropriate and/or unexpected location sharing, which was the leading cause of location-sharing regret expressed by our respondents.

Privacy considerations in LSS are tied to undesired social consequences. More than 1 in 4 respondents reported experiencing regret over having shared location at one time or another. Our results show that a majority of these regrets stem not from the *act* of sharing location, but from a misalignment in the *audience*, i.e., the audience to which the location was available was not well-matched with the audience for which the information was intended. This misalignment leaked information across contexts [20] and relationship boundaries [24]. Moreover, the level of sensitivity of the information being shared and of the location attached to that information may differ across different audiences. For instance, certain locations were appropriate for sharing only with close friends, while others only with coworkers. However, the integration of LSS within SNS led to “context collapse” [20] flattening multiple audiences and resulting in regrettable disclosures.

As described in the previous section, respondents indicated facing undesired social consequences as a result of unintended location disclosure. Therefore, it seems crucial to explore effective ways to define and manage access based on audiences, locations, and specific times and situations. This is of particular importance for ‘always on’ modes of location disclosure in which sharing becomes a background action as opposed to the primary task. The ‘temporary location sharing’ feature offered by LSS providers like Glympse (<http://glympse.com>) is an example of such a mechanism, but touches on only a small portion of the design space.

Alluring rewards could erode privacy. We found that a sizable fraction (39%) of respondents shared their location to obtain rewards offered by businesses. We believe that such economic motivators expose LSS users to additional privacy risks. In practice, people (including those who report being privacy-sensitive) have been shown to place a relatively low value on sensitive information, both within and outside of the LSS context, (e.g., [9, 10, 13]). Acquisti and Grossklags [1, 2] discuss various factors to explain this dichotomy: (i) people often have limited information about privacy risks, (ii) people are often not able to calculate privacy costs, which undermines ‘rational’ decision making, and (iii) people typically apply ‘hyperbolic discounting’ to short-term rewards (i.e., people overestimate the benefits of an immediate reward and/or underestimate the risks of longer-term harm).

Economic motivators, such as rewards and offers, may therefore lead to unintended location disclosure unless users are made more aware of the short- and long-term risks as-

sociated with sharing location in response to such rewards. For example, such awareness mechanisms might quantify the value and risks of the location disclosure to enable users to judge whether the reward is worth the computed privacy risk. The risk computation could be based on a combination of social factors along with the privacy policy of the business for handling the disclosed information. Design explorations along this line, such as incorporating the pseudonymous location disclosure technique proposed by Beresford and Stajano [5], could counteract the factors suggested by Acquisti and Grossklags [1] and result in better individual decisions in privacy-sensitive situations.

6. DESIGN SUGGESTIONS

Based on the above findings and discussion, we provide a few suggestions for enhancing privacy-management support in LSS.

Delayed disclosure. Communicating one’s *current* location was often not the main goal reported by our respondents: Table 1 suggests that location sharing was frequently driven more by the desire to build and maintain interpersonal relationships and accrue rewards than by the need to keep social circles informed of up-to-the-minute whereabouts. This usage suggests that it may be possible to mitigate many location-sharing regrets and privacy violations simply by decoupling the time of location broadcast from the time of the decision to share location (e.g., by daily or weekly batching). Such delayed disclosure affords some level of ambiguity and plausible deniability regarding exact details of personal routines and actions and can help avoid situations in which a user is caught out of his or her expected social context. Quarantining ‘check ins’ prior to disclosure further provides an interval within which regrettable disclosures may be canceled prior to broadcast. Moreover, delayed disclosures need not adversely impact the interests of businesses interested in using LSS to advertise through a user’s social network. Businesses will still realize this benefit, although on a delayed time scale.

Special handling of purpose-driven sharing. In cases where location disclosures serve an immediate and specific purpose, specialized handling could provide better privacy depending on the purpose. For example, if a user shares location at a particular art studio in order to recommend it to others, the LSS might only convey the vote without revealing when and how often the user was at that studio. As a result, the purpose behind sharing location (i.e., providing a recommendation) is achieved, yet no raw or fine-grained location information is revealed, thereby reducing privacy risks. To some extent such functionality can be provided through Facebook’s “Like” or Google’s “+1” features. However, LSS could provide additional indicators of recommendation quality based on the user’s expertise and experience on the topic as suggested by the aggregated location history of how often the user visits art districts and events.

Conflict detection. Over 20% of our respondents who experienced location-sharing regrets mentioned that the regret was caused by being caught lying. Given that many people use multiple social platforms — in fact more than 70% of our respondents used not just multiple social platforms but

also multiple LSS — there is availability of rich contextual information that could aid in developing *conflict detection* tools to help avoid such regrets. For example, a user might be cautioned before sharing location if his or her calendar indicates a conflicting event at another location. Such conflict detection tools could also be useful within a single LSS. For instance, it may be possible to build Markov models representing a user’s typical behavior in terms of the likelihood of transition from one (class of) location to another (e.g., as was done by Shokri et al. [29] to quantify location privacy). Given sufficient data, it may also be possible to detect unusual circumstances (e.g., being at a bar during typical work hours) and caution users to consider the possible ramifications of sharing such atypical locations. This approach could minimize many of the undesired social consequences discussed in Section 5. Notably, these strategies do not require LSS participation and can be provided as third-party services or client applications running locally on the user’s computer or mobile phone. Conflict detection and handling must however be designed and implemented in a manner that takes into account the potential burden of configuration and interaction.

7. LIMITATIONS

Our results can be considered to apply mainly to the US population. The study needs to be repeated with samples from other countries for cross-cultural comparisons and insights. Some limitations must be kept in mind when considering the general applicability of these results to the larger US population. Although we strived for breadth and diversity when seeking participants, the sample cannot be considered a representative sample of the broader population of LSS users in the US. In addition to self-selection bias, the sample is also slightly gender-biased toward females and comprises mainly of individuals who are well-educated and comfortable with using technology. It is also important to note that these responses come from LSS users. Studying those who do not currently use LSS can provide additional insights for improving LSS. Moreover, the study is based on self-reporting; further research is needed to verify the extent to which self-reported preferences and behaviors match actual practice. Techniques such as recording actual interactions and data mining usage logs could be useful for these purposes.

8. CONCLUSION

LSS are increasingly gaining a mainstream user base by leveraging capabilities of location-aware mobile phones and weaving themselves as a feature within popular systems for everyday interactions. This shift — to a general user base from tech-savvy early adopters and to a general interactive act from sharing driven by specific purposes (like locating coworkers) — necessitates a re-examination, refinement, and extension of findings generated from studies conducted during LSS infancy. Toward this end we reported on motivations, preferences, and practices of LSS users drawn from a diverse general sample of the population. The study examined why people chose to use LSS, how they responded to external rewards that encourage LSS use, and whether and why they experienced regrets over their disclosure choices. The findings suggest that users favor explicitly-initiated, episodic location disclosure rather than constant and au-

tomated broadcast. Most importantly, the findings reveal that location sharing is no longer simply a matter of finding people based on their whereabouts; it also serves the larger interactive purposes of maintaining interpersonal bonds and projecting an interesting impression of oneself. We described how privacy considerations in LSS, especially those integrated within a larger SNS, are tied to undesired social consequences. External rewards also introduce the element of consumer privacy in the mix. Our results point to design explorations, such as delayed disclosure and conflict detection, that can enhance privacy management support in LSS.

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10. REFERENCES

- [1] A. Acquisti and J. Grossklags. Losses, gains, and hyperbolic discounting: An experimental approach to personal information security attitudes and behavior. In *Workshop on Economics and Information Security (WEIS)*, May 2003.
- [2] A. Acquisti and J. Grossklags. Privacy and rationality in individual decision making. *IEEE Security & Privacy*, 3(1):26–33, 2005.
- [3] D. Anthony, T. Henderson, and D. Kotz. Privacy in location-aware computing environments. *IEEE Pervasive Computing*, 6:64–72, 2007.
- [4] M. Benisch, P. Kelley, N. Sadeh, and L. Cranor. Capturing location-privacy preferences: Quantifying accuracy and user-burden tradeoffs. *Personal and Ubiquitous Computing*, 15(7):679–694, 2011.
- [5] A. Beresford and F. Stajano. Location privacy in pervasive computing. *Pervasive Computing, IEEE*, 2(1):46–55, 2003.
- [6] J. Bonneau and S. Preibusch. The privacy jungle: On the market for data protection in social networks. In *Eighth Workshop on the Economics of Information Security (WEIS)*, June 2009.
- [7] A. Brush, J. Krumm, and J. Scott. Exploring end user preferences for location obfuscation, location-based services, and the value of location. In *Proceedings of the 12th ACM international conference on Ubiquitous computing*, pages 95–104, 2010.
- [8] S. Consolvo, I. Smith, T. Matthews, A. LaMarca, J. Tabert, and P. Powledge. Location disclosure to social relations: Why, when, & what people want to share. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '05)*, pages 81–90, 2005.
- [9] D. Cvrcek, M. Kumpost, V. Matyas, and G. Danezis. A study on the value of location privacy. In *Proceedings of the 5th ACM workshop on Privacy in electronic society*, pages 109–118, 2006.
- [10] G. Danezis, S. Lewis, and R. Anderson. How much is location privacy worth. In *Fourth Workshop on the Economics of Information Security*, 2005.
- [11] Facebook Blog: Who, What, When, and Now...Where. <https://blog.facebook.com/blog.php?post=418175202130>, Aug. 2010.
- [12] E. Goffman. The presentation of self in everyday life. 1959. *Garden City, NY*, 1959.
- [13] J. Grossklags and A. Acquisti. When 25 cents is too much: An experiment on willingness-to-sell and willingness-to-protect personal information. In *Proceedings of Sixth Workshop on the Economics of Information Security (WEIS)*, 2007.
- [14] S. Harrison and P. Dourish. Re-place-ing space: the roles of place and space in collaborative systems. In *Proceedings of the 1996 ACM conference on Computer supported cooperative work, CSCW '96*, pages 67–76, New York, NY, USA, 1996. ACM.
- [15] B. A. Huberman, E. Adar, and L. R. Fine. Valuating privacy. *IEEE Security and Privacy*, 3:22–25, 2005.
- [16] L. Humphreys. Mobile social networks and social practice: A case study of Dodgeball. *Journal of Computer-Mediated Communication*, 13(1):341–360, 2008.
- [17] A. Kobsa, S. Patil, and B. Meyer. Privacy in instant messaging: An impression management model. *Behaviour & Information Technology*, 31(4):355–370, 2012.
- [18] J. Lindqvist, J. Cranshaw, J. Wiese, J. Hong, and J. Zimmerman. I’m the mayor of my house: Examining why people use foursquare - a social-driven location sharing application. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*, pages 2409–2418, 2011.
- [19] N. K. Malhotra, S. S. Kim, and J. Agarwal. Internet Users’ Information Privacy Concerns (IUIPC): The construct, the scale, and a causal model. *Information Systems Research*, 15:336–355, December 2004.
- [20] A. E. Marwick and d. boyd. I tweet honestly, I tweet passionately: Twitter users, context collapse, and the imagined audience. *New Media & Society*, 13(1):114–133, 2011.
- [21] New York Times Gadgetwise Blog: Google+ for Everyone: What You Need to Know . <http://gadgetwise.blogs.nytimes.com/2011/09/20/google-for-everyone-what-you-need-to-know/>, Sept. 2011.
- [22] H. Nissenbaum. Privacy as contextual integrity. *Wash. L. Rev.*, 79:119, 2004.
- [23] X. Page and A. Kobsa. The circles of latitude: Adoption and usage of location tracking in online social networking. In *CSE (4)*, pages 1027–1030, 2009.
- [24] X. Page, A. Kobsa, and B. P. Knijnenburg. Don’t disturb my circles! Boundary preservation is at the center of location-sharing concerns. In *Twenty-Fifth AAAI Conference on Artificial Intelligence*, 2011.

- [25] S. Patil and J. Lai. Who gets to know what when: Configuring privacy permissions in an awareness application. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '05)*, pages 101–110, 2005.
- [26] S. Patil, G. Norcie, A. Kapadia, and A. J. Lee. “Check out where I am!”: Location sharing motivations, preferences, and practices. In *Extended Abstracts of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI EA '12)*, To appear, May 2012.
- [27] PCWorld: Twitter Now Supports Location-Based Tweets. http://www.pcworld.com/article/191467/twitter_now_supports_locationbased_tweets.html, Mar. 2010.
- [28] N. Sadeh, J. Hong, L. Cranor, I. Fette, P. Kelley, M. Prabaker, and J. Rao. Understanding and capturing people’s privacy policies in a mobile social networking application. *Personal and Ubiquitous Computing*, 13(6):401–412, 2009.
- [29] R. Shokri, G. Theodorakopoulos, J.-Y. L. Boudec, and J.-P. Hubaux. Quantifying location privacy. In *Proceedings of the 31st IEEE Symposium on Security and Privacy*, May 2011.
- [30] W. Spangler, K. Hartzel, and M. Gal-Or. Exploring the privacy implications of addressable advertising and viewer profiling. *Communications of the ACM*, 49(5):119–123, 2006.
- [31] K. Tang, J. Lin, J. Hong, D. Siewiorek, and N. Sadeh. Rethinking location sharing: Exploring the implications of social-driven vs. purpose-driven location sharing. In *Proceedings of the 12th ACM international conference on Ubiquitous computing*, pages 85–94, 2010.
- [32] The Economist: Marketing To Women: Recession Hit Companies Target Female Customers. <http://www.economist.com/node/13278440>, Mar. 2009.
- [33] E. Toch, J. Cranshaw, P. Hankes-Drielsma, J. Springfield, P. G. Kelley, L. Cranor, J. Hong, and N. Sadeh. Locaccino: a privacy-centric location sharing application. In *Proceedings of the 12th ACM international conference adjunct papers on Ubiquitous computing*, UbiComp '10, pages 381–382, 2010.
- [34] J. Tsai, P. Kelley, L. Cranor, and N. Sadeh. Location-sharing technologies: Privacy risks and controls. *ISJLP*, 6:119–317, 2010.
- [35] Y. Wang, S. Komanduri, P. Leon, G. Norcie, A. Acquisti, and L. Cranor. “I regretted the minute I pressed share”: A qualitative study of regrets on facebook. In *Symposium on Usable Privacy and Security*, 2011.
- [36] R. Want, A. Hopper, V. Falcão, and J. Gibbons. The active badge location system. *ACM Transactions on Information Systems (TOIS)*, 10(1):91–102, 1992.

APPENDIX

A. SCREENING QUESTIONNAIRE

1. What year were you born in?
2. What country do you currently live in?
3. How many years have you lived in this country?
4. Location sharing services, such as Foursquare and Google Latitude, allow you to let other people see where you are. Services like Facebook or Twitter also allow you to attach locations to status updates. Have you ever shared your location using any such services?
 - (a) Yes
 - (b) No

B. STUDY QUESTIONNAIRE

1. Which of the following social networking sites do you use the most often?
 - (a) Facebook
 - (b) Twitter
 - (c) Google+
 - (d) Other. Please specify:
2. Which of the following social networking sites do you use the most often to share your location?
 - (a) Facebook
 - (b) Twitter
 - (c) Foursquare
 - (d) Google Latitude
 - (e) Loopt
 - (f) Gowalla
 - (g) Google+
 - (h) Other. Please specify:
3. Which of the following services have you ever used to share your location? (*Check all that apply.*)
 - (a) Facebook
 - (b) Twitter
 - (c) Foursquare
 - (d) Google Latitude
 - (e) Loopt
 - (f) Gowalla
 - (g) Google+
4. How long have you been sharing your location on the Internet using location sharing services?
 - (a) About a week
 - (b) A month or so
 - (c) 2 months
 - (d) 4 months
 - (e) 8 months
 - (f) A year
 - (g) Multiple years
5. Which of the following are reasons you shared your location? (Check all that apply.)
 - (a) I wanted to record and remember that I had visited this place.

- (b) I was offered a coupon or some other financial incentive.
- (c) I wanted people to join me at the location.
- (d) I like to keep my social circle informed of where I am.
- (e) I wanted to appear cool and interesting by sharing where I was.
- (f) I wanted geographically distant friends/family to feel that they were part of my day-to-day activities.
- (g) I wanted to tell my friends that I liked the place.
- (h) I was visiting a different city and wanted local friends to know that I was around.
- (i) I was at a political/social/artistic event and wanted to promote it.
- (j) Other. Please specify:
6. Location sharing services fall into two categories:
- 1.) A “check in” system where your location is made available to those whom you have authorized, but only when you explicitly choose to do so. For example, you might “check in” when you go to a restaurant or when you arrive at work.
- 2.) An “always on” system where your location is automatically and constantly made available to those whom you have authorized.
- On a scale from 1 (Extremely uncomfortable) to 7 (Extremely comfortable), how comfortable are you with these two types of location sharing services, regardless of whether you use such services yourself.
- (a) Check in
- (b) Always on
7. Which of the following statements best describes the location sharing service(s) you use?
- (a) I most often use a service dedicated principally to location sharing, e.g., Foursquare.
- (b) I most often use a location sharing feature embedded in a larger service such as Facebook or Twitter.
- (c) I use both types of services roughly equally.
8. Do you use a smart phone (e.g., iPhone, Android, Blackberry, etc.)?
- (a) Yes
- (b) No
9. How often do you use your smartphone (to make calls, use apps, browse the web, etc.)?
(Appears only if respondent said Y to question 8.)
- (a) More than 8 hours a day
- (b) 5–8 hours a day
- (c) 1–4 hours a day
- (d) 2 or 3 days a week
- (e) Less than once per week
10. What kind of smartphone(s) do you use? (Check all that apply.)
(Appears only if respondent said Y to question 8.)
- (a) Android
- (b) iPhone
- (c) Blackberry
- (d) Windows Phone
- (e) Other. Please specify:
11. On average, how often do you tend to check in to locations using location sharing services and/or attach locations to your status updates in social networking or instant messaging?
- (a) Once a week or more
- (b) Once a month or so
- (c) Every 2 months
- (d) Every 4 months
- (e) Every 8 months
- (f) Once per year
- (g) Less than once per year
- (h) Never
12. When you choose to make your location available to others, which devices do you use to do so? (Check all that apply.)
- (a) Phone
- (b) Notebook/laptop computer
- (c) Portable mobile device which does not make phone calls (iPod, iPad, tablet, etc.)
- (d) Desktop computer
- (e) Other. Please specify:
13. Please tell us *in detail* why and how you use location sharing services?
14. Have you ever checked into a location or attached your location to a status update in order to receive a prize, special deal, or other incentive?
- (a) Yes
- (b) No
15. What specifically did you receive for sharing location?
16. What sort of incentive did you receive for sharing your location? (Check all that apply.)
(Appears only if respondent said Y to question 14.)
- (a) A discount
- (b) Free goods (e.g., an appetizer, t-shirt, etc.)
- (c) Free services (e.g., an extra movie ticket, a car wash, etc.)
- (d) Other. Please specify:
17. When is the first time you remember “checking into” a location in exchange for a coupon, prize, food, services, or any other sort of incentive? (It is ok to estimate.)
(Appears only if respondent said Y to question 14.)
- (a) Within the last week
- (b) 1–2 weeks ago
- (c) 3–4 weeks ago
- (d) 1–2 months ago
- (e) 3–4 months ago
- (f) 5–8 months ago
- (g) 8–12 months ago
- (h) More than a year ago
18. Some location sharing services provide features that allow your friends to share your location, for instance, by “tagging” you or by indicating that you are with them at a given location. How comfortable are you with other people tagging you in locations?
- Seven point Likert, ranging from 1 (Very Uncomfortable) to 7 (Very Comfortable)

19. What social networks have you used in the past month? (Check all that apply.)
 - (a) Facebook
 - (b) Twitter
 - (c) Google+
 - (d) Orkut
 - (e) MySpace
 - (f) Other. Please specify:
20. Have you ever shared your location and later regretted it?
 - (a) Yes
 - (b) No
21. You indicated you have regretted sharing your location. Think of your biggest regret. How much did you regret sharing your location on that occasion? (*Appears only if respondent said Y to question 20.*)
 - 7 point scale ranging from 1 (Did not regret at all) to 7 (Regretted Deeply)
22. Why do you regret checking in/sharing your location on that occasion? (Please give as much detail as possible to help us understand the situation.) (*Appears only if respondent said Y to question 20.*)
23. Internet Users' Information Privacy Concerns (IUIPC) scale (short form). Taken from Malhotra et al. [19].
24. Do you have children?
 - (a) Yes
 - (b) No
25. Are you currently in a committed relationship?
 - (a) Yes (b) No
26. What is your current income?
 - (a) Less than \$10,000
 - (b) \$10,001–\$20,000
 - (c) \$20,001–\$40,000
 - (d) \$40,001–\$60,000
 - (e) \$60,000–\$80,000
 - (f) \$80,000–\$100,000
 - (g) More than \$100,000
27. What country were you born in?
28. What is the highest level of education you have completed?
 - (a) Some school, no degree
 - (b) High school graduate
 - (c) Some college, no degree
 - (d) Bachelor's degree
 - (e) Master's degree
 - (f) Professional degree
 - (g) Doctorate
29. What is your gender?
 - (a) Female
 - (b) Male
30. What is your ethnicity? (Check all that apply.)
 - (a) African American (black)
 - (b) Asian (including the Indian subcontinent and the Middle East)

- (c) Caucasian (white)
- (d) Hispanic (latino)
- (e) Prefer not to answer
- (f) Other. Please specify:

C. CODING CATEGORIES

The subsections below list the themes that were identified in the responses to open-ended questions regarding reasons, rewards, and regrets related to location sharing, respectively. After the authors determined these themes, three independent coders categorized each open-ended response according to these themes. Note that themes are not mutually exclusive; a response could be categorized under multiple themes.

C.1 Reason(s) for Using LSS

(N=352)

- **Accepting default settings with location broadcast enabled**
Sharing location because the default setting for the device or the service has location broadcast enabled and is unchanged due to the inconvenience of changing, ignorance regarding how to change, or lack of motivation to make the change. (N = 9 , 2.56%)
- **Interacting with friends**
Using location sharing as part of everyday, routine interactions geared toward building and maintaining bonds with one's friends. (N = 228, 64.77%)
- **Interacting with family**
Using location sharing as part of everyday, routine interactions geared toward building and maintaining bonds with one's family. (N = 59, 16.76%)
- **Coordinating and collaborating with (work/school) colleagues**
Making one's location accessible to colleagues and peers to facilitate coordination and collaboration over work or school matters. (N = 17, 4.83%)
- **Finding/seeking others nearby in one's home/work area**
Trying to find others who are known or expected to be nearby, or to seek or check who is near one's location (in areas around one's normal home or work locality). (N = 77, 21.88%)
- **Findings/seeking others nearby while traveling**
Trying to find others who are known or expected to be nearby or to seek or check who is near one's location (when traveling to places away from one's normal home or work locality). (N = 8, 2.27%)
- **Sharing location with a provider of a location-based service**
Allowing location access to a provider of a location-based service or application (e.g., a nearby restaurant finder) in order to receive information or services relevant to one's current location. (N = 16, 4.55%)
- **Reporting movement while on the move**
Providing periodic or continuous updates of one's location while on the move (e.g., commuting, traveling, being on the way to an activity or location, etc.). (N = 2, 0.57%)

- **Being accountable to others**
Facilitating accountability toward others by sharing one's whereabouts and movements. (N = 3, 0.85%)
- **Visiting an unusual/non-routine location**
Signaling that the visited location is unusual, non-routine, or uncommon. (N = 20, 5.68%)
- **Journaling one's experiences for future recollection**
Recording a visit to the location as an external memory aid for keeping a journal of one's experiences and/or recollecting the visit in the future. (N = 30, 8.52%)
- **Projecting a positive and interesting impression of oneself**
Using the properties of a location to project oneself as an interesting, fun, exciting person. (N = 25, 7.10%)
- **Attending/taking part in an event**
Attending or taking part in a specific event taking place at the location (e.g., concert, conference, exhibition, rally, etc.). (N = 24, 6.82%)
- **Recommending to others**
Putting in a positive (or negative) recommendation about the location for the benefit of others (i.e., potential future visitors). (N = 38, 10.80%)
- **Promoting/advertising**
Being involved in activities geared toward active promotions and advertising for a location. (N = 14, 3.98%)
- **Receiving a reward or compensation**
Receiving any form of reward or compensation, such as discounts, goods, services, cash, etc., in exchange for sharing location. (N = 14, 3.98%)
- **Responding to an offer of a reward**
Responding when coming across an offer that provides some form of a reward for sharing location. (N = 13, 3.96%)
- **Actively seeking rewards for sharing location**
Actively searching for offers that provide some form of a reward for sharing location. (N = 9, 2.56%)
- **Participating in games and entertainment**
Participating in LSS-based games and entertainment, such as geocaching, smart mobs, etc. (N = 14, 3.98%)
- **Automatically adding a geotag to photo(s)**
Automatically (knowingly or unknowingly) adding a geotag when posting photo(s) to the LSS. (N = 14, 3.98%)
- **Automatically adding a geotag to a status message**
Automatically (knowingly or unknowingly) adding a geotag when updating one's LSS status message. (N = 7, 1.99%)
- **Being tagged in a location by someone else**
Having a third party indicate one's presence at a location by using LSS 'tagging' mechanisms. (N = 8, 2.27%)
- **Receiving information on the whereabouts of others**
Using LSS to know about the locations of others. (N = 15, 4.26%)

C.2 Reward(s) Received for Location Sharing

(N = 135)

- **Food**
Any offer related to food, such as food items, discounts on meals, etc. (N = 49, 36.30%)
- **Drink**
Any offer related to alcoholic or non-alcoholic beverages, such as a free beverage, discounts on drinks, etc. (N = 21, 15.56%)
- **Coupon**
A coupon redeemable at a particular store or business. (N = 31, 22.96%)
- **Discount**
Discounted price for goods or services. (N = 44, 32.59%)
- **Gift certificate**
A gift certificate redeemable at a particular store or business. (N = 12, 8.89%)
- **Tickets or entry**
Tickets or entrance to the location or to an event held at the location. (N = 4, 2.96%)
- **Entry in a drawing**
An entry into a drawing of any form, such as a raffle, lottery, contest, etc. (regardless of whether or not the person ultimately won the prize). (N = 8, 5.93%)
- **Clothing**
Any offer related to clothing, such as discounts on clothing, an article of clothing like a hat, t-shirt, etc. (N = 9, 6.67%)
- **Game objects**
Virtual objects, such as points, badges, etc., used in online games. (N = 9, 6.67%)
- **Cash**
Money paid as coins or banknotes. (N = 1, 0.74%)
- **Music**
Music in any form, such as physical media, online download, etc. (N = 1, 0.74%)
- **Videogame**
A video game in any form, such as physical media, online download, etc. (N = 1, 0.74%)
- **Loyalty program points**
Points or rewards that count toward a loyalty program, such as frequent flyer miles, frequent shopper account, etc. (N = 1, 0.74%)
- **Magazine**
A magazine or similar publication. (N = 1, 0.74%)

C.3 Reason(s) for Biggest Regret over Location Disclosure

(N=98)

- **Disclosing location to a broader audience**
Location disclosure was meant for a specific set of people but was available to a broader audience (accessible directly or revealed indirectly via parties with direct access). (N = 30, 30.61%)
- **Being caught lying**
Location disclosure exposed disparities between one's words and actions regarding one's whereabouts and activities. (N = 21, 21.43%)

- **Leaking secondary information (beyond just the location)**

Information beyond just the location was revealed and/or inferred due to contextual factors, such as time, co-presence of others, type of location, etc. (N = 6, 6.12%)

- **Being at an unusual or unconventional location**

Being at a location that could be perceived by others as unconventional or inappropriate (e.g., casino, bar, strip club, etc.). (N = 3, 3.06%)

- **Dealing with an encounter with an unwanted party**

Someone unwanted or undesired showed up at the location because of becoming aware of one's whereabouts revealed via location sharing. (N = 17, 17.35%)

- **Dealing with an encounter with an ex**

An ex showed up at the location because of becoming aware of one's whereabouts via location sharing. (N = 7, 7.14%)

- **Being stalked**

Location information was used for stalking. (N = 7, 7.14%)

- **Being judged negatively**

Location sharing led to being judged negatively by those to whom location was disclosed. (N = 7, 7.14%)

- **Hurting feelings of others**

Location disclosure resulted in hurting feelings of other people (e.g., because of feeling uninvited, lied to, etc.). (N = 9, 9.18%)

- **Experiencing romantic repercussions**

Location disclosure affected past, present, or future romantic relationships. (N = 4, 4.08%)

- **Ruining a surprise**

Revealing location ruined a planned surprise (e.g., party, gift, etc.). (N = 1, 1.02%)

- **Exposing someone's lie**

Location disclosure exposed disparities between the words and actions of a third party. (N = 2, 2.04%)

- **Projecting unwanted associations**

Location disclosure led to being associated with unwanted, undesired, or unfavorable people or places. (N = 2, 2.04%)