University of Twente

Master Thesis

Research Group Human Media Interaction

Picalilly: Sharing Photos through Locative Social Media

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August 6, 2013

UNIVERSITY OF TWENTE.

Summary

In this thesis, we present research on locative media. Locative media systems are systems that use automatic reports of the user's geographical location for goals such as wayfinding, augmented reality, creation and sharing of geo-tagged data. For this research, we focus on the last two of these categories. Many different aspects are discussed, from the design to the evaluation of locative media systems. Two prototypes of a location-based mobile photo sharing application called Picalilly were designed, implemented and evaluated to investigate the influences of locative media on the way people share information with each other.

The design rationales of the two prototypes of Picalilly are explained and choices for functionality and layout are clarified. This way it is shown how Picalilly evolved over time. Then we explain the choices made for the research methods that were used during the evaluation of Picalilly. We preferred a longitudinal field study over lab research, in order to fully capture the user experience and give the users enough time to grasp the possibilities of location-based sharing. Interviews and questionnaires are the main types of methods used for gathering data during the evaluation of Picalilly. The AttrakDiff and UTAUT questionnaires are used to capture data about the user experience, usability and acceptance of Picalilly.

We found that the opinions regarding the usefulness of location-based sharing were divided. It was examined that when users are sharing information with a group of close friends, the location does not add much value to the overall experience. Information about the location of a photo becomes more interesting when context information is lacking. Location-based groups are most useful when available context information about the location or topic of the group is scarce. It can help users filter out relevant content based on time and their location. Furthermore, we have seen that locative media can stimulate the user to explore his surroundings, either through the application or it could motivate him to visit a particular location in the physical world. Participants of the user studies reported that they deemed Picalilly most useful in the context of events, such as festivals and small scale communities. It was observed that users wanted control over their privacy, regarding the locational information they share. Users enjoyed using Picalilly for the exploration aspect and for sharing with their close friends.

Contents

1 Introduction

Nowadays people have access to many kinds of information, at any place and any time. This is mainly caused by the advent of the pocket size computers called smart phones, that have become widely available to the mass public over the last few years. A fast data connection allows access to the internet and in combination with a set of sensors, these devices can provide context-aware information to the user. These sensors (e.g. motion, environmental, position) eliminate the need for the user to report the data collected by the sensors manually. Furthermore, significant changes in the environment of the user can be automatically sensed by the device and the user can be notified of these events, if necessary. The critical issue here is that the applications we use and the information we search for are becoming more and more context aware. Especially in a mobile setting the software needs to understand what the user is doing and should provide the right content to the user based on this data.

Probably the most pervasive of these sensors is the GPS sensor, which enables a constant reporting of the device's (and therefore the user's) location. Location-based services have become very popular over the last few years and have been applied in several different contexts, such as wayfinding, personal life (friend finding applications), work (object tracking), entertainment (place-recommendation software), advertising (location-based deals or coupons), gaming, etc. This creates interesting new opportunities for interactions among users.

Locative media has been around for a few years now, but it has not been extensively covered in literature. Especially topics that relate to research of user experience and the effects of every day use of locative media systems seem to be neglected. As described above, the information we search for is becoming more and more location aware. The most popular social media sites that use locative media, such as Foursquare and Instagram are still growing, but how and why are people actually using it? Learning about the use of locative media might tell us something about its impact on society.

These new social media are especially popular among the tech-savvy, younger generations. The effectiveness of these media can be seen by looking at (the aftermath of) the so called *Project-X* parties. In a relatively short duration, thousands of people are invited through social network sites to join a party and invite as many other people as possible. In many cases these parties escalate into riots, simply because the scale of the party is not suited for the location or because the authorities inadequately handle the situation. Locative media can help facilitate congregations on short notice, which might become a concern in the case that was just described.

This thesis focuses on the influences of locative media on creating, consuming and sharing social information. Social signals are defined by Poggi and D'Errico as *a communicative or informative signal that, either directly or indirectly, conveys information about social interactions, social emotions, social attitudes and social relationships.* What makes these signals social is the type of information rather than the act of sharing information between entities. Social interaction is a sequence of actions addressed by multiple entities to each other, while being physically or virtually present [31].

In the context of locative media systems, the information is shared through online social networks, where the geograpical information attached to the message has the function of a social signal (for example, a photo of an interesting landmark shared to friends, in order to motivate them to visit that location). Locative media systems can be used in many different contexts, as described above.

This research focuses specifically on a real time locative photo sharing application called *Picalilly*. By developing and evaluating this application, we try to answer questions such as *how* people use locative media, *what* kind of information is shared and *what* interactions among users stem from the usage of locative media. This might shed a light on the question *why* people use locative media. This leads us to the following research questions:

1. How do users share information using locative media?
   (a) What kind of content do they share?
   (b) How and when do people share this content?
   (c) Why do they share this content?
2. How do users form groups using locative media?
3. What are the effects of locative media on the user?

In order to answer these research questions, a locative photo sharing application called Picalilly is developed and evaluated. Picalilly allows its users to form groups and share photos in real time. As a differentiator, Picalilly introduces the concept of location-locked groups, which means that users can assign a geographical boundary to the group. If a user creates a location-locked group, members of this group can only share photos to it when they are physically within the boundary of the group.

First, a proof of concept prototype was developed by students of a bachelor course. For this thesis, two fully functional prototypes were developed as an Android mobile phone application. After the development phase of each prototype, it was tested during a field trial. The first trial was meant as a pilot study, to get early results about the user experience with regard to location-locked groups and usability of the application itself. A related article about the first user trial was published by Vyas et. al [39]. This article is focused on the potential of the geo-locking feature, which means that users can manually define boundaries for groups they create. Photos can then only be shared from within the boundaries of these kind of groups. The goal of the second user trial was to get a deeper understanding of how people use locative media systems such as Picalilly.

In Section 2 related work on locative media is presented. The history and current state of locative media is discussed, as well as theories about urban society and the role of strangers that help explain locative media. Then, the influences of locative media system on user interactions from previous work are presented. We will discuss design issues regarding locative media systems and the choices we made for the design of Picalilly in Section 3. In Section 4 we explain which research methods were used during

the evaluation of Picalilly. The actual evaluation process and all its related aspects are covered in Section 5. The results of the evaluation of both prototypes is presented in Section 6. These results are further discussed and compared in Section 7. Finally, conclusions about locative media are drawn and our research questions are answered in Section 8.

2 Theory

In this chapter, many different aspects of locative media will be discussed as they are presented in related work. First of all, the developments that have led to the current position of locative media in our everyday lives will be explained. Then it will be shown how our online communication methods have moved from the private sphere into public spaces. Locative media is defined and placed into the context of our everyday lives.

2.1 A history of locative media

The concept of annotating user created data with geographical co-ordinates has existed long before the arrival of GPS enabled devices. Web communities allow their users to manually attach a locational information to photographs or status updates. The novelty of locative media is the ability to automatically report the user's location with the need to do this manually. [15]

Another big change that occurred is the extension of the web to physical locations. More and more the information that we search for on the web is organized by and depending on where we are. In the early days of the internet, there was a clear distinction between the physical world around us and the virtual world wide web. We used to sit in front of a screen in order to connect to the web. This gave many the feeling that in the end, communicating with each other would be done mostly in digital spaces. There would no longer be a need to leave the house for social interactions in public space, as long as the web could make us feel physically present when connecting to other people. Mobile phones contributed to this feeling, as they too can detach us from the physical world and our social interactions. Who hasn't found himself in the situation where the person you are having a conversation with is suddenly looking down at his hand, because a distant other has something more important to say? [15]

The internet is always present, around us and location aware, which allows for new types of interaction with both technology and other people. This changed the way we use to think about the web: today 'being connected' means that you are connected always and everywhere through your personal mobile phone and other systems surrounding us, instead of browsing the web in front of a monitor. As Gordon and de Souza e Silva describe it, *references to physical space on the web are no longer metaphors for digital information; physical space has become the context for that information.* [15]

Crawford describes a small wireless device named *Lovegety* in her article [9] that is used for proximity matchmaking. This system is reported as the first commercial location-based social networking application and was only available in Japan, back in 1998. It allows the user to program his favorite activities and the device will start blinking when a Lovegety user with shared interests enters his proximity. Mobile internet has been available in Japan for years now through the so called *i-mode* service. People that have been using social network services through desktop-based applications are now catching up with the access habits of the rest of the world. The advent of high speed mobile networks and the popularity of social networking sites (SNS) enabled the transformation of SNS from the private into the public space.

Several mobile social software applications were developed in the next few years. One example is *Serendipity*, a matchmaking program using Bluetooth technology, was one of the first mobile social software applications [11]. To generalize, Crawford [9] writes that most of these applications pre-sort strangers into groups with shared interests, in order to improve the users' experience of the urban space around them in some way. These systems are designed to facilitate specific types of social encounters in a specific context such as dating or conferences [6], but the more recent location-based systems change the way we perceive the spaces around us by making its social properties visible to the users. This is achieved by making effective use of the contextual information, such as the device's current GPS location that modern mobile devices are able to register.

2.2 State of the art

A more general term for GPS enabled mobile devices is 'locative media', that was coined as a title for an international workshop for researchers and artists in 2003. The goal of the work shop was to explore the social interactions and implications of location-based media [6]. Later on, the term Mobile Spatial Interaction (MSI) was used at a workshop at the CHI 2007, that stands for the emerging opportunities and affordances for social navigation of space that location sensitive and Internet capable devices offer to its users [14]. At this workshop, relevant locative media applications were classified in four categories. Systems that:

1. Facilitate navigation and way finding in geographic places. For example, car navigation systems that help the driver find his route through interactive maps and spoken directions or mobile interfaces that let users find places of interest near to their physical location [5].

2. Augment reality by adding virtual information to real life objects in the physical world. This type of application makes use of the live camera feed and image processing techniques such as object recognition to display relevant information to the user, for example by virtually overlaying interesting sights on the recorded image of a physical map. [28]

3. Allow users to create [5, 12, 19, 34] or...

4. ... provide access to geo-tagged information attached to physical places or objects [3, 32]. These applications enables text, pictures or video to be placed in a specific geographic context by assigning latitude and longitude identifiers to it. Examples include recommendation systems or social network services named above.

The advent of the iPhone 3G in 2008 and other smartphones that would follow helped location aware applications become mainstream. The technology they offer make it easy for users to always be connected and share stories to people in their network, creating a social element to annotation. Among the first Location Based Social Networks (LBSNS) were applications such as *Loopt, Whrrl*, and *Brightkite*. Users could post

location-updates and photos that were displayed in order of proximity rather than reverse chronology, which was usually the case in online blogs and forums. The result of these interactions form a social narrative around a physical location. The main aspects that these applications introduced are automatically displaying the user's location using GPS technology, eliminating the need for self-reported position and displaying this data on a map. Some LBSNs started introducing game-like elements to their interactions, such as giving virtual rewards for checking in at a physical location multiple times. This, combined with the affordances of social networking, is one of the reasons for the enormous popularity of the application *Foursquare* (see figure 1).[1]

(a) Europe (b) The Netherlands (c) Amsterdam

Figure 1: A geographical display of (a subset of) 500 million check-ins created in the last three months of 2012 using the Foursquare application. Note that this figure only contains check-in locations marked by a white spot on the black background.

2.3 Mobile media and urban spaces

Crawford [9] describes that the environment in which mobile social software is developed and put to use often is the urban space, although other places are suitable as well. New media have always shaped and influenced the urban life. Cities provide the environment that is essential for these media to develop. Furthermore, she argues that our everyday activities are so interwoven with electronic interfaces these days that they increasingly influence our experience of time, space, identity, community and sexuality. These technologies enable certain practices through their interface while at the same time making other options impossible (so called *affordances*). For instance, the *Lovegety* system only allowed their users to choose between "man seeking woman" or "woman seeking man". It is argued that *any speculation about creating diverse public urban space in the future will have to take [the affordances of a system] into account.*

Crawford warns us that new mobile media have the tendency to strengthen relations and interactions between people that already know each other, which conflicts with the ideal of a heterogeneous urban space. Matching algorithms to find personal interests and friend-of-a-friend functionality that social software most often make use of are the main contributors to this "social cocooning". Crawford's main point of critique toward mobile

[1] https://foursquare.com/infographics/500million

social software is that these affordances limit social encounters to preselected matches in public space. She also indicates this does not necessarily determines the future of urban life, but the context and spirit in which this technology is used will.

2.4 Strangers and street sociability

The urban environment is interesting for mobile social software, because of the role that strangers play in everyday life. A person does not expect to encounter strangers in private spheres, such as home. This is also what makes mobile SNS different from SNS used in private space. Crawford argues that there is a certain openness of people towards the differences in people that one encounters in a city, which allows for random encounters that provide the opportunity to *transport us out of ourselves and our accustomed way of thinking*. However, some people experience the encounters with strangers as a source of danger and anxiety. The potential for random interpersonal encounters, combined with the unfamiliar spaces where stranger meet and interact, make urban space unique.

Sutko [36] frames the social implications of locative media within known sociological theory by re-purposing three social theories. First of all Erving Goffman's *presentation of the self* is applied to a new presentation of place. Goffman theorized that we make judgments about strangers based upon appearances. There are intended and unintended impressions that form these judgments. This is a theory about unmediated face-to-face communication and is often used to explain how mobile communication disconnects us from physical places. Sutko argues that indirect communication methods do not directly disconnect us. Instead, they can connect us to surrounding spaces and people. There are multiple agents that influence the impression of a place. The owner of the place can explicitly show his intentions through design and advertising. Over time, a recognizable character of the place is developed by the people that visit it. Likewise, locative media can generate familiarity with a place by using information about the users that visit it and vice versa.

Second, there is Georg Simmel's theory of *sociability* in the modern city, about issues of trust, freedom and anonymity in public spaces. People on the street are anonymous, because they are strangers to each other and differ from each other. At the same time, this is also what unites them. Sutko explains that this is also the case for anonymous locative media systems: a group of strangers connected through the same interface. Strangers who are only temporarily collocated experience less fear of the social consequences of their actions. This allows for a more playful social environment, which is termed sociability by Simmel. In relation to Simmel's theory, it is often suggested that mobile phones give us freedom, because they don't bind us to a physical location and the distant other remains anonymous (which makes it easier to discuss private matters in a phone conversation). Sutko explains that mobile interfaces can be used to filter relevant information in situ, which helps to manage interactions with city space.

Finally, Sutko uses Turo-Kimmo Lehtonen and Pasi Mäenpää's theory of *street sociability*. They emphasize the playful nature of social interactions and the excitement of random chance encounters in the street. The presence of strangers in a familiar place may be acceptable, because of the person's prior knowledge of that place. We assume

that others are like us and will behave like we would. Therefore, people are not likely to visit places where they might encounter a more diverse population. The balance between trust and unpredictability creates sociability in urban spaces. Locative media applications focus on interactions between the spatial and the social. By showing groups of people with similar interests, a sense of familiarity with the place and the people visiting it is created.

Overall, Sutko argues that location based social networks create a tension between the anonymity and the intimacy, or the strangeness and familiarity in urban life. Locative media do nothing more than support already established social norms. However, there is a tradeoff in which users of locative media engage more in direct coordination and less in direct communication. This can lead to unexpected and pleasant social experiences.

In this chapter, the influences of locative media on user interactions, spatial awareness and privacy are investigated. Finally, the social acceptance of locative media in society is questioned.

2.5 Influences of locative media on user interaction

Bilandzic and Foth [6] explain that our person-to-person relationships have become more complex by mobile technologies. They allow us to be connected to anyone while not being physically present. Locative media contribute to this phenomenon by mapping our communications and interactions to physical space around us. These locational messages are virtual traces that show a history of interactions and can be used by others to make inferences about a place.

As Gorden and Souza [15] describe, public spaces are inherently social. Location aware mobile applications tend to alter the ways we experience our surroundings. Therefore they can reconfigure the social interactions within them. One of the main influences of locative media on user experience is the changing sense of proximity. Location aware applications let users who are not physically present connect with each other and (more importantly) create a sense of familiarity with other users and the user's surroundings [23]. Locative media influences how users think about their surroundings when creating localized content and how they might use other peoples' messages to form personal relationships.

Opinions diverge on the influence of locative media on personal relationships. Crawford [9] explains that matchmaking algorithms pre-sort users into groups of demographically compatible people, which causes mobile cocoons of similar people. Furthermore, new media tend to connect people who already know each other through friend-of-a-friend suggestions [19, 36].

On the other hand, there are also examples of studies that indicate the ability of locative media to facilitate random encounters with strangers. Locative applications can lead to unexpected and pleasant social and spatial experiences by facilitating coordination in urban spaces. Especially anonymous interfaces afford personal chance encounters with strangers [36]. Locative media games encourage players to explore their surroundings and meet other players [25, 24]. Humphreys concludes that mobile social networks do not change who is interacting with whom in public space. They rather *encourage a par-*

ticipation of the public realm by relying on and simultaneously showcasing the aesthetic pleasures of the public realm including public sociality, unexpectedness and crowding. [19]

O'Hara [29] explains that the results of a study into geocaching is interesting for the field of locative media, because it is an ongoing everyday practice that exists for years now. This allows the researcher to highlight social motivations and behaviours related to it. For many people, geocaching provides a social occasion, to walk with friends or family. It motivates people to get involved in social activities, while the technology is not a dominant factor during the interactions. O'Hara explains that just looking for explanations of behaviour that was observed in one discreet experience is overly simplistic. It is emphasized that geocaching, like other location-based experiences, is an ongoing activity. Behaviour and motivations related to locative media are built up over time.

A lot of applications have been designed to facilitate particular types of interactions, such as dating (the Lovegety system [9]), conferences [11] or finding a specific place of interest [4]. More recent LBSNs such as Foursquare and Dodgeball [19] do not have those explicit goals, but make social properties of physical space visible. By changing the perception of public space our social interactions and practices are also affected.

Community driven services can empower people in urban settings to harness the collective intelligence and discuss local community issues. This allows for the urban public to engage in questions of city planning and design [34].

2.6 Spatial awareness and perception of place

Humphreys describes in his paper [19] how Dodgeball caused *parochialization*. This means that people share social and locational information in public space in order to have a sense of commonality with each other. For instance, groups of friends could coordinate congregations by broadcasting location information among the group. Humpreys argues that *redirection* is an important aspect in this process. Redirection can be defined as the ability of people to act on the information to receive and possibly change their planned route as they go. Timing, distance and traveling time are important factors that influence redirection. The information shared through Dodgeball was in some cases also used to avoid congregation, which highlights the complexity of social interactions and spatial practice in everyday life.

Sutko [36] explains that the *CitySense* application shows hotspots of user activity on a map. If a user sees his favourite bar is crowded with people, he might infer that there might be people he might like to meet. The presentation of place performs coordinative functions for the user. This means that the user can make decisions and judgments about people in a particular place, based on previous experiences with this place. The opposite is known as *crowd sourcing*: recommendations by (un)known people about a place can help the user make his decisions about it.

Rost [32] describes that our perception of place is not just dependant on geographical coordinates alone. A place is transformed into something meaningful and identifiable by interactions and activities. Previous local knowledge about a place might influence how localized content is appreciated. If users are familiar with the location, they look

for recognizable sights, while users unfamiliar with the location use the application in a more exploratory fashion.

2.7 Locative media and privacy

Höflich [18] describes that the boundaries of what is public and private are constantly shifting and media contribute significantly to this, as their influence on our everyday communication becomes larger and larger. These boundaries are not static and depend on historical and cultural differences. Socio-economic factors also play an important role in the explanation of behavioural patterns observed in different cultures. Höflich explains this shift is more readily accepted these days. Various media previously based in the home environment can now easily be experienced in public spaces. The mobile phone is a special case, because this device causes both public and private domains to merge.

The mobile phone network consists of people who already know each other, which makes it a rather private medium. Whether this also holds true for locative media remains the question. As described in section 2.3, matchmaking algorithms implemented in these new social media can cause social cocooning. On the other hand, systems that promote exploration can also facilitate heterogeneity and random encounters. The next question is whether sharing your whereabouts with random strangers is desirable.

2.7.1 Control over personal privacy

Information about our physical location becomes more and more important in digital (social) networks, which means control and access to this information also require attention. Some applications require personal locational information in order to work, therefore people must be willing to share it. This might lead to a feeling of anxiety if it is unclear who is able to access your information. In other words, this fear is caused by the concerns of *losing control* over one's personal location information. When this information is aggregated, it can be used to predict people's behaviour in the city. This type of data mining could lead to location-specific profiles of an area or exclusion of users based on their location. The fear of losing privacy can either be the fear of top-down surveillance (by governments or companies with commercial interest) or the fear of collateral surveillance (disclosing information to other people).

The shift from private to public can be illustrated by the Google Street View service, that adds street level photographs to Google Maps. Several lawsuits have been filed by people who feel their privacy is violated by publicly displaying their private property. Privacy laws in the United States do not protect against being photographed in public space. Several European countries have stricter privacy laws and insist that faces and license plates are blurred. Then there is still the issue of photographing private property. Google complied in most cases where people asked to take down photos taken in private streets. This shows a certain discomfort of being publicly mapped, which is caused by the sense of losing control over personal information. *Making the world searchable is*

equated to locating and identifying users. Making everything findable presupposes that everyone wants to be found. [15]

2.7.2 Privacy and location based services

Most of the location based services (LBS) for finding localized information (such as tourist information applications, Google Maps, *WikiMe* (a mobile phone application showing local Wikipedia articles)) do not publish a user's location and users must allow the service provider to pinpoint their location in order to provide the service. However, most users don't know that this information is sometimes shared with commercial partners. Location based *social networks* (e.g. *Foursquare, Google Latitude, Loopt*) do often share the user's position in order to facilitate meetings and other social behaviour.

These location based services are often monetized by advertising. Users can access the service for free, but when near a store, for example, they can find coupons for this store to stimulate impulsive purchasing (so called *just-in-time* model for advertising). The users are willing to put up with this as long as they see the value of using the service. The problem is that the privacy policy is often unclear about which companies receive their location information or what happens with it. Designers usually allow users to control their privacy settings. Users can *opt-in* by downloading the location aware application and explicitly allowing personal location information to be used. Sometimes, the user can *adjust the accuracy* of the information by specifying how precise his location can be tracked or by manually submitting the information [33]. Still, for many users it remains difficult to understand what the implications of the privacy settings are or whether they can be controlled at all [15].

Publicly disclosing location based information can become dangerous when this information is used to mount real-world attacks. Users are sometimes not aware of the risks of publishing such information or even *when* they publish it. For example, the newer iPhone models automatically embed locational data inside the meta-tags of all photos and videos taken with the internal camera by default [33]. Furthermore, some LBSs allow users to reference others users in resources (so called *co-located privacy* or *multi-user privacy*), which is generally hard to control [30]. This privacy threat is even increased by the ease of searching for location based information. Combined with the large amount of data and services available, this makes it easy to combine information to mount systematic privacy attacks. For example, geotagged photographs of valuable items posted on Craigslist or real-time published holiday videos on YouTube might be used by burglars to plan break-ins. [33]

2.7.3 Improving locational privacy

Friedland and Choi offer several suggestions to improve locational privacy. First, users should be put into the position to make informed decisions. Second, users should be sufficiently protected by location based services unless they opt-in to potentially risky exposure [13]. Vicente et. al. [33] suggest using the principle of *k-anonymity* to improve locational privacy. This means that a user reported location is altered so it can be asso-

ciated with at least k users, in order to prevent (re-)identification. This can be achieved by query enlargement techniques such as *temporal* and *spatial cloaking*. Spatial cloaking generalizes the location of the message to a region (as described above) and temporal cloaking generalizes the temporal information to, for example, an entire day. Burghardt conducted a user study about user preferences and awareness with regard to privacy [8]. In addition to k-anonymity, other mechanisms to improve privacy are suggested, such as disabling tracking in marked areas and fine grained control for each piece of shared information. Results showed that participants preferred privacy increasing mechanisms that were easy to understand. Mechanisms that required constant personal attention (a switch to turn GPS tracking on or off) failed in practise.

2.8 Social acceptance

A topic that is closely related to privacy concerns expressed above is the social acceptance of locative media. Höflich [18] explains that especially in big cities people need to create a distance from each other, despite the conditions of close proximity. This is a form of civility, meaning that personal matters not intended for others are held back to avoid awkward situations. Proximity and distance are strongly connected to social and communicative rules, for example, to determine whether usage of a medium or face-to-face communication is appropriate in a particular situation.

The issue of stalking was encountered in the locative media game *Mogi* by Licoppe and Inada [26], where a female player felt threatened by an individual player located on the game map that remained anonymous, despite the messages sent by the female. Licoppe and Inada compared it to the feeling of safety when being in a mass of strangers while encountering an individual in an alley can create a sense of danger.

Furthermore, locative media can create a tension with regard to social norms such as greeting an acquaintance on the street. It might be considered rude not doing so, but what if locative applications become the norm? Would it also be rude to not visit a friend if you located him nearby through this application? [36]

2.9 Conclusions

Recent technological developments facilitate a movement of private communications into public space. Locative media use data about the user's physical location to display relevant information to the user. The fact that these applications can automatically report locational information introduces both interesting new interactions and privacy issues. In this research, these influences of locative media on our personal life will be further investigated during the user trials.

3 Design

In this section, the design of locative media systems will be discussed. First, it will be shown how the design of locative media applications is covered in related work. Only relevant topics related to the design of Picalilly are mentioned in this thesis. A complete overview of design issues regarding locative media systems can be found in an earlier literature study [22]. The second part of this section will cover the design of the Picalilly photo sharing application. The choices made during the design process will be related to previous work on locative media systems.

3.1 Design of locative media systems

Several different aspects of designing locative media are discussed in this chapter. It is shown how the choice for a particular technology or interaction method can influence the use of a locative media system. Various examples and properties of these systems are given.

3.1.1 Interaction methods

Many different design choices can be applied to locative media systems, depending on the goal of the application and its intended interaction methods. Several characteristics and their consequences that can play a role when developing and designing locative media systems are explained below [4].

Remote access vs. in situ access This comparison is about the way users access their information. *In situ* access means that the user can only view, produce or share information at the location where a system is situated or where the system allows these interactions. We will look at a few different examples of systems that allow their users to interact only when they are at a particular physical location. Remote access on the other hand entails interactions where the user can access location based information from anywhere at any time. A mixture of these modes of access is also possible. For example, this is the case when the user can only create new information in a particular place, while it can be viewed from any location.

Løvlie describes in his article [27] that locative media projects based on spatial annotation can be distinguished by their spatial range. Projects such as city tours and museum guides usually span a small geographical area, up to a few city blocks. They are typically only accessible through a custom interface or platform and do not allow user input. On the other hand there are projects with open boundaries, potentially encompassing the whole world.

The *Columbus* system, a typical example of in situ access, is a mobile application that lets users explore their physical surroundings by viewing geotagged photographs on a map based interface. The user has to move around to unlock photographs in the vicinity, which according to the authors promotes exploration of the physical world (see Figure 2). Previously explored areas can be viewed at any time [32]. In order to provide

a more complete experience to the users, it is suggested to provide alternative methods of access to user generated content. For example, online communities and forums can allow users to access geotagged content they have produced earlier, even when they are not able to use a GPS enabled device at that moment [25, 28].

Figure 2: The Columbus map interface showing geotagged photographs. The top images shows pictures unlocked at the user's physical position, the bottom images shows areas that were previously explored. [32]

Another example of in situ access are systems that allow the users to interact through large screen displays. Most often users can submit messages to these systems using their own mobile devices, which will then be displayed in a central location where many users convene. Schroeter et al [34] investigated what influenced the sharing behavior of people using a large public display, to which everyone could send text messages through SMS or Twitter. The goal of the system is to get valuable feedback about specific topics or issues of civic and/or local nature (with topics such as "How would you like to see the city grow?"). Eight different case studies were conducted to determine the sweet spot for the application of such a system, which the researchers describe as a place where the system collects user input frequently and content is of high quality (relevant to the discussion).

Behrendt also explains how applications such as The National Mall discriminate in terms of geographical location of the user [3]. In order to fully experience this application, the user has to walk around several parts of a shopping mall in order to hear different

kinds of music. The user has to be at one specific place to experience interactions, others who can not travel to the location are excluded. This illustrates the tension between the promise of mobile media to have access anywhere and at any time and on the other hand the potential of locative media to interact at very specific sites.

Push vs. pull messaging This concept relates to the way the user accesses the information in the system. A user can automatically receive a message when a certain event occurs (*push* notifications). For example, when a message is submitted in which a user mentioned, he may automatically receive a notification, including (a link to) the contents of the message. In a more location aware context, such a notification might happen when a user is in the vicinity of a physical object or place of interest. In a *pull* scenario, the user actively searches for information. In relation to locative media, the user might for instance search for specific locations or limit a search query to results from a particular geographical area. Mixed scenarios with both push and pull interaction can also occur.

Espinoza et al [12] describe that push notifications can be a disturbance rather than helpful, but in public spaces users are often more leisure oriented, where they are more curious about their geographical and social surrounding than in a workplace environment. Still, information pushed onto the user has to be informational or socially relevant to the user and the user should be able to configure how often he receives push notifications.

Locative media offers new possibilities for notifying the user about events occurring in his vicinity. For example, the user can be notified when content has been submitted to a geographically relevant area or when the user physically enters a particular area of interest.

Anonymous vs. eponymous Sutko [36] explains that the majority of location based social networks (LBSNs) can be classified as eponymous or anonymous. The first type allows users to find a specific person in urban places. Users can typically be identified by username and location that are available to either select friends or complete strangers. The latter promotes awareness of the location of unknown masses. Anonymous applications do not identify the user or at most aggregate user activity, for example, as a "heat map" of a city. Sutko relates how LBSNs deal with anonymity to sociological theories about street sociability. This theory emphasizes the playful nature of social interactions and the value of random encounters that urban spaces facilitate. The anonymity allows individuals on the street to create a more playful social environment, because there is less risk for social consequences of their actions.

Citysense is an application that lets users see activity of people in a city represented by hotspots on a map. Sutko argues that users seem to prefer indirect methods of communication when finding their way in a city. Therefore, anonymous interfaces can be important when users try to find locations, instead of other people. This type of coordination can lead to chance encounters.

3.1.2 Representation of user data

A common way for locative media applications to represent geo-tagged user data is by showing the location of geo-tagged content as a point on a map. This allows the user to easily see what is around him, sometimes even relative to his own position if the device is GPS enabled.

Rost et. al. [32] describe that in a pilot study, users of the Columbus system appreciated seeing an overview of pictures in addition to the map interface, instead of viewing one picture at a time (see Figure 2). Secondly, not knowing the actual location of a photograph was sometimes frustrating to the users. This could be related to not knowing the direction in which the picture was taken or the photograph not being tagged correctly or taken from inside a building. Finally, if a picture is located too far from the user's position, the sense of locality is lost, therefore the radius of viewable pictures around the user should be small. Interest in content decreases with distance from the user. Especially in systems that support exploration or provide localized content, the user should be able to deduce the location of the photo, allowing him to experience the photograph in unison with his location. Otherwise the picture will essentially be useless to him. Annotative locative media systems should pay attention to the representation of its information (as what size and shape should a point of interest be shown on a map?): the issue of *granularity*. If the representation is too small it might not be noticed by many users. On the other hand, if the representation is too large, the connection between message and place might lose its meaning [27].

3.1.3 Other properties of locative media

Løvlie proposes a set of principles and challenges for the design of annotative locative media [27]. *Serendipity* means the ability to have unplanned casual encounters that hold some kind of value. In case of locative media, this can be explained as the way a user chooses his own path (more or less randomly), leaving it to the system to establish where he is and what information to present based on his location. As with the locative sound application described above, this encourages the user to explore his surroundings. For such a system to reach its full potential and become truly ubiquitous, it should cover the largest possible area. A high degree of user *participation* is required to allow for serendipitous encounters.

3.2 Design of the Picalilly system

In this section, the design phase of the Picalilly system will be described. Three implementations of the system were developed. A concept version was created by bachelor students for a bachelor course and two fully functional prototypes were developed for this research. The concept version was developed as a web application. For the next version, Picalilly was rewritten from scratch as a native Android application, in order to provide a smoother experience to the user and to make effective use of Android's camera, mapping and GPS functionality.

3.2.1 Picalilly: real time photo sharing

The idea behind Picalilly was to create a photosharing application that allows for automatic geo-tagging and real-time sharing in user created groups. Users can create groups ad hoc for friends and photos can be shared to these groups (similiar to a photo album). A group can either be public or private, where the latter means that users have to be a member of the group in order to view and upload photos. A member of a group can invite other people to become a member. Users can place comments on photos and indicate that they like a photo. The user can see overviews of the photos that are shared in a few different ways. For example, the group overview page shows which groups the user is a member of and preview of the most recently shared photos. Other features of Picalilly will be discussed below, in the specific version in which they were first introduced.

3.2.2 Concept version

Picalilly originated from an assignment that was carried out by a group of bachelor students. For the course *Living and Working Tomorrow* the students had to create a system for a future living and working situation. The students felt the need for a real time photo sharing application that allows large groups of people to share photos in a centralized way. Some of the existing photo applications are real time, but not centralized, meaning that there is no central place (typically an event that is represented by a group) where people can upload their photos. On the other hand, there are applications that allow users to form groups or make photo albums, but these are not real time, in the sense that users have to share a link to the album manually with their friends.

The focus of the application is on sharing photos in the context of festivals, families or other events that co-locatie people based on a shared interest. Users share photos of happenings or points of interest in real time, while at the same time they can view contributions to a group made by others. The application should be very intuitive and easy to use, since the application is used in a mobile setting. Users should be able to get a quick overview of what is going on in a certain group or at a certain place or quickly share a photo, without the hassle of configuring a lot of settings or sharing options.

In the design of Picalilly, the students tried to achieve consistency througout the application, by using the same colours and user interface elements on every screen. A lot of inspiration for the design has been borrowed from existing applications, such as placing the camera icon in the center and protruding a little bit from the menu bar to catch the user's attention. All the core functionality is accessible from the menu bar at the bottom of the screen. This constrains the amount of possible interactions, which keeps the application simple and well-organized.

The final prototype of the concept version included functionality to upload photos to a group together with the GPS coordinate and to view these photos. It was not yet possible for the user to create groups. The presentation of this prototype during a central meeting was the final result of the students' project, no further user tests were conducted. Screenshots of the concept version can be found in Figure 3.

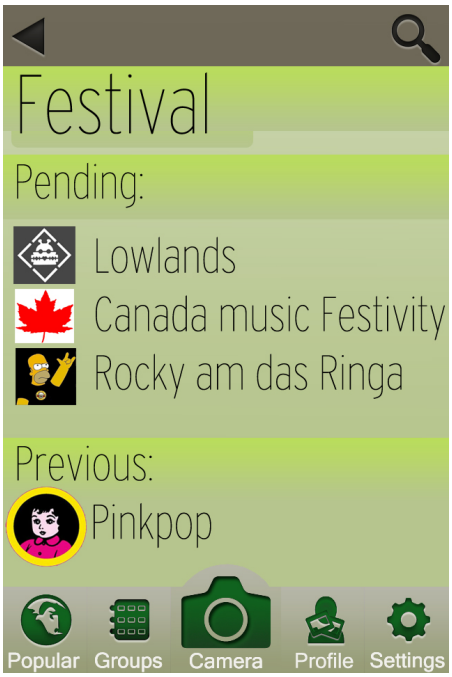
Technical specification The concept version of Picalilly exists of a client-side web application that was developed using PhoneGap, a framework that allows developers to create mobile applications using HTML, CSS and JavaScript. PhoneGap was chosen since there was a lack of knowledge about the Java programming lanaguage, which is required to build native Android applications. Android was chosen as the operating system for Picalilly, since it is open source, it has clear documentation and testing an application can be done independently from the marketplace (contrary to Apple's iOS). The server-side implementation consists of a database to store user data, a file server to store photos and an API to communicate with the client-side (similar to the prototype implementation described below).

3.2.3 First prototype

The first fully functional prototype was created from scratch, with the concept version in mind. The core functionality remained the same as in the concept version. The focus for this prototype is on location based groups. The user should be able to create a group for friends, assign a location to it and choose whether the group is public or private. Other users should be able to view and join these groups. When a photo is viewed in detail, the user should be able to see specific details and leave a comment. The functional specification of Picalilly was established during previous work by Vyas et. al. [39].

This version of Picalilly combines remote and in-situ modes of access, since it only allows users to post photos to a location-locked group when they are physically within the boundaries of this group. On the other hand, users can view photos from anywhere. By assigning a location to a group, the photos posted to location-locked groups can be viewed in a centralized way. We expect that photos in a location-locked group will form a more coherent set than when pictures can be posted to a group from anywhere in the world. By automatically determining the user's location while chosing a group for a photo, Picalilly can suggest relevant groups that are near the user. Picalilly is eponymous, in the sense that everyone that can view particular photo can identify the creator. A group can be made private in order to give users privacy control over who gets to see the information they share. Screenshots of the first prototype of Picalilly can be seen in Figure 4.

Subscriptions The user should also be able to 'subscribe' to a person and/or a location. The resulting subscription will then only show photos as defined by the user, as a personal photo stream. A user can create multiple subscriptions, in order to follow more people and locations at the same time. By selecting both a user and a location, the user will get a photo stream showing photos from the selected user that are taken within the specified region. This could be useful when the user is interested in the area where he lives or when there is an event going on. Without subscriptions, the user would have to join every group in a particular area in order to see all the photos taken within this area. The user can create a subscription to automatically receive all photos taken within this area. The combination of location and person allows the user to filter the person of interest's photos. A possible use case is that a user wants to follow a friend who is going



(a) Recent festivals

(b) Group overview

(c) Personal photos

(d) Uploading a photo

Figure 3: Four screens from the concept version of Picalilly.

on a holiday and is taking pictures there. The user can then easily filter out his friend's holiday photos by assigning a location to the subscription.

Technical specification The Picalilly system can be split up into two parts: the Android client and the server-side API. The client was fully written in the Java programming language using the Android SDK (supporting Android 2.3.3 up to 4.0.3). The Google API Add-On is used to support interactive maps in the application and the Google Static Maps API for serving static map images. Furthermore, Google Cloud messaging provides push notification functionality. Gson is a Java library that can be used to convert Java Objects into their JSON representation and JSON strings into an equivalent Java object. This is used to communicate with the web server through a RESTful JSON API. This API is written in the PHP language. The frontend interface for registering a user account is made using HTML, CSS and the JavaScript library jQuery. User data is stored in a MySQL database on the server.

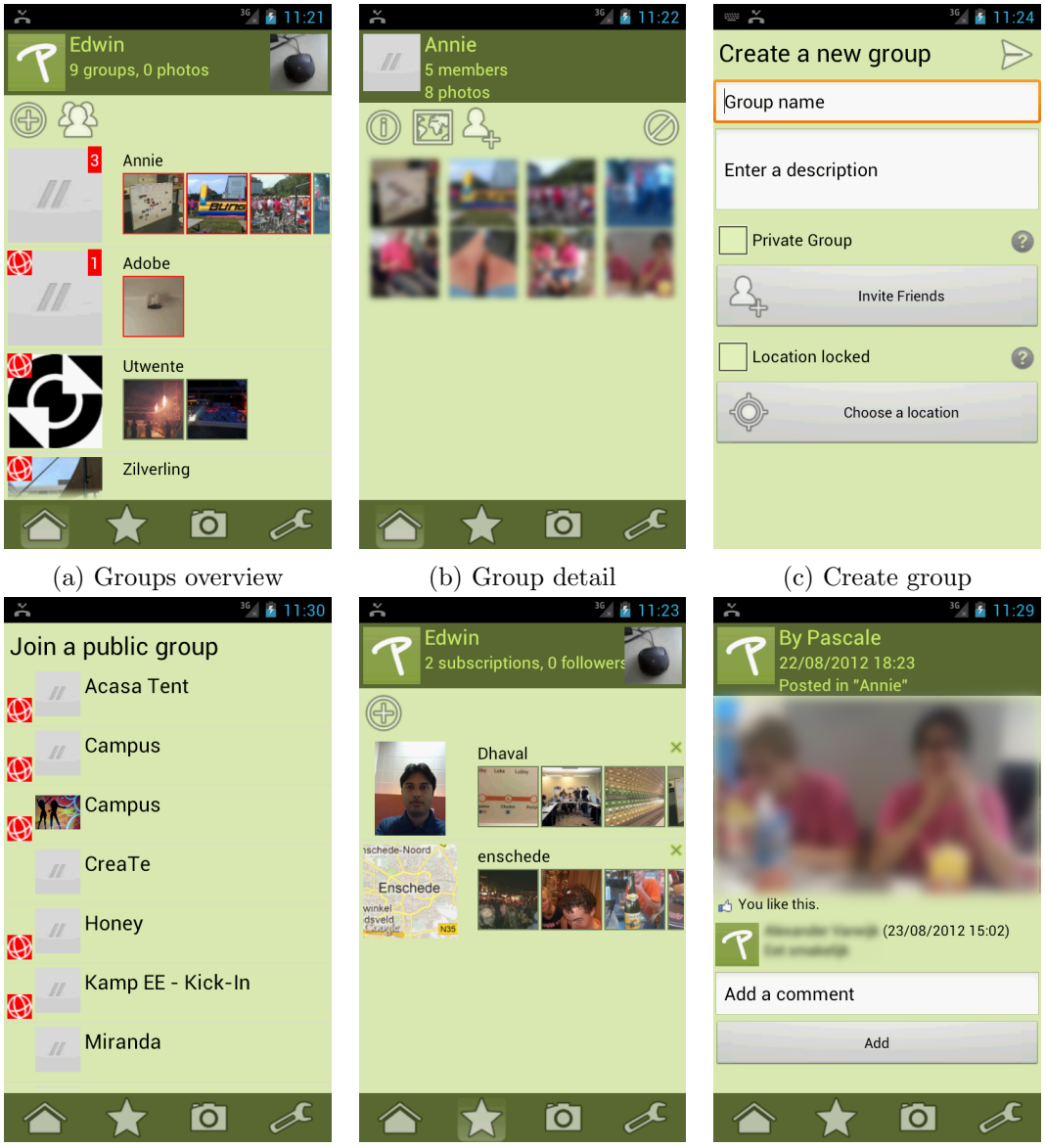
Every uploaded photo is given a unique and randomly generated filename, which makes it harder for malevolent users to guess the filename of a photo. The photos are resized on the server in order to reduce the amount of data being sent to the user. Reducing the size of a photo could mean a loss of detail when the users can only see small versions of it, but this trade-off between photo quality and application response time was deemed acceptable for a mobile photo sharing application.

3.2.4 Second prototype

The results of the first user trial were combined with the findings of a literature study [22] in order to develop the second prototype. A list of requirements for the second prototype was formed based on all the previous results. These results gave the inspiration for new features that should be added to Picalilly. The core functionaliy that is required for Picalilly includes features that allow the user to upload and view photos, create groups and features to locate the position of the user and his photographs. In the literature study, it was shown that a map interface can give the users a better overview of what is happening in his surroundings and that adding game-like elements could provoke playful use of the application. The complete user requirements can be found in Appendix A.

Although users indicated during the first trial that they hardly used the subscription functionality, it was left in the second prototype in order to see whether participants of the second trial would use it more intensively. We felt that subscriptions could be a useful addition to Picalilly, in case the user wants to receive photos from a particular area without having to join all groups in that area.

During the eary stages of this design phase, a small-scale test which resembles a cognitive walkthrough was conducted with two users. The goal of this test is to identify usability issues in the design in an early stage of development. This test does not qualify as a full cognitive walkthrough, since the participants were not asked a complete set of questions after each subtask and not all functionality was tested in detail. Rather, a short scenario was created, describing tasks that the user needed to complete and only the significant issues regarding the design were discussed. The full task scenario can be found



(a) Groups overview (b) Group detail (c) Create group

(d) Join group (e) Subscriptions (f) Photo detail

Figure 4: Six screens from the first prototype version of Picalilly.

in Appendix B.1. The results consist of a list of bugs, issues and recommendations that should be resolved before the second user trial. For example, one participant commented that he did not understand the meaning of icons on the photo detail page. The other participant suggested to relocate all on screen buttons to a menu, in order to make interface less cluttered. The complete list of results can be found in Appendix B.2. Screenshots from the second prototype of Picalilly can be seen in Figure 5.

Map interface A map interface was added to the second prototype that shows the location of photos near the user's location as markers on the map. The user can view a photo in detail by pressing the marker. Furthermore, the map shows the boundaries of publicly available groups. The details of a particular group can also be looked up by the user. During the cognitive walkthrough, one participant indicated that the map could become very crowded with markers if many people share photos in one specific area. To solve this problem, we implemented features to filter photos and groups based on time, friends and groups of which the user is a member. The user can enter a textual description of a location that he wants to search for, which will redirect him to the nearest matching location on the map.

Friend functionality We wanted the users to be able to connect to other people they know, who are also using Picalilly. Users can manually request other users as their friend and an overview of all friends can be found on one page. This feature is used in other functionality of Picalilly (such as the news feed and the interactive map) to filter out content based on friendship relations. It would also make it easier for users to stay up to date with their friends' activity.

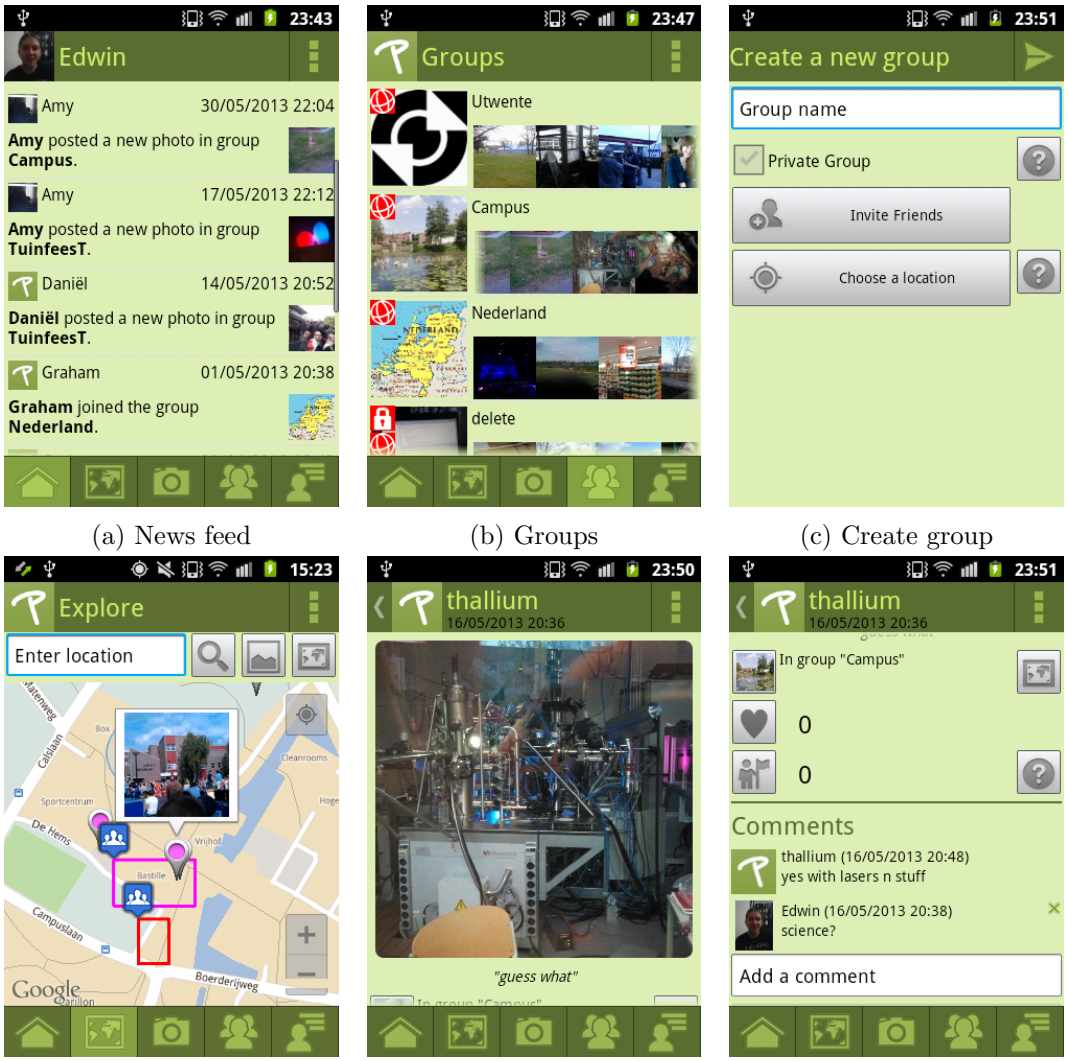
News feed In the first prototype, the groups overview page was the first page a user would view after logging in. We felt the need to show the most recent updates that are relevant to the user on one central place. The news feed shows photos taken by friends and groups that were recently joined or created by friends.

User interface The user interface of the first prototype was not very consistent. To solve this, we unified the interface of the second prototype: a bar on top of the screen always shows what page the user is currently viewing, with a context sensitive icon on the left side and a menu icon on the right side. All the on screen buttons are moved to the overflow menu to clean up the interface. With these and some other minor changes, we aimed for more consistency throughout the application.

Manual geotagging One of the main issues that the participants indicated during the first user trial, was the inability to tag photos manually. Users suggested this feature in order to share photos from a different location than where it is actually taken. This is useful when the user has no signal reception or when he simple wants to share the photo later on. It also helps when the location determined by the GPS receiver is inaccurate. Therefore, this feature was added to the second prototype.

Spotting photos We wanted to introduce a game-like element to Picalilly to provoke playful behaviour among the users. We added functionality to let the user *spot* a photo taken by another user. By spotting a photo, the user can indicate that he has been at the location of that photo. The user has to be near (within a 50 meter radius) the physical location where the photo was taken to successfully spot the photo. This way, users could compete for getting the most spots or keep a personal log of all places that he previously visited.

Technical specification The two prototypes are very similar with regard to implementation. For the imiplementation of the second prototype, only some new features are introduced and a few usability issues that were indicated during the test phase of the first prototype are resolved.



(a) News feed (b) Groups (c) Create group

(d) Map (e) Photo detail (1/2) (f) Photo detail (2/2)

Figure 5: Six screens from the second prototype version of Picalilly.

4 Research methods

The type of evaluation method that is suited for measuring quality of locative media systems strongly depends on the type of interactions that the system facilitates, the duration of one session and intended frequency of use. Systems that are only used for consuming geo-location based content can be tested in a controlled environment. A city tour application, for example, will mostly provide new and unseen content to the user. Typical user scenarios involve the user trying to find a relevant location through the system. Such a task can perfectly be evaluated by observation in relatively short trial sessions. Several studies put this method to use in a scenario where the user tries to find his way in an unknown city. In all of these cases, the researcher directly observes the user's interactions and assists the user if necessary [5, 32, 20]. In this section we will describe the types of research and research methods that were used during the evaluation of Picalilly.

4.1 Lab research vs. field study

In the early stages of development, it might be useful to conduct user trials in a lab environments. Paper prototypes can be produced quickly and cheaply and allow for quick feedback about interactions and user interfaces [5]. These can be used in *Wizard of Oz* type of evaluations, where the researcher plays the role of the system, reacting to user input and moving around pieces of the prototype [32].

However, in later stages fieldwork is inevitable for the evaluation of locative media systems. As described in section 3.1.1, one of the main types of interactions in locative media systems that provide in situ access is walking. This also applies to systems that provide remote access, perhaps in lesser amount. The user will probably experience different content at different locations, so in order to get a satisfying user experience, the user will need to travel between several physical locations. Furthermore, outdoor testing will be required, given the fact that most GPS enabled devices need to be used outside for the GPS triangulation to work.

Kardes [21] argues that experiments conducted in a natural environment can be useful, although they are often overrated, for several reasons. People prefer to rely on prior subjective beliefs rather than objective data when attempting to asses the relation between two variables in a natural setting. Standards for making judgments may change over time, which causes people to change their conceptions about the past to fit the present. This can make it difficult to learn systematically from unstructured natural experience. Finally, learning from experience can be hindered by a very limited or selective set of hypotheses. Even if very weak or ambiguous evidence is found to support the focal hypothesis, the search for additional evidence is often prematurely terminated. Artificial research settings on the other hand are underrated, according to Kardes. These artificial settings and conditions are used to isolate the effects of specific causal variables.

Still, conducting the evaluation of locative media applications in a natural setting might be preferred. User trials of relatively short duration, in which the user has to

perform a specific goal-oriented task could be conducted in a laboratory environment. However, the user should be able to experience localized content in unison with the direct surroundings in order to increase the immersion in the experience [32, 20].

As described in section 3.1.3, user participation is required for meaningful interactions. This is a process that takes time, which will probably take too long for lab research and user observation sessions. This implicates that lengthy user trials might yield better results, but also produce more user created content for the researchers to process. The main point here is that when the user's task is a teleological one, direct observations and short user trial sessions might be well suited. Otherwise, long term studies that involve multiple cycles of analysis, design and re-design might be more practical when the everyday practices of users are investigated [6].

For this research, we wanted to see how users share information and interact with others using locative media. We think that a field study is best suited for the evaluation of Picalilly for the reasons stated above. We want to investigate how Picalilly is used over a timespan of a few weeks, in order to give the participants enough time to experience sharing from several locations and receiving new content from others in real time. We prefer to learn from authentic and spontaneous use of a social media application such as Picalilly in a natural setting, instead of observing interactions in a laboratory setting over a short period of time.

4.2 Measuring user experience, usability and acceptance

The quality of a system can be measured by assessing different aspects, including user experience, usability and acceptance. To measure these aspects, several types of evaluation can be performed using generic evaluation methods such as interviews, questionnaires, observations, story-telling, cognitive walkthroughs or a combination of these. Individual methods are also available that measure a specific part of the user experience. AttrakDiff is such a specific method to test the overall user experience. UTAUT is specifically used to test the usability and acceptance of a product. These two methods will further described below.

User experience (or *UX*) can be used to describe the quality of a system and is defined by Hassenzahl [17] as *a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service.* He further differentiates between do-goals (desciбing tasks that the user wants to accomplish) and be-goals (goals related to the user's self). Hassenzahl further defines UX: *Good UX is the consequence of fulfilling the human needs for autonomy, competency, stimulation (self-oriented), relatedness, and popularity (others-oriented) through interacting with the product or service (i.e., hedonic quality). Pragmatic quality facilitates the potential fulfilment of be-goals.* UX is a temporal and dynamic phenomenon that describes the interactions between human and product.

Usability is defined in the ISO 9241 standard as *the extend to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.* Users for whom the system is designed should be able to learn and use it with ease, also considering the context in which the system is applied. [35]

Technology acceptance is required among the users to ensure that users actually want to use the system. The *Technology Acceptance Model (TAM)* explains how several factors can influence the actual use of a system, these factors are: the perceived ease of use (how easy it is to learn to work with a system), the perceived usefulness (the extent to which the user thinks this system might help in his tasks), the attitude towards using the system and the behavioural intention to use the system. The model is based on Ajzen and Fishbein's theory of reasoned action (TRA) [1]. A graphical representation of TAM can be found in Figure 6, which shows that the perceived ease of use and perceived usefulness are at the core of this model and how they influence the other factors [10]. TAM has been criticized for focussing on the user's perceived usefulness of a system, ignoring the question whether more technology is always better and its social consequences [2]. TAM has been continuously studied, tested for reliability and expanded, for example by TAM 2 [37] and the *Unified Theory of Acceptance and Use of Technology (UTAUT)* [38]. The UTAUT model is further discussed below.

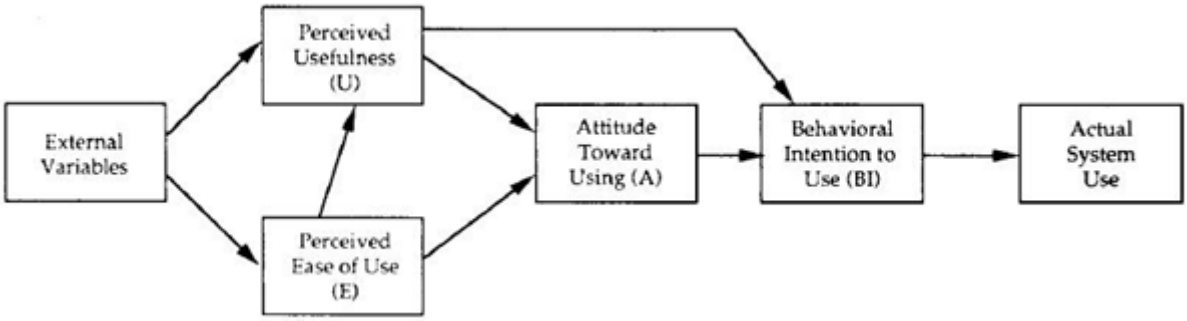


Figure 6: Technology Acceptance Model

For the evaluation of Picalilly we used a combination of cognitive walkthroughs, semi-structured interviews and questionnaires. The cognitive walkthrough is conducted early in the design phase to detect and solve usability issues. With the interview sessions we aim to obtain rich responses from the users regarding their experience with Picalilly and location-based sharing. The questionnaires are used to gather quantitative data about usability, acceptance and user experience (using UTAUT and AttrakDiff) and some qualitative data in the form of open questions (see Section 5 for further information about the evaluation procedure).

4.2.1 AttrakDiff

AttrakDiff[2] is an instrument for measuring the overall user experience of interactive systems. With the help of pairs of opposite adjectives, users (or potential users) can indicate their perception of the product on a semantic differential scale. These adjective-pairs make a collation of the evaluation dimensions possible. The following product dimensions are evaluated:

[2]AttrakDiff: http://www.attrakdiff.de/

Pragmatic Quality (PQ) Describes the usability of a product and indicates how successfully users are in achieving their goals using the product.

Hedonic quality - Stimulation (HQ-S) Mankind has an inherent need to develop and move forward. This dimension indicates to what extent the product can support those needs in terms of novel, interesting, and stimulating functions, contents, and interaction- and presentation-styles.

Hedonic Quality - Identity (HQ-I) Indicates to what extent the product allows the user to identify with it.

Attractiveness (ATT) Describes a global value of the product based on the quality perception. Hedonic and pragmatic qualities are independent of one another, and contribute equally to the rating of attractiveness.

Hassenzahl argues that until recently evaluation methods were confined to the essential usability, which usually meant just the pragmatic quality. He created a theoretical model which through which both the recognised pragmatic quality as well as the hedonic quality of an interactive product can be gauged. This model explains how the pragmatic and hedonic qualities influence subjective perceptions of attractiveness resulting in respective behavioural and emotional responses. The theoretical work model was researched and tested in several studies by Hassenzahl and colleagues. The newest version of AttrakDiff optimises and supports the distinction between the sub-qualities, stimulation and identity, of hedonic quality. [16]

4.2.2 UTAUT

UTAUT aims to explain user intentions to use a system and subsequent usage behavior. Venkatesh proposes that four main constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) are direct determinants of usage intention and behaviour. The theory was developed through a review of the constructs of eight models that earlier research had employed to explain usage behaviour (including TRA and TAM). Subsequent validation of UTAUT in a longitudinal study found it to account for 70% of the variance in usage intention, which is more than other models achieved in previous studies [38]. UTAUT has been criticised by Bagozzi [2] for using too many independent variables to predict intentions and behaviour, “reaching a state of chaos”.

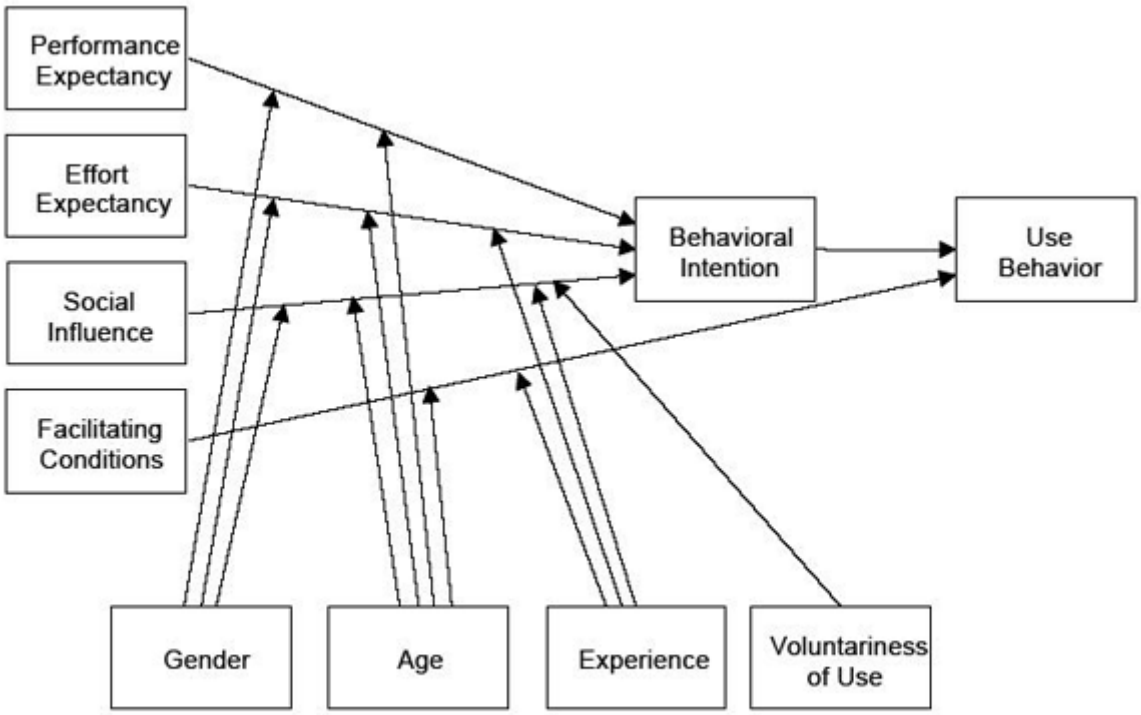


Figure 7: Unified Theory of Acceptance and Use of Technology

5 Picalilly evaluation

In this section we will describe the evaluation of both Picalilly prototypes. For each prototype, we will provide information about participants, materials that were used and finally explain the data analysis.

5.1 Evaluation of the first Picalilly prototype

For the first user trial, we evaluated the prototype that is described in Section 3.2.3. This evaluation was designed as a relatively small scale test. The goal of the user trial was to find out how the users would make use of the application and how the location based aspect worked out. In this field trial, our aim was not to test Picalilly, but to explore the potential of location-based sharing. It was meant as a pilot study for the second evaluation, which will be performed on a larger scale with a fully functional prototype. The field trial was carried out during the introduction period of the University of Twente. The introduction program is called *Kick-In*. During this 2 weeks long event students participate in many activities on and around the campus area.

5.1.1 Participants

We asked eight freshman students (divided in two groups; group 1: 4 male; group 2: 3 male, 1 female; age ranging from 18 to 21) to participate in the Picalilly user trial, because they will travel around different parts of the university and neighbouring cities. We believed that Picalilly could contribute to their experience during this introduction period and that they might have interesting stories to share with their fellow students during this event.

5.1.2 Procedure

At the initial meeting with each group we explained our research project and showed a short demo of Picalilly. Consent forms were handed out to the participants, including a short written manual describing the functionality of Picalilly and how they should get started with the application. We asked the students to describe their Kick-In experience in series of photos and comments using the Picalilly system.

During the trial we monitored the progress of both groups. At the end of the first week, we invited the participants for a group meeting where the participants could ask questions if there was any confusion about Picalilly or if they had other kinds of problems with the application.

In these two weeks, participants were free to use Picalilly as much as they wanted. Aterwards, the participants were invited for a semi-structured group interview, which will be described below. The interview was recorded digitally (all participants gave permission to do so).

5.1.3 Materials

Each of the participants owned an Android phone capable of running the Picalilly application. The photos that a user shares are stored on his phone (as a local copy) and on the Picalilly server. All other data that the participants produce (such as comments, groups and likes) resides in the database of the server.

For the interview session, a graphical representation of the participants' activities was created. We used a whiteboard and stuck all the photos based on timeline, users, and different groups they had created. We thought that when they see their activities with reference to others they would be able to answer our questions better.

A list of questions was prepared as a guideline for the semi-structured interview. The questions are focused on the location based aspect of Picalilly, since we wanted to find out how the principle of location based groups worked out (questions such as *Could you notice any difference between photos that were shared to either location-based groups or 'normal' groups?* and *What kind of new information did the location-based sharing of photos give you?*). The full list of questions can be found in Appendix C.1.

5.1.4 Data analysis

The interview recordings were transcribed for easy reference. This data was investigated for reoccurring themes. Some illustrative quotes from the interviews are chosen as examples. The results of this analysis are combined with an analysis of all the user generated content (shared photos, groups created by users, comments on photos) will be presented in Section 6.1.

5.2 Evaluation of the second Picalilly prototype

The second evaluation involved a fully functional prototype of Picalilly. The goal of this evaluation is twofold: we still wanted to learn more about the different aspects of location based sharing. Second, we wanted to test the quality of Picalilly with regard to user experience and usability. The goal was to find out how (and whether) Picalilly influences the way people share information using locative media applications. The results about user experience and usability might provide additional information about the way people used Picalilly. Analysis of the data that users produced while using Picalilly, in combination with the results of interviews and questionnaires should give us enough information to answer our research questions.

5.2.1 Participants

We personally invited a group of eight students (6 male, 2 female; age ranging from 23 to 29) to partake in the second user trial of Picalilly. These participants are all part of a larger group of friends that have known each other since the beginning of their study at the University of Twente. Some of them have recently graduated and have moved to other parts of the country, which means the group is geographically spread out over a large area. We thought this might be an interesting aspect to investigate, which is different from the participants in the first user trials (who were all co-located during the whole field trial). A second group of five students was invited to participate, but they indicated that they lacked the motivation to use Picalilly for the duration of the study.

Other than this group of people (which we will refer to as the *invited participants*), people were asked to use Picalilly during this field trial through posters, flyers and social media. One of the biggest issues during the first field trial was the low amount of user generated content, which was caused by the small number of participants. For the second user study, we wanted to allow anyone who was interested to participate in the experiment, in order to increase the amount of content that was shared. This way, the experience of Picalilly would become more like a real world social media application, where new content is constantly flowing in. A total of 24 users (20 male, 4 female; age ranging from 20 to 37) signed up for Picalilly (including the group of eight people who were personally invited).

5.2.2 Procedure

Similar to the first evaluation, we explained our research and the application during an initial meeting with the invited group and handed out consent forms. The users that were not personally invited could find all the information they needed through the text on the poster or flyer, which redirected them to a website where they could sign up and download the application.

The invited participants used Picalilly for 6 weeks. They could ask for help with Picalilly during a short central meeting, similar to the one described in Section 5.1.1. The duration of use by the other participants varied, depending on when they started using Picalilly. The field trial was planned in a period in which many large events happened (both on a national and local scale) that could potentially be visited by the participants.

After the field trial, all 24 users were asked to fill out a digital questionnaire about Picalilly, which addresses (a) the user's previous experience with systems similar to Picalilly, (b) the user experience, (c) usability and finally (d) some open questions regarding location-based sharing. The user experience was measured using the AttrakDiff questionnaire, as described in Section 4.2.1. UTAUT was used to test the usability and acceptance of Picalilly, which is described in Section 4.2.2. The invited participants are asked to fill out the questionnaire at the start of the interview, the other participants are asked through email to complete the questionnaire.

Then the invited participants were asked for individual semi-structured interview sessions. At the start of the meeting, the participant was asked to tag each photo with his motivation for sharing that photo. The goal of this method is to investigate whether a user has other motivations for sharing to location-based groups than when sharing to non-location-based groups. The participant could choose from a list of 5 predefined motivations (namely (1) Bring value and entertainment to others, (2) Define ourselves, (3) Grow relationships, (4) Brands and causes, (5) Self fulfillment) or fill in his own motivation.

When the tagging was finished, the user was asked to fill out the online questionnaire if he had not done so. This was done before the actual interview to make the user remember his experience with Picalilly. This could refresh the participant's memory, so he is better able to answer the interview questions. Finally, the interview is conducted using the script described below.

5.2.3 Materials

As in the first user trial, all of the participants already owned an Android phone that could run the Picalilly application. Data is stored in the same way as described above.

First of all, the user is asked to tag his photos with motivations for sharing. This is performed through an online form. The data is stored in the database.

In the questionnaire, the user is first asked some general questions about age, sex, his motivations for and prior experience with using smartphones. Next, the user is asked to fill out the AttrakDiff and UTAUT questionnaires. Finally, some general questions

about different aspects of Picalilly are asked (such as *How do you feel about the concept of sharing photographs to location-based groups?* and *Were you ever concerned about your privacy while using Picalilly?*). These questions intentionally overlap with those of the interview. The invited participants can be asked in further detail about these topics during the interview. The complete questionnaire can be found in Appendix D.2.

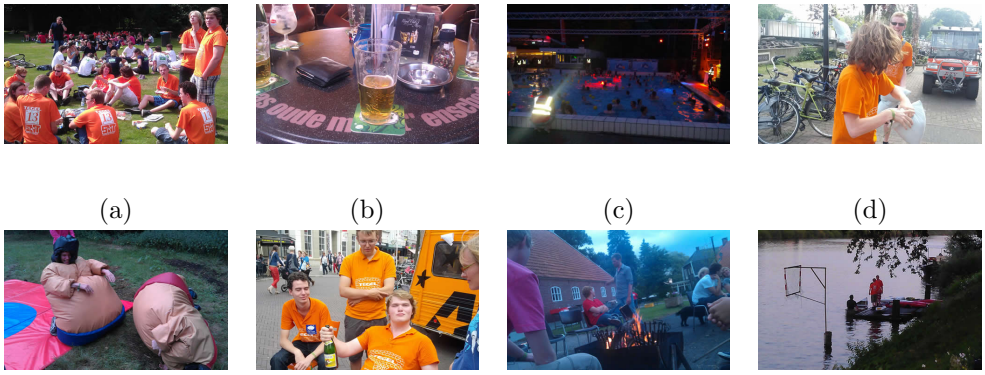
The interview questions resemble those of the first evaluation. A few questions are added about how people use Picalilly (e.g. *What method did you use to look at photos you want to see?* and *How would you use Picalilly in your everyday life?*) and privacy related issues (e.g. *Were you ever concerned about your privacy while using Picalilly? For example, about who could see your photos?*). The complete interview script can be found in Appendix D.1.

5.2.4 Data analysis

First of all, we looked at how Picalilly was used during the field trial. The usage data that was gathered by Google Analytics and user generated content stored in the database is inspected to get an overview of user activity and how Picalilly's functionality was used. This data could show, for example, that a particular function or page was hardly used and which pages were used the most. This could lead to more specific questions about the usage of Picalilly during the interview sessions.

After all the participants were interviewed, the recordings were transcribed and investigated for reoccurring themes, just as in the first evaluation. The AttrakDiff and UTAUT questionnaires are processed to obtain an insight of the user experience and usability and reliability scores are calculated. The results from these questionnaires are used to underpin the findings from the interviews in Section 7. Finally, the user assigned tags for their photo sharing motivation are grouped by tag and presented as a table.

The results are presented in Section 6.2. The findings from all these types of analysis will be presented in Section 7.



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 8: Eight photos that were shared during the first user trial.

6 Results

The results of both user trials will be presented in this section. Our findings from these results will be discussed in Section 7.

6.1 Results of the first field trial

In this section, the results of the interviews from the first user trial are presented. Some topics were repeatedly mentioned by the two groups of participants during the interviews. Most of them are directly related to the location-based aspect of Picalilly, others are about the usability issues they encountered while using Picalilly. The major themes are discussed individually below. As the interviews were conducted in group sessions, it was harder to pin-point how many users agreed with a certain statement, which is why we refer to groups of participants instead of individual opinions. The first user trial and the first two categories below are also described in related work by Vyas et. al. [39].

In total, 32 photos were shared during this trial, of which 6 were shared to location locked groups. A selection of photos that were shared by the participants can be found in Figure 8. These photos show various activities that the two groups participated in during their introduction program.

Localized exploration When sharing a photo through Picalilly, people discover the groups that are around them and are encouraged to share to them. Five participants also subscribed to several locations to see if people posted pictures in that particular area. One participant commented: *As a new student, I would not have to look for a specific group. I would just make a subscription to the campus area and get an idea of what is happening here. If there is a public group at a location such as UTwente [a geo-locked group] it would be interesting for new people to see what is here and how everything looks. You*

would get a sort of Google Street View look of the area, but then more personal.

Another participant described that the location bound groups can be useful on holidays and sightseeing tours. The pictures that show places of interest can inform tourists and encourage them to go see those places. He commented that *for festivals such as Pinkpop it might be interesting. The organization can make pre-arranged groups on that location. It is such a massive place, so that's again the exploration thing where some people see certain things and you might see other things. That way you know what is going on there.*

Picalilly showed its users where other people have been. The user can follow in the foot-steps of others who visited that area earlier. One participant commented: *It might be that people take pictures of things that I missed in the area while walking around, so I think exploration is something that this can help with. The extra information [comments/ description] would tell me more if it is worth going there or if it is interesting.*

Sharing places In the interviews, people indicated that the public groups bound to a location take the function of informing other people about the environment and experiences surrounding it. For example, both groups of participants wanted other people to see what was going on around campus or their freshmen camp: *I knew that there were many students at the camp other than us and many back at the campus. I wanted to share these photos so that they know what we did there and what kind of activities they can expect.* They intentionally shared photos to a group called *Campus* for new students to get a view of the campus area, from a student perspective. In this case, the personal aspect of sharing photos with each other is minimized: the people appearing on the pictures play a smaller role than the location that is described with the photograph.

The participants used Picalilly to share with people that they did not know, in order to inform them about the things that are going on at that particular location. One participant shared a picture of a party he was at, in order to invite other people to join him and to let his friends know that his group was still having fun.

Overlap between groups It was sometimes ambiguous for participants to know which group they should share to. One group of participants mentioned they found two groups available where one was a (geographical) subgroup of the other. Dealing with subgroups was not handled yet in the first prototype of Picalilly. Furthermore, people would like to share to multiple groups, if the interests of both group overlap. A picture that contains a group of friends can be shared to a group that is dedicated to pictures of those people (as a personal album), but might also be shared to the group that contains the location that these people were physically at (for instance, the city center).

Tagging photos with people and location The biggest problem with subscribing to a person was the fact that the resulting set of photos contains pictures taken *by* this person, but not necessarily photos *of* this person. Tagging people in the picture would most likely solve this problem. Furthermore, one group of participants complained about the fact that they had to create or join a group for each place they visited, which can

become cumbersome if they want to take a quick look at what is happening in their vicinity: *If you are traveling around you would have to make a lot of separate groups to post each photo at a certain location.*

Another problem mentioned by both groups of participants was that the location constraint in location-locked groups prevented people from sharing photos a few hours after the picture was taken. In the mean time, the users may have traveled outside the boundary of the group, which means they are no longer able to share to the location-locked group: *One of the problems I did encounter was that if I take a picture in camp and I come back to university I can't post it to the camp location, because I'm not there although the picture was taken there. If I want to associate pictures with the location it's nice if you can do that afterwards even if you're not at the location anymore.* Storing the location with the picture when it is taken or reading it from the EXIF meta-data might solve this problem. Participants also suggested to allow users to manually tag photos with a location. This could also be helpful if the location determined by the device is not accurate enough.

User activity There were only eight participants during this user trial, which is rather small for a social network application. This makes it more likely that one group of participants only shares photos with each other, without seeing photos from people they don't know. A larger community that is actively sharing content would make Picalilly much more diverse and interesting: *When I look at pictures of our camp, I see the campfires and I was there myself, so it brings up memories of what we have done there. But if I wouldn't have been there and look at the pictures I would say that it would be nice to be there, but from just these two photos I can't tell much about the surroundings. But that is where the social part would come into play, if you have a lot of people photographing the camp or the university grounds, then you would have more photos. You could more easily see how everything looks.*

6.2 Results of the second field trial

For the second evaluation the results are split up six sections: a quantitative analysis of the shared photos, a qualitative analysis of the interview sessions, a categorization of photos on motivation, and the results of the UTAUT and AttrakDiff questionnaires.

6.2.1 Picalilly usage

During the second user trial, a total of 130 photos were shared to Picalilly of which 34 were shared to a location locked group. Photos were shared to 16 different groups, of which 8 were location locked and 3 were private (2 of the private groups were location locked) as is shown in Table 1. The majority of photos (86) was posted to one private group. Examples of photos that were shared during the second user trial can be found in Figure 10 and Figure 11.

The data that was gathered using Google Analytics shows that the screens for viewing a photo and the news page (the first page the user sees after logging in) are the most

Table 1: This table shows the amount of photos per group and whether the group is location locked and whether the group is private.

Name	Photos	Location	Private
TuinfeesT	84	no	yes
Campus	15	yes	no
Utwente	6	yes	no
SkyBox	6	yes	no
Miranda	3	no	no
Nederland	3	yes	no
CreaTe	3	no	no
GvS laan	2	no	no
thuis	1	yes	yes
Cuba liebre	1	no	no
Brabant	1	no	no
my group	1	no	no
supersecret pandora group	1	yes	yes
Huisje Blij	1	no	no
Zilverling	1	yes	no
Grolsche shenanigans	1	yes	no
Total	130	34	86

viewed screens, as can be seen in Figure 9. A possible explanation for this is that users view multiple photos per session and that users directly go to the photo detail screen by clicking on a notification. The activity at the end of the figure can be explained by the usage of Picalilly during the interview sessions. Users viewed a single screen for an average of 27 seconds and viewed 4.33 screens per session. An average Picalilly session lasted 1 minute and 32 seconds. The screens that were viewed for the longest duration are the map overview and the login screen (about one minute). A photo detail screen was viewed for an average of 10 seconds.

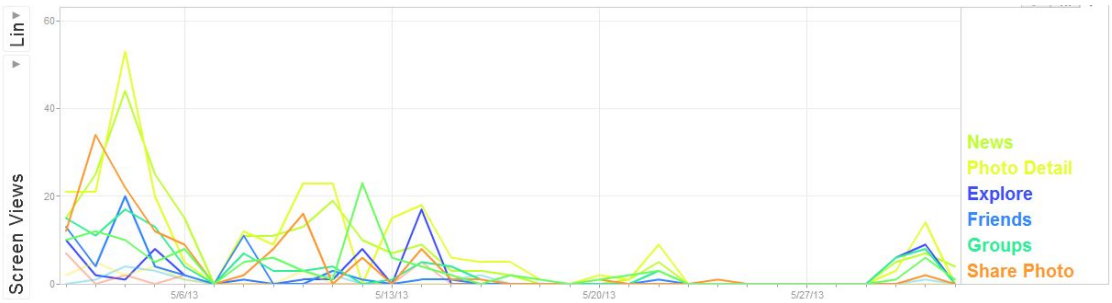
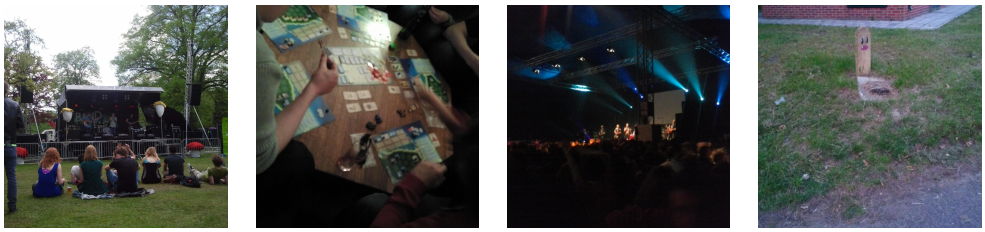


Figure 9: The number of views per screen over time

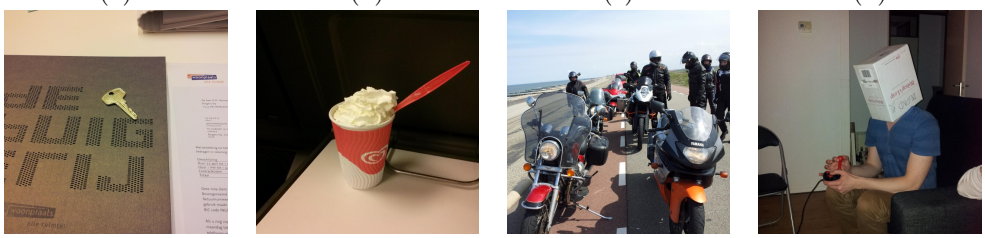
(a) (b) (c) (d)



(e) (f) (g) (h)

Figure 10: Eight photos that were shared to location-based groups.

(a) (b) (c) (d)



(e) (f) (g) (h)

Figure 11: Eight photos that were shared to non-location-based groups.

6.2.2 Interviews

In this section the participants' experience with Picalilly will be summarized by aggregating all the interview data into recurring topics. Quotes from the interviews will be mentioned here as examples of these categories. When multiple users share the same opinion, the number of participants is stated in parentheses.

The purpose of groups Users indicate that location-bound groups are mostly useful for events such as concerts and festivals (7), small scale communities (4), catering facilities such as bars, restaurants and music halls (2). On the other hand, three users indicated that location-bound groups are undesirable for sharing photos among a group of friends. In this case, the location constraint prevents users from sharing photos to the group. This kind of group is focused on a group of people, rather than particular location: *If the group created for a fixed location such as the campus then it is well suited, or in case of a bar. When you're having a night out and you're taking pictures and everyone around you immediately sees that, based on your location, that's fun. Especially if you are a member of that group. For example in the Aspen [disco] or an event such as Lowlands [a large pop-music festival]. [...] For groups of friends a location-based group would be less useful, because everyone is in different locations. Then the location constraint works against you.*

One of the participants clearly noticed the difference between the groups: *I have seen a few different groups. I shared some photos to Nederland, Campus and Tuinfeest [three groups]. To the Campus group I only shared more generic things, photos that were about things that happened on the campus. Such as the BBQ, which was during the Batavierenrace [a yearly sports event]. Everyone on campus is barbecuing that day, so I decided to take a picture of it. In the Tuinfeest group you will only find things that have to do with Tuinfeest specifically, but they could also happen here on campus.*

Relevance of photos There were several public groups available that users could join and share photos to. Three users indicated that the size of a group is important for the relevance of the photos in that group. The size of the groups varied from a building such as a flat or lecture-hall to whole cities or the whole country. This size is very important for determining whether a group is relevant to a user: *A region such as The Netherlands is too large, I think. It could be nice for tourists who visit our country, but then they will see lots of random things, mostly the 'hotspots' of The Netherlands, or the Eiffeltower in France. But then you will see those things a thousand times. It should be a bit small, for events or buildings. For cities it might work out. If the group becomes too large, you lose the overview. It should be intuitive what group you should choose, so the photos will stay relevant to the group.*

One participant indicated that time is also an important factor for the relevance of photos: *Sometimes I look at the map, then see some interesting photos and think 'I visit this place some times' and I get curious. Then I see that the photos were taken more than half a year ago by someone I don't know, which makes me lose my interest. There are many photos from the introduction programme [of the University of Twente, from*

the first user trial] that I do not care about. The group that these photos belong to should be closed, or something.

Usefulness of location The location of a photograph can be utilized in several ways. The user can simply see where the photo was taken if the location is unknown to him. However, five users indicated that this is not always relevant information. Often it is easy to tell the location from the picture itself (3) or the people on the photo are simply more important than the location (5). It only becomes interesting information when the user wants to know more about the context of the photograph. As the viewer learns more about the location of the photograph, he can become motivated to visit this particular location or it can present a well known place from a new perspective.

One of the particpants argued: *I think it is more interesting to find photos based on your location than to know where a particular photo is taken exactly. The latter is often not too interesting.*

Use of Picalilly The participants mostly saw Picalilly as a photo sharing application that they used to share funny things with their friends. However, four users doubted whether they would use it as such in their everyday lives. The biggest motivation was that their friends were using it as well. In order to make it interesting to keep using Picalilly for sharing among friends, it should be part of a larger social network. Three participants said they would be interested in using Picalilly for location-based sharing in case of events.

Although the location of the user is automatically determined via GPS, four users indicated that it also raises new issues. The user has to think about when sharing a photo on the spot: do I want to share my location? To what group do I need to share (for whom is this relevant)? One of the users mentioned that he found it too much effort to manually select the location for a photo and pressed random locations on the map: *Sometimes Picalilly could not find my location, so then I clicked on the map and thought "oh, it shows me the map of Africa, ok: click". That is why you have a lot of photos located in Africa, I guess.*

Another participant mentioned that location-based sharing could cause awkward situations: *If you call of for a party, lying that you are ill and then post a photo showing you are located at a bar, that's not very clever.*

One participant told us that they use these kind of mobile applications very differently than desktop applications. They want to take a quick look at their phone and then be done with it: *it [apps such as Picalilly] is really a spur of the moment kind of thing. That's what those applications mean to me, anyway. You think that you see something funny, make a picture of it and then forget about it [using the application].*

One of the participants mentioned that *it [Picalilly] is something you would use now and then. You do not really need it to maintain your friendships. It is more like, when you have some spare time you can browse photos or if you stumble upon something funny you share a photo of it.*

Motivations for sharing The motivation for a user to grab his phone, take a photo and share it on Picalilly varied. Some examples are sharing funny things that other people might like (3), informing others who are not present (3), creating an overview of an event (1) or memorizing where something happened for personal use (1).

One participant said: *In some occasions I thought it would be fun to share a photo with Picalilly, at the BBQ or on a party. I like that the photo will be in a location-based group, so others can see it. This way they know what is going on at that place.* Another participant said it was more likely that she would share some photos through Picalilly than through some other medium: *I only shared photos of which I thought they were fun to share. When you take a photo you immediately know 'this group of people might like it'. This app [meaning: the people who use Picalilly] is like such a group: this photo might be fun to share, because the location is interesting and the photo looks nice. Both factors have to be right. I shared a lot of light-hearted photos that are too spammy to share with specific people, but they are fine for this kind of app. In some cases I thought it would be funny to tell people I have been there-and-there.*

Types of shared photos The difference between location-based groups and non-location-based groups is also reflected in the type of photos posted to these groups. Location-based groups mostly show more generic photos than 'open' groups. Five participants indicate that the photos posted in open groups would only be relevant to the members of this group. Someone who would stumble upon a picture shared to an open group would miss out on too much context information to make sense of it: *It would have to be a very generic photo if I shared it to a public group. I would not post a close-up of friends to a public group, but rather an overview picture. It really depends on the context information.*

Exploration According to three participants, Picalilly could also stimulate people to look around in their environment. Users like seeing the things in their living environment that usually don't pay attention to, but might be interesting: *I would like it if there were a lot of photos of the campus or Enschede [city]. I would like to see curiosities, things you don't see everyday because you cycle straight past them. A statue on the side of the road, which you will pay a visit to the next time you are there. Near the roundabout in Twekkelerveld [a neighbourhood], there are these tiny concrete posts that indicate underground pipes or cables. One day they were all sprayed with grafitti in a funny way. Those are the things that might be nice to share. That could motivate people to take a look the next time they are there.*

Privacy issues In the interviews, six participants said they were not too worried about their privacy for several reasons. First of all, they controlled the information they shared (5): *I was not worried about the things I shared because I do not really care about that kind of information. The information does not have any value to someone else. I can image that someone will complain if he was photographed in an awkward situation, but that is not unique to Picalilly.*

Participants were also not too bothered about their location being shared, because they did not share sensitive information (2): *There will always be information about where you have been. If you don't like that, you should not use it. I don't mind for myself, because I don't share privacy sensitive information. You can nearly always tell the location from just the photo.*

Four users indicated they were concerned that Picalilly could be used to track people over a period of time. Three users were concerned about who could see their photos.

Playfulness Three users commented that location-based media could easily be used to facilitate game-like interactions: *When you see photos made by strangers, it [the location-based aspect] might be fun. You could make a game out of it, where you can indicate that you have been to a particular place and sort of tag the photo with that information, similar to Geocaching [Geocaching is a location based activity in which participants try to find "geocaches", tiny hidden containers that can be found in public places by solving a puzzle or finding the GPS coordinates]. But then the GPS would have to work very accurately.*

6.2.3 Photo Categorization

In order to get an overview of why people shared photos, we asked the interview participants to tag each photo they took with a preselected motivation or to define one themselves. A total of 67 photos were tagged this way. From Table 2, we can see that the most important motivations for sharing a photo are (a) bringing value and entertainment to others, (b) defining ourselves and (c) growing relationships. Only 6 photos were shared to location-locked groups, which is not enough to draw any conclusions from this data about the difference between location-locked and open groups.

Table 2: The total number of photos shared to either location-locked/open groups or public/private groups per motivation.

Tag	Location locked	Open	Public	Private
Bring value and entertainment to others	1	15	1	15
Define ourselves	3	23	4	22
Grow relationships	2	13	2	13
Brands and Causes	0	2	0	2
Self fulfillment	0	6	0	6
Other	0	2	0	2
Total	6	61	7	60

6.2.4 User Experience

The user experience of Picalilly was measured using the AttrakDiff questionnaire, as was described in Section 4.2.1. The results are displayed in Figure 12. Each of the

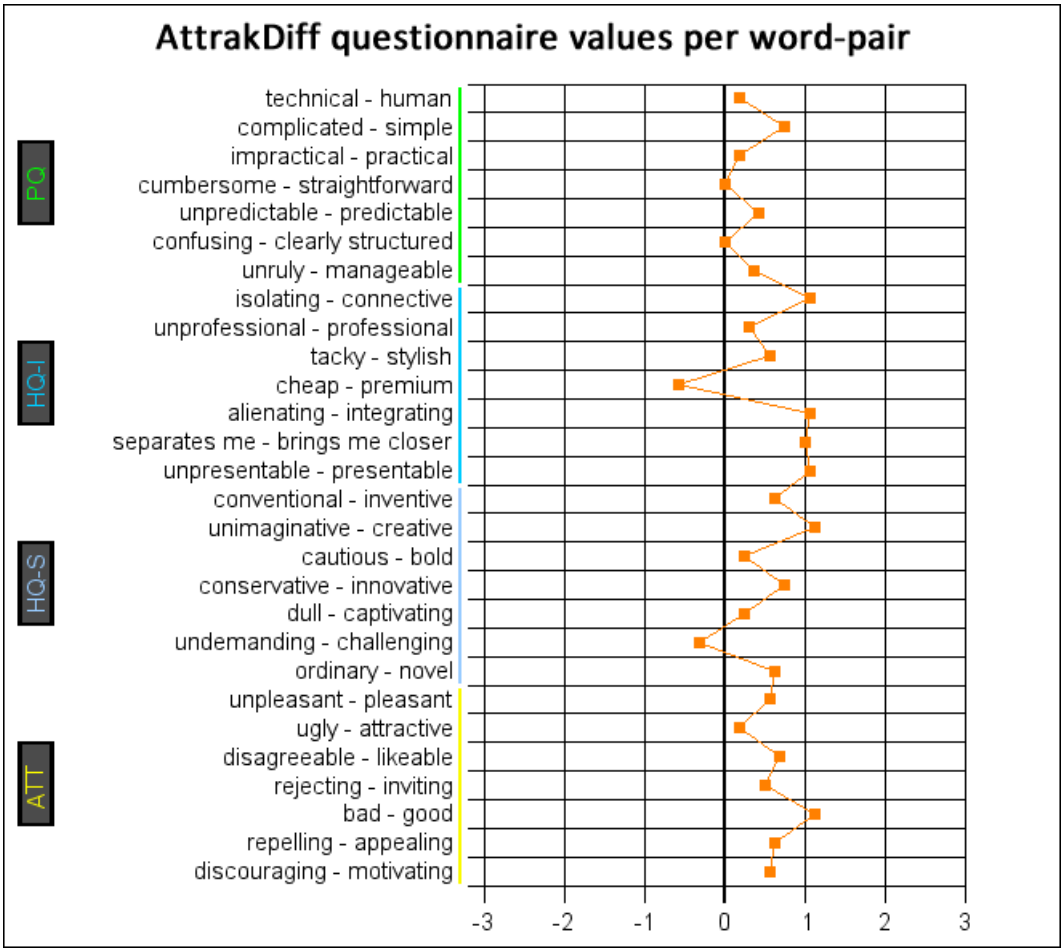


Figure 12: Results of the AttrakDiff questionnaire, showing word pairs per category: pragmatic quality (green) $\alpha = 0.64$, hedonic quality - identity (blue) $\alpha = 0.71$, hedonic quality - stimulation (light blue) $\alpha = 0.80$, attractive quality (yellow) $\alpha = 0.76$

four dimensions are represented by a coloured bar on the side of the figure. As can be seen from the figure, the most negative scoring word pairs are *cheap - premium* and *undemanding - challenging*. The best scoring word pairs are *isolating - connective*, *alienating - integrating*, *separates me - brings me closer*, *unpresentable - presentable*, *unimaginative - creative* and *bad - good*. All other word pairs have a moderately positive score.

The reliability of all dimensions is acceptable (Cronbach's alpha > 0.7) except for the pragmatic quality ($\alpha = 0.64$). By removing the word pair *unruly - manageable*, the reliability is increased to $\alpha = 0.70$. The hedonic quality - identity and attractive quality score the highest of all dimensions on average, as can be seen in Figure 13.

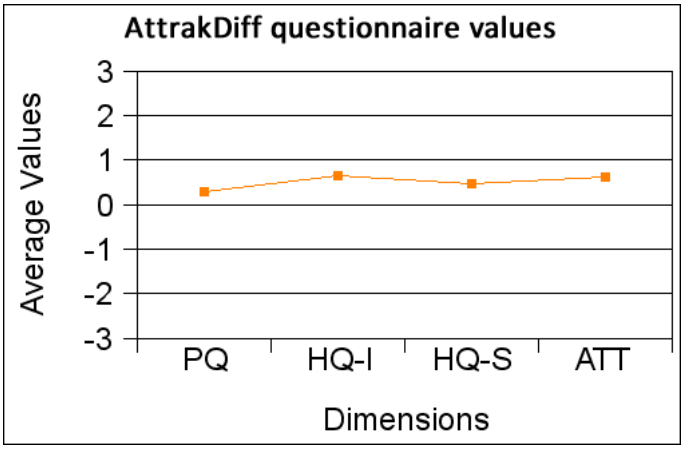


Figure 13: Average values of the AttrakDiff questionnaire per dimension.

6.2.5 Usability and acceptance

In order to measure the usability of Picalilly, we used the UTAUT questionnaire. Figure 14 displays the average score of each construct. All constructs have a moderately positive score (between 4 and 5.3), only anxiety (i.e. users were anxious about using Picalilly) and behavioural intention to use the system scored low (2.6 and 2.9). The average scores per individual question can be found in Appendix D.3.

We calculated the reliability scores per construct: Effort expectancy: $\alpha = 0.69$ (0.79 by removing *It would be easy for me to become skilful at using the system.*); Attitude towards using technology: $\alpha = 0.62$ (0.77 by removing *Working with the system is fun*); Facilitating conditions: $\alpha = 0.69$ (0.70 by removing *A specific person (or group) is available for assistance with system difficulties*); Self-efficacy: $\alpha = 0.85$; Anxiety: $\alpha = 0.72$; Behavioural intention to use the system: $\alpha = 0.97$.

6.2.6 Questionnaires

The last section of the questionnaire contained four open questions which we used to ask the user about his experience with Picalilly and location based sharing.

Do you find it useful to share your location automatically with your photo? About half of the users found it useful to share their location automatically for several reasons. They mentioned it would be easier to find interesting sights at publicly accessible places or events, if the photos are taken by other people. Others said it was useful for memorizing places with your own photos: *Even if you just use your own photos with locations, you could see were the photos are taken and therefore identify items on the picture (via google maps) or remembering where that nice piece of nature was.* The reasons why the other half did not find it useful were (a) privacy infringement and (b) that in their opinion, the subject that is photographed (people, objects or scenery) is more important than the location where it was taken.

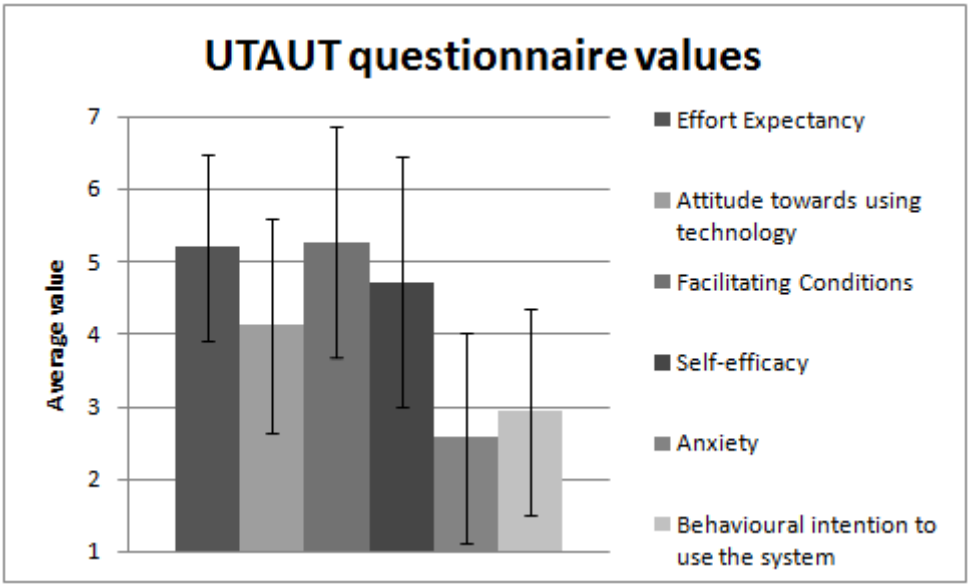


Figure 14: Average values of the UTAUT questionnaire per construct.

How do you feel about the concept of location-based groups? The users were moderately positive about the idea of location based groups. The users liked it for events and festivals, but they also preferred to know who they were sharing with, which was unclear to some users.

Were you ever concerned about your privacy while using Picalilly? A total of seven users were not worried about their privacy while using Picalilly, either because they trusted the system or they intentionally did not share privacy sensitive information. Eight of the users indicated that they were (somewhat) concerned about their privacy, mostly about who has acces to the photos: *there are still some privacy issues that should be tackled with care and should be communicated to the user very properly. Who may join your group? Who can see your picture? How public is public?*. Two users mentioned they were worried about being tracked by other people (or third parties) by sharing their location.

Further suggestions and remarks Overall, the users commented that they liked Picalilly as a new approach to social media: *I definitally like the idea of this application, this application is particularly useful for sharing pictures with unknown people at the same location. Sharing with friends is already well covered via facebook/whatsapp etc. Sharing with unknown people at your location/the same event is a gap in the app-market and therefore I see some opportunities there.* A few users indicated that the user interface could improve, as some functionality felt unintuitive.

7 Discussion

In this section we will take a closer look at the results and point out some interesting findings. All the results from different parts of the evaluation, as described in Section 6, are brought together, compared and discussed.

7.1 Location-locked groups

The amount of context information that the user has about a photo is crucial to understand the photo. The users in a group need some kind of common ground in order to make the group useful to them. This shared interest could be on a personal level (such as a family sharing with relatives who live abroad) or a nonpersonal level (a group of strangers who are only geographically co-located).

The latter is exactly the situation in which location-based groups are most useful. The more personal the information that a group of people is sharing, the less relevant the location will become. As indicated by the participants during the interviews, a location-locked group of geographically dispersed friends would only be bothered by the location constraint. It would not make much sense to enlarge the boundary of the group to make it span the area in which most of its users reside. The boundary would not add any significant value to the group, other than showing how dispersed the group members are.

However, if a group of people is (temporarily) co-located and they share another common interest, then location-based groups can be very useful indeed. The most commonly mentioned situation where the participants would use location-locked groups are events such as festivals and parties. The organization of the event can create one or more groups beforehand and let the visitors share to them. Both the organizations and the visitor would benefit from this, since the event gets a lot of publicity and photos are stored in a central place which should be easy to find for the visitors.

Other uses for location-locked groups include venues and small scale communities. Some of the participants indicated that they would be interested in photos from the campus area of their university. They would expect to see photos that show the everyday life on campus and the special events and happenings. Members of a group such as *Utwente* or *Campus* have a commonality of interest between them, namely that they all work, live or study in the same geographical area. This makes the purpose of such a group more general than a group created for an event that only lasts temporarily. One participant argued that there is a relation between the size of such a community type of group and the relevance of the photos for the members. A relatively small group spanning the campus area will probably contain interesting photos for the students who live there. However, if a group would span all of The Netherlands, then the photos would either become very general (only showing the major tourist attractions) or too context sensitive to be informative for most of the users.

7.2 Exploration

Locational information can help the user explore his surroundings. Location-based media can show users where nearby places of interest are, based on previous input. This is closely related to the matchmaking algorithms that have succesfully been applied in many social media applications [9]. The user can also manually start looking at what is around him through a map based interface, but this requires the initiative from the user. Although no actual situation was reported where the user was motivated by Picalilly to visit the location of a photo, users did mention they could be stimulated to do so. Furthermore, we have seen how locative media can show familiar places in a new and interesting way. It shows the user well known places from a different perspective, allowing him to rediscover his surroundings.

7.3 Filtering

The user might face an abundance of information if he is unable to filter out the useful pieces of information. The location can be applied as a filter to the total amount of information that is available to the user. When a user is out on the street and quickly wants to find a nearby restaurant, he can use public recommendation services to find one that aligns with his taste. In this situation, the location can be used to filter out the restaurants that are too far away and that are therefore probably less relevant to the user. In a similar way, the location-based aspect can be used to filter groups of people who might have similar interests. In this research, the users indicated that they would find location-based sharing most useful during events such as festivals and other places of entertainment. The main point is that the combination of location and time can be used to present the most recent and relevant information to the user.

7.4 Locational privacy

There is a conflict between topicality of the photographs and privacy issues. For this kind of application, it is useful to see photos directly when they are taken. Users want to see photos that are relevant to them. When a group is created for an event, users expect to see recent photos of this event. Yet they indicated in the interviews and questionnaires that they do not always feel comfortable with the idea anyone can see their photo and location, or that an anonymous user or third party can track their position in real time.

It is interesting to look at the role of the stranger in society, as described in Section 2.4. From this related work we have shown that there is a tension between anonymity and intimacy and that locative media supports existing norms regarding these notions [36]. During our field trials, we saw similar results: users want to know who they share with, but at the same time location-based is most useful in unfamiliar places.

User might not directly see the consequences of automatically sharing their location with a photograph. When asked in the interviews, most users indicate that they are not really bothered by the fact that anyone can see the location of their photos, because the information presented on those photos is not very privacy-sensitive. However, some

users find it disturbing that they can be tracked in (relatively) real time when they share a photo to a public group. As long as users can control who get to see the photos, they don't mind sharing their location. This confirms previous work on privacy implications of locative media [15]. Still, users say it remains unclear who will be able to view a photo while sharing it through Picalilly.

7.5 User experience

The results of the AttrakDiff questionnaire show that Picalilly scores moderately positive on all dimensions. The word pairs *isolating - connective* and *seperates me - bring me closer* scored relatively high compared to the other word pairs. This suggests that Picalilly has the property to strengthen relation ships and bring people together. It is unclear how the location-based aspect relates to this. Participants indicated that they used Picalilly as a photo sharing application among a group of friends. This could have played a bigger role for the users than the location-based aspects of Picalilly. Picalilly scores below average on the word pairs *cheap - premium* and *undemanding-challenging*. The first word pair could be explained by the fact that Picalilly is still a prototype, not much effort has been spent to make the user interface look very attractive. This was also noticed by participants in the interviews. The second word pair might be a little ambiguous, both sides could be interpreted as positive and negative.

Picalilly was praised by the users for filling the gap on the market, with regard to photo sharing applications that allows users to form groups and to facilitate events. Therefore we would expect the hedonic quality (stimulation) to score high on the AttrakDiff questionnaire, but this was not the case. This could be explained by the way participants used the application, which is as a photo sharing tool for friends. A lot of this kind of applications already exist. Overall, users enjoyed using Picalilly as a photo sharing application and experienced location-based sharing as useful for events.

7.6 Usability issues

Although nearly all the functional requirements of the second prototype were met, there were still some usability issues with Picalilly. One of the most prevalent issues was the user session that expired after a while, requiring the user to log in again in order to use Picalilly. As some users indicated in the interviews, that is very undesirable for a smartphone application.

This is closely related to the way the participants use these kind of phone applications: if the user wants to actively use the application, he should be able to take a quick look at the new things that have happened and then be done with it. The statistics about Picalilly usage (Section 6.2.1) confirm this: users only look at a screen for about half a minute or even less. Interrupting the user's flow too much might demotivate him to use the application at all, which was the case for one of the participants.

Picalilly has acceptable usability according to the results of the UTAUT questionnaire, although there is room for improvement. Picalilly scored high in terms of effort

expectancy, facilitating conditions and self-efficacy. Users also indicated during the interviews that Picalilly was relatively easy to (learn to) use. The attitude towards using technology has a lower score, but is still average. This could be explained by some of the issues explained in the previous paragraph.

The lowest scoring item was *the system makes my life more interesting*, which could be explained by the way Picalilly was used in the users' everyday life. It is not something they need to maintain relationships. Instead, users described Picalilly as an entertaining application they use now and then to see what is happening around them. Anxiety was one of the lowest scoring constructs, which means users were not afraid to make mistakes while using Picalilly. The other low scoring construct is the behavioural intention to use the system. As described in Section 6.2.2, users do not expect they will continue using Picalilly after the trial, either because they are not too interested in location-based services or because their friends are already using similar social network sites. A possibility could be to integrate Picalilly with other social media.

7.7 Comparison of Picalilly prototypes

The second prototype of Picalilly was used more intensively than the first prototype. More photos were shared due to a larger number of users, who were also more active. One of the reasons for the difference in activity could also be that the participants of the first trial were too busy with their introduction program too pay attention to Picalilly. Where the first trial mainly resulted in photos about the Kick-In program, the second trial showed personal stories and various events over a larger time span.

Still, the two field trials showed interesting results about the way locative media is used. Both featured examples of users that shared photos to location based groups to show what is going on around a particular area. However, in the second user trial, it was observed that users preferred non-location-locked groups for sharing photos with a group of close friends. Results showed that there is a clear distinction between the types of groups, which is reflected in the perceived usefulness of location.

8 Conclusion

For this study we looked at many different aspects of locative media. Two prototypes of a location-based photo sharing application called Picalilly were designed, implemented and evaluated in order to investigate the effects of locative media on the sharing behaviour of its users.

Two longitudinal field studies were conducted to see the effects of locative media, which let the participants use Picalilly as they would use any other social media application. The participants were interviewed and questionnaires were taken to gather data about user experience, usability and acceptance of Picalilly.

The results of the evaluations showed that location-based sharing is only useful in particular situations. Users indicated that they would find it most useful for events such as festivals and parties. When Picalilly is used to share photos among a close group of friends, the location constraint will only bother the users. Users indicated they liked to see what is happening in their surroundings when they join a location-based group. The type of photos shared through Picalilly varied from portraits or groups of friends to funny looking objects to overview photos of events and happenings. The reasons why people share these photos include informing other people that are not present, entertaining others, creating an overview of an event and memorizing a location.

Picalilly was not regarded as crucial for maintaining personal relationships, but it can be used to stay up-to-date with geographically dispersed friends. Picalilly is a typical example of a smartphone application: users want to be able to get an overview of relevant information quickly. Only if a user really wants to know more about a group or a location, he might put more effort into finding this information. The ease of use and interaction flow can determine the success of such an application.

Users would join a group if there are a lot of people they know and if they are interested in the common theme of that group, which could simply be the location itself or something that is happening in that area. A group of unknown people would only be joined when the user wants to learn more about the location. The users preferred to know who they were sharing with and who could see their photos and they adjusted the type of information they shared based on this knowledge.

In general we can say that locative media is most useful when the user has only little knowledge of the context of message that is shared. The location can be helpful in several ways, for filtering information that might be interesting to the user, for exploring unknown locations or even rediscovering familiar places. Locative media has only minor use when applied for personal communication. The only uses for social information sharing among friends that we found during this research are the *"I am now here"* type of messages that users can send to each other in order to arrange a congregation or to memorize where past events took place.

There are some privacy related issues that might determine the future of locative media. In this research, the users often indicated that they would like to use location-based sharing for events. However, users also indicated that they want some form of control over who they share their information with and who has access to it. In some

cases, the users only wanted to share with the people they know. We have not found significant evidence that users might be willing to sacrifice a part of their privacy in return for more contextual information about a location.

The kind of information that people shared was not very privacy-sensitive. To most users it did not matter who could see it, because they did not care too much about it. However, they do want to be able to control their privacy settings. Most users would also not appreciate it if they could be tracked by the system at all times, even if that allows them to see where their friends are.

In this respect, locative media applications would be most successful in a situation where its users are co-located temporarily in a fixed location and where the users remain anonymous at all times.

8.1 Future work

It might be interesting to perform a user study on an existing community of a locative media application and compare the results to this research on Picalilly. Although the second user trial was on a larger scale than the first, it still doesn't come close to the size of a real life social network. We feel that we have not reached the full potential of Picalilly in this research with regard to location-based sharing. Picalilly was used as a 'normal' photo sharing application by some users, ignoring the location-based aspects. An application in which the location-based aspects are more prominent might show more diverse results. Since Picalilly was designed for the context of events, the effects of using this kind of application could be further investigated if it was tightly coupled to a particular event (or even multiple events on different locations). It could be investigated how users react to locative media when the content they share is shown on a large screen display in a central place.

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Appendices

A Picalilly requirements

In this appendix, the functional requirements for the Picalilly system are presented. The MoSCoW method is used to prioritize the requirements [7].

Table 3: This table identifies every requirement with a number and shows the priority of it. The meanings of the priorities are: (M = must have; S = should have; C = could have; W = would have).

ID	Requirement	Priority			
		M	S	C	W
R1	The system shall allow the user to upload a photograph to the server and create a record of this photograph in the database.	x			
R1.1	The system shall allow the user to take a photograph using the device on which the system is installed.	x			
R1.2	The system shall be able to handle and upload photographs that are stored on the device.		x		
R1.3	The system shall allow the user to assign the photograph to a group, which is stored in the database.	x			
R1.4	The system shall allow the user to write a description of the photograph, which is stored in the database.		x		
R1.5	The system shall record the user's geographical location where the photograph is uploaded and store it in the database.	x			
R1.5.1	The system shall allow the user to manually select his geographical location through a map interface.			x	
R1.6	The user should be able to add tags that describe the photograph.				x
R2	The system shall present the groups to the user of which he is a member.	x			
R2.1	The system shall present the photographs that were shared to this group to the members of this group.	x			
R2.2	The system shall allow the user to become a member of a group, if this group is a public group.		x		
R2.2.1	The system shall allow the user to resign his membership of a group that he previously was a member of.			x	
R2.3	The system shall allow the user to invite other users (who are not yet a member of this group) to become a member this group.	x			

		M	S	C	W
R2.4	The system should be able to let the user create a new group, which will be stored in the database	x			
R2.4.1	The user should be able to specify a name for the group.		x		
R2.4.2	The user should be able to select a geographical location for the group on a map interface.	x			
R2.4.3	The user should be able to choose whether the group's visibility to uninvited members is public or private.		x		
R2.5	The creator of a group should be able to remove the group.			x	
R2.6	The user should be able to change the privacy settings and location of a group after it is created.				x
R2.7	The system should be able to present an overview of groups that the user is not a member of.		x		
R2.7.1	The user should be able to prioritize location bound groups near the user's physical location above non-location-bound groups.		x		
R2.8	The creator of a group should be able to change the group icon by taking a photo with the device.			x	
R3	The system shall allow the user to create multiple subscriptions on another user and/or a geographical area.		x		
R3.1	The user should be able to see all photos that are relevant to each subscription in a photo gallery.		x		
R3.2	The user should be able to remove a subscription.			x	
R3.3	The user should be able to change the location and person settings after it is created.				x
R4	The system shall allow the user to add other users to this friends list.			x	
R4.1	The user should be able to accept or decline friend list invites by other users.			x	
R4.2	The system should display an overview of the user's friends and their photos.			x	
R4.3	The user should be able to remove a friend from his friends list.				x
R5	The system shall present publicly visible photographs and groups to the user on a map interface.		x		
R5.1	The system should show the boundary of groups in the visible region on the map interface.		x		
R5.1.1	The system should display information about a group when the user selects it from the map interface.		x		
R5.2	The system should show the location of photos that are within the visible region as markers on the map interface.		x		
R5.2.1	The system should display information about a photo when the user selects it from the map interface.		x		

		M	S	C	W
R5.3	The system should display the user's physical location in the form of a marker on the map.		x		
R6	The user should be able to sign in to his account using his personal credentials that are stored in the database.		x		
R6.1	The user should be able to log in using existing credentials of other organizations (Google, Facebook).				x
R7	The system shall display detailed information about a photograph that is stored in the database to the user.		x		
R7.1	The system should display the name of the creator and timestamp of the photo.		x		
R7.2	The system should allow the user to see the photo in its original size.			x	
R7.3	The user should be able to see the location of the photograph on a map interface.		x		
R7.4	The user should be able to 'like' the photo.		x		
R7.5	The user should be able to indicate that he is currently at the physical location of the photo by 'spotting' the photo.		x		
R7.6	The user should be able to leave a comment about the photo.		x		
R7.6.1	The system should display all comments about a photo.		x		
R8	The user should be able to access help functionality from every screen.		x		
R9	The system should notify the user when a photo is shared through Picalilly to a group the user is a member of or to a relevant subscription.	x			
R9.1	The user should be able to configure for what kind of events he wants to receive notifications.		x		
R9.2	The system should redirect the user to the relevant photo or group if he wants to know more about it.		x		

B Cognitive walkthrough

B.1 Task scenario

During the cognitive walkthrough that was conducted at the start of the second design phase, the user was asked to complete the following tasks.

1. Register an account on the Picalilly website and log in to the application.
2. Join the group called “Utwente”.
3. Look at the picture showing a pool in the “Utwente” group.
4. Try to find the location of the “Utwente” group.
5. Invite the user named “Edwin” to your friends list.
6. Create a new location-locked group called “Test” and select a location for it.
7. Add the user named “Edwin” to this group.
8. Share a photo to this group.
9. Add a comment to the shared photo.
10. Create a subscription for user Edwin for the campus area of the University of Twente.
11. Look at the photos from the subscription you just created.
12. Try to find photos in your surroundings.
13. Try to find a photo of a beer bottle near the center of the city of Enschede.

B.2 Results

The results of both user tests are listed below. The numbers correspond to the tasks in the scenario described above. Whenever the user completed a task without any issues, the result is described as "OK".

User 1

1. Whitespace should be stripped from the login fields or the user can not login. The user suggests to change the landing page (currently the "groups" page) after the user logs in to a "news feed" that shows the most recent activity of his friends.
2. OK.
3. The user understands the UI showing the photo details, only the icons below the photo are unclear. It is not clear that the star icon represents a 'liked' photo. The red icon (showing the number of updates) in the group overview is a little unclear, the user does not understand what it means.
4. OK.
5. When a user sends a friend invite to another user by whom he was just invited, then the other user is still notified incorrectly and asked for confirmation.
6. The user was unable to select a location on the map interface, since he was missing the Google Services software on his device. After a manual update, the user could continue his task. The user would like to resize the selected area for the group, instead of the currently visible screen area. The user suggests adding draggable markers on the corners of the area. After creating the group, the user indicates that he would like to change the group settings, such as the location or the public/private flag. The user is unable to change the group icon, since the camera gets stuck on the camera screen.
7. The user was unable to view photos of his friends, the message 'you are not a member of this group' was displayed.
8. OK.
9. The user started writing his comment and rotated his phone in order to type on his hardware keyboard. This crashed the application.
10. OK.
11. OK.
12. It is unclear what the colours of the group boundaries and photo markers relate to. The user would like to find information about the group from the map interface, but there currently is no option to do so. It is confusing to the user that the photo markers disappear when the map is zoomed out.

13. OK.

User 2

1. While the user is exploring the different tabs, he suggests to move all on screen buttons into the overflow menu, to save up space on the screen.
2. The user find the "Utwente" group but can't figure out how to join the group from the detail page, since there is no "join" button. The application crashed when the user tried to click a button when the content has not completed loading.
3. OK.
4. OK.
5. The user suggests adding a search bar to make it easier to find users in a large list.
6. OK.
7. The user presses the "back" button on the device and presses the "select location" button again to clear the selected area for a group, instead of simpy long-pressing the map twice. The user tries to rotate the map's orientation to select the shape that wants. He succeeds in doing so, but the application incorrectly calculates the rotation. The user accidentally presses the "send" button twice, which causes the group to be duplicated.
8. The user was unable to share a photo to a group; the application crashes after the photo is taken. This is most likely a hardware specific issue.
9. OK.
10. OK.
11. OK.
12. The users immediately mentions that there are too many markers on the map, making it too crowded. The user suggests adding filtering functionality for group/friends'/everyone's photos.
13. OK.

C First user trial

C.1 Interview script

In this appendix, the questions that were used during the semi-structured interview of the first user trial are listed.

1. How do you feel about the concept of sharing photos from a location?
    - What are the advantages/disadvantages of location based sharing?
2. Did the location constraint ever bother you or prevent you from sharing a photo?
3. Was there any difference in photos that you shared to different groups, e.g. did you post different pictures to a private group than to a public group?
4. Would location-based sharing influence your privacy any different from normal sharing?
5. Did location based sharing give you any extra information? Can you imagine how it can give extra information? Would it be useful?
6. Did you notice a difference between groups that are location bound and those that are not?
7. Does the fact that groups are locked to a location change anything to the type of pictures? Is there a clear 'theme' for each group or are the pictures just random?
8. Do you think that subscriptions bound to a location give you any new information? Or do they help in any other way?
9. In what situation would you join/create a location based group? And when would you subscribe to a particular location?
10. Did the photos that you saw influence anything about the location?
11. How did you react to photos or groups of other people? Why did you share to groups that you did not create?
12. How would you use Picalilly in your everyday life? Can you name situations where location based sharing would help in photo sharing?

D Second user trial

D.1 Interview script

1. What was your general impression of Picalilly? Did it work as expected?
2. How do you feel about the concept of sharing photos from a location?
    - What are the advantages/disadvantages of location based sharing?
3. Did the location constraint ever bother you or prevent you from sharing a photo?
4. What method did you mainly use to look at photos you want to see? (news/map/group list)
5. How did you feel about the idea of location based groups?
6. Did you notice a difference between groups that are location bound and those that are not?
7. Does the fact that groups are locked to a location change anything to the type of pictures? Is there a clear 'theme' for each group or are the pictures just random?
8. In what situation would you join/create a location based group?
9. Did you subscribe to a person or location?
10. When would you subscribe to a particular location or location?
11. Do you think that subscriptions bound to a location give you any new information? Or are they useful in any other way?
12. Were you ever concerned about your privacy? About who could see your photos?
13. Would location-based sharing influence your privacy any different from normal sharing?
14. Was there any difference in photos that you shared to different groups, e.g. did you post different pictures to a private group than to a public group?
15. Did location based sharing give you any new information? Can you imagine how it can give extra information? Would it be useful?
16. Did the photos that you saw influence anything about the location?
17. How did you react to photos or groups of other people? Why did you share to groups that you did not create?
18. On what kind of moments do you decide to take and share a photo? How does the location-based aspect influence this?

19. Does the location-based aspect of sharing change anything about the way you communicate with other people?

20. How would you use Picalilly in your everyday life? Can you name situations where location based sharing would help in photo sharing?

D.2 Picalilly questionnaire

1. Age:

---

2. Sex:
O Male
O Female

3. For what purposes do you usually use your smartphone?

---

4. How much experience do you have with the following concepts?

	Very little							Very much		
Smartphones	O	O	O	O	O	O	O	O	O	O
Social Media	O	O	O	O	O	O	O	O	O	O
Mobile internet	O	O	O	O	O	O	O	O	O	O
Locatie based services	O	O	O	O	O	O	O	O	O	O

5. Please indicate how you would describe Picalilly, using these word pairs.

predictable	O	O	O	O	O	O	O	unpredictable
cheap	O	O	O	O	O	O	O	premium
connective	O	O	O	O	O	O	O	isolating
practical	O	O	O	O	O	O	O	impractical
captivating	O	O	O	O	O	O	O	dull
repelling	O	O	O	O	O	O	O	appealing
unpleasant	O	O	O	O	O	O	O	pleasant
unimaginative	O	O	O	O	O	O	O	creative
attractive	O	O	O	O	O	O	O	ugly

6. Please indicate how you would describe Picalilly, using these word pairs.

tacky	O	O	O	O	O	O	O	stylish
alienating	O	O	O	O	O	O	O	integrating
likeable	O	O	O	O	O	O	O	disagreeable
inviting	O	O	O	O	O	O	O	rejecting
cumbersome	O	O	O	O	O	O	O	straightforward
clearly structured	O	O	O	O	O	O	O	confusing
conservative	O	O	O	O	O	O	O	innovative
bold	O	O	O	O	O	O	O	cautious
simple	O	O	O	O	O	O	O	complicated

7. Please indicate how you would describe Picalilly, using these word pairs.

bad	O	O	O	O	O	O	O	good
discouraging	O	O	O	O	O	O	O	motivating
brings me closer	O	O	O	O	O	O	O	separates me
presentable	O	O	O	O	O	O	O	unpresentable
unprofessional	O	O	O	O	O	O	O	professional
unruly	O	O	O	O	O	O	O	manageable
inventive	O	O	O	O	O	O	O	conventional
undemanding	O	O	O	O	O	O	O	challenging
ordinary	O	O	O	O	O	O	O	novel

8. Please indicate whether you agree with the following statements.

	Fully disagree						Fully agree
My interaction with the system would be clear and understandable.	O	O	O	O	O	O	O
The system is somewhat intimidating to me.	O	O	O	O	O	O	O
I would find the system easy to use.	O	O	O	O	O	O	O
It scares me to think that I could lose a lot of information using the system by hitting the wrong key.	O	O	O	O	O	O	O
I intend to use the system in the next month.	O	O	O	O	O	O	O
Working with the system is fun.	O	O	O	O	O	O	O
The system is not compatible with other systems I use.	O	O	O	O	O	O	O
Learning to operate the system is easy for me.	O	O	O	O	O	O	O

9. Please indicate whether you agree with the following statements.

	Fully disagree						Fully agree
The system makes my life more interesting	O	O	O	O	O	O	O
I predict I would use the system in the next month	O	O	O	O	O	O	O
I could find the location of a photo on the map using the system If I had a lot of time to complete the job for which the software was provided	O	O	O	O	O	O	O
I plan to use the system in the next month	O	O	O	O	O	O	O
I have the resources necessary to use the system	O	O	O	O	O	O	O
I hesitate to use the system for fear of making mistakes I cannot correct	O	O	O	O	O	O	O
I could find the location of a photo on the map using the system If I could call someone for help if I got stuck	O	O	O	O	O	O	O
I have the knowledge necessary to use the system	O	O	O	O	O	O	O

10. Please indicate whether you agree with the following statements.

	Fully disagree						Fully agree
I like working with the system	O	O	O	O	O	O	O
I could find the location of a photo on the map using the system If there was no one around to tell me what to do as I go	O	O	O	O	O	O	O
Using the system is a good idea	O	O	O	O	O	O	O
It would be easy for me to become skilful at using the system	O	O	O	O	O	O	O
A specific person (or group) is available for assistance with system difficulties	O	O	O	O	O	O	O
I feel apprehensive about using the system	O	O	O	O	O	O	O
I could find the location of a photo on the map using the system If I had just the built-in help facility for assistance	O	O	O	O	O	O	O

11. Do you find it useful to automatically share your location in combination with the photo that you want to share? Why?

---

12. How do you feel about the concept of sharing photographs to location based groups?

---

13. Were you ever concerned about your privacy while using Picalilly? If so, could you indicate why?

---

14. Do you have any final remarks about Picalilly or location based photo sharing in general?

D.3 Results of the UTAUT questionnaire

These tables show the mean value for each question and total per construct of the UTAUT questionnaire. The questions were answered on a seven point scale, where a score of 1 represents *Completely disagree* and a score of 7 represents *Completely agree*.

Effort expectancy	Mean
My interaction with the system would be clear and understandable.	4.93
It would be easy for me to become skilful at using the system.	5.67
I would find the system easy to use.	4.67
Learning to operate the system is easy for me.	5.53
Total	5.20

Attitude towards using the technology	Mean
Using the system is a good idea.	4.53
The system makes my life more interesting.	3.40
Working with the system is fun.	4.33
I like working with the system.	4.20
Total	4.12

Facilitating conditions	Mean
I have the resources necessary to use the system.	5.93
I have the knowledge necessary to use the system.	6.00
The system is not compatible with other systems I use.	4.13
A specific person (or group) is available for assistance with system difficulties.	5.00
Total	5.27

Self-efficacy	Mean
I could find the location of a photo on the map using the system If there was no one around to tell me what to do as I go.	5.27
I could find the location of a photo on the map using the system If I could call someone for help if I got stuck.	4.27
I could find the location of a photo on the map using the system If I had a lot of time to complete the job for which the software was provided.	4.47
I could find the location of a photo on the map using the system If I had just the built-in help facility for assistance.	4.87
Total	4.72

Anxiety	Mean
I feel apprehensive about using the system.	2.8
It scares me to think that I could lose a lot of information using the system by hitting the wrong key.	2.2
I hesitate to use the system for fear of making mistakes I cannot correct.	1.93
The system is somewhat intimidating to me.	3.33
Total	2.57

Behavioural intention to use the system	Mean
I intend to use the system in the next month.	2.93
I predict I would use the system in the next month.	3.00
I plan to use the system in the next month.	2.87
Total	2.93