# Rethinking Reminders: The Design and Evaluation of a Mobile Islamic Call to Prayer Application

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**Abstract.** Within the ubicomp and related communities two areas are receiving attention, mobile phone-based reminders and techno-spiritual practices. We explore the relationship of these through the development and real world deployment of "sun dial," a mobile Islamic call to prayer application that alerts American Muslims to daily salāt times. We describe the design, a formative evaluation, and a two-week exploratory user study. Our findings suggest that: graphical imagery helped our participants connect to their faith; there is an important difference between the right prayer time and the right time to pray; and suggest a reconsideration of location as a reminder cue. We conclude with a discussing our study's broader implications for ubicomp research and some lessons learned about mobile development for techno-spiritual purposes.

# **1** Introduction

As computers use has left the office and entered homes and public spaces, so ubiquitous computing has been presented with new design opportunities and challenges. Research in this area has expanded to incorporate an examination of values and beliefs that shape how people want to use computers in their professional and personal lives. Most recently, this has broadened to include the recognition that many people want to incorporate technology into their spiritual practices.

This paper contributes to this growing area of research by reporting on the design and evaluation of an application that prompts Muslims to their daily prayer times. "Sun Dial" is a mobile application that relies on visual and auditory cues to alert American Muslims to their five daily prayer times. We wanted to focus on American Muslims, in part, because the societal cues more evident in predominantly Islamic cultures are lacking in our [anonymous city][4, 34].

We begin by reviewing previous research examining reminder systems and religious uses of technology. Following that we provide an overview of Muslim prayer practices, sun dial's development process and findings from a formative evaluation. Our broader findings focus on the 2-week real-world deployment of our mobile call to prayer system with American Muslims. The findings showed that: graphical imagery helped our participants connect to their faith, there is an important difference between the right prayer time and the right time to pray, and suggest a reconsideration of location as a reminder cue, and how prompts can suggest identity. We conclude with a discussion of the implications for ubicomp research, and some lessons learned about mobile development for techno-spiritual purposes.

# 2 Background and Related Work

Our research lies at the intersection of two bodies of related work. The first focuses on the design and deployment of reminder systems–although prayer times might seem unusual to characterize in this way—technologically speaking the system that designed shared characteristics with its more secular counterparts. The second consists of recent literature demonstrating how understanding users' *techno-spiritual* practices can inform the design of ubiquitous computing systems. Specifically, this literature argues that considering religious practice is not only instructive for the innovations that result–but provides a lens for reconsidering what computing means. Thus, exploring techno-spiritual practices opens us up to an examination of alternatives that might be harder to identify from just purely considering secular design domains. Prior research examining reminder systems and techno-spiritual practices has treated them as separate topics. In this paper, we seek to fill this gap in our knowledge with an empirical study of Muslims' religious practices and how they can contribute to the development of a novel ubiquitous computing application.

#### 2.1 Reminder Systems

Within the ubicomp and related communities, reminder systems typically serve to assist users with prospective memory tasks, also known as "the ability to remember to remember" [41]. Examples of this include remembering to go to a meeting at a certain point in time, to buy milk at the grocery store, or to mail a bill. These systems have tended to focus on using event, or context-triggered notifications to perform these actions [14]. These notifications are often associated with events that have scheduled start and end points and serve to proactively gain a user's attention, with the purpose of cueing them about upcoming events. Much of the research in this area has revolved around building sensing and context aware systems to feed reminder applications.

As research examining reminder systems extends beyond the office and home, there is a corresponding growth in interest in exploring how mobile phones can be used to remind people of prospective memory tasks [23, 35]. An assumption embedded within these systems is that location or some other contextual information is the primary factor in determining when a reminder is appropriate. Indeed, location is critical, however as reminder systems become more present in everyday life comes a need to consider additional factors. Previous systems have used a fixed reminder that was dictated by the computational system—in other words, the machine takes total responsibility for reminding its user. However, in some cases it may be desirable for technology to play a more assistive role instead of taking over a task completely. Instead of acting on behalf of the user, technology can "displace" certain contextual cues so that the user can take an explicit action on their own without having to be strictly reminded [27].

## 2.2 Religious Technologies

Our work is also guided by the growing interest in non-secular uses of computing and particularly prospective memory's role in prayer. In our prior research examining technology use among senior pastors of large Christian churches, we found that remembering prayer requests is an important, yet challenging aspect of their jobs [41]. Some pastors relied on e-mail, while others used the contact lists on their mobile phones to help them remember parishioners in need of prayer requests.

Recently, Bell has urged designers to consider the widespread appropriation of technology for religious purposes and suggests that doing so will open new space for novel computing applications [7, 8]. Specifically, she argues that by engaging with "techno-spiritual practices," ubicomp developers can begin to incorporate a wider set of values into their work, particularly ones unrelated to speed, efficiency, and production. In this sense, she suggests that techno-spiritual practices have the potential to *defamiliarize* assumptions embedded in technology development, thus opening new space for design [9].

Other researchers have begun to explore how users' spiritual practices can inform the development of ubiquitous computing environments. Woodruff *et al.*[42] interviewed Orthodox Jewish families who use automated technology to adhere to the Sabbath code of conduct prescribed by Jewish law in their homes. Their findings offered design implications including offering users less control over their domestic devices, thus contradicting traditional wisdom that argues for a high degree of end user control. Indeed, examining Orthodox Jew's religious practices prompted them to consider a richer set of options in the design space.

Since we wanted to understand what designing an application to support prayer practices, we decided to examine Muslims, a group we considered to be an "edge case" in this area [39]. Muslims pray five times a day in a structured and scheduled manner. In addition to their prayer schedule, they have also historically relied on various analogue and digital systems to support this ritual (e.g., compasses, telescopes, computer widgets). For example, previous research examining Islamic uses of technology has highlighted Muslims' scientific contributions to mathematics, physics, and astronomy, achievements that have partially stemmed from their desire to know Mecca's location and the sun's location for salāt [2, 22]. Because prayer is an activity that is fully integrated into Muslims' lives, they present a wonderful opportunity for a study of how to design and evaluate technology used to support religious practices.

# **3** An Introduction to Muslims and Prayer

There is some debate regarding the exact figures, but there are an estimated 1.2 billion Muslims worldwide. Though the number of Muslims in the United States is relatively small (estimated to be between 2 and 9 million), Islam is growing and some figures suggest that within the next ten years there will be more Muslims than Catholics in the United States [15]. This mirrors growth elsewhere and is one reason why Islam is widely considered one of the world's fastest growing religion [4, 13, 14].

Muslims differ widely in terms of their traditions, schools of thought, and sects (i.e., Sunni, Shi'ite, and Sufi), but one thing that remains consistent among all is an adherence to "The Five Pillars of Worship," or the basic acts all Muslims are expected to fulfill during their lifetimes. They are: confession of faith; giving charity to the poor and needy; fasting in the month of Ramadan; making at least one ritual pilgrimage to Mecca; and performing ritual prayers or *salāt*.<sup>1</sup>

Salāt is the term commonly used to describe the five daily Islamic prayers. Most Muslims would agree that, regardless of the degree of their own conformity, regular performance of the salāt is required of them [11, 15]. Prayers are done to raise one's mind to God in supplication, praise, thanksgiving, and to seek his forgiveness. The frequency is set forth in the Qur'an; it is done so that no more than a few hours pass, before a Muslim is called to turn to God in prayer. Salāt times are worked out according to the passage of the sun. They slightly differ from day to day in response the sun's location and to worshipers' geographic position. The five times are: *fajr*, before sunrise; *zuhr*, a little after the sun has passed its zenith; 'asr, in the later afternoon when the shadows lengthen; *maghrib*, directly after sunset; and 'isha at nighttime.

The prayer ritual begins with the *adhan*, or call to prayer. Following the call, Muslims wash their bodies and perform three or four ritual cycles called *raka'ahs* facing Mecca. Each prayer cycle is comprised of a sequence of movements that include standing, prostrating, kneeling, sitting, and reciting fixed Arabic texts. Salāt does not need to take place in a mosque; it can take place at home, work, or an open park. Prayer times vary in length according to how much time the worshipper has and can last anywhere from a few minutes to much longer.

# 4 Design and Formative Evaluation of a Mobile Islamic Call to Prayer Application

The design and evaluation of our application had three phases. First, motivated by our interest in Muslim prayer practices and technology we used "rapid ethnography" to quickly gain a reasonable understanding of our topic and to inform a series of design concepts [24]. The techniques employed included an interview with a prominent Islamic scholar at a local University, multiple interviews with Muslim students, observations at two mosques, and a survey of related literature. We then brainstormed multiple concepts and based on user feedback—from Muslims—decided to develop a call to prayer application for mobile phones. The projects' initial phase lasted 4 weeks.

The second phase involved the development, design, and formative evaluation of a prototype system. The formative evaluation was done with Muslims students at our university. During the project's third phase we embarked on a longer-term evaluation to understand our application's broader usefulness to the American Muslim community and to compare two interface designs. The findings we report in this

<sup>&</sup>lt;sup>1</sup> We use the term *sālat* throughout our paper. The Turkish and Persian equivalent is *namaz*, while *sembahyang* is commonly used in Indonesia.

paper, come from this long-term evaluation, and consequently in the remainder of this section we will discuss the second and third phases—the context for those results.

## 4.1 Development: Surveying Existing Salāt Computer Programs

During the project's development stage we reviewed existing digital systems used to support Muslim's prayer practice while continuing to interview members of our user group. It was during this phase we identified the need for a system designed specifically for American Muslims.

Given that Muslims are open to technological innovation and that Islam is the growing, it is not surprising that a variety of digital applications exist to support the salāt ritual or that novel ones are being developed (e.g., Ozenc's "digital prayer rug" [26, 33]). There are multiple computer programs, handheld devices, and websites that provide the *qibla* (direction to Mecca), prayer times, recordings of the adhan, and directions on how to pray (see [11] for an overview). Recently, the mobile phone has been adopted as a platform to alert Muslims to daily prayer times.

The system that has received the most attention is the Ilkone i800 [6, 10, 19, 33]. Introduced in 2004, it is described as "the first fully Islamic mobile phone" and as "a place where spirits and emotions come alive" [45]. The phone's form factor and interface looks and feels like a commonly seen flip style handsets. Daily prayer times are presented in static list adjacent to an image of the sun (Fig. 1 (G)). In addition, to the call to prayer application, the phone has other features including the full text of the Qur'an, an automatic pointer showing qibla, and a Ramadan calendar. The phones' manufacturer reports that sales are in the tens of millions and are expected to



Fig. 1. Screen shots and names of existing mobile phone prayer application

grow [10, 16, 45]. Though the Ilkone i800 is not currently available in the United States and Canada there are plans to offer them to Muslims in North America soon [45].

We surveyed seven other mobile phone salāt programs to inform the design of ours in addition to the Ilkone i800 (Fig. 1). Though, we could find no scholarly data describing how widespread these systems are, evidence from popular media and developers' websites suggests that their use is growing rapidly in the Middle East and Europe [3, 18, 21, 25, 30, 31]. Through personal communications with the developers of these systems, we learned that unlike in North America, cell phone platforms are more stable in Europe and the Middle East, making it easier for users to download various programs to their phones [1, 20]. American Muslims we talked to throughout the project—many who were highly technical students at our university—described being aware of these programs, but not having one on their mobile phones.

We speculated that platform variances, the fact that these applications were not advertised by American mobile phone providers and social differences between how Islam is understood in the United States compared to abroad partly explain why salāt systems are not widely used among American Muslims. Reviewing existing systems was useful for two reasons. First, it supported need for a mobile call to prayer system existed. Second, it motivated us to explore the cultural and social differences between being Muslim in the United States and in a predominantly Islamic country.

## 4.2 Design: The Sun Dial Interface

Understandably (though perhaps overlooked in the design of previous Muslim prayer applications), practicing Islam is different in the United States than in countries where it is the dominant faith. In Saudi Arabia, television programming halts during salāt, the adhan's melodic chant, and pointers indicating the qibla are ever present parts of the environment [40]. In Indonesia, Pakistan, and Iran, Muslims comprise 80 to 99 percent of the population as compared to the Unites States where they are estimated to make up less than one percent [12, 22]. Additionally, Islam and its practices are perceived as being misunderstood in the United States, particularly within student populations [36] and the American south [4]. These environmental and community differences presented an opportunity to design a system for American Muslims.

After reviewing established systems and developing concepts for a new one, we met again with Muslims students. We conducted two informal focus groups and three observations of prayer sessions held on our campus. In total, 15-20 Muslim students attended the prayer sessions and 5 different students attended each focus group. Following the congregational prayer sessions, we conducted the focus groups and asked more questions about salāt. We learned that prayer times take place during a "window of opportunity," rather a precise time. Once the sun reaches its appropriate location, Muslims typically have 15-20 minutes to perform salāt. Praying in a mosque was not imperative; instead it was important that the setting be clean and free of distractions. We observed, and Muslims described the multiple steps that accompany salāt ritual. First, they must know the time, cleanse their body, listen for the adahn, find Mecca, and then beginning the *raka'ah* cycles.

We also considered the existing strategies Muslims used to remember the five daily prayer times, since they slightly differ from day to day. All described using printed prayer calendars they obtained from their mosque or the internet, computer software, natural indicators (e.g., the sun, sky's color), and social cues (e.g., friend and family) to determine salāt times. With further questioning we learned that some Muslims preferred looking at the sun to know prayer times for two reasons. First, because doing so was more in-line with how the actual times are determined. Second, knowing the sun's location made them more cognizant of how "God's greatness manifests in nature." However, students said knowing the sun's location was difficult in urban areas for a number of reasons, including smog, bad weather, tall buildings, and being in windowless offices. Finally students described the benefits of having a call to prayer application on their mobile phones. Unlike personal computers or prayer sheets, students said they always had their mobile phones with them.

This information guided the development of our call to prayer application, sun dial (Fig. 2). The prototype was developed using mobile processing, a Java 2 Micro Edition (J2ME) programming language and environment that allows for fast development and the easy integration of graphics. The application was then downloaded onto a Nokia Series 60 phone, an appealing platform because of its advanced development environment and large screen.



Fig. 2. Sun Dial Interface As the sun moves from east to west the screen background changes color to mimic the changing colors in the sky.

The interface depicts a moving sun, the sky, Arab text indicating the 5 prayer times, and a silhouette of a mosque. The sun passes through the sky mimicking how natural movement. As it moves closer to a prayer times (e.g., fajr, dhuhr, 'asr, maghrib, and 'isha) the background begins to lighten. During the prayer time a subtle burst of light fills the screen and quickly disappears. Throughout the day the sky's color changes much like it does naturally (e.g., the background is dark blue in the morning and evening and yellow during the day). Prayer times were hard-coded into the phone and taken from a popular and reliable website widely used by Muslims to know prayer times, http://www.islamicfinder.com. In addition to wanting to imitate the sun's natural movement, other factors informed our design decisions.

Not wanting to communicate precise times like existing applications, the sun dial gently prompts users to realize a prayer time is approaching. We believed that relying on graphics instead of text or numbers on a clock more appropriately reflected our understanding that salāt is flexible and open-ended rather than a precise and rigid event. The Arabic text and mosque were placed on the interface because they are

commonly associated with Islam and frequently seen on prayer rugs. Unlike existing interfaces that tended to be cluttered with information about past and future prayer times, the sun dial's interface was kept as simple as possible. This decision reflected our understanding that prayer is a time of intense concentration and should be free of distraction.

We felt that existing interfaces more closely resembled the interfaces of other types of reminder systems (i.e., rigid tables, predominately text rather than graphics) and that by grounding our design in an awareness of American Muslims' practices related to the salāt opened space for a dramatically different design.

## 4.3 Formative Evaluation

Upon completing a working prototype of our system, we evaluated it with Muslim students at our university. We wanted to understand users' experiences with the application and to gather requirements that could contribute to further iterations. The findings from this influenced design modifications, which we made to the system before deploying it for a more formal evaluation.

**Method.** Following a one week deployment among the research team to identify any high-level technical problems with the application, we recruited 4 Muslim students to evaluate the sun dial. Participants were given a Nokia series 60 mobile phone with the application running on it. We asked them to treat the phone as their own for the duration of the study. Their SIM cards and contact information were transferred to the new phone making this more likely [29].

Wanting to understand user's daily experience with the application we employed a voice-mail diary technique to collect data [28]. This involved sending questions to participants' phones via SMS after the daily evening prayer during the deployment. Questions were designed to elicit different kinds of information that would be useful in determining users' reactions to the application. On the first day, we inquired into whether or not the system was functioning correctly. On the following days, we asked users to describe what happened during a specific prayer time, if the system impacted their routine prayer practices, and we requested that they describe their overall experience with the system. Once participants received the text message they were instructed to dial a number and leave a voice recording answering the question. At the end of the study, we conducted an informal focus group with the participants to get more feedback.

**Results.** We received 10 voice mail responses during the 4-day evaluation period. Due to scheduling conflict not all participants were able to respond to questions each day. They ranged from 0:23 to 10:45 minutes in length, with the mean time being 2:45 minutes. Participants' responses were transcribed and team members independently read the transcripts looking for common themes. The following emerged: awareness, focus, and functionality. Participants described looking at their phone more often and paying particular attention to the interface when they were using it for other things (e.g., making a call or texting a message). Like we anticipated, the sun's subtle movement towards the prayer time alerted participants that salāt was approaching. Knowing this gave participants more time to prepare for prayer and thus be more focused when performing the raka'ahs. All commented on

the application's functionality. While they found it useful during some of the daily prayer times, it did not effectively alert them to all five. Because participants were not constantly observing their phones display the sun's subtle movement and change in background color was not sufficient enough to alert them. Participants suggested we include a vibration or auditory signal to complement the visual ones.

All noted the interface's attractiveness and agreed it was the application's best feature. But attitudes towards the Arabic text were mixed. Some participants did not understand it because it was too small and/or because the user did not read Arabic.

**Changes to interface and platform.** Based on these findings, we made changes to the system. Responding to participants' desire for a more robust alert we added a digital clock on the interface's upper left corner, a vibration, and a digitized auditory adhan. An 18 second segment of the Arabic call was downloaded from the internet and programmed to play during prayer times. Accompanying this change came custom menu controls to enable or disable the vibration and audio features. We replaced the Arabic text with green circles, which supported our initial desire to develop an interface that communicated a window of opportunity, rather than communicating a precise time to pray. We chose to make the circles green because it is a color that is traditionally associated with Islam [13]. Some of these changes contradicted out original intent (*i.e.*, to create a subtle system without using text), however because all study participants desired these features we implemented them. Finally, in order to implement the sound, vibration, and menus, we transitioned from mobile processing to Java 2 Micro Edition (J2ME) to develop the next iteration of our prototype.

# **5** Understanding Sun Dial and Prayer Practices

The formative study showed the feasibility and potential usefulness of the sun dial application in American Muslims' daily life. Wanting to further evaluate the application over a longer period of time and with a more diverse sample, we undertook a two-week deployment of the application with 10 American Muslims. This evaluation was also done for comparative purposes; we wanted to understand if our graphical interface with an auditory adhan, which was grounded in our understanding of Muslims' prayer practices, would be preferred over a text-based one with a digital "beep" and that more closely resembled interfaces of other mobile reminder applications.

## 5.1 Study Overview

The entire study was conducted over a 3-week period. As in our formative evaluation, we asked participants to carry the cell phone with them and treat it as their own for the study's duration. However, instead of using the phone for four days, we asked them to use it for three weeks. During the first week, we met participants, swapped their SIM cards, and copied information from their original phone to a Nokia mobile phone capable of running our application. We also provided a basic phone tutorial for all participants. We did not install the application at this time because we

wanted to participants to overcome the novelty of having a new phone, thus increasing the likelihood that they would treat it as their own during the following weeks.



Fig. 3: Graphical Interface (left) with Auditory Adhan and Text Interface (right) with Digital Beep

Ten American Muslims participated in the study (6 female, 4 male, ranging in age from 20 to 53 years). We recruited participants by posting flyers at local mosques and by sending e-mails to Muslim organizations in the [anonymous] area. Each received \$100 for completing the entire study. Our participants held a variety of occupations including a physician, school bus driver, retail salesperson and full-time homemaker (Fig. 3). None had used a mobile call to prayer application before. All identified as being Sunni Muslim; some had been practicing Islam their entire lives while two described themselves as converts. Participants had a variety of existing methods to assist them in knowing prayer times. Six used paper based charts, the second most common method was relying on natural indicators.

Participant	Gender	Age	Profession	Existing method(s) to know prayer times
1	М	52	Physician	Paper based prayer time chart
2	F	32	Bus Driver	Paper based prayer time chart
3	М	24	Graduate Student	Computer program that plays the adhan; alarm function on cell phone
4	F	53	Homemaker	Uses natural indicators (i.e. the sun in the sky); alarm function on cell phone
5	F	30	Unemployed	Computer program that plays the adhan
6	М	20	Undergraduate Student	Natural indicators (i.e. the sun in the sky)
7	М	31	Non-profit Coordinator	Paper based prayer time chart; natural indicators (i.e. the sun in the sky); social cues (i.e. friends and family)
8	F	53	Retail Worker	Paper based prayer time chart
9	F	32	Lawyer	Paper based prayer time chart; natural indicators (i.e. the sun in the sky); social cues (i.e. friends and family); internet
10	F	21	Undergraduate Student	Paper based prayer time chart

Fig. 3. Participant Demographics

In the second week, we met participants and installed either the text -or graphicsbased application onto their mobile phone. We then demonstrated how the system worked and showed participants how to enable or disable to auditory and vibration alerts. At this time we administered a survey to gather demographic data and information about users' prayer practices. The text- and graphics-based applications were counterbalanced across participants, so that half received the text-based system during week one and half received the image-based system. We asked participants to interact with both of these different interfaces because we wanted to be able to compare not only preferences between the graphic- and text-based interfaces, but to more generally understand their reactions to having a reminder application on their mobile phone. Because there are 5 prayer times a day, we anticipated that users would have 35 potential opportunities to interact with each version of the system.

During the third week, either the text or graphic-prayer application was installed, replacing whichever had been installed previously. At this point we conducted 30-minute semi-structured interviews asking them about whether the system worked like they expected, to describe a specific prayer time, and to describe their overall experience with the application. During the final meeting we asked participants the same set of questions we asked them the prior week, then a series of comparative questions regarding the two interfaces, and their general reaction to having a mobile call to prayer application. The study concluded with each participant returning the Nokia phone.

# 6 Preliminary Findings: New Perspectives on Reminder Systems

In this section, we present preliminary findings from our exploratory study organized into three areas. First, we share participants' reactions to the graphical interface. These generally-positive findings suggest that grounding interface design in users' religious practices rather than existing systems can open space for new interface designs. Second, we discuss drawbacks of the system, focusing on those related to the application's auditory adahn. Our findings suggest that additional information about user's daily routines should be taken into account when developing mobile applications. Finally, we discuss how individual's religious identity should be considered when developing a mobile reminder system that alerts them to prayer. We then discuss by describing how our findings forced us to question assumptions embedded in mobile reminder systems and, more broadly, ubiquitous computing.

## 6.1 Reactions to graphical interface

The results of our deployment suggest that the sun dial interface effectively and pleasurably communicated prayer time to Muslims. For 8 of the 10 participants, the system was well received. All but one preferred the graphical display over the text. The following quote is indicative of most users' reaction to the graphical interface:

What I liked about it was when I was in school and couldn't see outside, I could see exactly where the sun was and how much time I had for each prayer. -21 year old female

When asked what they liked about the interface participants described the Islamic imagery, the sun's movement, and because it evoked memories of the *hajj* (ritual trip to Mecca). For a recent convert, it reminded him that he was part of a larger worldwide faith despite being a minority in [anonymous city] and consequently removed from a traditional Islamic environment (built and social):

...because of the minarets and the Islamic architecture, it is [a] reminder, especially for a lot of people in the U.S. we wish we could be in the Middle East or in a country that had more of this, especially for me, since I became Muslim in the U.S., I have never lived in the Middle East, and the people who have lived in the Middle East or who live in Pakistan, they take this for granted because this is what they see everywhere. -24 year old male

When participants were asked to recall a particular prayer time, half described enjoying the sun's natural movement. Their reasons for this included: 1) it was more inline with how actual salāt times are determined, and 2) it prompted them that salāt was approaching. Knowing this, rather than the precise time gave them more time to prepare for prayer (e.g., cleanse their bodies, find a location). Importantly, this additional time allowed them to prepare for a sacred event calmly, further creating an appropriate reverent frame of mind. Finally, whereas the graphical interface elicited rich responses from users, participants tended to describe the text based one as "plain," "a regular alarm," and as looking like other applications on their phone. We interpreted this as potentially problematic, a loss of the rich context that people desire during prayer.

## 6.2 When "the time is right" rather than "at the right time"

Though most of our participants saw the potential usefulness of our system, there were problems that arose during the deployment. These largely stemmed from the auditory alert on the graphics and text-based systems sounding at inappropriate times. Users had the option to enable or disable the auditory system on the phone. Most described keeping it on during the first days of using the application, then shifting the phone to vibrate mode. Based on this common reaction we wanted to know more about why that was the case.

One thing we learned as we started to unpack the issues with the auditory alert revealed a subtle assumption that we had held: that the alert should sound right at the start of prayer times. During our interviews we learned there was an important distinction between the *right prayer time* and the *right time to pray*.

One example of this corresponds to their lives in the United States—a country not organized around the five prayer times. Participants told us that sometimes they wanted to be prompted to pray when they were done with whatever they were currently doing, such as the end of class, the end of the meeting, or towards the end of their drive. They told us:

...the midday prayer, that usually goes off at work so depending on what is going on - if I don't have a client coming in soon, then I might not get up and make it right then, but if I know I don't have to do something then I will go

ahead and make the ablution [washing before prayer] and go ahead and make the prayer there in my office. But if I have a client coming in soon then usually I will wait till closer, so to that gives me about 15 minutes before the next prayer 'asr time,- 32 year old woman

Other participants described a similar balancing act—working with schedules set by employers and schools alongside those set by prayer times. Of course, previous studies have shown the complexities of time and boundary management [37], but we think that this research emphasizes how schedules set by others—employers and religious institutions—then become balancing acts that individuals must sort through and find solutions, and further that some groups may have a much harder time reconciling those constraints. Minimally, future design might suggest combining prayer time schedules with other calendars, such as business appointments, to create a more personalized and nuanced reminder system.

The difference between the right time to pray and the right prayer time also revealed another advantage in our graphical user interface. In the text-based interface of our system, and those of the others that we surveyed, what you see is a binary time—the time to pray is now—and much less sense of how long the opportunity to pray lasts. As our participants explained, although there is a start time to prayer, there is also a window in which it remains an appropriate time to pray, and that flexibility was crucial in being able to juggle their schedules. Pleasingly, for us, our graphical interface helped in this regard, because it suggested a context, provided a sense of how much longer is left in the pray period, before the prayer time passes.

#### 6.3 Location and other context cues

Our findings shed, unsurprisingly, an interesting dimension on the importance of location [23, 35]. For Muslims, two locations have importance, their position, and their position relative to another place—namely Mecca. Of course, there is the possibility that this is unique to Islamic practice, but it does suggest that consideration of location is broader than just the place where I am, and that might be useful in other applications. Indeed, we see it sometimes embedded into systems as—and how long will it take me to get to my destination with the groceries I've been reminded to collect now I am here. But, Islamic prayer suggests that not all locations are destinations (at least not right now) but suggestive of other types of reminders—being connected to something larger, communicative of an experience that the person is now a part of—in this case to be holy.

This connection to remote locations—and the experience that they evoked—came out in our participants' descriptions of hearing our digitized version of the adhan wake them at home in the morning for fajr or alerting them to midday prayers while in their car or personal office. Indeed, some of our participants talked about how our version of the adhan was better than other forms that they had heard—because we used a recording of a real call to prayer rather than a beep or something that was very digital sounding.

Despite evoking this connection to Mecca, the adhan was a different type of cue, one, in our system, that was based on time, but that was also an externalization of Islamic practice. When the adhan sounded, whether from a phone or from the local mosque, the response it generates in those who are called, immediately identifies them as Muslim. In other words, it was an identity-based alert, and while in some cases that was appropriate, we also learned about complexities that it raised. In particular, we learned that our participants wanted to control the externalization of their identity. For example,

I want it to be private, when I am at work, and I work with mostly Muslims, but still, it is just a privacy issue and just not wanting to announce it. I just didn't want it to intrude on other people, you know? I found myself turning it off a lot, because I didn't want to disturb others, I work in cubicle. I really enjoy hearing the adhan, but being here, it is intrusive and you don't want people thinking you are, "look at me I am a Muslim, I am going to pray now, and somehow self-righteous or something."–31 year old male

Participants displayed a much greater range of responses to what precisely constituted an appropriate amount of externalization. It varied depending on setting (work, home, the Mosque), people around (Muslim or not—although the quote above illustrates that it was not the case that being around other Muslims meant that it was time to externalize identity), and the activity at hand. This is what we learned—we expect that other factors also exist. Interestingly one participant compared her experience with that of wearing her *hijab*, the head scarf or veil frequently worn by Muslim women. So, history of externalization of identity may also play a role in how comfortable people feel calling attention to themselves.

Again, although this was a study of Muslim prayer practice, we suggest that a consideration of how reminder systems can potentially reveal traits or knowledge about a person particularly when used in public—as well as drawing attention to that person may have broader implications for ubicomp systems. For example, consider ring-tones used on mobile phones which when they ring in public places suggest that the owner might be a Britney Spears fan or follow Norwich City Football Club,

A final observation about this externalization of identity was that for our participants this was the first multimedia application that they had ever used to help them pray at the right time. They all reported using it in conjunction with their established methods of remembering—paper charts, clocks, and the computer—but also spoke of taking this new application to places where their charts, clocks, and computer did not readily go because of our system's mobility.

## 7 Discussion

Bell suggests that a key reason ubicomp developers should engage with spiritual uses of technology is that it challenges them to rethink assumptions embedded in technology [7]. Through the development, design and real-world deployment of a mobile call to prayer system, we demonstrated how examining and designing for religious practices can be useful in generating new ideas about technology. In this section we discuss the wider implications of our research. First, we describe how our study points to novel ways to think about interface design. Second, we describe how the findings from our deployment of mobile reminder systems have design implications for reminder systems in general, specifically those used for medical purposes.

What we found most interesting was that our idea to ground the interface in a careful examination of Muslim prayer practices rather than existing interfaces created a richer experience than the paper- and computer-based methods our participants used. In this sense we see our project as being "reflective design" [32]. By examining a user group and practice the design team was unfamiliar with it revealed unconscious assumptions we had about reminder systems. For instance, we assumed that Muslims wanted to be alerted all five prayer times, without acknowledging and understanding that prayer might not come before other activities. Much of the existing research on reminder systems described their usefulness to older individuals. However, the three oldest participants in our study had little need for a reminder. They had been praying daily for 40 or more years and had a well-formed mental model of when prayer times occur.

In the same way that Palen *et. al* [27] suggest designers leverage the ways elders make use of features of their homes to inform ubiquitous system designs to support prospective memory, we suggest leveraging users' existing practices to inspire novel interface design. Rather than continuing to develop interfaces that are text- and table-heavy, we encourage designers to explore a broader range of graphical options for more personalized reminder systems.

Hansson *et. al* note the need to understand the potential social problems that may arise when mobile devices convey notification signals [16]. Our preliminary findings offer empirical evidence to support this claim and suggest that individual's identity should be taken into account when considering the social appropriateness of auditory reminder systems. For instance, people suffering a long-term illness that requires a rigid medication schedule may not want reminder systems to alert them at times that might draw unwanted attention. Also, a deeper understanding of a user's identity can act as a resource for novel design, as we demonstrated with our interface design.

# 8 Lessons Learned

Because research in both mobile systems deployment and techno-spiritual practices is increasing we present some lessons learned from our project. With any deployment, there are many technical factors to consider. The initial week where we deployed the phone without our custom application proved valuable in allowing participants to become accustomed to using the new phone. For many participants, this mitigated unnecessary frustrations when the application was installed. In addition, since the new phones did not have the same battery lifetime as a standard powerful mobile phone, the initial week allowed the participants to establish a basic phone regimen, such as when and where to charge and where they would keep the phone. Despite this attempt, some participants still noted some aspects of the phone itself as being frustrating, such as the shorter battery life, the size of the phone, and its slower start time.

Ubicomp developers continue to collaborate with researchers from disciplines ranging from creative design, to anthropology, and social history [44]. During our project, we discovered the benefits of extending these collaborations to include religious and Islamic studies. Our research team understood, to varying degrees, what it meant to have a personal religious identity, though none of us identified as Muslim. Engaging in informal dialogues with those who knew a great deal more about Islam, for instance, students at our university, imams at area mosques, and scholars, helped our design process. Critically, we learned about Islam, its practices, and their importance to Muslims. Whereas interfaith dialogues and interfaith communications are typically used as a pretext for conflict resolution or peace building, we found it to be useful in the design of our ubiquitous computing application. Specifically, in that it helped us learn how to ask appropriately phrased questions with participants—which we could argue is a valuable skill whatever the topic, but in the case of religion is critical in order to avoid offending. Further, it forced us to re-examine our own assumptions about technology design.

## 9 Conclusions and Future Work

We have presented an exploratory study of the real-world deployment of a mobile application designed to help remind American Muslims of their five daily prayer times. We demonstrated that using religion as a lens to explore technology use has the potential to force designers to question assumptions embedded in their work and open new space for design. Furthermore, qualitative interview data from ten participants who used our system for two weeks suggests that ubicomp developers must consider a broader range of factors when determining when a mobile reminder system is appropriate and inappropriate. Finally, we explored the boundaries of traditional reminder systems. Reminder systems are not only systems which allocate (in this case prospective) memory functions to machines, rather they can also suggest to a user to maintain her own awareness of upcoming events.

Our study was exploratory in nature and provides a foundation for further research into both techno-spiritual practices and reminder systems. This study highlighted research opportunities in understanding the role of users' personal identity and concept of time in notification systems. Additionally, implicit in this research is the assumption that users are within close proximity of their cell phones during daily prayer times. In future work, we will use a proven technique to determine a user's proximity to their cell phone [29]. We are interested in using this proximity information, combined with focused interviews to more accurately determine how often our users relied on the application during prayer times and to more broadly explore how implementing an application designed for a particular user group effects their mobile phone usage.

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