Understanding Mobile Q&A Usage: An Exploratory Study

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ABSTRACT

Recently questioning and answering (Q&A) communities that facilitate knowledge sharing among people have been introduced to the mobile environments such as Naver Mobile Q&A and ChaCha. These mobile Q&A services are very different from traditional Q&A sites in that questions/answers are short in length and are exchanged via mobile devices (e.g., SMS or mobile Internet). While traditional Q&A sites have been well investigated, so far little is known about the mobile Q&A usage. To understand mobile Q&A usage, we analyzed 2.4 million question/answer pairs spanning a 14 month period from Naver Mobile Q&A and performed a complementary survey study of 555 active mobile Q&A users. We find that mobile Q&A is deeply wired into users' everyday life activities—its usage is largely dependent on users' spatial, temporal, and social contexts; the key factors of mobile Q&A usage are accessibility/convenience of mobile Q&A, promptness of receiving answers, and users' satisficing behavior of information seeking (i.e., minimizing efforts and settling with good enough information). We also observe that users tend to seek more factual information attributed to everyday life activities than they do on traditional Q&A sites and that they exhibit unique interaction patterns such as repeating and refining questions as coping strategies in seeking information needs. Our main findings reported in the paper have significant implications on the design of mobile Q&A systems.

Author Keywords

Mobile Q&A System; Online Community; Ubiquitous Computing

ACM Classification Keywords

H.5.3 Information Interfaces and Presentation: Group and Organizational Interfaces

General Terms

Measurement; Human Factors; Design

INTRODUCTION

Question and answering (Q&A) sites such as Yahoo! Answers and Naver KiN facilitate knowledge sharing among users by leveraging the wisdom of crowds. Q&A sites complement existing Web search engines by supporting flexible query formulation and customized answer delivery. With the rising popularity of mobile phones, mobile versions of Q&A sites have recently been introduced to the market, including Naver Mobile Q&A, ChaCha, Jisiklog, and AQA. The popularity of mobile Q&A services has been increasing over the past several years. For example, by September 2011 ChaCha answered more than 1.7 billion questions, surpassing the number of answers made in Yahoo! Answers. In mobile Q&A, users post short questions using their cell phones to solicit answers from other users on the Web (e.g., via SMS). The main departure from conventional Q&A sites is that the length of questions and answers has a limit (e.g., 150 letters), and that a mobile phone has its own characteristics (i.e., small screen, portability, restrictive keyboard).

While conventional Q&A sites have received a lot of attention from the research community, and significant research has been conducted, so far little is known about the mobile Q&A usage. In this paper, we seek to improve our understanding of mobile Q&A usage with the following research questions:

- Why do people use mobile Q&A services? When compared to existing information sources that people often use, what are the key drivers of mobile Q&A usage?
- What kinds of questions are asked and (not) answered over mobile Q&A? Are there any factors that influence the likelihood of receiving answers? Are the types of asked questions different from those in other information channels?
- How do users interact with mobile Q&A to meet their information needs (e.g., coping strategies, asker-answerer social networks, etc.)?

We answer these research questions by studying Naver KiN, the largest Q&A service in Korea. Naver the most popular online search provider in Korea offers both conventional and mobile Q&A services, i.e., Naver KiN and Naver Mobile Q&A, respectively. Naver Mobile Q&A was launched in April 2010 and has become one of the largest mobile Q&A services in Korea. We analyze the crawled data set from Naver Mobile Q&A in the period of June 1, 2010 to July 31, 2011. We also perform a survey study with 555 active Q&A users to supplement a large scale data analysis. To the best of our knowledge, our work is the first large scale study on mobile Q&A services. The following are the main contributions of the paper.

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- We find that mobile Q&A is deeply wired into users' everyday life activities, and its usage is largely dependent on spatial, temporal, and social contexts. When compared to traditional Q&A sites, mobile Q&A users tend to ask a much broader range of questions attributed to everyday life activities. The key factors of mobile Q&A usage are (1) accessibility and convenience of mobile Q&A, (2) promptness of receiving answers, and (3) users' satisficing behavior of information seeking (i.e., minimizing efforts and settling with good enough information).
- We classify questions based on types (e.g., fact, suggestion, opinion), topics, and personalness and investigate how those qualities are related to the chances of receiving answers. Our classification shows that in mobile Q&A, asking simple facts is more dominant than traditional Q&A—questions from everyday life activities are more likely to seek factual information. The types of questions significantly differ from one topic to another. Interestingly, personalness of questions does not improve the chances of receiving answers.
- We analyze macroscopic user interactions by analyzing the crawled data set. We find unique interaction patterns such as repeating and refining questions as coping strategies of seeking information needs. Asking/answering behavior is heavy-tailed, meaning that there are quite a few light/heavy askers/answerers. The length of an answer linearly scales with that of a question; i.e., a longer question tends to result in a longer answer.
- We discuss several design implications: (1) user interface design that lowers the cognitive burden of askers, (2) context sharing mechanism that permits answerers to know the previous interactions, (3) answerer's personalized user interface that potentially improves the answer speed and quality, and (4) privacy aware system design that protects the privacy of askers.

RELATED WORK

Conventional Q&A sites

Some of the large-scale Q&A sites analyzed in the research community include Yahoo! Answer, Naver KiN, Microsoft Live Q&A, Google Answer, and Mahalo. In the following, we review the related work that characterizes the Q&A sites.

Adamic et al. [4] showed that in Yahoo! Answers, interaction among users varies depending on the topic and is highly skewed, knowledge sharing patterns across different topic categories (i.e., experts in different domains help one another) exist, and best answers can be predicted based on reply/thread length. In their analysis of Naver KiN, Nam et al. [22] studied the user behavior of answerers and found that the level of participation is highly skewed, answerers' participation tends to be intermittent, and the expected level of their expertise is lower than that in specialized online forums.

Questions in Q&A sites are generally classified as soliciting facts, opinions, and suggestions [18]. Harper et al. [8] showed that the types of questions in Q&A sites can be broadly classified into two categories, namely informational questions (e.g., fact and advice) and conventional questions (e.g., opinions and self-expression). Rodrigues et al. [27] found that Q&A sites can also be used for socializing, such as by chatting and searching for entertainment (puzzles, riddles), and unlike Yahoo! Answer, a significant fraction of answers in Microsoft Live Q&A (16.4%) belong to such a category.

In Q&A sites, the response time tends to be fairly long. Hsieh and Counts [12] reported that in Microsoft Live Q&A, the average time to receive an answer was 2 hours and 53 minutes, and 20% of the questions never received an answer. Zhang et al. [36] showed that in a specialized Q&A site for Java program language, the average time to receive an answer was around 9 hours.

The motivation behind answering questions is largely dependent on a mixture of intrinsic factors (e.g., perceived ownership of knowledge, enjoyment and feelings of gratitude and respect) and extrinsic factors (e.g., monetary rewards, reputation systems) [25]. Online discussion forums such as Usenet groups do not offer any explicit incentive mechanisms and mostly rely on intrinsic factors. In contrast, Q&A sites typically employ incentive mechanisms to solicit users' participation. Nam et al. [22] showed that the motivation for answering in Naver KiN is due to both intrinsic and extrinsic factors; i.e., altruism is the leading factor, followed by business motives, learning, hobbies, and earning points (in its reputation system). When monetary rewards are involved, it is reported that fee-based sites elicit better answers than free sites (e.g., Google Answer vs. Yahoo! Answer), and that higher quality answers can be acquired by paying more money [9]. Hsieh et al. [13] analyzed Mahalo, a fee-based Q&A site and showed that askers wish to pay when requesting facts and will pay more when asking difficult questions.

Unlike that of existing work, our focus is to characterize the usage of mobile Q&A services. In particular, we study why people use a *mobile Q&A service* as opposed to other available information channels (including traditional Q&A sites and web search) and investigate such a service's social network graph, types of questions, and unique usage patterns.

Real-time Q&A systems

Real-time (or synchronous) Q&A systems typically support question answering in the following steps: (1) identify experts for a given question (e.g., by analyzing documents such as emails and Web pages [16]), and (2) solicit answers from the experts. Various strategies are used for soliciting answers: (1) broadcasting questions to all the users (no expert selection), e.g., mimir [12], (2) multicasting questions to the specific expert group for a given question, e.g., Aardvark [11] and IM-an-expert [26], and (3) topic-based publish-subscription (any users who subscribed to a certain topic group), e.g., ReachOut and Quora. For direct communication, real-time Q&A systems use emails (e.g., Aardvark, Quora) or dedicated instant messaging (e.g., mimir, IM-an-Expert, ReachOut). Mobile Q&A services deliver near real-time question answering as in real-time Q&A systems. However, this is achieved through *asynchronous* communications; i.e., as in conventional Q&A systems, answerers must visit mobile Q&A web sites.

	Interaction Method	Incentive	Mixed
Naver Mobile	SMS, Mobile App/Web	Reputation	No
ChaCha	SMS, Mobile App/Web, Web	ChaCha pays	-
Jisiklog	SMS, Mobile App	Asker pays	-
AQA	SMS, Mobile App	Asker pays	-
kgb answers	SMS, Mobile App	Asker pays	-
Ask People	Mobile App/Web, Web	Reputation	Yes
Daum Live	Mobile App/Web, Web	Reputation	No

Table 1. Classification of mobile Q&A services (ChaCha, Jisiklog, AQA, and kgb answers do not have conventional Q&A services)

Mobile Q&A Systems

Popular mobile Q&A services include ChaCha, kgb answers, Ask People in the US, AQA in the UK, and Jisiklog, Naver Mobile Q&A and Daum Live Q&A in Korea. Mobile Q&A services in the market can be classified based on the following dimensions: (1) whether question posting is limited to mobile devices (i.e., SMS/MMS and mobile App/Web), (2) whether there is a monetary incentive mechanism, and if any, who pays the fees, and (3) whether a mobile Q&A service is mixed with a conventional Q&A service (i.e., presented together). Table 1 summarizes the classification of various mobile Q&A services. Note that those services that only support mobile devices (ChaCha, AQA, kgb answers, Naver Mobile Q&A) have a length limit on questions/answers as SMS/MMS is mainly used (due to ease of billing), but a mixed service like Ask People does not have such a constraint. ChaCha originally accepted questions via SMS only, but this restriction was recently relaxed, and questions can now be posted via the Web. In this paper, we analyze the usage patterns of Naver Mobile Q&A, a representative mobile Q&A service as it supports only question posting via mobile devices. We believe that our work sheds light on understanding the overall usage patterns of mobile Q&A systems in general.

Mobile Web and Web Search Usage

The taxonomy of web tasks is generally classified as information seeking, casual browsing, communication (e.g., chatting), and transactions (e.g., bank services) [17]. In their recent study, Cui and Roto [6] reported that in mobile environments, tasks are rather limited to information seeking, communication, and transactions with an additional task of maintaining personal content as a part of personal space extension. User behavior studies about mobile Internet use show that such web tasks are largely dependent on users' contexts, e.g., personal context (e.g., goals) and environmental context (e.g., distractions, social interactions) [19, 6]. Kamvar and Baluja [15] performed quantitative analysis of mobile web search usage from the Google Mobile Search data set in 2004 (connected via mobile Internet). The overall topics are quite consistent with the desktop search statistics. Popular topics include adults (e.g., "free porn"), computer and communications (e.g., "free ringtones"), and entertainments (e.g.,"imdb"). The average number of words per query is 2.3, with an average letter length of 15.5. Users tend to perform a series of related queries by refining/repeating previous queries, including automatic spell correction. In their recent study of mobile search pattern evolution, Yi and Maghoul [35] reported that the query topics experienced significant change (consistent with desktop search) when comparing the data sets from year 2007 and 2010 (e.g., decrease of entertainment queries, increase of local and commerce queries). In this paper, we discuss mobile Q&A communities that are very different from traditional web search. Our work compliments the prior research on user behavior in mobile web search in that we use a large-scale mobile Q&A data set supplemented with a survey study of 555 active service users to characterize information seeking behavior with mobile Q&A.

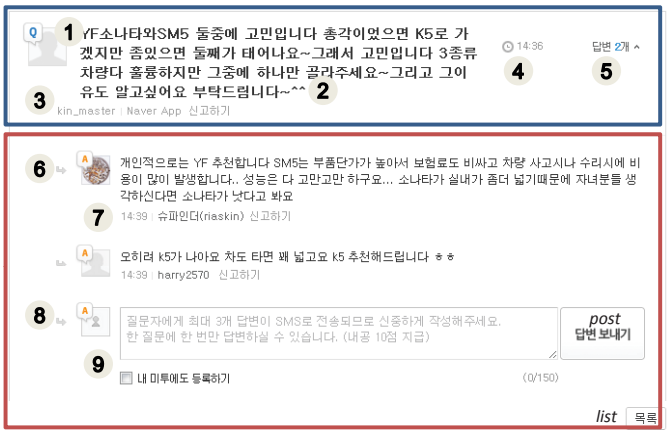

Figure 1. A question and its answers posted on the Naver Mobile Q&A Web site: (1) a user's profile image (if present), (2) question, (3) user ID, sent-from information (SMS, Mobile Web, Naver App), and abuse report, (4) posted time, (5) click to answer and the number of answers posted, (6) posted answers, (7) posted time, answerer ID, and abuse report (8) posting a new answer, (9) uploading the answer to the answerer's Me2day simultaneously (a Twitter-like service offered by Naver). If a user posts an image, its thumbnail will be shown next to the user's profile image.

INTERACTION IN NAVER MOBILE Q&A

In Naver Mobile Q&A, users can post questions only via mobile devices; a list of supported methods of communication includes SMS/MMS, Mobile Web, and Naver App. Since it basically uses SMS, there is a strict limit on the length of a question/answer, i.e., 150 letters. For a given question, users can also attach related images using MMS. Registered users of Naver can post their questions on the Web via such interaction methods. As shown in Figure 1, a requester's user ID is revealed along with the delivery method (e.g., SMS, Mobile Web, and Naver App). Naver currently restricts users to posting at most 30 questions a day.

The registered users can only post answers through the Naver Mobile Q&A Web site as in the traditional Q&A sites (see Figure 1). The front page of the Web site presents a list of the 20 most recent questions (in the form of the upper box in Figure 1 stacked). The old lists can be browsed by clicking the next button located at the bottom of the page. The questions are basically ranked on the basis of recency; whenever a new question arrives, the entire rank trickles down by one, and the 20^{th} ranked question on the front page will be placed on the second page. Answerers can pause/resume real-time updates of questions using the pause/resume button located at the top of the page. Requesters can choose to receive answers via SMS (regardless of whether they posted questions

via Mobile Web or Naver App). Due to the financial burden involved, Naver Mobile Q&A only delivers at most three answers via SMS. If more than three answers are made, the rest can be accessed via mobile Web and Naver App. Naver has a point-based reputation system for answerers. A user can earn 10 points for each answer. The following are the notable differences from the traditional Q&A: (1) a question expires after 24 hours, and expired questions cannot be answered; (2) users cannot edit the submitted questions/answers; (3) there is no option for selecting the best answer; and (4) there is no predefined question category.

METHODOLOGY

Our methodology is composed of two complementary parts: (1) automated crawling of publicly accessible questions and answers on Naver Mobile Q&A [3] and (2) email-based surveys. The crawl of millions of questions/answers allows us to gain comprehensive statistics about user behavior, whereas the email-based survey results from Mobile Q&A users help us to develop an in-depth understanding of the underlying factors that derive the observed usage behavior. As the reader will see later, such a combination has provided mutually supporting evidence on our findings.

Naver Mobile Q&A launched its service in April 2010. We crawled the Q&A data set from June 1, 2010 to July 31, 2011. The total number of questions and answers were 2,483,624 and 3,086,365, respectively. For a given question, we extracted a set of associated items for analysis, including user ID, posted time, and posted answers.

We supplemented the data set with the surveys of active Naver Mobile Q&A users. From the users who posted questions in July 2011, we randomly selected 9,000 Naver Mobile Q&A users on the basis of their usage level of high, moderate and low (3,000 each) and sent the survey questionnaire via the Naver email service in August 2011. The total number of participants was 223 (after removing duplicate/erroneous answers). To check whether there are nonresponse errors, we sent the first part of the survey questionnaire in November 2011 to those users who did not answer the earlier survey. The total number of participants in the second survey was 332 (after removing duplicate/erroneous answers). Our statistical analysis with chi-square goodness of fit tests reveals that in each usage level group, the two survey results are almost statistically identical.

The survey begins with demographic questions. The results of 555 participants show that 49.5% are males. The majority of participants (73.9%) are the teenagers, and 15% are in their 20s. 3.1%, 1.6%, and 0.4% are in their 30s, 40s, and 50s, respectively. When looking at their jobs, we have the following distribution: elementary school (5.6%), junior high school (33.5%), high school (33.3%), college (14.3%), and working (7.2%). 70.5% of participants use smartphones. As mobile Q&A is based on short messaging, we found that the age distribution is similar to that of SMS/IM usage—teenagers are the dominant user groups, and SMS/IM are preferred to emails and voice calls in these user groups [2]. Given that the Naver Mobile Q&A users were randomly selected, we believe that our survey participants are representative.

The rest of the survey was composed of two parts: (1) asking about the overall usage of Mobile Q&A, and (2) describing the detailed situations/reasons for the questions that participants actually asked in July 2011. In the first part, we asked users about the types of questions posted using Mobile Q&A, asking them to rate whether Mobile Q&A usage is different from that of Naver KiN. We also asked users to rate the perceived answer quality of Naver Mobile Q&A in general and to select alternative methods when the answers were less satisfactory. In addition, we asked a few questions to find out why Q&A services are preferred to other information sources. In the second part of the survey, to better understand why people use mobile Q&A, we showed the actual questions that the participants posted in July 2011 and asked them to describe the detailed situation/reason when they asked those questions. Due to privacy concerns, only 86 participants (38.6%) completed the second part of the survey.

WHY PEOPLE USE MOBILE Q&A

We illustrate the concept of everyday life information seeking and information practices which is closely related to the contexts of mobile Q&A usage; we then derive the key factors of mobile Q&A usage from the data set.

Everyday Life Information Seeking

Information seeking occurs in both work-related and non-work related contexts of everyday life. While work-related information seeking is self-explanatory, the concept of non-work related information seeking is rather elusive. To bridge this gap, a number of theoretical models have been proposed as summarized in the survey article [28]. One model of particular interest is information practice, which defines socially and culturally constituted (often *habitualized*) ways of identifying, seeking, using, and sharing information [20].

Everyday information practices are deeply embedded in spatio-temporal contexts of our everyday lives (e.g, watching TV news, reading newspapers and searching the Web) in order to deal with the *life projects* at large (i.e., information practices as caring activities of life projects or *mastery of life*) [29]. Some life projects are generic and routine in that they are common to most people (e.g., household care, entertainment), and other projects are specific in that they originate from an individual's life situation (e.g., hobbies, child rearing) [10]. Various activities associated with life projects are performed in our daily life places (e.g., home, café, clubs, and library) in which social interaction is likely to occur, and as a by-product, the needs for information seeking/sharing arise [23].

For everyday life information seeking, people rely on an information horizon that consists of a variety of information sources such as social networks, books, information retrieval tools, web pages, and Q&A services [29]. People typically judge the relevance of information sources available in the information environment, select a set of *preferred sources* to resolve the issue related to the everyday project, and consult the sources by following the preferred sequence, learned over time [14]. For information needs in mobile environments, readers can find more detailed information in recent diary

studies [31, 5]. In the following, we analyze the role of a mobile Q&A service in a person's information horizon and present the key factors of mobile Q&A usage.

Factors of Mobile Q&A Usage

The types of information sources that are closely related to Q&A services are human resources over the social networks (e.g., family members/friends, members in Q&A site communities). First of all, mobile phones have greatly improved the accessibility of one's social network and have given users a great level of freedom in terms of mobility. Whenever information needs arise, a user's mobile phone provides a convenient way of accessing remote information sources at the user's finger tips. In this case, the availability of potential answers is of critical concern. Yet, mobile Q&A significantly improves the availability by tapping a large pool of users over the Internet as in traditional Q&A. Unlike traditional Q&A, mobile Q&A permits users to submit questions and receive answers via SMS which greatly lowers the cognitive burden (due to short in length with a small number of touches) when compared to accessing traditional sources (e.g., searching the Web using desktop computers and smartphones). Further, users can receive answers much faster (median delay of 2.1 minutes in Naver Mobile Q&A vs. mean delay of 2 hours 52 minutes in Microsoft Live Q&A [12]).

We carefully designed the survey questionnaire based on these observations. To examine why a traditional Q&A service is preferred to generic web search, we asked users to select all the reasons from the following options: (1) I am not good at web search (1.6%) (2) web search results were less satisfactory (27.6%), (3) it is more convenient (36.9%), (4) I can save time (46.5%), (5) I do not want to be distracted from the task at hand (25.2%), and (6) I can receive personalized answers (34.2%). If they had other reasons, we asked participants to write them, but we did not find any other significant reasons. As expected, users generally believe that Q&A sites allow them to conveniently interact with human answerers and to receive customized answers without spending much effort.

We then asked users why mobile Q&A is preferred to traditional mechanisms by presenting a set of reasons as before: (1) I can readily ask questions anytime anywhere (63.2%), (2) it is more convenient than accessing Q&A sites using PCs (35.6%), (3) it is more convenient than web searching with PCs and smartphones (32.3%), (4) it gives faster responses (43.1%), (5) it provides more satisfactory answers (7%), and (6) I do not want to be distracted from the task at hand (19.1%). If they had other reasons, we asked the participants to write them, but we did not find any other significant reasons. These results clearly show that the key factors are accessibility (portability), convenience, and promptness. In addition, regarding the answer quality of Mobile Q&A, as shown later most users believe that they are somewhat satisfied/dissatisfied. Yet, users' coping strategies are rather limited within mobile Q&A, and users tend to show satisficing behavior—accepting less satisfactory answers without spending further efforts. In the following, we further examine these factors by analyzing the data set.

Note that in our survey, we also asked participants to write why mobile Q&A is more useful than seeking information directly from other people (e.g., friends). Our manual classification reveals that the majority of participants (75%) believe that answerers in mobile Q&A are likely to have more expertise than their friends (availability of answerers) and can possibly deliver better answers. Promptness and convenience are mentioned by 20% and 16% of the participants respectively. Other minor reasons include seeking for more objective opinions from the crowd (5%), asking private questions that may be embarrassing if revealed to their friends (5%), and not disturbing one's friends (5%).

Accessibility and Convenience of Mobile Q&A

In our survey we asked users to describe the detailed contexts in which they posted the questions, by presenting at most five questions asked by the participants in the month of July 2011. We received detailed descriptions of 206 questions from 83 participants. Our manual investigation shows that information seeking is largely attributed to everyday life activities: (1) while watching TV and movies (12%), (2) while talking with someone (13%), (3) while studying (10%), (4) while planning something (18%), and (5) while performing other activities such as exercising and observing unusual conditions (42%). Several example questions and descriptions are the following:

Question: *"What's the name of an exercise device that looks like a jump rope, but you can hold your foot on it and pull it?"*
Description: *"When I was watching a diet program on TV, I saw that device and wanted to buy that device. But I didn't know the name."*

Question: *"What's the broadcast schedule of the all-star baseball game today?"*
Description: *"I knew that the game happened that day, but I didn't know the time and channel. Also, I didn't have enough time to go and check with my desktop PC."*

Since its usage is largely dependent on our everyday life activities, we expect that mobile Q&A usage will increase over the course of a day as people will perform more activities and experience more social interactions, which will greatly increase information seeking needs (e.g., morning vs. afternoon vs. evening). To confirm this, in Figure 2 we plot the percentage of hourly usage of mobile Q&A and juxtapose it with that of mobile web browsing and PC based *web browsing* measured by a large Internet portal service provider in Korea [1]. The figure shows that mobile Q&A usage continues to increase over time until it tapers off at 9PM. Interestingly, the usage pattern of mobile web browsing differs from that of mobile Q&A usage in that web browsing has a much higher usage level during the commuting hours in the morning (e.g., reading newspapers) and the usage drops after midnight. The role of PC and mobile devices appears to be complementary; more usage of mobile web during the commuting and evening hours, and dramatic drop of PC-based web browsing after 5PM. In Figure 3, we plot the daily usage pattern of mobile Q&A. The figure shows that the activity level on weekends is higher than that on weekdays, corrobo-

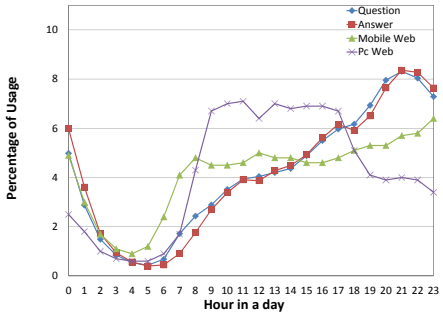

Figure 2. Hourly usage percentage: mobile web browsing, PC-based web browsing, and mobile Q&A

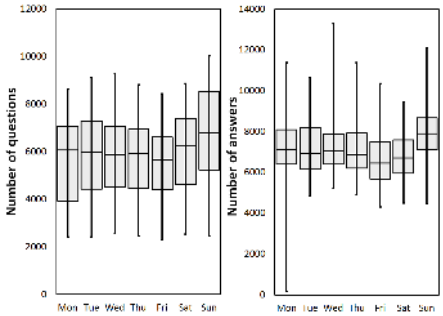

Figure 3. Daily usage pattern of mobile Q&A (left: questions, right: answers)

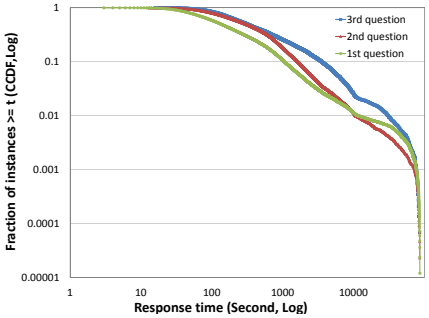

Figure 4. Response delay of Mobile Q&A (time to receive the first, second, third answer (log-log)

rating our observation that mobile Q&A usage is dependent on our everyday life activities.

Promptness of Receiving Answers

Unlike traditional Q&A, in which the response delay tends to be fairly long, we find that mobile Q&A delivers a much smaller response delay. In Figure 4 we plot the cumulative distribution of response delay of Naver Mobile Q&A under the following cases: time to receive (1) the first answer, (2) the second answer, and (3) the third answer. The shape of the graphs approximately follows a power law distribution with exponential cut-off. This exponential cut-off is due to the fact that Naver Mobile Q&A enforces a restriction according to which answers can be made only within 24 hours after posting. In the delay distribution graph of receiving the first answer, for instance, the average is 932.9 seconds (15.5 minutes), whereas the median is 127 seconds (2.1 minutes); the minimum is as small as 3 seconds, and the maximum is as large as 23.99 hours. The mean inter-arrival time between the first and second answer is 143.3 seconds, and that between the second and third answers is 911.6 seconds.

Users' Satisficing Behavior of Information Seeking

Simon defines satisficing as a decision-making process in which an individual forgoes the best solution in favor of one that is acceptable [30]. The concept of satisifcing has been applied to a number of disciplines in the social sciences. It was recently adopted in the information science field to explain how and when individuals stop looking for information—"the information is good enough to satisfy a need even though a full cost-benefit analysis was not performed" [24]. For instance, Warwick et al. [33] reported that university students strategically use satisficing behavior to minimize their efforts for time-saving.

As illustrated earlier, we received the detailed context information about questions posted by 83 users. In that part of our survey study, we also asked participants to rate urgency (in minutes), importance, and satisfaction (on a 5 level Likert scale) for each question. The expected urgency varies, ranging from less than 10 minutes (54%), to less than 1 hour (80%) to less than 1 day (90%). For importance, 46% answered important (4, 5), 33% answered somewhat important/unimportant (3), and 21% answered unimportant (1, 2). Our analysis shows that urgent questions are likely to be more important ($p < 0.001$, Gamma: .494). For satisfaction, 50% answered satisfactory (3, 4), 25% answered somewhat satisfactory/dissatisfactory, and 25% answered unsatisfactory (1, 2). In our survey, we also asked participants to select personal coping strategies for less satisfactory answers from the following options: (1) post the same question again (32.3%), (2) rephrase the question (36.8%), (3) wait for other answers (27.8%), (4) seek other information sources such as web search (41.7%), and (5) stop looking for information (39.8%). If there were other strategies, we asked to write them, but we did not find any other significant strategies. The results clearly show evidence of satisficing behavior in Mobile Q&A; i.e., participants want to minimize their efforts of searching (option 1, 2, 3) or even want to stop searching (39.8%). Given that not all the questions are considered important (only 46%), some of the questions would have never been asked if mobile Q&A were not available.

QUESTIONS IN MOBILE Q&A

We classify questions based on types, topics, and personalness and investigate how they are related to the chances of receiving answers. To this end, we randomly selected 1000 questions from the Naver Mobile Q&A data set. The questions were coded by two raters (600 each). We used 200 common questions and measured the inter-rater agreement with Cohen's Kappa statistic, which indicated substantial agreement: $\kappa = 0.711$. The following are the criteria used for classification. For question types, we used the classification proposed by Kim et al. [18], in which questions are classified into three types, namely information, suggestion, and opinion. Information is for finding specific facts (e.g., *"I am at the train station. Which bus should I take to go to Sadang?"*); suggestion is for seeking recommendation and advice (e.g., *"I need to go to Sadang from Seoul Station, which one is better: taxi or subway?"*); and opinion is for surveying other people's thoughts or tastes (e.g., *"I screwed up my finals. What should I do?"*). We extended this model with two additional types that are commonly used to describe the functions of dyadic interactions [7], i.e., request for resources or services (e.g., *"Please send me some interesting e-books"*), and expressive monologue (e.g., expression of joy, sorrow, anger). For question topics, we use the main topic categories in Naver KiN; i.e., living, computer & communications (C&C), education, entertainment, games, health, and sports. In terms of personalness, we judge that a question is personal if the question is narrated based on a personal account, (e.g., *"I need to get an X-ray of my foot. How much will it cost?"*). The coding results of 962 questions are presented in Table 2; the raters

	Type	Personal		Topic Category						
		Yes	No	Living	C&C	Edu	Entertain	Game	Health	Sports
Information	51.1%	26.6%	60.9%	41.1%	55.9%	72.3%	53.6%	34.4%	44.0%	94.3%
Suggestion	18.7%	25.9%	15.8%	21.1%	27.3%	9.5%	22.6%	26.2%	9.3%	3.8%
Opinion	23.4%	40.1%	16.7%	31.7%	14.3%	16.8%	14.3%	21.3%	45.3%	1.9%
Monologue	4.1%	3.6%	4.2%	4.5%	1.9%	.0%	2.4%	3.3%	1.3%	.0%
Request	2.7%	3.6%	2.3%	1.6%	.6%	1.5%	7.1%	14.8%	.0%	.0%
Count	962	274	688	375	161	137	84	61	75	53

Table 2. Breakdown of questions based on types, topics, and personalness

Answer	Type					Personal		Topic Category						
	Inf.	Sug.	Opi.	Mon.	Req.	Yes	No	Liv.	C&C	Edu.	Ent.	Game	Hea.	Spt.
No	41.1%	51.7%	35.1%	43.6%	65.4%	43.8%	41.9%	42.1%	49.7%	33.6%	53.6%	55.7%	30.7%	30.2%
Yes	58.9%	48.3%	64.9%	56.4%	34.6%	56.2%	58.1%	57.9%	50.3%	66.4%	46.4%	44.3%	69.3%	69.8%
Count	492	180	225	39	26	274	688	375	161	137	84	61	75	53

Table 3. Receiving answers vs. question type, personalness, and topic

failed to classify 38 questions because they are either unreadable (5) or incomplete (33).

Our results show that seeking information is the dominant usage (51.1%), followed by opinion (18.7%) and suggestion (23.4%). Given that questions in mobile Q&A are mostly attributed to everyday life activities (e.g., while watching TV or chatting with friends), it is more likely that users will seek for factual knowledge. This unique pattern significantly differs from that of traditional Q&A sites or status message based Q&A using social networking systems (SNS), where the role of suggestion is more significant. For instance, Kim et al. [18] showed that in Yahoo! Answer, the fractions of information, opinion, and suggestion questions are 35%, 23%, 39%, respectively (others: 3%); Morris et al. [21] showed that in SNS based Q&A, the fractions are 15.3%, 23.6%, 31.2%, respectively (others include rhetorical and invitation: 19.7%), and this pattern is quite consistent across different cultures [34].

The distribution of question types across various topics is significantly different. For instance, Information is more pronounced in Education (72.3%), and Sports (94.3%); suggestion is more pronounced in Games (26.2%), and Computer & Communications (27.3%); opinions are more important in Health (45.3%). Note that information questions in Sports (94.3%) are mostly to check current scores or the results. Finally, among the sample questions, we find that 26.3% are personal questions that are based on personal accounts. We find that the types of *personal* questions are very different from the general statistics; the dominant type is opinion (40.1%), followed by information (26.6%) and suggestion (25.9%).

We also investigated how this classification is correlated with the chances of receiving answers. When question types are considered, the answer rate of opinion questions is the highest (64.9%); the rate of answers for request questions is the lowest (34.6%). When the topic categories are considered, several topics, namely Health (69.3%), Sports (69.8%), and Education (66.4%) received higher answer rates than did the others. Interestingly, personalness does not have any statistically significant impact on the chances of receiving answers ($p = .585$). Personal questions typically have more detailed descriptions and are longer in length (personal average: 79.8 vs. overall average: 35.9), but, unfortunately, such efforts do not yield a better answering rate.

INTERACTION PATTERNS

We examine macroscopic user interaction patterns of mobile Q&A by analyzing the crawled data set. First, we present a unique pattern of user's interaction with answerers as coping strategies of meeting a user's information needs. Second, we analyze the inter-arrival patterns of questions/answers and the answer-to social network. Third, we show the relationship between the question length and the answer length to see whether short questions elicit short answers.

Interactive Behavior: Repeating, Refining Questions

For a given question, we can expect the following scenarios: (1) a user's question is not answered, (2) a user's question is answered, but it is less than satisfactory, and (3) a user's question is answered, and it is satisfactory. As shown earlier, our survey results indicate that people use various coping strategies to meet the information needs attributed to everyday life activities or tasks: posting the same question again, rephrasing or refining the previous question, waiting for other answers, seeking other information sources, or stopping information seeking. Among these strategies, we use our data set to perform a quantitative analysis of user behavior of repeating and refining questions.

We first take a look at the repeating behavior. In Naver Mobile Q&A, our results show that 34% of questions are never answered. To receive an answer, one strategy that a user can use is simply re-sending an unanswered question. This behavior can be modeled mathematically. Assuming that a question is answered with probability p, the number of trials (Y) to receive an answer simply follows a geometric distribution: $Pr(Y = k) = (1 - p)^k p$, and the expected number of trials is $1/p$. In the case of Naver Mobile Q&A, assuming that answering is an independent, identical process, we have $p = 0.66$, and thus, the expected number of trials is 1.5.

Besides repetition, we observe that users often refine a question into a new question that more accurately reflects the information needs attributed to life activities. In mobile Q&A,

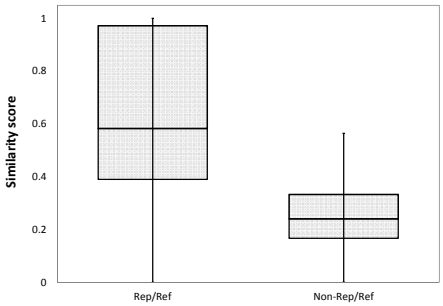

Figure 5. Manual classification results: similarity scores of repeating/refining and non-repeating/refining questions

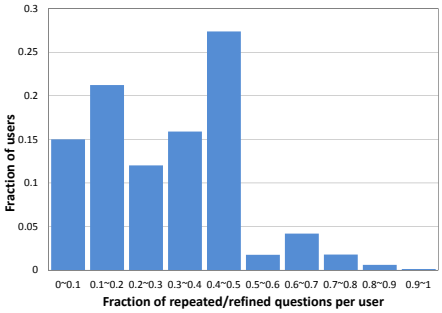

Figure 6. Fraction of users who have a specific fraction range of repeated/refined questions

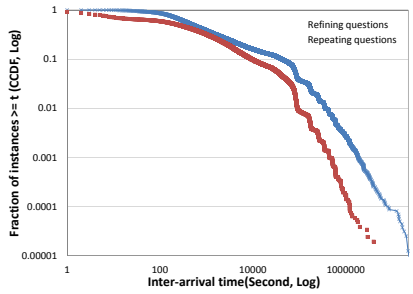

Figure 7. Inter-arrival time distribution of repeated (score=1) [bottom] and refined (0.6≤score<1) questions [top] (log-log)

we observe that users typically wish to interact with potential answerers to meet their information needs or complete their tasks at hand. The refining behavior could be as simple as rephrasing the question with more information or as complex as making some decision (e.g., choosing which smartphones to buy). Interestingly, this user behavior is somewhat similar to the query refinement behavior in information retrieval: when facing too many documents, a user narrows down the scope of search results by refining the previous query [32]. Due to its unique interactions, question refinement in mobile Q&A is very different from query refinement in traditional information retrieval. First of all, a series of answers is delivered in sequence to the users opportunistically, and yet a user cannot predict how many answers will be received. It usually takes a long time to receive an answer (on the order of minutes), and the time scale of the refining process is much greater than that in traditional information retrieval.

To illustrate an asker's interactive behavior, we present the following interaction example adapted from one of our participants. The question was originally sent while the asker was on the train bound to Seoul Station and was planning to travel to Sadang Station.

Question 1 (10:23AM): *"How do I get to Sadang Station from Seoul Station?"*
Answer 1 (10:25AM): *"Take a subway line number 4"*
Answer 2 (10:27AM): *"Just take a taxi"*
Question 2 (10:28AM) : *"How long does it take and how much does it cost to go to Sadang Station from Seoul Station by taxi?*
Answer 1 (10:30AM): *"About 31 minutes, and 9,400 Won"*

To quantify how often repeating or refining behavior occurs, we analyzed the data set as follows. For a given user, we examine a pair of consecutive questions in sequence and measure the cosine similarity. Each question is represented as a vector in which each element is a unique letter. Given two vectors $\vec{r_1}$ and $\vec{r_2}$, the *cosine of the angle* between $\vec{r_1}$ and $\vec{r_2}$ is given as: $sim(\vec{r_1}, \vec{r_2}) = \vec{r_1} \cdot \vec{r_2} / |\vec{r_1} \times \vec{r_2}|$. Here, a similarity score of 1 means a perfect match (i.e., repeated questions), and that of 0 means no match. Note that we used a rather simple cosine metric instated of semantic analysis due to the unique challenge; i.e., a large fraction of questions are worded without spaces, which is quite common when texting in Korean. Fortunately, our approach works well in practice as the total number of unique Korean letters is 11,172.

To choose a proper threshold value, we randomly chose three heavy users and manually classified 782 questions. Figure 5 clearly shows that the similarity score distributions are very different from one another. Given that the similarity scores of non-refinement questions are lower than 0.6, we use this value to automatically detect refined questions. While conservative, the automatic classification allows us to understand such behavior on a large scale. In Figure 6, we plot the fraction of repeated/refined questions per user. A large fraction of users utilize query refinement quite often (e.g., mode is 40-50% of all the questions). Interestingly, there are users whose questions are almost the same. These are the users who ask a few similar questions over the period of time; e.g., checking game scores such as *"today's baseball results?"* or repeatedly posting their concerns such as *"I have some problem with my girlfriend..."* Finally, we plot the inter-arrival time distribution of repeated (score=1) and refined (0.6≤score<1) questions in Figure 7. The figure shows that both repeated and refined distributions approximately follow a power-law distribution. The median inter-arrival time of repeated and refined questions (i.e., the time difference between two consecutive questions) is 250s (4.1 min) and 550s (9.2 min), respectively.

Questioning/Answering Process and Social Relationship

Given that a mobile Q&A service can be considered as a queueing system, we analyze the arrival process of questions and answers. We select five bins of hourly activities and plot the aggregated inter-arrival time distribution of questions and answers in Figure 8 and Figure 9. By inter-arrival time we mean the time difference between two consecutive questions or answers. These figures show that the arrival patterns of questions and answers approximately follow an exponential distribution (log-linear plot). The system can be simplified as an M/M/1 queueing model, and various math analyses can be performed, which we will defer as a part of future work.

To understand questioning/answering patterns, we analyze an answer-to social network in which a node represents a user, and a directed edge from user i to user j means that i gave an answer to j. Given this answer-to graph, we plot the indegree and outdegree distribution in Figure 10. Here, an indegree of a user means the number of answers that the user received, which is proportional to the number of questions asked, and an outdegree of a user means the number of answers that the user gave. Both distributions approximately follow the power law distribution. While quite a few users have a very low

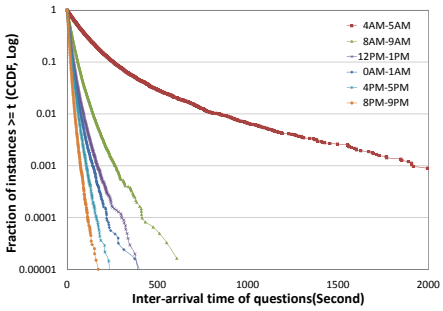

Figure 8. Inter-arrival time distribution of questions (log-linear)

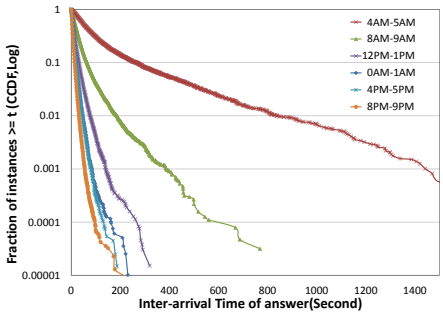

Figure 9. Inter-arrival time distribution of answers (log-linear)

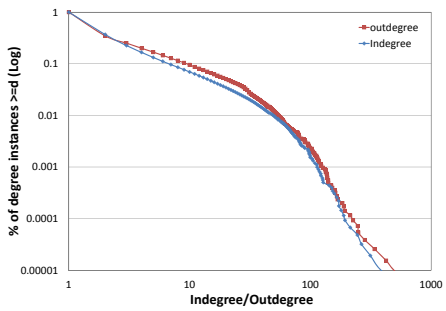

Figure 10. Indegree (bottom) and outdegree (top) distribution (log-log)

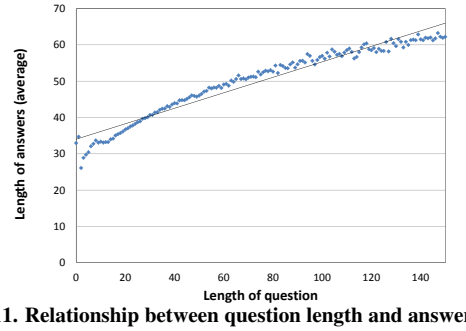

Figure 11. Relationship between question length and answer length

activity level, there are also a large fraction of users with relatively high activity levels. This behavior is also observed in the traditional Q&A site as well [4].

Question Length vs. Answer Length

Another interesting question is whether there is any relationship between the length of a question and that of an answer. As shown earlier, the average length of questions posted in Naver Mobile Q&A is 35.9 letters, which is much longer than that of mobile web search (e.g., Google Mobile Search: 15.5 letters). For a given question length, we calculate the average length of all the answers and plot the graph in Figure 11. The figure shows that the length of answers is strongly correlated with that of questions (Spearman's rho = 0.96, $p < 0.001$). The average answer length linearly increases. If a user texts a longer question, in general we expect that the user will receive a longer answer.

DESIGN IMPLICATIONS

In this section, we discuss several system design implications. First of all, we found that a significant fraction of users exhibit interactive behavior (i.e., repeating, refining questions) in mobile Q&A. One critical problem is that the asker knows the current context, but it is likely the case that the potential answerers do not have any information about the user's current context.[1] For instance, during the peak hours the inter-arrival time between questions is very short, and there are many answerers working together. The chance that an answerer can successfully select a follow-up question is fairly low. One simple way of solving this problem is to list the recently posted questions by a specific person in a reverse chronological order.

Another system design issue is to enhance the mobile user interface of mobile Q&A systems. For fast dyadic interaction with mobile devices, users should be able to browse and copy/paste previous questions—typing with mobile devices tends to be a slow and laborious task. This interaction is quite natural with the SMS interface, but the current systems lack such a feature. This partly explains why SMS is preferred to other methods among heavy mobile Q&A users. We analyzed the questions posted in the month of July 2011 (a total of 248,646 questions asked by 105,825 users). The fractions of SMS, Naver App, and Mobile Web were 7%, 55%, and 34% (the rest is the combination of those methods). If we restrict our scope to heavy users (say, those who send more than 20 queries in that month), we find that the distribution is significantly different; i.e., SMS (55%) is preferred to Naver App (25%) and Mobile Web (8%). Interestingly, 4% of heavy users utilize both SMS and Naver App/Web—SMS is much easy to interact with.

Enhancing answerer's user interface of mobile Q&A is necessary. In mobile Q&A, there are several trending topics, and some of the queries are repeatedly asked say over the course of a day (e.g., sports game results or some hot issues of a day). The system should help quickly answer those questions, which can improve the overall answering rate. For those questions, one can even design an answering system that automatically answers with a high level of accuracy. The system can treat users based on their communication methods; in particular, we can deliver additional search results along with answers to smartphone users. Another improvement is to personalize the question listing based on the answer's expertise. One simple way is to use topic categories to match answerer's expertise or interest.

Finally, our analysis reveals that a significant fraction of questions (26.3%) are based on personal accounts. Given that questions in mobile Q&A are mostly attributed to the asker's daily activities, those who are heavily using the service may suffer from potential privacy leakage. Our manual investigation shows that we were able to easily identify a fair amount of sensitive information about the askers (e.g., age, hometown, personal relationship, medical records). Existing mobile Q&A systems should at least anonymize user IDs to prevent the potential attacks. At the time of this paper write-up (September 2011), Naver changed its policy to reveal only

[1]Note that our investigation shows that only handful askers use answerers' IDs in the questions to solicit follow-up answers (e.g., "*asgsky12: I would really appreciate it if you recommend more songs!*").

first three letters of a user ID (e.g., *bmw******) to prevent potential privacy attacks.

CONCLUSION

We studied Naver Mobile Q&A, a large-scale mobile Q&A service in Korea. To understand mobile Q&A usage, we analyzed 2.4 million question/answer pairs spanning a 14 month period from Naver Mobile Q&A and performed a complementary survey study of 555 active mobile Q&A users. We found that the usage of mobile Q&A significantly differs from that of conventional Q&A sites as it is deeply wired into users' everyday life activities. We characterized the key factors of mobile Q&A usage, namely accessibility/convenience, promptness, and satisficing behavior. Our query classification study revealed that in mobile Q&A asking simple facts is more dominant than it is traditional Q&A. Further, we analyzed the macroscopic user interactions and identified the interactive user behavior such as repeating and refining questions as coping strategies of seeking information needs, the questioning/answering process, and the relationship between query length and answer length. Finally, we discussed the system design implications such as user interface design, context sharing, and privacy-awareness. As with any qualitative or single-site work, the generalizability of this work is limited such that an additional work on similar mobile Q&A services such as ChaCha and AQA is necessary, which will be part of our future work.

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