The Influence of Social Network in Mobile Experience Sampling - Development and Implementation of Android based Mobile Experience Sampling tool

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Abstract

The Experience Sampling Method (ESM), a research technique, was initiated to understand human experience and behavior upon a certain subject. This subject can be a commercial product, a period of time or even the quality of our lives. The mostly used pattern in the ESM is questionnaire, a common example of which can be customer satisfactory survey. During the past three decades, the technology used in this kind of research has changed dramatically: from primitively written on paper to vividly popping up in your modern devices [1]. Therefore, a new approach called Mobile Experience Sampling has been developed, which relies on the ubiquitous computing technologies to collect data. Among these technologies, there is an emerging star—social network. Nowadays, everyone is networking, not really by actual socializing but via countless social network sites: Facebook, Twitter, LinkedIn, etc. Life details are generously shared on these sites: what they do, where they go and, of course, how they feel. As the user population rockets, this special kind of sites has potentially become an ideal source for information/data collection of Experience Sampling. In this paper, quantitative and qualitative research methodologies are combined with the ESM to study the influence of social network on Mobile Experience Sampling. The study shows that the social network sites significantly affect the response and participation rate in the Mobile Experience Sampling experiment designed by the researcher, which indicates its influence on participants’ compliance and motivation levels.

Keywords

ESM, Android, Mobile Experience Sampling, XML, Java
Acknowledgement

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1 Introduction

In the recent few years, there is an explosive multiplication in the network socialization: exchanging personal information on social network site has become a “new fashion”. Moreover, information shared on the social network by their friends usually gives people inspiration and motivation [10]. And ESM was originally introduced to understanding personality, which is an important tool for building modern idiographic approach [2]. The goal is achieved by asking individuals to provide responses to both subjective and objective questions at specified or random points throughout a period of time. The questions can be tailored, especially, and corresponded with actual research interests and goals. The method captures multiple snapshots of human’s behaviors over time, in both external and internal dimensions of people’s experiences [1].

However, the basic paper-based ESM brings about several drawbacks. It requires substantial investment of time and resources by both researchers and participants [3]. The information distribution and collecting is expensive and time-consuming. Also, data on paper could be very inconvenient to gather and store. These disadvantages have addressed the attention of some researchers. With the development of mobile technologies, mobile devices begin to be used in conducting the Experience Sampling research. The specific characteristics of mobile devices have improved the research to be easier and more accurate, especially in the parts of question distribution, real time data capturing and data analysis. Nevertheless, Mobile ESM inherits the same problem as the traditional ESM, which is the difficulty in keeping user compliance during the whole Experience Sampling period.

This paper/thesis would analyze the former mobile experience sampling projects, especially on the usage of the mobile technology, and review the tools for mobile experience sampling. After that, a hypothesis that social networking mechanism may have influence on participants' motivation and compliance in the mobile experience sampling experiment has been suggested. In order to examine the hypothesis, a real time experiment is designed with a self-developed system by the researcher. Finally the experiment data will be analyzed to see whether social networking has an influence on the mobile experience sampling.

The field experiment shows that “share” button enabling the social networking function directly affect the response and participation rate. The study explains the indirect influence of social network in the mobile experience sampling experiment.
1.1 Background

Experience Sampling Method (ESM) is a common data collection method, using various techniques to capture human’s experience in real time. The ESM was originally designed by Csikszentmihalyi and Larson [19] to study human feelings and behaviors. Basically the method achieves its goal by asking individuals to provide responses to specified questions throughout the whole experience sampling process. The traditional ESM conducts surveys by asking users to fill out questionnaires written on papers. “These questions can be designed specially to match the goal and interest of the researches but generally include queries emphasized on physical context (weather, location), social context (relationship), feelings, thoughts, and "cognitive and motivational self-appraisals "[1].

Comparing to other methods of data gathering, information gained by ESM can accurately reflect how people interact with the contexts without losing cognitive and affective dimensions of experience [1]. However, there are some drawbacks in the traditional ESM. Since the experiment largely relies on responses, participants can sometimes suffer from stress. Another drawback is its high cost in implementation and complexity in operation. But on the other hand, ESM has its advanced feature of being able to collect data of high quality. The core principle of ESM has made it highly suitable for mobile and contextual learning [11]. In the research of ubiquitous computing and media science, its reliability has also been proven. To make it more efficient, researchers are trying to do experience sampling experiment with the help of mobile technology.

With the development of information technology, the researchers now can rely on mobile technology. The remote research method uses mobile devices to capture natural, spontaneous context without being obtrusive. The mobile technology has pushed ESM onto a new level, which has been given the name of Mobile Experience Sampling Method (MESM), which can significantly reduce burdens on both participants and researchers.

Some former researches have opened a new vista for mobile experience sampling. The Experience-sampling Program (ESP), developed by Intel Research, uses native application to conduct ESM questionnaires on PDA. The Context-aware Experience Sampling (CAES) is also available on PDA, running Microsoft’s PocketPC, to capture natural contexts. And now a newer project, MyExperience, is jointly developed by Intel Research and University of Washington. Besides loading questionnaires on Windows Mobile Smartphone, the tool even contains a sensor system to adjust the questionnaire in
accordance with different contexts. But the technology platforms planted in these projects are relatively old-fashioned, which make them difficult for diversely implementation. Recently a group of researchers in Germany developed an application named Pocket Bee for field research. The application is based on Android platform, running a multi-modal diary application. Since the application is Android powered, it can be easily deployed in all Android smart phones.

The pioneers above mostly focus on developing tool for mobile experience sampling, while few researches give solutions to how to improve the level of participants’ compliance or motivation. As addressed before, Experience Sampling Method highly relies on responses. It may bring burdens to participants, and cause delay or even suspension of data collection. Therefore research about people’s motivations towards the mobile experience sampling is essential in designing future experience sampling experiment.

1.2 Research Overview

The research is mainly divided into three parts, theoretical study on former research, software development and experiment.

Theoretical study covers former research projects of experience sampling, especially reviews of tools development for mobile experience sampling.

To complete the research and answer my research question, I developed a system with the purpose of understanding the influence of social network in mobile experience sampling. The system comes with two parts, Android application and server. The Android application will be published on Android Market¹, and distributed to the participants before the experiment. A server will be developed for questions distribution and data collection. The chart below shows the procedures of the research.

¹ An virtual software market for Android devices owned by Google.
2 Literature Review

2.1 Former Studies

In this section, some former projects related to Mobile Experience Sampling would be reviewed. The features and key technologies used in these projects will be discussed. And their advantages and disadvantage will also be assessed.

One of the earliest pioneers is a project named CAES [28], which stands for Context-aware Experience Sampling, developed by Massachusetts Institute of Technology (MIT). The project can be described as a sensor based system that triggers the questions according to different environments. The individual client of Context-Aware Experience Sampling Tool (CAES) is a questionnaire application on Windows Mobile based PDA. The system is capable of gathering qualitative data and quantitative data, such as data obtained by sensors.

The advantage of CAES tool is that it can collect real time environmental data, which enables the system to revise the questionnaire for participants. That means the researcher receives more accurate data in the experience sampling. On the other hand, during the experiment participants are required to wear a bunch of devices (sensor) on the body, which may causes unpleasant user experience. To some extent it may even result in inaccurate data.
There are two other projects similar to CAES. One is Experience Sampling Program (ESP), the system of which is based upon Palm OS platform. As the study must be scripted into the application that runs on the Palm OS device only, it is less flexible.

The other one is MyExperience project [29], joint developed by Intel Research and Washington University. MyExperience includes two parts: questionnaire software installed in Windows Mobile Smartphone and wearable sensor responsible for environment detection. The core principle of this tool is quite similar to CAES. Besides that, the questionnaires of MyExperience tool are written in Extensible Markup Language (XML). The XML is a 'tag' based language. The greatest advantage of XML is its simplicity, which is easily understandable to both researchers and amateurs without professional programming skills.

Below is a sample question of MyExperience. The Question element format can be changed depending on the specified response widget. The widget includes RadioButtonList, CheckBoxList, TextBox and so on.

```
<question id="RateMood" text="Please rate your current mood.">
  <response widget="RadioButtonList">
    <options>
      <option>Depressed</option>
      <option>Sad</option>
      <option>Neither sad or happy</option>
      <option>Happy</option>
      <option>Ecstatic</option>
    </options>
  </response>
</question>
```

Another advantage of MyExperience is that there is wireless connectivity in the system. When it runs on Windows Mobile Smartphone, the real time data can be transferred back to server over air, which is extremely efficient.

Affect Sampler [31] is a private project developed by a British developer. The software is powered by Android and also comes with a server part written in python scripts for the Google App Engine. It is mainly developed for self-tracking and it is available under the Apache License [11]. But the information about this software is very limited.
The popularity of iOS and Android exploded in the last three years. These two mobile operating systems have drawn quite a lot attention. Two recent projects, MobXamp and Pocket Bee are powered by iOS and Android respectively.

The MobXamp application is developed on iOS platform by TUM - Technical University of Munich [30]. This application adapted similar principle of ESP to the iOS devices. The research group has kept the project under wraps.

Another close-source project Pocket Bee is jointly developed by University of Konstanz and Daimler AG – Customer Research Center [5]. The application is Android powered, and mainly designed for diary input. The application comes with fully functioned backend control center. According to their report, the Pocket Bee system allows researcher to remotely operate via web-based control center, e.g. pushing specific assignments. And its friendly User Interface (UI) is claimed to reduce the pressure on the participants.
The system is now still under lab testing. It has not been used in any study or experiment yet. The research group is planning to improve the system with more complex visual representations of the diary entries in order to allow better remote evaluation.
The aforementioned projects have inspired me when designing the system structure and choosing the appropriate platform. The mobile platform used by CAES and MyExperience is out of date, the mobile application development now largely based on iOS and Android. The examples, Affect Sampler, MobXamp and Pocket Bee inspired me when developing the system structure, “native application + server”. Those three systems have either native Android or iOS application and a server was also developed for data collection and analysis center. My system architecture would be described in the next sections.

2.2 Research Gap

Most former research projects are mostly focused on the development of experiment tools, while another experiment sector about how to keep/motivate participants' compliance level during the sampling is ignored.

The level of participants’ motivation directly affects the experiment results, and could be influenced by many elements: the outer contexts, social relationships and personal emotions. Although several studies discussed above have realized the effects of contexts and succeeded in conquering it by sensors, how about the other factors that are social and interpersonal? They cannot be detected by existing sensors. However, the emergence of social networking might have unveiled a direction of resolution for us.

Nowadays, our lives are greatly affected by social networking, and its effect is greater than nearly anything else [12]. Almost everyone opens their hearts to social network, putting details of their lives online: what they do, where they go and, of course, how they feel, etc. As the user population rockets, the social network has become one of the largest potential sources for information/data collection of Experience Sampling.

The idea is to enlighten the effect of social network, exploring the influence of social network in the mobile experience sampling experiment, to see to see whether the social network sharing function in the Mobile Experience Sampling application could affect the participants' compliance and motivation.
3 Research Methodology

3.1 Research Question

To summarize the former discussion, the research direction and interest of the researcher is to assess the influence of social network on mobile experience sampling experiment. However, this topic appears to be too broad to be practice. So the research question for this thesis has been specified as:
Will the social network sharing function affect the level of participants’ motivation and compliance of the mobile experience sampling experiment?

In order to answer the research question, there are two other sub-questions addressed:
1) Is there any difference between 'share group' and 'no share group'?
2) If there is difference, how were participants affected by the sharing function of the sampling application?

3.2 Research Methods

The research is patricianly based on former research study of experience sampling and will be carried out by theoretical analysis and experimental research rather than an empirical or conceptual research. The research is carried out according to the following procedure: literature study, software development and experimental test.

In order to achieve an adequate answer, Comparative Research and Survey Research are introduced into the assessment of the questions.

As for the first question, difference between two groups is to be detected, which makes a typical request for comparison [25]. Thus, the common but effective approach, Comparative Research, is naturally chosen. The group would be randomly halved, and respectively given tests that is with sharing function and that is not. Their performances would be recorded then analyzed by the researcher.
Survey Research was initiated to understand people’s behaviors and firstly used to assess the influence radio has on politics [26]. All the features of this methodology fill right into what is demanded in the research question(s): How participants’ thoughts are affected, and what influence results from the affection. In order to obtain detailed and accurate information as possible, not only a survey would be conducted, but also interviews based upon selected survey questions would be carried out.

More detailed research process would be discussed in the later sections.

### 3.3 Technology Platform

#### 3.3.1 Theory and Rationale

This section discusses the theory of technology using in the system, given the name of 'ActiveSampler'. The ActiveSampler includes two parts, the Android application and the server.

Why Android? Given its easy-to-use feature, Android has quickly developed into one of the most popular mobile operating systems in the world. According to the latest research from Canalys, Android has now dominated 48% market share of Smartphone worldwide [27]. To develop an application for mobile experience sampling, building in on a popular mobile platform is essential — not only because of its easy deployment, but because it would be more approachable for other researchers and further improvement. Besides, it also possesses several stunning features that make it an ideal option.

**Customizability**

Comparing to other popular mobile operating system such as iOS, Blackberry OS, webOS, there is a unique feature about Android: Open-source; most of the Android software code is released under the Apache License, a free software license [13]. For the maintenance and future development, Google founded the Android Open Source Project (AOSP) with the purpose of further better development [14]. With Android, developer can customize ROM, extending its functionality to match research or business goal.

**Good Expansibility**
The research of mobile experience sampling is to explore, more functions may be added into the tool. Considering its expansibility, Android stands out from the other mobile OS. Excellent voice commands. Even though my application has not used voice recognition technology, further development may integrate this function. Android has fabulous voice command. It can be activated for searching, email and message texting and so on.

Widget design
One of the most useful components of Android OS is widget. Developer can customize the application adding widget, which enable dynamic information presentation. The widgets can be fully flexibility, usability and functionality. The widget can be used as progress indicator and displaying core question of experience sampling.

Android Open Accessory Development Kit
The future development of mobile experience sampling tool is context-aware tool integrating with various sensors, such as ambient light sensor, temperature sensor and infrared sensor and so on. Integrated sensor can detect various environments then triggering corresponding questionnaire. The Android Open Accessory Development Kit (ADK) makes it possible. The Android ADK allows external USB devices (USB accessory) to interact with an Android device in "accessory" mode. The communication between Android USB accessories and Android-powered devices is based on Arduino\(^2\) open source electronics prototyping platform [15]. The hardware and software design of the USB accessories implements the accessory's firmware and the Android applications that interact with the accessory [16]. The Arduino open source electronics prototyping platform is flexible, adding extra sensors are also easy. Arduino platform simplifies the development of a context-aware tool.

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\(^2\) Arduino, an open source electronics platform, designed for anyone who is designing multidisciplinary projects. Arduino hardware is programmable using Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). (Source: http://www.arduino.cc/)
3.3.2 Questionnaire Notification

The system of ActiveSampler includes an external service, Google Calendar. The Google Calendar serves as an alarm which notifies the users of experiment schedules. A variety of notification options are offered by Google Calendar, e.g. email, SMS. The notifications can be set for the following events: New Invitations, Changed Invitations, Cancelled Invitations, Invitation Replies, Daily Agenda (email only), and Event Reminders. However, due to the limited time for development, the Google Calendar SMS notification service will be used as the ONLY notification tool for the real time experiment of this thesis. The suggestion for better solution in the future development will be described in the section of Future Work.
3.4 Software development

This section describes the software architecture of ActiveSampler. The software system of ActiveSampler contains two parts: the Android application and the server. The following paragraph presents the requirement and design concept of the Android application, as well as the functions of it. Secondly the description of the server architecture and functions will be presented in the later part.

Figure 6 System Architecture
3.4.1 QuizPlace - the Android Application

3.4.1.1 Overview

ESM is a method that collecting information about the daily life of individuals. The method achieves this goal by asking individuals to provide responses to predefined questions during several or random time points throughout a day.

As a basic tool for mobile experience sampling, the most important function of this tool is questionnaire presentation. What's more, since my research question is discussing whether the share function in such application could affect the participants' compliance rate, the social networking function is integrated into the application.

• Questionnaire Presentation

The technology on ESM has changed dramatically in the past three decades, moving from paper-pen based questionnaire to programmable mobile devices, from two-way "personal assistant" to solicit respondents' answers at random moments of the days. However, one basic feature of the method, asking responses from participants, has remained essentially the same since its inception in the 1970s. As technology grows, the classic feature will remain the same in the future as well [1].

Therefore presenting the questionnaire to the participants is a key step of the application. The straightforward solution is storing the entire questionnaire locally; the application read the local data and displaying questions for the participants. However, the locally storage of questions prompts difficulty for questionnaire modification by developers, which is not efficient for data acquisition. A better solution is cloud storage. The questions are stored in the cloud server with control center, allowing researchers to make amendment over the air. The control center will be used as data acquisition and analysis system. Cloud storage is a networked service model of online storage where data is stored on virtualized storage space that generally hosted by trustable cloud provider. Typically it allows remote maintenance, management and back up. The information presented in the new few paragraphs gives an intensive description of how "ActiveSampler" works in the cloud.
3.4.1.2 Features of QuizPlace

The previous sections described the requirements and design ideas of the mobile experience-sampling tool.

**User Interface**

The design of the user interface is focused on simplicity and usability. The design simplicity does not mean reducing functionality or access to information. The simplicity here is to reduce irrelevant elements and contents in the user interface without causing user confusion. It is designed such that users even user without any handheld devices experience will be able to easily interact with the application. Since the application is developed for ESM study, the user interface is at least meet the needs of most standard ESM studies, which is displaying questionnaires. However, if the need arise for more functions, new interface/screen can be easily added to the design of QuizPlace.

The user interface of QuizPlace has primary one screen, one main UI with three buttons, "BACK", "Share", "NEXT", allowing user to easily navigate questionnaire progress and sharing to social network.

The layout of QuizPlace is basically based on "LinearLayout". Within the "LinearLayout", there is "TextView" and "RelativeLayout". The "TextView" is used to display question text while the "RelativeLayout" is used to positioning the three buttons "BACK", "Share", "NEXT". The figure below shows the outline of the UI.

![Figure 7. Overview of UI layout](image)
**Questionnaire widgets**

Due to the limited development time, the Android application has only two formats of questionnaire presentation: questions with radio button and questions with free text input area. The design concept is similar to the MyExperience tool. Those two widgets, "Radiogroup" and "EditText", are built-in widgets in Android SDK, under "android.widget.TextView"[17]. The application is extendable for other widgets, such as checkbox, slider and etc. The following figure shows the user interface of the two widget presentation.

![Figure 8 User Interface of QuizPlace](image)

**Social Networking Integration**

The research question is about to find out the influence of social network in participants' compliance and motivation in mobile experience sampling experiment. Integrating the
social network function is an essential feature of the application. In QuizPlace, a "Share" button is added into the user interface. The share function works with broadcast intents in Android. The application creates intent and the Android system broadcast that intent to all the activities that can execute the "share" intent (e.g. twitter, Facebook, LinkedIn, Email and etc.) An intent filter can be used to specify specific activities.

![Figure 9. Share-list UI](image)

The share function in the QuizPlace application can automatically attach the question text and also the participant's response/answer to the post window. If the user is about to share via email, the email subject will be filled automatically, modification is applicable. Meanwhile participants are allowed to modify the text before they post to their social network.
The experiment for this thesis will be carried out with two groups who used two different version of the Quiz application, one group with social networking function while the other does not. The social networking function will be hided when distrusting the application on Android Market.

● **Data Communication.**
QuizPlace includes wireless connectivity that communicates with cloud server, fetches questions and presents to the user. To study the influence of social network on the participants' compliance rate and motivation, several groups of data are needed to be captured for further analysis, which are the "Number of total answered questions", "Sharing frequency", "Time of data submission", "Device ID", "Phone Number", "Application type".

1) "Number of total answered questions". QuizPlace has a built-in counter calculates the total number of answers questions. The number will be prompted as a toast notification right after the data has been submitted.
2) "Sharing frequency". To study the influence of social network on participants' compliance rate, this number is essential. QuizPlace's built-in counter calculates
frequency of sharing. The quantitative data analysis based on the number will be presented in the later section.

3) "Time of data submission", the data includes a time stamp indicating the time of data submission that accurate to millisecond. Instead of using the server time stamp, the time is read from the user's device. Since the tool may distributed to multiple time zone participant, for the accuracy of the experiment data, the time should be stamped with the user's own time.

● Identification of the participants
In the research, an experiment will be carried out with the purpose of testing the system and also answering the research question of this paper. In order to identify the participant in the software system, a unique identifier should be used. Android SDK provides several symbols that could be used as identifier. The class, “TelephonyManager”, provides access to telephony information of the device. Application can use method in the class to determine telephony services and states, as well as to access some types of subscriber information. Applications can also register a listener to receive notification of telephony state changes. Some methods under the “TelephonyManager” provides access to unique identifier of the device.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>getDeviceId()</td>
<td>Returns the unique device ID, for example, the IMEI for GSM and the MEID or ESN for CDMA phones.</td>
</tr>
<tr>
<td>getLine1Number()</td>
<td>Returns the phone number string for line 1, for example, the MSISDN for a GSM phone.</td>
</tr>
</tbody>
</table>

4) "Device ID". The device ID is used to identity each participant. The device ID is the IMEI, International Mobile Equipment Identity. IMEI is usually a unique number to identify mobile phones [18]. However the IMEI is possible to be disable by network provider, for instance, stolen mobile phones. The network provider can ban the stolen phone by its IMEI number [20]. Besides, the IMEI number could be hacked by some illegal software. To ensure the identification process, another identifier should be added.

5) "Phone Number". Phone number is the second identifier besides the device ID.

• Sample of uploaded data.

<table>
<thead>
<tr>
<th>Answered question number: 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share times : 2</td>
</tr>
</tbody>
</table>
● Data Format

The preceding section presents the types of data generated by QuizPlace. This section will present the data format used in the data transaction.

Android is an open source mobile platform. The Android SDK gives developer access to most mobile devices to run on. Building great application needs good backend services which means server support. To build such bridge between local application and server, we need to a data format that conducts data transaction. XML, a markup language, is commonly used as a data format. It is designed to transfer data and store data, especially for structured information. The structured information contains contents and identifier. The identifier always serves as indicator of the role that content plays. While XML is being designed to deliver structured information over the web, Android does not support XML directly. Android leverages the Java programming language, however, the Android SDK does not fully support standard Java Runtime Environment (JRE). Since Android leverages the Java programming language, it supported many Java’s XML related APIs. Android supports both Java’s Simple API for XML(SAX) and Document Object Model (DOM). Those two APIs have been used for years. XML can be implemented on Android. However, these heavyweight APIs needs a lot more code to represent XML. Thus it is not an ideal solution for light weight data solution on Android. In the following paragraphs, I will present the data format I choose for data transaction.

JSON is used in the data transaction between the QuizPlace and server. To get information exchanged between server and mobile app, JSON is a good solution. Android already contains required JSON library. JSON, JavaScript Object Notation, derived from JavaScript scripting language. It is a lightweight data-interchange format representing simple data structures despite its relationship to JavaScript, it is a text format that language-independent [23]. It has parser for many languages, which is easy to parse and generate for machines.

Comparing to XML, there are several reasons that JSON over XML.
1) JSON is easier to read. Even though the raw data during the transaction in the ActiveSampler system does not ask researcher to read raw JSON data. For developer, JSON is obviously a readable language. JSON objects are constructed in a key:value pair format. The object's elements are separated by commas, and each object is
contained within curly braces {}. An array of objects is contained within square brackets. This is a common approach to transferring a series of rows from a database to an array of objects in which each array element corresponds to a database row, and each property of the object represents a column of data.

2) JSON is clean and simple. It does not require many tags as XML. The content in XML must be wrapped in open and close tag, whereas JSON just name the tag once. JSON is much more compact than XML which means light weigh.

Beside those two merit points, there are other advantages that JSON over XML.

JSON is built on two structures: a collection of name/values pairs; an ordered list of values. JSON supports some Java objects, such as string, integer, Boolean, arrays of objects and vector. The conversion is needed when transferring objects, we have to convert the objects to bytes, and then Base64 encode those bytes to strings. Conversely, when desterilizing, we have to reverse the process to get object.

The types of data have been presented in the last section. The following code shows how those types of data decoded into JSON format.

```java
private void sendBackAnswer() {
    Calendar calendar = Calendar.getInstance();
    java.util.Date now = calendar.getTime();
    java.sql.Timestamp currentTimestamp = new java.sql.Timestamp(now.getTime());
    JSONObject json = new JSONObject();
    try {
        json.put("answerCounter", countAnswered());
        json.put("sharedCounter", counterShare); //
        json.put("timestamp", currentTimestamp.getTime());
        json.put("deviceId", deviceId + " +WITH SHARE");
    } catch (JSONException e) {
        e.printStackTrace();
    }
}
```

For information about the data processing in the server will be presented in the next section.

### 3.4.2 Server of ActiveSampler
The whole system of ActiveSampler contains the Android application (QuizPlace/QuizLife) and the server. The server in the system serves as a control center, monitoring the data transaction and data collection. This section will present the architecture of server and functions of the server.

The architecture of the server shows as below,

![Architecture of ActiveSampler Cloud Server](image)

The core of ActiveSampler server is a jetty server. It implements on Rackspace Cloud server platform. Basically the jetty server runs in the visualized Ubuntu Linux on Rackspace cloud server.

- **What’s cloud computing and why use cloud computing?**
  Cloud computing is basically a set of pooled computing resources delivered over the Internet. The cloud delivers a hosting environment that doesn't limit an application to a specific set of resources. Depending on the platform, an application can scale dynamically and increase its share of resources on-the-fly [24].

  Efficient implementation. Unlike the traditional dedicated server. The cloud can easily and quickly scale to visualized server to make resources available as we are needed. Using cloud server to host the web application is efficient without worry about complex configuration and implementation [24]. The cloud server is cost effective as well. Most services have been integrated into the cloud, such as firewalls, back ups and you name it. Those virtualized resources are dynamically scalable. It is consequence of the
ease-of-access to remote server. Configuration and implementation can be finished done through web-based tools or applications, or even through a web browser.

Cloud server provides similar level of security as physical server, and even higher. Rackspace, as a world-renowned cloud-computing provider, the cloud server performance ensures the system stability. Rackspace also provides remote monitoring and control tool on the mobile devices, its Android and iOS application is capable of monitoring the detailed status of my cloud server, termination and relaunch can also be done on the fly.

Public IP. One of the biggest reason using cloud server is the server has a public IP address, allowing participants remotely access the server via QuizPlac or QuizLife.

- **Configuration of the cloud server**

The figure shows the architecture of the cloud server. The server implements on the virtualized operating system, the figure below shows the configuration of the cloud server.

<table>
<thead>
<tr>
<th>Memory</th>
<th>Server Size</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>256MB RAM</td>
<td>10GB Disk</td>
<td>Ubuntu Linux 10.4</td>
</tr>
</tbody>
</table>

The software implementation of the cloud server includes installation of FTP software and Java Runtime Environment.

<table>
<thead>
<tr>
<th>Software Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Java Runtime Environment</td>
<td>To run the jetty server on the cloud operating system, JDK must be installed. In this case, the OpenJDK 6 is installed.</td>
</tr>
<tr>
<td>FTP</td>
<td>FTP is in charge of data transaction. Every log and output data can be downloaded to local drive via FTP client.</td>
</tr>
</tbody>
</table>

---

3 OpenJDK (Open Java Development Kit) is a free and open source implementation of the Java programming language.[2] It is the result of an effort Sun Microsystems began in 2006. The implementation is licensed under the GNU General Public License (GPL) with a linking exception, which exempts components of the Java class library from the GPL licensing terms. (source: http://en.wikipedia.org/wiki/OpenJDK)
3.4.2.1 Jetty server

The core of ActiveSampler server is a jetty server. Jetty is a free, open source and pure Java-based HTTP client/server, WebSocket/server and servlet container. Jetty is similar to its counterparts, Tomcat. Both of them are java application server offering implementation of the 2.5 servlet specification with optional extras giving many JEE features [23]. Jetty can be embedded in devices, tools, frameworks, application servers, and clusters. There are several functions of the ActiveSampler server. First of all, the server hosts batches of questionnaire, pushing questionnaire to the signal Android phones which installed QuizPlace or QuizLife. Whenever the user tries to launch the QuizPlace application, a new batch of questionnaire will be fetched from the server. Theoretically, the server can host as many questions as the user needs. Secondly, the server is responsible for data collection of the ActiveSampler system. The forementioned types of data will be stored in the server for further data analysis.

There are mainly two kinds of data stored in the server: the questionnaire and the uploaded data by the QuizPlace.

3.4.2.1 Questionnaire Structure

One of the main function of the server is data hosting. For ESM researchers, creating questionnaire is one of the biggest tasks. Therefore providing an efficient way to create questionnaire becomes a essential goal for this system. The questionnaire in the mobile experience sampling is kind of survey made of a list of questions and response widgets. In this section, I focus on the structure of the question elements and outline of creating questions.

- Question Format

There are basically two types of questions that have been described in the former section, “Radiobutton” and “Free text input”. Simple and easy is the final goal when developing this tool for researcher. The tool must be easy to use without requiring intensive programming skill. The former research project MyExperience tool provides a good example in questions creation. All the questions are written into XML files. XML, a tag based markup language. The biggest advantage for the XML for question creation is its structural format, allowing researchers easily input questions into the XML file.
Structured information contains both content (words, pictures, etc.) and some indication of what role that content plays.

Obviously XML is a good solution for questions creation. However using XML means the server needs to add more code with function of encoding XML contents into JSON data. That would add more workload. To make it simple and reduce the development time, I provide a new solution, “Data. java”. All the questions are written into the Java files, code is so structural that researchers can easily find related identifier, which looks like content wrapper. There are two types of questions, Radiobutton and EditText. “OPT” and “TXT” represents each type of question respectively. Down below shows sample code, part of the questionnaire file.

```java
temp = new Questions();
temp.setQuestion("Do you believe tablet computer is the most efficient mobile computing device?");
temp.setType("OPT");
opts = new ArrayList<String>();
opts.add("Yes, easy to use & friendly UI");
opts.add("Easy distribution and maintain by enterprise IT");
opts.add("No, it still cannot replace PC");
opts.add("No, it's not safe enough to be used in enterprise");
temp.setOpts(opts);
qs[12] = temp;
```

The figure above shows the code of a sample question.

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>temp=new Questions()</td>
<td>Add a new question to the question list</td>
</tr>
<tr>
<td>temp.setQuestion(&quot;&quot;)</td>
<td>Set the question subject</td>
</tr>
<tr>
<td>temp.setType(&quot;OPT&quot;);</td>
<td>Set the question type, OPT or TXT</td>
</tr>
<tr>
<td>opts=new ArrayList&lt;String&gt;();</td>
<td>Transfer the strings in the “opt”, the options, into ArrayList</td>
</tr>
</tbody>
</table>
opts.add("""); Add the options for the radio button list
opts.add("""); Add the options for the radio button list
temp.setOpts(opts);
qs[n] = temp; “n” means the number of question

The above form and figure shows the sample question with “Radiobutton” list, the below is a sample question with “EditText”.

```java
    temp = new Questions();
    temp.setPosition("How do you feel about the weather today?");
    temp.setType("TXT");
    qs[6] = temp;
```

- **Security – Hashed IMEI**

IMEI number is a unique identifier for participant. The IMEI number is a sensitive serial number of mobile phones. IMEI is hashed with SHA-1 number to increase the security level.
SHA-1 is cryptographic hash function published by the National Institute of Standards and Technology as a U.S. Federal Information Processing Standard: SHA-1A 160-bit hash function that resembles the earlier MD5 algorithm. This was designed by the National Security Agency (NSA) to be part of the Digital Signature Algorithm.

### 3.5 Pilot test

In Dr. Teijlingen and Dr. Hundley’s opinion (2001), pilot study is the key factor in any sound research design. It can be conducted with two aims. The term can refer to trial-run or feasibility test, which is carried out as a smaller-scale rehearsal before the major study. It allows the researcher to determine whether the design is efficient in terms of cost and time, where the computing could go wrong, or whether the approach is too complicated.

In my study, the pilot study is intended to test the software system and the experiment process, trying to find out problem and sort out. In the pilot experiment, testers installed the QuizPlace on their own Android phones. They were told to launch the application whenever they receive the Google Calendar SMS notification. The events are all pre-scheduled on a master Google Calendar, then export the calendar as “experiment.ics.
Testers were asked to import the experiment calendar “experiment.ics”. A video tutorial is recorded, and uploaded to YouTube with the purpose of guiding the testers setting up the experiment calendar, enabling the SMS notification for the experiment calendar. After the calendar configuration is done, testers are told to launch the application and submit a sample data in order to verify the success of the configuration. However, the tutorial results is totally abominable. None of them has successfully set up the calendar notification service at first. After the pilot experiment, they start to complain about the complexity of calendar configuration. That is the biggest problem found in the pilot study. Besides of that, some pilot testers also commented “It would be great if you could offer an Android phone specially configured for the experiment”.

Optimizations for the experiment setup were based on the feedbacks of pilot test. Firstly, the experiment calendar is pre-configured by me, and ten Google accounts were created for experiment use ONLY. The idea of this solution was trying to reduce the burden among the participants, providing the most easiest way to complete the experiment. Secondly, I could not provide free Android phones for the participants due to the funding. Future study may do something to optimize this problem.

Nevertheless, a pilot study can also be organized for the purpose of testing the study instrument, which, in this study, is the software system. The software system works fine during the pilot test. QuizPlace has been tested in several devices. The Android OS version varies from 2.0 to 2.3.3. No bug is found during the test. Besides, the server running on Rackspace cloud server also works quite stable.

### 3.6 Actual Experiment

- Participants Recruitment

On the whole, recruiting the participants was very difficult. According to former research, the students’ motivation is highest, and the highest levels of concentration when they are taking tests or quizzes. Therefore my target participants were students. Meanwhile females are usually overrepresented among ESM participants. This reflects both a greater tendency of females to volunteer for ESM studies and to complete more questions than males do [1]. The recruitment ad was distributed via two ways, posting on ad board across KTH main campus and Kista Campus; sending the ad via KTH mail list (KTH IT service is actually responsible for the recruitment email delivery). However, only three students signed up the experiment three weeks before the experiment started. Unfortunately, due to insufficient number of participant, I failed to launch the experiment in time. All these three students dropped out as they lost their interests when I was trying to contact them for experiment confirmation.
Finally I asked ten of my friends to attend this experiment. All of them are willing to do the experiment.

- **Flow Sheet of Experiment**
The figure below represents the experiment flow, the experiment lasted for 7 days. According to former research, sampling the participants for a full week is desirable in most cases since seven days are likely to yield a fairly representative sample of them. Sampling for more than seven days may place excessive burden on some participants [1]. However, this is possible to be modified according to certain research questions.

![Flow Sheet of Experiment](image)

Figure 12 Flow sheet of Experiment

Before launching the experiment, a face-to-face software tutorial was given with each participant separately. Participants were told about the detailed process of the experiment. Meanwhile, considering about the ethic issues, an agreement was signed by each participant.

During the experiment, feedback emails would be sent to the users. These emails enclose not only researcher’s gratitude for their participation, but also their answering rates, which according to [4], would be considerably related to the users’ level of compliance/motivation.
Questionnaire schedule. The participants will be signaled three times every day. Each session of the questionnaire contains five questions; all the questions would be randomly fetched from the server. The signal time was schedule at 10:30, 13:30, 16:30. The signal time was set at “Off-peak” time considering about the participants’ convenience, this may gave the participants enough time or appropriate time to complete the questionnaire. Moreover, I considered about that the participants were always busy, the number of signaled questions was only five, so that they could finish them within one minutes.

An after experiment interview would be conducted to understand more about the participants’ feelings towards the experiment and the software as well. Some questions will be asked. The interview questions were attached as appendix in the final part of this paper.

4 Data Analysis

This section presents the data. The forms “Data Analysis 1” and “Data Analysis 2” represents the participation rate of those two groups. Obviously from the percentage, the participation rate of the group with “Share” button is higher than the group without given “Share” function. What’s more, the participation rate of the first session is significantly lower than the other two sessions; the second session is the highest, following closely is the third session. This scheme applies to the both. In the after experiment interview, participants were questioned why they failed to answer the first session questions. Most of them replied that it was a little bit early in the morning: “I just get up”, “I was eating breakfast”, “I muted the phone when sleeping and forgot to turn it back.” Quoted from the participants’ answers. The second session triggered after lunch break, most participants told that they prefer to answer questions after lunch and in the afternoon (before postshift or by the end of class), as they may not ignore the notification on their way home.

Besides, we can see the participation rate of the “NO SHARE” group, in general, it gradually declines over time. On the other hand, the “SHARE” group shows much higher enthusiasm in the experiment. The following analysis of “Number of Answered Questions” also shows the similar scheme.

<table>
<thead>
<tr>
<th>Session</th>
<th>Participation Rate (%) by Day, SHARE GROUP</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAY1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DAY7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Data Analysis 1: Participation Rate of SHARE Group

<table>
<thead>
<tr>
<th>Session</th>
<th>DAY1</th>
<th>DAY2</th>
<th>DAY3</th>
<th>DAY4</th>
<th>DAY5</th>
<th>DAY6</th>
<th>DAY7</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session_1</td>
<td>100</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>34.3%</td>
</tr>
<tr>
<td>Session_2</td>
<td>60</td>
<td>80</td>
<td>40</td>
<td>60</td>
<td>80</td>
<td>40</td>
<td>80</td>
<td>62.9%</td>
</tr>
<tr>
<td>Session_3</td>
<td>100</td>
<td>80</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>80</td>
<td>48.6%</td>
</tr>
</tbody>
</table>

### Data Analysis 2: Participation Rate of NO SHARE Group

When we look at the “Number of Answered Questions”, the figure shows the “Share” group answer more questions than the other. Since each day has a different theme of questions, the response rate varies according to different themes. During DAY 4 and DAY 5, participants were asked questions about “Love & Relationship” and “Personal Questions”. They also shows some complains about asking private questions in the experiment.

The two figures below shows the preference of question theme by two different groups.

![Figure 13 Preference of Question Theme (SHARE Group)](image_url)
Figure 14 Preference of Question Theme (NO SHARE Group)

<table>
<thead>
<tr>
<th>What type of question do you prefer?</th>
<th>Fun &amp; humor</th>
<th>News &amp; politics</th>
<th>Entertainment</th>
<th>Lifestyle</th>
<th>Personal</th>
<th>Love</th>
<th>Technology</th>
<th>Experiment related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun &amp; humor</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>News &amp; politics</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entertainment</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifestyle</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Love</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment related</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

People may select more than one checkbox, so percentages may add up to more than 100%.

Data Analysis 3: Number of Answered, NO SHARE Group

<table>
<thead>
<tr>
<th>Number of Answered Questions, NO SHARE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Answered</td>
</tr>
</tbody>
</table>

Figure 15 Response Rate of NO SHARE Group

<table>
<thead>
<tr>
<th>Number of Answered Questions, SHARE GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Answered</td>
</tr>
</tbody>
</table>
Take a look at the correlation of “(Number of Share) / Total Answered Questions”. From the figure below, it seems like participants in the “SHARE” group prefer to share information about “Fun & Humors” (DAY5). Conversely when asked about private question on DAY3 & DAY4, they seems to be relatively conservative.

<table>
<thead>
<tr>
<th></th>
<th>(Number of Share) / Total Answered Questions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DAY1</td>
<td>DAY2</td>
</tr>
<tr>
<td>Rate</td>
<td>4/57</td>
<td>2/49</td>
</tr>
</tbody>
</table>

In the after experiment interview, the participants were asked many questions related to social network usage and some other questions. According the survey, 70% of the participants spends 30-60mins everyday playing social network. When asking them if they have any discussion with their friends about this experiment or questions in the experiment. Nine out of ten persons said they did have some discussion with their friends and 70% of them developed more interests after their discussions.

When asking “SHARE” group members, three of them believe the “Share” button does not make the experiment more interesting, only two persons think the “Share” button is helpful when developing their interests. Nonetheless, all of them commented that the
socialized application is interesting, even people from “NO SHARE” group questioned me why not offering social networking function so that they could share some fun questions with their friends. “The share button is actually not helpful in developing interest, but the back end function, social network really makes the experiment enjoyable.” “I like to share some funny stuff with my friends, making jokes or something like that. But no private story!” People from the “NO SHARE” group told they felt a little bit boring gradually over time, and sometimes they did not launch the application because they guess those questions may not attractive to them.

Comparing the participation rate and response rate of those two groups, the compliance rate of the “SHARE” group is significantly higher than “NO SHARE” group. What’s more, they also felt they were “self-motivated” because of discussion with their friends on social network. To some extent, the result matches our expectation. Providing the social networking function, letting participant to share their thoughts or questions and their answers to their social network has affect their behavior in the experiment.

There is probably one potential explanation. While users shared information related to the experiment on their social network, some ideas exchange and discussions might occur between the use and his/her friends. The discussion and information exchange has affected the participant’s thoughts or feelings. They would like to share more if they feel something interesting and they would be motivated to answer more questions, conversely, they don’t share that much information when they feel the topic is too boring. And they do not like to show private information on their social network. Such superficial phenomenon might be different with different cultures. Most of the participants in the experiment are Chinese. As China’s government has intensive control on Internet information, to avoid from troubles of Chinese law, they may stay calm on some topics even though they felt interesting and willing to share, e.g. politics story. “We know some content might be masked by China’s internet firewall”, “I don't want any trouble.”

The results of the interview also suggest some other factors that may affect their motivation or compliance rate. First, the experiment feedback. All the participants
thought the feedback emails encourage them to keep up with the experiment. They said “I feel my answers in helpful in the research” “My ideas have been taken into consideration” “The research needs me” and so on. Secondly, the user experience of software really matters. Some participants complains about the QuizPlace application did not prompt the toast notification that when submitting data. The user interface should be simple and elegant without losing practical functions, and it should make the design more consistent with people's habits, like defining functions of menu or back button on the Android phones.

5 Conclusion

This chapter presented the conclusions from the thesis project and also describes my vision with the system that could be done in the future; suggestions on the project will also be given.

5.1 Conclusion

The study of this paper largely replied on experiment and interviews. Lots of information and feedbacks from the pilot test that drive me to use a new experiment setup, the preset experiment calendar notification. The detail design has a good effect on reducing participants’ burden. There are other suggestions on the system, such as using Google C2DM (Google Cloud to Device Messaging). Unfortunately, due to the time and resource limit for the thesis, the research also has some limitations, e.g. immature software platform development, limited sampling time and investigated participant population.

In this paper, we discussed the influence of social network on participants’ compliance rate in mobile experience sampling experiment. The research question addressed: Will the social network sharing function affect the level of participants’ motivation and compliance of the mobile experience sampling experiment?

To help answering the research questions, there are two other sub-questions addressed:
1) Is there any difference between 'share group' and 'no share group'?
2) If there is difference, how were participants affected by the sharing function of the sampling application?

In this project, a software system was specially developed to explore the influence of social network, it combines an Android based client application and a server acting as control center. To better conduct the study, a pilot test has been designed to test the entire
system. The study used comparative research method and survey to conduct the research. The field experiment demonstrates that showing function of “share” button increases the participation rates by 11.4% comparing to the group without “share” button. Meanwhile, according to the feedback and comments from the after experiment interviews with the participants, we drew some conclusions that this also indirectly reflects that the social networking function affect the compliance rate, which means participants have been motivated. Additionally, providing interesting topics of questionnaire is also sufficient to increase the response rate. Those two symbols represent the differences between two groups. Moreover, we also learn that the response rate, participation rate and the sharing frequency can be affected by the question topics. Interesting topics drive the incensement of the response rate, sharing rate.

Those conclusions were drawn from the filed experiment with 10 participants. Due to the limited time, only ten participants enrolled in the experiment. This small sample size means the project may not identify all the problems as they came from similar background, but it may reveals the most obvious issues. More studies should be done in order to better define the conclusions in the future.

5.2 Future Work

This section gives the remains. It focused on my vision and suggestions on improvements to the system and the experiment.

Firstly, extensive experiment is needed to deeply understanding the influence of social network on participants’ compliance rate. Since time and resources limited the project and experiment, the sample size is small and the problems we discovered may not reveal all the issues. The experiment should be conducted with more participants, dynamic background. Moreover, the contents of questionnaire could be more dynamic, such as using Flickr APIs to load images and videos as part of question.

Secondly, the software system needs further development. The tool presented in the paper is developed for researchers who want to implement a mobile experience sampling experiment. However the system still requires some programming knowledge. Therefore the tool must be easy to use even for people who do not have programming knowledge. The questionnaire creation tool should be much more simple, user friendly that allowing researchers to easily create different types of questions, e.g. radio button, checkbox, slider and even video and audio recording. For the notification system, the Google Cloud to Device Messaging (Google C2DM) service could be implemented. Google C2DM can send data from server to the Android application. The service provides simple and lightweight push message that tell the application to contact the server and exchange information instantly. For the experience sampling research, the researchers need a tool to push information in real time on the fly, sending instructions or commands to the participants.
Last but not least, adding sensors to the sampling tool. The context-aware experience sampling is a much more efficient way to conduct experience sampling research. The context-aware experience sampling tool is integrated with various kinds of sensor with the ability of detecting dynamic environment and trigger the corresponding questionnaire based on the environment or even user’s emotion. The former paragraphs described about Arduino open platform and Android ADK, the Arduino platform could be used to extend more functions of Android devices. It allows developer to add a wide range of sensor, enabling the environment detecting ability of the Android application.
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Appendix

Please read the following pages.