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A MORE ACCURATE WAY OF COLLECTING SMARTPHONE USAGE DATA

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Purpose –Despite extensive use of smart phone usage data in research studies, there is doubt about whether self-reported questionnaires provide accurate information. The purpose of this paper is to explore a more accurate method of data collection.

Design/methodology/approach –The cross-sectionalstudy was limited to university students in the Greater China Region, of whom 15were asked to identify possible mobile applications that could provide a more reliable way of collecting phone usage data. After a suitable app was found, another 132 students tested its use.

Findings –Data collection via mobile application provides data accurately and precisely. Both researcher and respondents can easily manage the new system.

Originality/Value –To our knowledge, this is the first time that data collection via mobile application has been used as a research method in social science.

Practical Implication– Compared with surveys using questionnaires, which are subject to the honesty, motivation and interpretation of the respondents, the new method has potential to reduce human error and potential bias.

Keywords: *smartphone, phone usage, self-reported questionnaire, data collection via mobile application*

1. Introduction

Statistics from the World Bank (2016) indicate that in affluent countries and regions, the number of landline telephone subscriptions (also known as main-line, fixed-line and wire-line) has decreased.By contrast, the number of smartphones (also known as cellular phones, cell phones, mobile phones and, in China, “hand-phones”)has increased aroundthe worldsince the

millennium, includeingin poorer countries. Large storage capacity and bandwidth ensure that smart phones can provide smooth transmission of multimedia materials, including text files, still image files, audio files and moving video files(Anderson n. d.).Old-style landline telephones only allowed only users to talk at home or in the office. Smart phones, however, with their expanded functionality, permit users not only to call or text, but also to access gaming and entertainment, use social media and browse the internet, check the time, and take photos or videos. This use can be anywhere, indoors or outdoors, provided telecom transmission is available (Hero 2016). The telephone has evolved from a simple voice communication device to an important part of social media andsocial networks. The continuing growth and ubiquity of smart phone sis changing the world (Ben-Av and Ben-Av 2016; Smith 2016). In some wealthy countries, including the United Arab Emirates, Saudi Arabia, Malaysia, Australia, Germany, United Kingdom, Ireland, New Zealand, South Korea and United States, the number of smartphone connections exceeds the total population. The total number of smartphone subscriptions has almost reached the level of the world population, sevenbillion (Peraman and Parasuraman 2016).

Thanks to hardware components such as Wi-Fi, Bluetooth, the Global Positioning System (GPS), accelerometers, magnetometers, and cellular modules(Chon et al.2014), people can wear headphones, chat, text, or play using their smartphones almost anywhere. Mostpeople have their phone switched on 24 hours a day, seven days a week (Oluyinka 2014; Paul et al. 2014). We find that many Chinese people demand Wi-Fi access wherever they are, includingin shopping malls, hotels, restaurants, cinemas, airports or even when buying from a one-man fast-food stall. With the continuous growth of smartphone functionality, it seems likely that interpersonal communication, or maintenance of social relations, may no longer be the primary purpose of these devices.

A smartphone can be a double-edged sword. Overuse, abuse or behavioral addiction to smart phones can be problematic (Hong et al. 2012). When someone, not necessarily a smartphone addict, finds that their smartphone is inactive, perhaps because its battery is flat, or that they are unable to communicate with others, a socio-psychological illness may be triggered. This is clinically called “nomophobia” (No-Mobile-phobia), and is a dependence syndrome that can even have effects on human health (Peraman and Parasuraman 2016). Charit (2014) categorized mobile phone addiction disorders as:

1) Textiety:a blend of *text* and *anxiety*. Sufferers have become text addicts. They are used to sending and receiving text messages and have a feeling of anxiety if they arenot receiving or sending a message, effectively, a fear of social isolation;
2) Ringxiety (Phantom ringing):a hybrid of *ring* and *anxiety*. Thisis the annoyance felt by sufferers when they mistakenly think that they can hear their mobile phone ringing; and
3) Communifaking:an act of pretending to be involved in calling, talking or texting in front of people but really communicating with nobody.

Smartphone use has increased dramatically in recent years, especially among young people(Harrison and Gilmore 2012).For example, the increasing use and acceptance of smartphones has become embedded in nearly all aspects of students' lives (for a review, see Elder 2013).

Many researchers are currently narrowing their focus in studying the impact of smartphones, from the general public to college students(Beaver et al. 2010; Elder 2013; Forese, et al., 2012; Fowler and Noyes 2015; Harman and Sato 2011; Lobo andJoshma 2013; Nathan andZeitzer 2013; Olufadi 2015; Oyewusi and Ayanlola 2014; Tessier 2013). In America,the average student is reported to spend from just underfive hours(Leppet al. 2013; Lepp et al. 2014) to nine hours aday using a smartphone (Oluyinka 2014).

Beaver et al. (2010) found that females use smartphones more often than males.Studying college students' cell phone use and its possible links to attachments, Lepp et al. (2016) found that for male undergraduates, calling, texting and total cellphone use per day were not related to parent or peer attachment.For females, however, calling was positively related to parental attachment, and texting to peer attachment.

Recent studies have correlated smartphone use with college students' mental health and physical fitness, with important implications for their health and wellbeing. The Leisure Experience Battery hasfour dimensions, boredom, challenge, distress and awareness, and isused to predict unhealthy leisure behaviors among college students (Caldwell et al.1992; Lepp et al. 2015). In spite of theportability of smartphones, their use seems to be a sedentary leisure behavior, and may therefore reduce physical activity and cardiorespiratory fitness, regardlessof the sex or self-efficacy of the user (Lepp et al., 2013). Increased phone use is predictive of greater sedentary behavior (Lepp et al., 2016). Zhong (2013) and Lepp et al. (2015) found that respondents who enjoy and undertake mental challenges and spend timethinking also tend to spend less time usingsmartphones.Compared with high frequency

smartphone users, low frequency users are more physically active and less sedentary during their leisure time (Beaver et al. 2010; Lepp 2013; Leppet al. 2015).

Burns and Lohenry (2010)found that smartphones have a negative impact on learning and that their usage isdistracting and problematic in classrooms. Elder (2013), however, arguedthat the distraction is not necessarily caused by the usage. In an experimental study, findings indicated that there wasno significant difference in quiz score between those who used smartphones in lectures and those who did not.

Many of thestudies described here usedself-reported questionnairesto collect phoneusage data (Baron andAf Segerstad 2010; Chu et al. 2011; Isiklar et al. 2013; Jankovic et al. 2016; North et al. 2014; Olufadi 2015; Oosthuizen 2005; Paul et al. 2014; Tessier 2013). These commonly-used questionnaires ask respondents to read the questions and select responses by themselves, without researcher or third party interference.The accuracy of the data, however, isopento question(Margetts et al.2003).

Data collected via self-reported questionnaires have included the total time spent on smartphone use (Barkley andLepp, 2016; Li et al., 2015; Lepp 2013; Lepp et al. 2014; 2015; 2016). Quantitative data such as time spent are often viewed as being standardized and reasonablyobjective(Sukamolson, n.d.).However, these questionnaires can come in many different forms, reducing the standardization. Even with a standardized form, inaccuracycan occur under several conditions:

1) Dishonesty – the respondent may lie to sound better than they are. For example, respondentswho are addicted to using their smartphone may find it embarrassing to be truthful in their answers;

2) Lack of conscientious response – there is no way ofknowing whether the respondent has really thought about the question(s) carefully before responding;

3) Social desirability bias – the respondentsmight hesitate to report addictive behavior, or spending excessive amounts oftime playinggames, especially if they think the report might begiven to someone in authority. This might, for example, happen with students if they thought the report might be seen bythe university authorities, or workers who thought that their managers might see the results;

4) Misinterpretation –respondents do not understand the questions and cannot ask for any explanation, because they do not have access to the researcher. These questions may therefore be given incorrect answers because they have been misinterpreted; and

5) Unwillingness toreveal private information– respondentsmay not be willing to answer if they feel that the questions invade theirprivacy (Debois 2016; Miline n.d.).

Usage maybe related to the user's context, including time, place, and environment. Chon et al. (2014) found that people tend to use their smartphones less when they werestaying in one place, but used themmore intensively when they were moving about. Students have reported that they most often check and read their phones in the early morning and before they go to bed at night (Randler, et al.,2016)

The place where they were most likely to check their phones was when they werein transit especially going to or from university, and theenvironment depended on having access to a signal, but they would use their phones wherever they could.

There are manymore studies on college students' use of smartphones.We doubt, however, whether thequestionnaires used in these studies haveprovided accurate information.The purpose of this paper is therefore to attempt to find a better and more accurate method of collecting dataon smartphone usage.The total time spent using a smartphone here refers to the total amount of time spent calling, texting, emailing, sending/watching photos and/or video, gaming individually and in a group, surfingthe Internet and using any downloaded or built-in apps.

There are a number of issues with assessing smartphone usage.The questionnaire designed by Lepp et al. (2015) includes sections on totalcellphone use per day, total number of text messages sent per day, and total number of timesper daythe phone was used to access social networking sites (Barkley andLepp 2016; Lepp 2013; Lepp et al. 2014; 2015; 2016; Li et al. 2015). In the measures section, in the methodology in the paper published by Lepp et al. (2016), total daily use wasassessed usingseveral questions, including:

- Section One: Total cellphone use per day

  "*As accurately as possible, please estimate the total number of calls you make each day using your cell phone*";and

  "*As accurately as possible, please estimate the total number of calls you receive each day using your cell phone*"(Lepp et al., 2016)

- Section Two: Total number of text messages

  "*As accurately as possible, please estimate the total number of text messages that you send each day using your cell phone*";and

  "*As accurately as possible, please estimate the total number of text messages you*

receive each day using your cell phone"(Lepp et al.2016).

- Section Three: Total daily cell phone use:

"*As accurately as possible, please estimate the total amount of time you spend using your cell phone each day. Please consider all uses except listening to music. For example, consider calling, texting, Facebook, e-mail, sending photos, gaming, surfing the Internet, watching videos, and all other uses driven by 'apps' and software*"(Lepp et al. 2016).

There are severalpossible causes of confusion here.For example, the questionnaire does not distinguish between social media and social networking sites. Section Three results in provision of information about all use, includingboth calls and texts and use of social networking sites such as Facebook, Twitter, Instagram, Pinterest, Tumblr, Google+, and Snapchat (Lepp et al. 2015).

Social media refers to electronic communication in which users create online communities to share and disseminate information, ideas, photos and videos with a broad audience. Social networking sites require the creation and maintenance of personal and business relationships with theaim of building a network that sharescommon interests. Social networking tends to result inmore personal, professional and purposeful communications among thoseuserswith similar experiences and background. In social networking, the host may spend more time on discussion, answering and conversation in hopes of growing the social network.

These differences may be why the researchers(Barkley andLepp 2016; Lepp 2013; Lepp et al. 2014; 2015; 2016; Li et al. 2015)separated phone use into several sections.Suchsurveys, including this one(Lepp et al. 2013) may not take into account current trends and usage patterns. For example,WeChat isWhatsApp's China-based competitor.Many Chinese use WeChat to text, but the app also provides the additional function of free voice calls and video calls. Many users therefore use it to call abroad (Horwitz, n.d.). It is important to note that some consider that a call via WeChat would not be a 'regular'telephone call, because thisrefers toa communication with another person through a telephone number, nota call via an app. WeChat,like WhatsApp, is a social media app that wasprimarily designed for text messages,but is now a platformwith many more functions.These include an online queue function, which allows people to find the shortest queue in nearby bank branches and obtain aqueue ticket fortheir preferred branch. People can choose to receive a reminder message when their turn approaches. The app also offersbus arrival information. Having

integratedthese useful functions, WeChat is becoming an all-in-one app,with far more functions than simple social media or social networking.Many of our Chinesestudents cannot tell the difference betweenthe 'text messages' covered in Section Two and'texting' in Section Three of the survey, and may combine both (Lepp et al. 2016).

Anotherproblemwith data generated from self-reported questionnaires like these is thatthe answersmay lack accuracy.Human memory is not very reliable, especially when it comes to recalling and assessing averagephone usage (Gabbe et al.2003).

When the participants are asked to fill in a blank form covering hours or minutes per day of phone use (Lepp et al.2015), they can find it difficult to assess 'average', because their daily phone use can change, for example, on days when they are in classes all day, or when they are on holiday. Taking an average across more days can neutralize this kind of fluctuation.The dilemma, however, is thatthe accuracy of recall in humans significantly depends on thetime interval between the event and the time of its assessment: alonger interval means a higher probability of incorrect recall (Margetts et al.2003).

The accuracy is the degree of closeness to the true value of phone usage, and therefore depends on the design of the survey (English Tips Daily, 2016). Statisticians like Taylor (1999) prefer to use the term 'bias'instead of 'accuracy', where bias is the amount of inaccuracy. Memory is how data or information is encoded, stored, and retrieved, while recall refers to the mental process of retrieving information aboutthe past (Miller, 1956).A memory bias is a cognitive bias that either enhances or impairs the recall of a memory or that alters the content of a reported memory.Recall bias is a systematic error caused by differences in the accuracy or completeness of the recollections retrieved by study subjects, in this case, about their previousphone usage (Koriat et al.2000).Bias represents a major threat to the internal validity and credibility of studies using self-reported data (Hassan, 2005).

In a 'quick and dirty' test for this study, the first author and his students tried to answer thequestionnairesproduced by Lepp and colleagues (Barkley and Lepp 2016; Lepp 2013; Lepp et al.2014; 2015; 2016; Li et al. 2015). Weall agreed thatit was difficult to recall accurately how wehad usedourphones, even in the last seven days.If higher data accuracy was demanded or thought important, or the time period was longer than seven days, estimates based on recall may therefore not be adequate.

2. Methods

By chance, we found an application (app) that can measure phone usage and thought it might be possible to use it as an alternative to questionnaires. The problem is that unless an app is downloaded from a well-reputed and trusted website, virus infection is always a concern.

Fifteen full-time university students from a faculty of business were therefore invited to explore mobile applicationsto see if they could find a safe and suitable tool. They were unable to find a suitable app that measured phone usagein both Android and iOS, the two most popular operating systems in smartphones and tablets. We therefore assumed that usersdo not spend more time on one particular brand or type of phone than others, that is, that iPhones, for example, are not likely to be used more or less than Android or other phones, so that a study using one type of phone would be representative. We selected Battery Usage, a built-in app in iOS,as suitable for this study.Billington (2015) has commented that the tool once used to measure which apps drained the battery now goes further by turning that percentage into time. The selected built-in app using iOS 9shows usage (screen-on) and standby (background) time for boththe last 24 hours andthe last sevendays. In a survey, it may be difficult for a respondent to assess their usageinminutes rather than hours. This pre-installed software, however, allows the usage of each app to be measured inminuteson-screen and background.

This exploratory studywas limited to university students from the Greater China Region, includingmainland China, Taiwan, Hong Kong and Macau. It assumed that there would be possible fluctuations in usage among the students at the start of a new semester, and during examination week andholidays. Data for seven-day usage were therefore collected about three weeks before the end of a semester.

We decided thatit might take a long time to contact individual academics from other university and ask them to distribute the survey, because of the time required to obtainapproval from university authorities.We therefore usedfirstly convenience samplingin our university, and secondly,snowball sampling via WeChat, the most popular social media tool among Chinese students. We asked the study participants to use a five-step process to collect their usage from the last sevendays:

(1) Find and hit “Settings” from an iOSphone;

(2) Find and hit “Battery”;

(3) Open “Battery”, then find “Last 7 Days”;

(4) Press the clock beside the label “Last 7 Days”; and

(5) Take a snapshot of the battery usage time (as shown in Appendix 1).

Instead of completing a questionnaire, the respondents were asked to takea snapshot directlyfrom the phone screen and send itanonymously to an assigned email account.A pilot was conducted prior to performance of a full-scale test. And, focus group was called to comment on the user-friendliness of the DCMA.

3. Results and Discussion

3.1 Hyperlink to a video demonstration

The pilot test found that some respondents were unable to access to this particular app properly. The survey was reconstructed with a hyperlink to a YouTube video showing a Battery Usage Check. The video demonstrates how to collect the data step by step, and is easy to follow. YouTubeis blocked in Mainland China, so we also provided a snapshot of each step, so that respondents could easily follow the five-step process.

3.2 Data privacy

Although the survey was anonymous, the respondents in the pilot test worried their personal data might be misused by third parties. They were reluctant to send their survey responses to a particular email address. The strategy was therefore adjusted and student leaders were asked to gather the data into a batch.In order to avoid the leader having any option to manipulate the data, they were asked to attach and emailall snapshotted tables with a list of apps from each anonymous respondent.

3.3 Different operating systems

The new method can only assess usage accurately ifthe respondent is using an operating system ofiOS 9.0 or above.We were able to collect data from only 132 respondents, of which only 102 responses were valid. This response rate was lowerthan expected, perhapsbecause few students had the necessary mobile operating system.

3.4 Multi-language portfolio

Although most participants were Chinese, a fewwere not. The official languages in the region are (simplified and traditional) Chinese, English and Portuguese. There are also students from Southeast Asia. The multi-language support in smartphones is able to reduce inconsistencies in translated questions and so improve the accuracy of the result. Data collection by mobile applicationis extendable to any respondent provided a suitable language setting is available in the multi-language portfolio.

3.5 Feedback from the students

After data collection was complete, we held a focus group with the student leaders about the user-friendliness of DCMA.The students commented that they did not bother to make the difference between social media and social networking sites and this did not matter to them. They were happier sending a snapshot than answering a series of questions partly because it was quicker and less personal.

4. Conclusion and recommendations

Probably very few phone users check their battery usage. This app, originally designed to tell which apps used more battery life, now has new potential as a research method. Data collection via mobile application has potential to increaseaccuracy of usage measurement over contemporary self-reported questionnaires. Instead of relying on recall or guesswork, respondents take a snapshot of the data.The multi-language portfolio allows researchers to avoid time-consuming back translation of study instruments.

Software applications are developed rapidly for mobile devices, depending on demand (Malizia and Kai, 2011).It seems likely that data collection via mobile applications may before long provide data on more than just phone usage, and in the process, become an essential tool forsocial science researchers.

The disadvantage of convenience sampling and snowball sampling is that it is impossible to determine the sampling error or make inferences about populationsusingthe sampleobtained.However, this is an exploratory study, and makes no inferences. The respondents, all students, were invited merely to trial the new method usingthe five-step process. The study was therefore considered a success since the students were able togenerate the raw data shown inAppendix I.This applies even though the appcannot distinguish differences of usage under different conditions, such as when the user isimmobile or moving.

Finally,this paper hasdescribed an exploratory study, designed to explore whether a more effective research method is available. For descriptive or explanatory research about smartphone usage, a larger sample size is recommended.

5. Implications

Compared with questionnaires, which are subject to potential bias, and depend on the honesty, motivation and interpretation of respondents, data collection via mobile application provides a new and more accurate option for data collection. We hope its use here is just the beginning of applying this new research method to social science.

When we were able to demonstrate the use of the app to collect data in class, the students were easily able to understand it.It took longer, however, to adjust the survey to make the self-reported questionnaire user-friendly. In using this new method, we strongly recommend that researchers provide a hyperlink to a video demonstration.

6. Further research

Usingsnapshots of usage by app, researchers canquickly and easily obtain details of thetotal amount of phone use.We made no further efforts to organize, process or code the raw data. When we looked at the data from different universities, we found thata widevariety of apps was being used. The types of apps and their usage patterns varied by respondent. Toensure thatdata collection via mobile appprovides a strongercontributionto the body of knowledge, we are now trying to find a way to sort, organize and consolidate the information about all these apps into meaningful and manageable groups.In other words, we are making an attempt to quantitatively summarize the large numberof apps using descriptive statistics. Asummary in bar chart or pie chart form may provide more useful indications to academics and society.

Besides textiety, ringxiety and communifaking, we found another dependence syndrome, which we have temporarily labelled“assimilanxiety”, a blend of assimilation and anxiety. It is a feeling of anxiety among members ofa group, who take out and immediately use their smartphones to adapt to the prevailing phone-engagement behaviour. This may occur in public, for example, on a train, bus or ferry.Although someone may have no initial intention ofusing their smartphone, they may choose to assimilate when they discover that the majority of those around are engaging with an electronic device. We asked students if they ever experienced this anxiety but the answers were inconclusive. Further deductive research may be necessary to explore this potential phenomenon.

Smartphone Platform Market Share data (comScore, 2016, Jan) suggested thatAndroid was the top smartphone platform in January 2016, with a market share of 52.8%, followed by Apple with 43.6% (up 0.3 percentage points from October), Microsoft with 2.7% and BlackBerry with 0.8%. China is projected to account for 28.34% of the global smartphone market by2018 (Statista-China, 2016), and regional use of particular platforms may therefore be important in considering the use of apps to collect data on smartphone usage. It may be usefulto describe and compare data for use of iOS9 or above in different regions to see where this method has most potential.

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Appendix 1: Snapshot of the battery usage time

Remarks: Taking one snapshot from screen is usually enough to collect the usage but whether one or two is required will depend on the number of apps used in the period.