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Investigating Response, Data Sending, and Completion Rates of a Smartphone-based Travel Survey Conducted in Kabul, Afghanistan

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Abstract

This study concentrates on the response, data sending, and survey completion rates of a smartphone-based travel survey in a developing country. A smartphone-based survey reinforced by a web-based survey was conducted in 2015 in Kabul, Afghanistan. The aims of this study are: 1) to explore the effects of age and gender on the response rate of the smartphone-based travel survey, and 2) to examine how gender, age, smartphone ownership history, and occupation influence the data sending and completion rates of the smartphone-based travel survey. The results show that gender had no effects on the response rate, while age had a significant impact. In addition, gender had effect on data sending rate, and the respondents who owned smartphones for longer time were more likely to complete the survey successfully. Furthermore, the survey withdraw rate of respondents was higher on weekends in comparison to weekdays.

Keywords: response rate, data sending rate, survey completion rate, smartphone-based travel survey

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1. Introduction

1.1. Background and objectives

Traditional methods, such as telephone interviews and face-to-face or mail-based travel surveys, have been used to collect the travel behavior data of respondents. In these methods, people are encouraged to record their travel behaviors, such as departure and arrival times (perceived travel time), travel modes, and other details of their daily trips. However, capturing such information using traditional survey methods places a significant burden on respondents and negatively affects data quality (Ferrer and Ruiz 2014). In traditional survey methods, respondents do not record completely accurate information regarding their trips. Furthermore, it is difficult to record daily trip variations in traditional survey methods unless two or more temporal surveys are conducted. Such repetitions of traditional surveys increase the cost, time consumption, and overall difficulty of surveying (Shin et al. 2015).

Recently, several technological innovations, including GPS, and survey apps on smartphones, have improved the quality of survey data and reduced the burden placed on respondents compared to traditional survey methods. Moreover, using smartphones as travel survey tools is a promising alternative to traditional survey methods. In contrast to traditional survey methods, smartphone-based survey methods facilitate the collection of detailed information regarding multi-day travel behaviors without incurring additional costs (Allstrom et al. 2017). Thus, smartphone-based travel surveys can play a vital role in collecting accurate data, as well as reducing the rental and shipping costs of survey instruments, such as GPS devices (Maruyama et al. 2015; Chen et al. 2010).

Applications for smartphone operating systems that automatically detect trips and their characteristics, such as travel modes, travel distance, and departure/arrival times, can provide advanced tools for collecting accurate data. Smartphones are ubiquitous and versatile devices that are rarely forgotten by their users and place no additional burdens on their users.

Various studies in developed countries have indicated that people prefer to participate in online surveys than paper-based surveys (Susilo et al. 2017; Greaves et al. 2015). Additionally, middle-aged and active groups of people are more willing to participate in online and smartphone-based travel surveys in developed countries (Nina et al. 2017; Safi et al. 2015). Therefore, using smartphone-based survey methods as an alternative to paper-based survey methods has attracted significant attention from researchers in developed countries. Researchers in developed countries are struggling to find effective methods to increase sample sizes and improve the representativeness of smartphone-based travel surveys (Maruyama et al. 2015). However, developing countries such as Afghanistan, are in the initial stages of using smartphones as technological data collection tools. Therefore, in order to determine the feasibility of such technological surveys, we conducted one of the first smartphone-based travel surveys in Kabul, Afghanistan.

Some studies in developed countries have stated that the response rates for smartphone-based surveys are affected by gender and that middle-aged people have higher response rates than elderly groups (Maruyama et al. 2015; Sato et al. 2019). However, few studies have investigated this issue in developing countries. Therefore, we aimed to analyze the participation choices of respondents to a smartphone-based travel survey conducted in Kabul, Afghanistan as a case study on developing countries. This study focused on investigating the following questions: Do age and gender influence the response rates of the survey? How do age, gender, smartphone ownership history, and occupational conditions affect data sending and completion rates in a smartphone-based travel survey? These questions are answered by analyzing data collected from a smartphone-based travel survey that began on August 15, 2015 and lasted for one month in Kabul, Afghanistan.

In this study, we concentrated on the response, data sending, and completion rates of the smartphone-based travel survey. The response rate of a travel survey is defined as the number of participants who were willing to share their travel diary over the total number of people who were asked to participate in the recruitment stage (Stopher 2012). The data sending rate is the ratio of participants who started sending data over the total number of consenting respondents. The completion rate is defined as the ratio of participants who successfully completed the requested survey period over the total number of respondents who started sending the data.

The main objectives of this study are as follows:

1. To investigate the effects of age and gender on response rate.
2. To explore the effects of age, gender, smartphone ownership history, and occupation on data sending and survey completion rates.

1.2. Literature review

The collection of travel data began with a face-to-face survey in the 1950s. In that survey, interviewers visited households, asked the participants for travel information, and recorded the answers using pencil and paper (Shafique et al. 2016; Wu, et al. 2016). A decade after, mail-out/mail-back paper-based travel survey method was implemented in the field of transportation. In the 1980s, a paper-and-pencil interview was combined with computer-assisted telephone interview in order to improve the accuracy and completeness of travel data. Several shortcomings including low response rate, high cost, errors in recording information, and data omission have been observed in these survey methods (Wu et al. 2016; Wolf et al. 2000; Gould 2013).

Due to the above-mentioned limitations of traditional travel survey methods, the recent innovated technology (e.g. GPS, smartphone, etc.) attracted a significant amount of attention from the researchers and policymakers toward automatic data collection method. Since the 1990s, the global positioning system (GPS) device used to measure personal travel data (Stopher et al. 2008a). Initially, due to the large weight of GPS and the battery charge issues, the devices were installed in the vehicle and electrified from the vehicle's battery (Gong et al. 2014). Therefore, the collected data was only attributed to the persons who were driving the vehicles equipped with GPS devices. In the beginning of the 21st century, small size wearable GPS devices appeared on the market that was to carry by people and the battery issue was also solved (Stopher et al. 2008a). Since then, a number of GPS-based travel surveys have been implemented in the field of transportation to obtain personal travel behaviors (Montini et al. 2015; Safi et al. 2017; Stopher et al. 2007, 2008a, 2008b and 2013; Federal Highway Administration 1997; Gong et al. 2014). GPS-based travel survey method has several advantages over the traditional survey methods. For instance, the location and movement information collected from GPS-based travel survey are more accurate in comparison to self-reported travel survey methods (Stopher et al. 2007). Furthermore, the survey burden generated from answering several travel-related questions in traditional survey methods can be also reduced by using GPS in travel data collection (Stopher 2012). GPS-based travel survey method has also several limitations including the high cost (the rental or buying cost of device for each respondent), technical issues (losing signal in the tunnels and urban canyons), and forgetting to carry the device by the respondents (Gadzinski 2018; Asakura et al. 2014; Gong et al. 2014; Wolf et al. 2003). In addition, GPS alone cannot automatically record the travel mode and trip purpose which are essential components of travel surveys (Stopher et al. 2008b).

Considering to these limitations of GPS-based travel survey method, transportation planners greatly encouraged by smartphones since this device appeared on the market in 2004. Recently, smartphones as ubiquitous product become an integral part of everyday life. The embedded technology in smartphones offers the opportunity to measure travel behavior of respondents with the reliable accuracy (Berger and Platzer 2015; Cottrill et al. 2013; Chen et al. 2010). In addition, smartphone-based travel survey method needs small operational cost, and incurs small survey burden over respondents in comparison to GPS-based and traditional travel survey methods (Allstrom et al. 2017; Zhao et al. 2015, Shin et al. 2015; Maruyama et al. 2015; Asakura et al. 2014; Chen et al. 2010). Despite the above-mentioned advantages of smartphone-based travel survey method, some barriers still remain including technology-related and respondent-related challenges. For example, the faster battery drain, slower device operation speed while app is running, and app malfunctioning are the main technology-related challenges of smartphone-based travel survey method (Safi et al. 2017; Gadzinski 2018). Additionally, privacy, and concern of being tracked are the dominant respondent-related challenges of this survey method (Zegras et al. 2018; Ketelaar and Van Balen 2018; Qudratullah and Maruyama 2019a; Safi et al. 2017; Danalet and Mathys 2017; Montini et al. 2015; Bhat 2015; Cottrill et al. 2013; TRB Travel Survey Method Committee 2013; Nitsche et al. 2012). Furthermore, some statistics confirmed that smartphones are not evenly distributed around the globe. For instance, Poushter and Stewart (2016) reported that the average smartphone ownership rate in developing and emerging communities is 37%, while that rate is 68% in the developed countries. These limitations can adversely affect the quality and quantity of the data collected from smartphone-based surveys. Therefore, the researchers should pay close attention to these concerns in smartphone-based travel surveys.

In developed countries, several strategies are being used to increase the response rate of smartphone-based travel surveys. For instance, Maruyama et al. (2015) offered an incentive (coupon worth 500 JPY) for increasing response rate of a smartphone-based travel survey conducted in 2013 in the city of Kumamoto, Japan. In addition, data sending rate is another essential factor for collecting reliable travel data using smartphones. In multi-day smartphone-based travel surveys, not only the initial sample size but also retention of respondents throughout the survey is an issue that is worth considering. In the other words, losing respondents between the survey periods in multi-day data collection can negatively affect the quality and the quantity of the collected data (Comendador and López-Lambas 2016). Therefore, for collecting reliable travel data, in addition to response and data sending rates, the survey completion rate is an important factor.

Several studies investigated sampling related issues of smartphone-based travel surveys in developed countries. For example, Safi et al. (2015) reported that the response rate was lower than data sending rate and survey completion rate of smartphone-based travel survey conducted in New Zealand. In the other words, the individuals in that survey were more likely to reject participation in the recruitment period. Moreover, the initially consented participants were more likely to send the data and remain until the end of the survey period. Larose and Sandy Tsai (2014) also reported sampling issues of an online survey that is similar to the smartphone-based survey. This study compared the survey completion rates with reward (pre-paid or sweepstakes) and without reward. The results of this study revealed that pre-paid reward was more effective in improving the survey completion rate when compared with the other two methods.

The current experiences of smartphone-based travel survey are mostly applied in the developed world (see e.g. Hoogendoorn-Lanser et al. 2015; Thomas et al. 2018; Maruyama et al. 2014; Montini et al. 2015; Safi et al. 2017; Berger and Platzer 2015; Gadzinski 2018; Comendador and López-Lambas 2016; Wu et al. 2016; Geurs et al. 2015). In developing countries, the feasibility of smartphone-based travel survey method has not been fully investigated. Therefore, this paper attempts to address response, data sending, and completion rates of a smartphone-based travel survey conducted in Afghanistan. In addition, this research work will also provide the necessary insights into the relationship between the individuals' attributes and survey sample throughout the two weeks smartphone-based travel survey. Therefore, the originality of this study is the extension of smartphone-based travel survey experience to Afghanistan as a developing country. Furthermore, investigating the sample issues throughout the survey period (from individuals' recruitment to survey completion) is another novelty of this study.

The remainder of this paper is organized as follows: The methods used in the study are described in Section 2. Section 3 focuses on discussion of our results. The factors affecting response, data sending, and survey completion rates are also discussed in this section. Finally, our major findings are summarized in Section 4.

2. Methodology

2.1. Respondents recruitment

Since there is no literature regarding the smartphone-based travel surveys in Afghanistan. Therefore, our survey in 2015 could be one of the first smartphone-based travel survey trial conducted in the city of Kabul. Culturally, recruiting females by stranger males could be one of the sensitive issues in Afghanistan. Hence, females are the hard-to-reach population in that country. Considering these reasons, we recruited individuals through personal networks of survey personnel. Initially, the recruits were categorized as consenting and non-consenting individuals. The gender and apparent age were the only information of the non-consenting individuals that were recorded by the survey personnel. In the case of consenting individuals, we sent a web questionnaire asking about their socio-demographic information, including age, gender, address, smartphone ownership, and employment status (government worker, private organization staff, self-employed, housewife, student, etc.).

The consenting individuals were also requested to install the application on their smartphones, create the account, and keep functioning the application for fourteen days (hereafter referred to survey period). Therefore, the respondents are further categorized into two groups of those who started sending and those who did not send the data. The respondents who sent the data are also grouped into below two categories: 1) those who successfully completed the survey period, and 2) those who stopped sending the data before ending the survey period. Considering these categorizations of recruits, we defined response, data sending, and survey completion rates as below:

n_1 / N: Response rate
n_2 / n_1: Data sending rate
n_3 / n_2: Survey Completion rate

Table 1. Sample information

		n	%	%	%
Kabul (2015)	Total recruited (N)	200	100		
	Non-consenting	125	62.5		
	Consenting (n_1)	75	37.5	100	
	Not sent data	27		36.0	
	Sent data (n_2)	48		64.0	100
	Not completed survey period	27			56.2
	Completed survey period (n_3)	21			43.8

Where N is the total number of recruits, n_1 is the total number of individuals who agreed to participate, n_2 is the total number of those who started sending the data, and n_3 is the total number of respondents who successfully completed the survey period.

As presented in Table 1, 75 out of the total (N=200) recruits agreed for their participation. This means the response rate is 37.5%. Then 48 out of 75 agreed respondents attempted to send the data that means the data sending rate is 64.0%. Finally, 21 out of 48 respondents successfully completed the survey period that means survey completion rate is 43.8%.

2.2. Smartphone application for data recording

In general, there are two sources of application development for travel data collection using smartphones. One is the application that is developed by the researchers for the specific purpose of travel data collection such as SmartMo (Berger and Platzer 2015), and UbiActive (Fan et al. 2013). Another one is the application developed and provided by third parties that is available for public use on the market (Wang et al. 2018). In our survey, as this was the first trial of smartphone-based travel survey in Afghanistan, we used an existing and predesigned application named MOVES. This was a free and famous life-log app available on the app store and Google play for iOS and android respectively. The survey was designed to collect trip information from the application installed on the respondents' smartphones. The individuals' attributes were collected through a web-based questionnaire that was sent to each consenting individual.

Prior to starting the survey, each respondent received face-to-face instruction regarding the use of the application. Additionally, a user guide and privacy policy documents for the survey were sent to participants over the web. The user guide describes the survey, overall process, and how to handle the app when the phone battery runs out. The privacy policy informs respondents how the collected data will be used. We provided an ID and password for each participant to create an account on MOVES. The purposes behind providing login ID and password information were: 1) to reduce the survey burden on users (e.g., downloading data and sending it to surveyors) and 2) to provide access for downloading the data from the server to surveyors. The participants were asked to keep the app running for two weeks and validate the data every night after returning home. Thus, the first fourteen days were the official survey period. Some participants continued sending data after the official survey period. This is referred to as the volunteer period of the survey.

3. Result and Discussion

In this section, we investigated and discussed the relationship between individuals' attributes and the response, data sending, and survey completion rates. We used bivariate analysis in order to investigate the factors that affect the above-mentioned rates. In addition, the influences of weekdays and weekends on survey withdraw choice of respondents have been also considered in this section.

Table 2. Comparison of response rate in term of gender and age

Attributes		Response		Non-response			
		n	%	n	%	χ^2	*P-value*
Gender	Male	49	36.3	86	63.7	.257	.612
	Female	26	40.0	39	60.0		
Age	Under 29	48	44.9	59	55.1	5.3181	.021*
	Over 30	27	29.0	66	71.0		

*Significant at 5% level

Table 3. Comparison of data sending rate in term of individuals' attributes

Attributes		Sent data		Not sent			
		n	%	n	%	χ^2	P-value
Gender	Male	38	77.5	11	22.5	11.2654	7.9×10^{-4}**
	Female	10	38.5	16	61.5		
Age	Under 29	34	70.8	14	29.2	2.7022	.100
	Over 30	14	51.8	13	48.2		
Smartphone-owning history	<2 years	30	62.5	18	37.5	.1302	.718
	>2 years	18	66.7	9	33.3		
Occupation	Employed	38	70.4	16	29.6	3.3969	.065
	Unemployed	10	47.6	11	52.4		

**Significant at 1% level

3.1. Response rate

During the recruitment process, we recorded the gender and apparent age of non-consenting respondents. In the case of consenting individuals, the attributes such as gender, age, occupation, and smartphone ownership history were obtained by web-based questionnaire. Hence, gender and age are common attributes collected from both the consenting and the non-consenting individuals. Therefore, the relationships between these two factors (gender and age) and response rate are considered in this section. The difference in response rate between males and females was not statistically significant, as stated in Table 2. The influence of age on response rate was determined to be statistically significant ($p=.02<.05$), as presented in Table 2. Participants aged less than 29 had a higher response rate than those aged over 30. The significant difference between older and younger people can be explained by the lack of familiarity with using smartphones for older people and the greater ability to speak English and operate the app for younger participants (the app is in English).

3.2. Data sending rate

In this subsection, we compared the data sending rate in term of individuals' attributes such as gender, age, occupation, and smartphone ownership history. We conducted a statistical test to determine if the difference in data sending rate between male and female respondents was statistically significant. The test confirmed a statistically significant difference between males and females ($p = 7.9 \times 10^{-4} <.01$), as presented in Table 3. The high rate of failure to submit data for female respondents could be due to their lower education level and English ability. Because females in Afghanistan are less educated in comparison to males. For example, a survey (Afghanistan Central Statistics Organization, 2017) reported that 72.9% males and 50.5% females in Kabul have attained primary (grade six of school) and over education.

The difference between younger and elderly respondents in term of data sending rate was not statistically significant (Table 3), but the younger generation was more likely to send the data. Similarly, no statistically significant difference in data sending rate was observed in term of smartphone-owning history, as stated in Table 3. We have also examined the relationship between occupation conditions of respondents and data sending rate. The difference was close to being statistically significant (p=.065 >.05) between employed and unemployed respondents (Table 3). The response rate of employed individuals was relatively higher in comparison of those who have no jobs.

3.3. Survey completion rate

As described in section 2, participants were asked to share their travel diaries for two weeks. Some respondents stopped sending data before the end of the survey period. In contrast, some participants completed the survey period and continued sending the data during the volunteer period as well. Figure 1 illustrates the decline of participation of respondents throughout the survey and volunteer periods in terms of entire sample and gender. In total, 21 respondents that comprised 43.7% of the entire sample size successfully completed the survey period. Sixteen were male and five were female. Male and female survey completion rates were 42.1% and 50.0%, respectively. Additionally, the volunteer period length for male respondents was longer than that for female participants. The survey completion rates between male and female respondents were statistically tested and the differences were not statistically significant, as presented in Table 4.

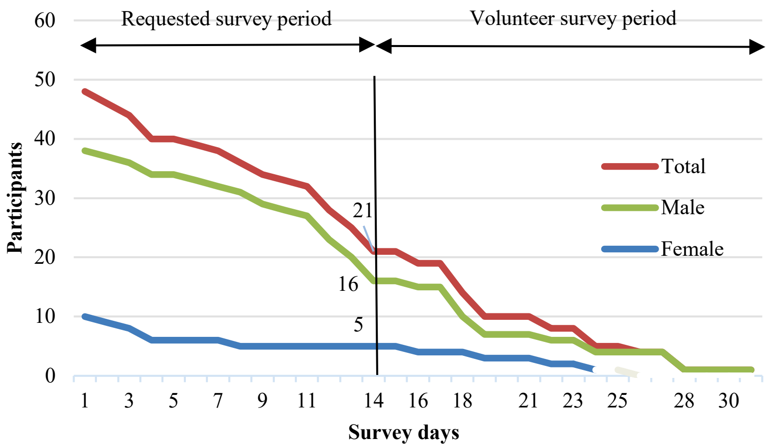

Figure 1. Decline in respondents' participation within requested and volunteer survey term (entire sample, male and female)

Table 4. Comparison of survey completion rate in term of individuals' attributes

Attributes		Completed survey period		Not completed survey period		χ²	P-value
		n	%	n	%		
Gender	Male	16	42.1	22	57.9	.2005	.654
	Female	5	50.0	5	50.0		
Age	Under 29	15	45.5	18	54.5	.1247	.724
	Over 30	6	40.0	9	60.0		
Smartphone-owning history	<2 years	9	30.0	21	70.0	6.146	.013*
	>2 years	12	66.7	6	33.3		
Occupation	Employed	18	47.3	20	52.7		.478[a]
	Unemployed	3	30.0	7	70.0		

Note) *: Significant at 5% level. [a]: Due to small number of unemployed respondents, the Fisher exact number test has been applied

The survey completion rates of respondents in term of age have been also considered in this section. We performed a statistical test to determine if the difference between the completion rates of respondents aged less than 29 and those aged over 30 is significant. The difference was not statistically significant, as presented in Table 4.

We have also considered the relationship between survey completion rate and smartphone ownership history. A statistical test was performed in order to compare the survey completion rates between those who owned smartphone for less than two years and those who owned it for more than two years. The difference was statistically significant ($p=.013<.05$), as stated in Table 4. The reason for these differences could be the greater familiarity with smartphone use of those who owned the devices for longer periods of time.

The effects of occupation conditions of the respondents on survey completion rate were also examined in this section. The completion rates of participants in terms of occupation were statistically tested and the difference between employed and unemployed respondents was not statistically significant, as stated in Table 4.

Furthermore, we examined the respondent withdrawal from the survey on weekdays and weekends in term of various attributes (gender, age, smartphone ownership history, and occupation). Please note that Thursday and Friday are considered to be the weekend in Kabul, while only Friday is considered to be the weekend in the rest of Afghanistan.

Figure 2 illustrates the number of participants who withdrew on each day of the week. The average number (12.0 per day) of respondents who stopped sending data on weekends is higher than the average number (4.8 per day) of respondents who stopped sending data on weekdays. We conjectured that the dominant reasons for higher withdraw rate of respondents on weekends (e.g. Thursday and Friday) as follow:

1. People in Afghanistan usually make amusement and recreational trips (e.g. going to park, mountainous areas, etc.) on weekends. Therefore, people may concern of being tracked for privacy reasons.
2. The battery consumption may increase due to frequent use of smartphones for taking photos, making videos, and using social media on weekends. Therefore, some respondents may withdraw from the survey to avoid the fast batteries drain of their smartphones.
3. There could be fewer opportunities to charge smartphone batteries at weekend travel destinations. For example, phone charging stations are not available in public spaces in Afghanistan.

We also concerned that the completion day (14th day) of the survey may fall on weekends for some respondents. Therefore, we considered the withdraw choices of respondents who succeeded to complete the survey. Twelve out of 21 successful respondents representing 57.1% of the total completion rate withdrew on weekends. Figure 3 depicts the number of participation days of those who successfully completed the survey and withdrew on weekends. The respondents send their data for more than the requested survey period. Therefore, we conjecture that the successful respondents who stopped sending data on weekends were not due to the completion of the survey period on those days. In addition, respondents may count the survey period on week basis (e.g. two weeks) than day basis (e.g. 14 days).

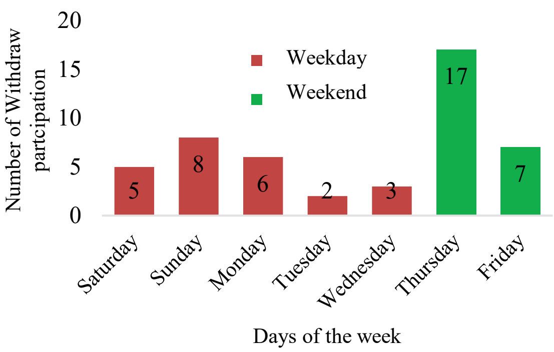

Figure 2. Number of respondents withdrew on each day of the week

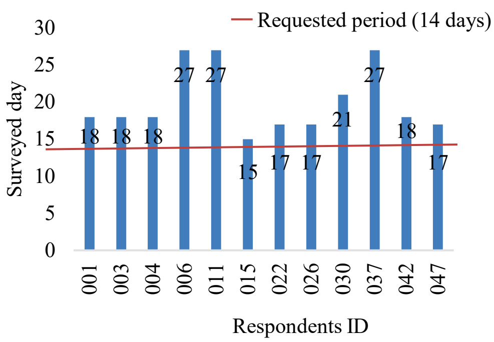

Figure 3. Number of participation days of respondents who succeeded to complete the survey and withdrew on weekend

Table 5. Comparison of respondents withdrew on weekdays and weekends in term of individuals' attributes

Attributes		Withdrew on weekdays		Withdrew on weekend			
		n	%	n	%	χ^2	P-value
Gender	Male	20	52.6	18	47.4		.723[a]
	Female	4	40.0	6	60.0		
Age	Under 29	18	52.9	16	47.1	.4034	.525
	Over 30	6	42.8	8	57.2		
Smartphone-owning history	<2 years	11	36.7	19	63.3	5.6889	.017*
	>2 years	13	72.2	5	27.8		
Occupation	Employed	16	42.1	22	57.9		.0723[a]
	Unemployed	8	80.0	2	20.0		

Note) *: Significant at 5% level. [a]: Due to small number of female and unemployed respondents, the Fisher exact number test has been applied

We examined the effects of weekdays and weekend on the withdraw choice of respondents. The statistical tests confirmed that the differences between the number of respondents who stopped on weekdays and weekends in term of gender, age, and occupation were not statistically significant, as stated in Table 5. In term of smartphone ownership history, the difference is statistically significant (p=.017<.05) between the respondents who owned smartphone for less than two years and those who had for more than two years (Table 5). Majority of respondents who owned smartphones for shorter time stopped sending the data on weekends. This could be due to the lack of experience with weekend battery management of participants who recently acquired smartphones. In the other words, due to the high battery drain on the weekends, the respondents who owned smartphones for a shorter time may turn the app off and not turn it on again. Please note, however, that we had not asked respondents the information on these hypotheses and these hypotheses should be examined in future work.

4. Conclusion

This study demonstrated the influence of respondent personal attributes, such as gender, age, smartphone ownership history, and occupation on the response, data sending, and survey completion rates of a smartphone-based survey conducted in Kabul, Afghanistan. The survey was conducted in August 2015. 200 people were recruited to participate in the survey for two weeks. 75 respondents agreed to participate in the survey. 48 successfully submitted data for more than one day.

We recruited a small sample of female subjects because it was difficult to recruit females in the traditional society of Afghanistan. Similarly, females were less likely to send their travel diaries compared to males. Additionally, younger respondents were more likely to send data compared to older respondents. It was also observed that more than half of the respondents stopped sending data before the end of the requested survey term. In addition, the respondents withdraw choice from survey was high on weekends in comparison to weekdays.

The following findings were obtained from the survey:

1. Younger participants were more likely to participate in the survey, while gender had no significant effect.
2. The male data sending rate was significantly higher than the female rate, but age, smartphone ownership history, and occupation had no effect.
3. Participants who owned smartphones for a longer period of time were more likely to complete the survey successfully, but age, gender, and occupation did not have any influence on survey completion rate.
4. New smartphone owners were more likely to withdraw on weekends.
5. The survey withdraw rate of respondents was higher on weekends in comparison to weekdays.

Based on these results, we believe that some modifications of survey methods may be necessary to facilitate participants with different backgrounds. For example, including female surveyors to recruit and target female participants, considering rewards to increase response rates, and introducing paper-based surveys in addition to smartphone-based surveys to facilitate the elderly could be useful modifications. Furthermore, in addition to Kabul, we wish to extend the smartphone-based travel survey to some non-capital cities to determine the feasibility of smartphone-based travel surveys in large cities and small communities. These concerns are considered in our recent surveys reported in one of our other works (Qudratullah and Maruyama 2019c).

Our study had several limitations. For instance, limited attribute information of respondents was obtained in our survey. In addition, we could not able to record the detail attributes of non-consenting individuals, and the reasons for non-response to our survey is another issue that is not investigated in this study. One of our other works addressed the reasons of non-response to smartphone-based travel survey method in Afghanistan (Qudratullah and Maruyama 2019a). This study reported that privacy concerns, and dependency in making decision rights were the dominant reasons of non-response for females. While small reward and security concerns as reasons of non-response were recorded by majority of male individuals. One of our papers have also focused the effects of survey recruitment method improvements on the data sending and survey completion rates (Qudratullah and Maruyama 2019b). We found that the data sending rate was improved by the improvements made to the survey recruitment methods. However, the effects on the survey completion rate was small.

In 2017, along with the smartphone-based travel surveys, we conducted a supplementary paper-based person trip survey using the same respondents. Using the smartphone and paper-based travel survey data to compare the recorded trips and travel time is the objective of our future work. In addition, the smartphone application we used was predesigned and existing one developed in English. Hence, our future work will also focus on developing original app in Afghanistan language (e.g. Pashto and Dari).

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