DEVELOPMENT OF SMARTPHONE-BASED TRAVEL SURVEY METHOD: PRELIMINARY RESULTS IN KUMAMOTO, JAPAN

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ABSTRACT

Many researchers argued traditional paper-based travel survey method has several problems. It needs high survey collection cost and collected data may be inaccurate. Route or path of travelers is difficult to obtain. In order to overcome these problems many GPS-based travel survey methods (or similar method using emerging mobile technology) are proposed and partly applied in practice. However, these survey methods are still expensive and large-scale distribution of these instruments is not easy.
Meanwhile, currently growing number of people have smartphones and apps in smartphone can easily track the peoples travel behavior. Use of smartphone app will open the new scheme of travel survey method and transport policymaking.
Then, the final objectives of this research project are (1) to develop and validate the smartphone-based travel survey method, (2) to compare the results by smartphone-based survey with paper-based survey and (3) to explore the strength and weakness of smartphone-based travel survey methods.

Keywords: Travel Survey Method, Smartphone, Big Data

INTRODUCTION

Many researchers argued traditional paper-based travel survey method has several problems. It needs high survey collection cost and collected data may be inaccurate. Route or path of travelers' is difficult to obtain. In order to overcome these problems many GPS-based travel survey methods (or similar method using emerging mobile technology) are

proposed and partly applied in practice (e.g. Hato and Asakura 2001, Hato 2010 and other papers cited therein or citing their papers). However, these survey methods are still expensive and large-scale distribution of these instruments is not easy.

Meanwhile, currently growing number of people have smartphones and apps in smartphone can easily track the peoples travel behavior. Use of smartphone app will open the new scheme of travel survey method and transport policymaking (TRB 2012).

Then, the final objectives of this research projects are (1) to develop and validate the smartphone-based travel survey method, (2) to compare the results by smartphone-based survey with paper-based survey and (3) to explore the strength and weakness of smartphone-based travel survey methods. In this article, we report the development of a smartphone-based survey system and a preliminary analysis of survey conducted in Kumamoto, Japan.

2. Summary of Existing and Emerging Travel Survey Method

Traditional paper-based and interview-based survey methods are known to have merit and demerit (TRB 2012, Ohya et al. 2005). Emerging travel survey methods have some advantage for existing ones, but it also holds a few shortcomings, we may summarize the merit and demerit of existing and emerging travel survey method (Table 1 and 2).

Table I – Merit and Demerit of Several Survey Method

	Reliability of content of response	Constraints of quantity and quality of response	Influence of interviewer	Response Ratio	Cost	Applicability of Large-scale survey	Selection Bias of Sample
Face-to-face Interviews	++	++	-	++	--	--	++
In-home placement interviews	-	+	+	++	-	-	++
Mail surveys	--	+	+	-	++	+	+
Telephone Interviews	-	--	-	-	++	++	+
Group interviews	+	+	-	(+)	++	-	-
Web survey	-	+	+	-	+++	++	--
Probe Person (PP)	++	+	+	??	+	-	--
Smartphone-based PP	++	+++	+	??	+++	+++	---

Source) Adopted from Ohya et al (2005) and modified some parts by authors .

Note) "+" means merit or advantage, "-" means demerit or disadvantage.

Table 2 – Comparison of Travel Survey Method

	Paper-based Survey	**Probe Person Survey (PP Survey)**	**Smartphone PP Survey (SPP Survey)**
Respondent Burden	Large	Small	Small
Survey Operation Cost	Large	Middle (Distribution Cost of GPS Instruments)	Very Small
Initial Cost and Component of Survey	Basic and traditional	New but Available	Development cost of App
Accuracy, Reliability and Preciseness of data	Low	High	High
Duration of Survey	Typically Autumn Weekday	Multi-days: Weekly, Monthly, Yearly	Multi-days Weekly, Monthly, Yearly
Path/Route of traveler	Not Available (N.A)	Available	Available
Bus Stop, Interchange, Trip Timing Information	Low accuracy Low response	Precisely Available	Precisely available
Trip purpose	Written	Select (by web diary)	Touch select by Smartphone or Auto voice input
Travel mode	Written (un-linked-trips are often neglected)	Select or auto detect by acceleration data	Select or auto detect by acceleration or auto voice input
Selection Bias Property of sample	Young people are reluctant to reply	Monitored person only	Limited only to owner of smartphone but largely distributed

2. DEVELOPMENT OF A SMARTPHONE-BASED PROBE PERSON SURVEY SYSTEM

We develop a system of smartphone-based probe person survey. We prepare two apps for two smartphone OS platforms (iOS for Apple iPhone and Android). These apps collect location of travelers (latitude and longitude) for each time period (Figure 1 & Figure 2).

The iPhone app is basic and simple function and it asks respondent to touch a screen bottom when they start and end a trip. It collects travelers' information if they move 100 m, it means distance-based collection setting.

The Android app is somewhat advanced one, and it asks respondent not only the start and end of trip but also travel mode. It collects travelers' information including acceleration data for each 10 sec, and it means time-based collection setting.

Fortunately a large-scale traditional household travel survey (Kumamoto Metropolitan Person Trip Survey, PT survey hereafter) was conducted in autumn 2012 by Local government (Kumamoto Prefecture and Kumamoto City). PT survey is very big survey and they asked around 120 thousand households living in Kumamoto metropolitan area about their trip in a weekday by mail-based survey. Our research team asked around 10 thousand household (out of 120 thousand household) to join the smartphone-based travel survey in addition to PT survey. We believe the target sample scale is one of the biggest one in the world in this kind of new survey.

Figure 1 – An Example of display of our Smartphone-App-based travel survey method

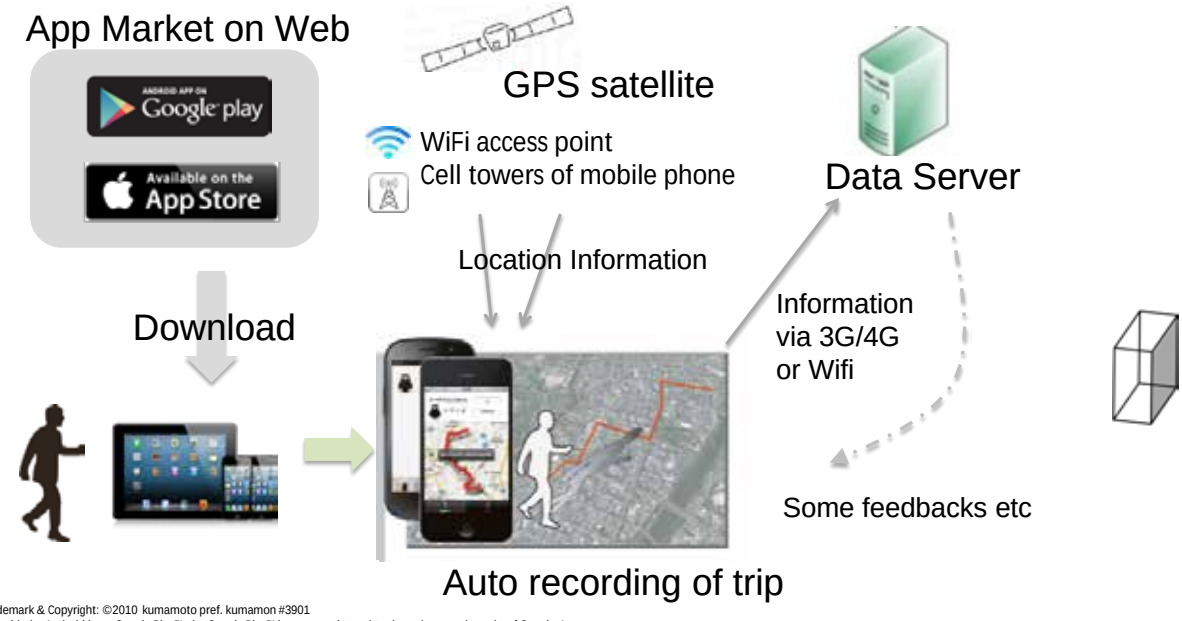

Figure 2 –Smartphone-based probe person survey system developed in this study

3. PILOT SURVEYS AND PRETESTS

In order to examine the people's attitude to this new type of travel survey, pilot surveys are conducted by Kumamoto University students before PT survey. Table 2 summarized the pilot survey.

Table 2 – Details of Pilot survey

Target	Second grade students 70 people (13 women included)	Third grade students 26 people (3 women included)
Day	October 3 (Wednesday), 2012	October 9(Tuesday), 2012
Class type	Compulsory subject	Optional subject
Platform available	Android	Android + iPhone

Table 3 –Students attitude to join the smartphone-based survey with no incentive

	Positive attitude	Negative attitude	Total	Positive person's rate
Male	18	38	56	32.1%*
Female	3	10	13	23.1%*
Total	21	48	69	30.4%

*) Statistically different at 1% level

Table 3 shows the students attitude to join the smartphone-based survey. Only 30.4% of student said that they will join the survey if there are no incentives. However, if rewarded (incentive given), most students said they will join the survey. We found that just JPY1,000 ~ 3,000 ($10~30) will be sufficient for university students to join this kind of survey.

Table 3 also shows interesting findings that female students are more reluctant to join the survey than male students. This gender difference is statistically significant at 1% level. The reason would be that female students will feel privacy issues more casually than male students.

In addition students have many comments on our smartphone survey method. It includes typically battery and privacy Issues. Furthermore some students made following valuable comments. App should be friendly to elderly people, the way of result output is important – No detection of individual should be guaranteed.

Considering partly these results in pilot survey, we conducted the main survey. It is described shortly in next section.

4. A QUICK REPORT OF SMARTPHONE-BASED SURVEY

As we partly mentioned before, 10 thousand household living in the Kumamoto City are asked to join the smartphone-based survey in addition to traditional paper-based PT survey. Samples are randomly selected from household data stored in local government. At first stage, only people aging between 20 and 49 are asked to join, because we guess the most aged people will not have their smartphones. October 16~18, October 23~25, 2012 are the survey periods.

Figure 3 and 4 shows the number of users who installed iPhone or Android based Apps. Roughly speaking, about up to 500 users installed iPhone App. and more than 170 users installed Android Apps. We also confirmed that around 120 users movement (Probe Person data) are collected. Although more detailed analysis should be done, 120 users out of 10,000 peoples join this new survey. Response rate is 1.2% and this is around the value the authors were expecting. It should be emphasized that this study no incentives (or rewards) are given to the respondent and we collect detailed data (N=120) for no additional cost. We believe this is amazing fact.

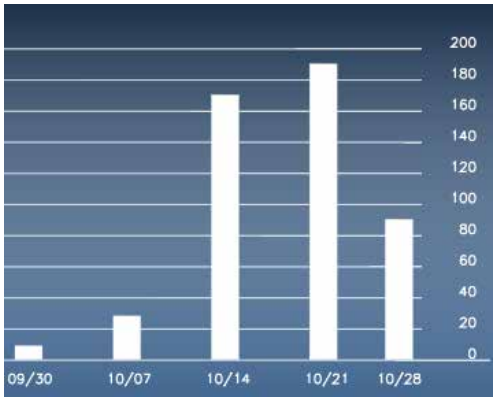

Figure 3 – Progress of Number of Installed Users: iPhone-based App

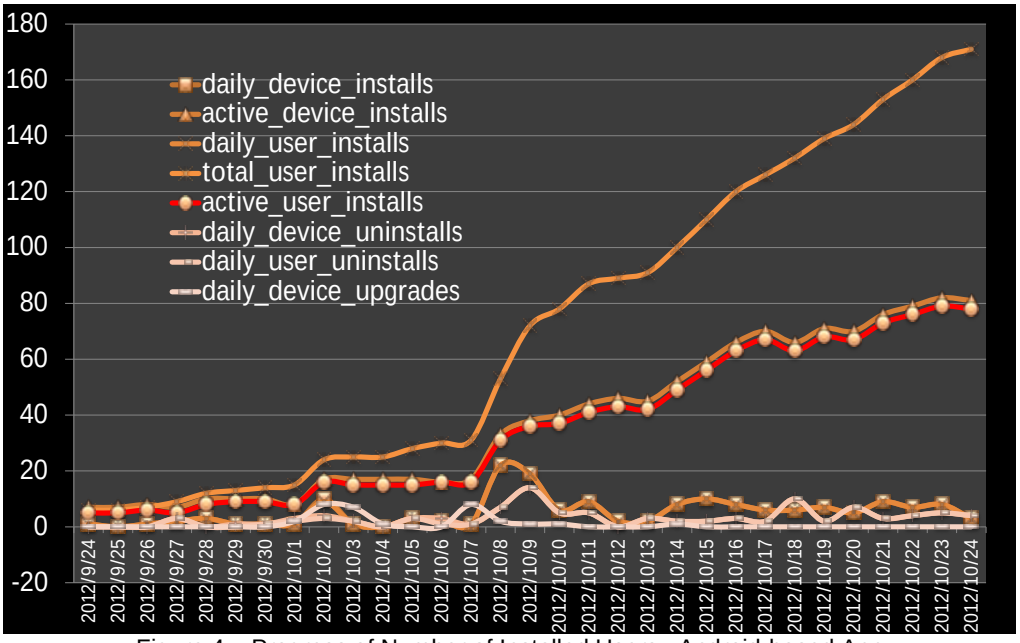

Figure 4 – Progress of Number of Installed Users: Android-based App

Figure 5 shows the distribution of age of participants of smartphone survey in addition to those of target of smartphone survey and population census in the city. As we expected, people around 30-49 year-old participated the smartphone survey.

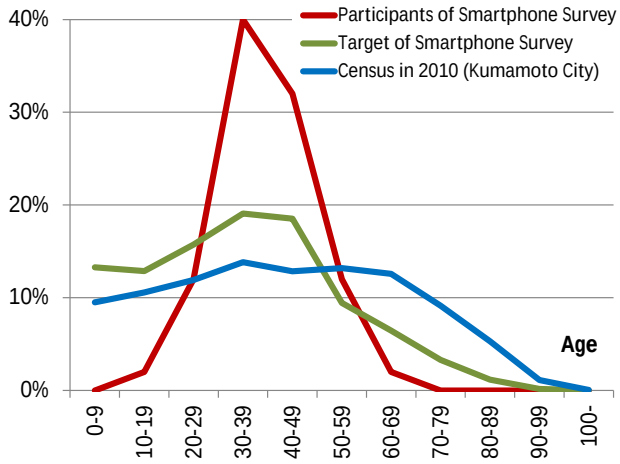

Figure 5 – Distribution of Age of Participants of Smartphone Survey Compared to Census

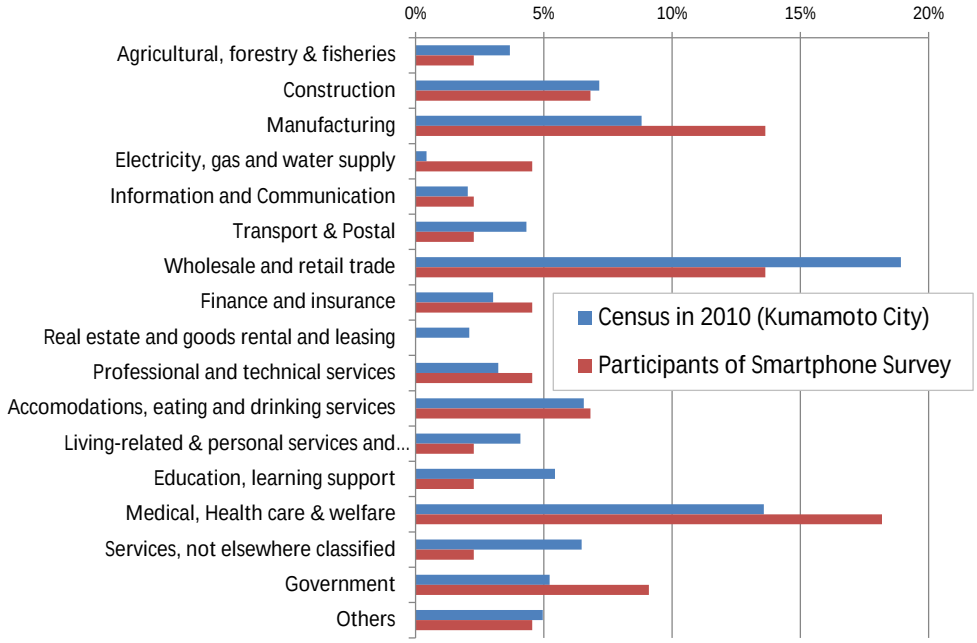

Figure 6 – Distribution of Occupations of Participants of Smartphone Survey Compared to Census

Figure 6 shows the distribution of occupations of participants of smartphone survey compared to that of population census in the city. People in (1) manufacturing industry, (2) electricity, gas and water supply, (3) medical, health care and welfare, and (4) governments, joined the survey particularly. Especially, the difference between census and participants of smartphone survey is statistically significant in 1% level in (2) electricity, gas and water supply. We guess people in such occupation related to public services are more willing to participate in this kind of survey.

We conduct Web-based questionnaire survey to the participants of smartphone-based survey. Figure 7, 8 and 9 shows a part of the results. Figure 7 shows cross tabulation of feeling of this new survey against reluctance to this survey. Most of the people answered “very good” or “good” to this new survey and feel no reluctance. We have to care about that the result can be reasonable just because we have answers only from participants of this new survey. There are people who didn’t join the survey and their answer will be different. Considering these potential bias, the results are promising for future travel survey.

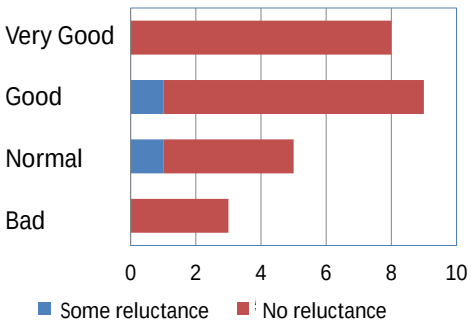

Figure 7 - Answers to “How do you feel about this Smartphone-based survey?” (unit: person)

In this study, we ask the participants to answer both the traditional paper-based survey and smartphone-based survey. We ask them which of the two surveys is easier to answer in web questionnaire. Figure 8 shows the results referring to the year of smartphone owning. Long-term owner of smartphone tend to answer Smartphone-based survey is better. Figure 9 demonstrate the answers to the question: "Which is better for future travel survey; smartphone-based or paper-based survey?". Most respondent said smartphone-based survey is better. Although the number of sample to answer these question is small, this is also promising results for future study.

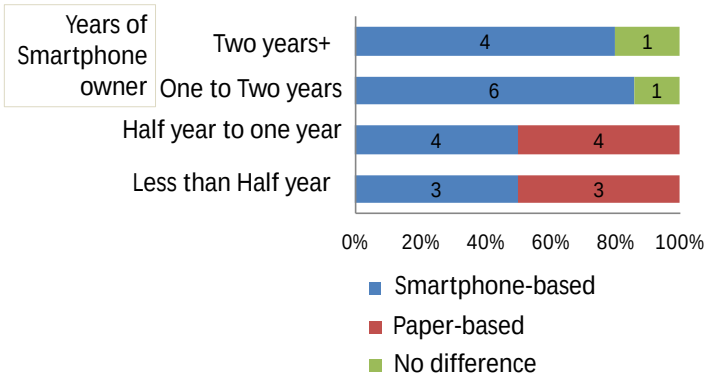

Figure 8 - Answers to "Which is easier to answer; smartphone-based or paper-based survey?" (unit: person)

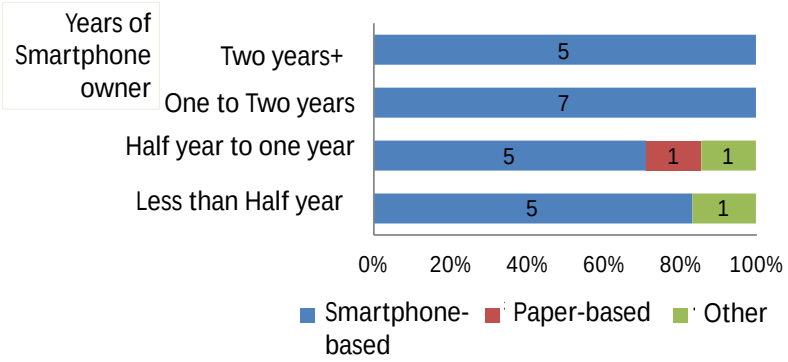

Figure 9 - Answers to "Which is better for future survey; smartphone-based or paper-based survey?" (unit: person)

5. CONCLUDING REMARKS

Smartphone-based travel survey method could make a big impact on transportation policy/planning scheme. It can collect huge and accurate travelers' detailed data with low cost. Of course, it'll also have problems to be overcome and we'll discuss the strength and weakness of this new-type survey and propose how we should use these survey methods in practice.

Actually this article is short progress report of ongoing research project. But full analysis of smartphone data and comparison between Paper-based data will be given in future paper.

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