

Assessing mobile-based online surveys

Methodological considerations and pilot study in an advertising context

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Despite important advances in mobile advertising research, most surveys have used self-reported questionnaires without ensuring that the survey respondents regularly receive and access mobile ads, and are therefore able to evaluate this new medium. This paper fills this research gap, by proposing a mobile-based survey method and conducting a pilot study. It focuses primarily on critical issues associated with online survey methodology, such as cost, target respondents, questionnaire format, response rate and data quality. A pilot study of mobile advertising is then designed and executed, in collaboration with a Japanese interactive advertising agency. 'Pseudo' mobile campaigns were created using a real brand (handheld audio player) as a real stimulus. One week after transmitting the mobile advertising, a structured questionnaire was sent directly via mobile device. A confirmatory factor analysis reveals that the multichotomous response formats applied in the questionnaire produced an acceptable scale reliability and validity. The methodological implications of the findings are discussed. In closing, limitations are recognised, while future research directions are suggested.

Introduction

The internet-enabled mobile handset has rapidly achieved worldwide penetration. The most drastic change seems to have occurred after the introduction of the Universal Mobile Telecommunications System (UMTS) and Wideband Code Division Multiple Access (WCDMA), which enabled many operators to move quickly to 3G ('third generation') standards. Global mobile players, such as NTT DoCoMo, Vodafone and Nokia, now

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achieve high-speed transmission of a wide variety of sophisticated internet services.

By combining personal telephony and sophisticated technologies, the mobile internet has opened up new opportunities to offer a diverse range of services, including advertising, information search, location-based services and traffic alerts. In particular, mobile-based advertising has been widely accepted as a practical mode of direct marketing that can be combined with other cross-media campaigns (Kavassalis *et al.* 2003; Mylonopoulos & Doukidis 2003). For example, for the DVD of *The Ring 2*, DreamWorks Home Entertainment used a viral campaign that operated on mobile phones and email accounts: visitors to the campaign site were invited to scare their friends by entering their email address and mobile telephone number. The site then sent them an email, inviting them to click on a link and watch the video (iMedia Connection 2005). Adidas enables consumers to download popular athletes' photos on its mobile site, and to digitally superimpose their own photos on those images (Sultan & Rohm 2005). In Japan, Kirin MC Danon Waters Co. launched a campaign for Volvic mineral water, in which consumers entered a sweepstake contest on mobile phones with a bottle serial number; while P&G sent a shampoo sample of the Pantene brand to users who responded to pull mobile advertising in i-mode (Senden Kaigi 2004).

In Japan, D2 Communications offers 'Message F (Free)', which is a push-type service delivering advertising exclusively to 'opt-in' users (D2 Communications 2004). It is delivered to a designated 'Message F inbox' and users are exempt from the normal packet transmission charges. This Message F can be sent to specific regions, genders or age groups, thus allowing firms to target messages to selected segments. Furthermore, an image attachment service began in July 2005; this supports the transmission of images, logos and other visual effects up to 8KB. In 2006, major Japanese mobile carriers began to launch mobile handsets that can receive terrestrial digital broadcasting signals, in addition to conventional analogue signals, thus enabling firms to take advantage of three basic elements in PC-based interactive advertising on mobile devices: static, animated and broadcast images (NTT DoCoMo 2005).

In the United States, many firms are still in the process of 'testing the water'. Even so, according to a recent study by Frost & Sullivan, the US market for mobile advertising and search is expected to reach \$2.1 billion in revenue by 2011 (Lunden 2007). By then, the value of this market will exceed \$19 billion worldwide, including mobile search and video

advertising (ABI Research 2007). However, whereas mobile advertising spending is growing at an astonishing rate, and both academics and practitioners have begun to recognise that an important question remains unanswered: ‘How can we actually measure mobile advertising effectiveness?’ The literature includes several empirical studies, but most of them used the traditional pen-and-pencil survey method. In addition, little attention has been paid so far to ensuring that respondents are regular mobile internet users with sufficient experience and knowledge to evaluate such a new medium. Given the ubiquitous nature of the mobile device, a conventional questionnaire may be inappropriate to capture true ‘moving targets’ and, unlike PC-based e-commerce research, several factors must be considered in terms of survey planning and executions.

The aim of the current study is to fill this research gap by proposing a mobile-based survey method and pre-testing its reliability. Specifically, we attempt to establish methodological guidelines for online surveys that send out a questionnaire via a push advertising service. Our objective is to examine the feasibility and reliability of the methodology in terms of cost, questionnaire format, target respondents, response rate and data quality. In evaluating the potential of mobile-based online surveys, we conduct a pilot study, by creating a ‘pseudo’ advertising campaign and sending a structured questionnaire to registered opt-in users via mobile device. On this basis, we critically evaluate the methodological issues of the mobile-based online survey.

In what follows, we first review the literature associated with the online survey method. Next, we explain in detail the execution of the pilot study and present the study results. We then discuss the implications of the study. Finally, we recognise some important limitations and suggest future research directions.

Critical issues in mobile-based online surveys

Prior research on mobile commerce covers a variety of topics, but little effort has been made to shed light on the methodological aspects. Specifically, our literature review found that the vast majority of studies commonly used a traditional ‘paper-and-pencil’ survey method, with the exception of Kim *et al.* (2004), who adopted a web-based online survey method and contacted actual users of mobile banking. The following section sets out the methodological considerations involved in conducting empirical research using mobile-based online questionnaires.

Cost

Prior research indicates that internet-based surveys require a higher set-up cost than paper-based surveys in designing, programming and hosting sites. However, internet-based surveys demand neither paper nor postage, and thus have overall costs 30–60% lower (Hanna *et al.* 2005). Furthermore, typical online surveys do not incur expenses for photocopying, clerical support or data entry, since the responses can be input into the data analysis software automatically (Llieva *et al.* 2002).

Similar benefits may be expected from mobile-based surveys, but the wireless device incurs a higher connection cost for data collection. This is an important issue because, although mobile penetration has been growing worldwide, internet connection capacity still varies across countries, both in infrastructure and in handset functionality. For example, at first sight SMS appears comparable to the Japanese email service, as it is cross-carrier compatible, text-based and immediate send-and-deliver, but the simple SMTP-based mail used by DoCoMo, KDDI and Vodafone offers more practical advantages. In particular, Japanese message lengths are longer (up to 1000 characters) and they offer unique linguistic extensions called ‘e-moji’, or picture characters, by which users can describe their ‘emotions’ (NTT DoCoMo 2005).

Target respondents

One of the major problems in research on mobile advertising is that researchers often cannot establish whether target consumers actually have sufficient experience and are capable of providing reliable responses. Our literature review found that much research on mobile commerce uses ‘general’ consumer samples, and seldom investigates respondents’ ‘real’ experience in using the mobile device for internet connection. Thus, it is impossible to be sure that target respondents are who they say they are, or that they are answering truthfully. In a mobile advertising context, it is extremely important that the survey select those people who, on a daily basis, regularly access mobile internet, read promotional messages and even access the linked sites to obtain further information (Okazaki 2004).

One way of maximising the truthfulness of respondents is to administer the survey via mobile device. In this way, the respondents’ perceived ability to use the mobile internet is guaranteed, because mobile-based questionnaires can be returned only by those able to reply via mobile device. This is significantly different from PC-based online surveys, in

which researchers can offer alternative response options, such as fax or post (Truell 2003).

When the mobile device is used for survey execution, several important issues arise. First, because of the nature of mobile-based message systems, ads are often sent via some type of message subscription service. However, they are sometimes considered as spam – that is, unsolicited or undesired bulk electronic messages, which are often deleted without being opened (Petty 2003). ‘Spim’ is a variation of spam sent via instant messaging systems. Theoretically, the deletion of messages requesting survey participation (as opposed to spam/spim) can be prevented by an effective ‘opt-in’ or ‘opt-out’ feature of the message service. Also, in many countries, such as Japan, Sweden, Norway and Finland, mobile newsletters have become a popular platform via which firms can publish and deliver promotional campaign messages to opt-in users. For example, according to an industry survey, as many as 71.1% of i-mode subscribers regularly receive email newsletters, 64% receive newsletters featuring new product information and 20% receive newsletters featuring electronic coupons (Scuka 2003). These data suggest both the advertising opportunities and the survey opportunities.

Questionnaire format

In general, both the online and offline survey literatures suggest that the number of questionnaire items adversely affects not only the response rate, but also the response quality (Heberlein & Baumgartner 1978; Yammarino *et al.* 1991; Deutschens *et al.* 2004). Similarly, the length of a mobile-based questionnaire may be significant in determining the response rate, because the device has obvious limitations in micro-browser screen space and scrolling-down capacity.

Although there are notable differences across countries in the number of characters that may be included in a mobile-based message (for example, only 300 characters in a WAP-based SMS message, but up to 1000 characters in an i-mode email message), the questionnaire can be created on the web, by linking the survey invitation to the site. Responders then browse in mobile internet and access the questionnaire item by item, without scrolling down the mobile device.

The choice of response format is also important. There are two basic issues: (i) dichotomous versus multichotomous scale formats, and (ii) the wording of the response scale points (Netemeyer *et al.* 2003). Dichotomous scales have practical advantages: they take less time for

respondents to complete and therefore allow them to respond to more items in a short time. However, they have been criticised for their tendency to have highly unbalanced response distributions – that is, all individuals always answering ‘true’ or all individuals always answering ‘false’ (Netemeyer *et al.* 2003).

Furthermore, any one item for a dichotomous scale produces only limited covariance with any other item, because of the binary format. Overall scale variance will be very limited. Multichotomous scales overcome these shortcomings by creating more scale variance than a dichotomous scale with a similar number of items. For these reasons, academic researchers tend to prefer multichotomous formats, while practitioners are more likely to adopt dichotomous formats. For example, our in-depth interview with an interactive agency practitioner reveals that, for online surveys conducted by professional agencies, a dichotomous scale has in the past been preferred to an interval scale, because of its ease of use and short response time (Fukada 2005). Therefore, there is a need for an empirical test to establish whether the choice of response format affects response rate and quality.

Response rate

The response rates of surveys have often been used to assess data quality (Deutskens *et al.* 2004). In 1999, the overall response rate of all virtual surveys ranged from 15 to 29% (Comley 2000). However, considerable discrepancies have been found between similar studies in similar periods (Wygant & Lindorf 1999; Ray *et al.* 2001; Virtual Surveys 2005). In many cases, the response rate was found to depend upon the topic researched, which may or may not have encouraged active participation (Sheehan & McMillan 1999; Ray *et al.* 2001). Deutskens *et al.* (2004) suggest that the format and design characteristics of an online survey will have an important impact on response rate and response quality, especially given the interactive and impersonal nature of the internet medium. In addition, a mobile-based online survey minimises the time needed to respond, and this positively affects the response rate.

Table 1 summarises mobile-based surveys, conducted by a Japanese mobile advertising agency, which examined consumers’ perceptions of newly launched brands, and used a dichotomous scale for fewer than 20 questions. Here, we can observe that the click-through rate of questionnaires was relatively high and stable: an average of 16.5%, which is much higher than ‘traditional’ online survey click-through (Coderre

Table 1 Response rate of recent mobile-based online surveys¹

Survey period	Sample				Number of clicks	Number of responses	Click-through	Response rate ²
	Product	Size	Demographics					
March 2003	Soft drink	33,053	10–30 years old; male and female; eastern Japan		5730	2489	17.3%	43.4%
April 2003	Soft drink	16,278	20–30 years old; female; Greater Tokyo area		3373	1624	20.7%	48.1%
May 2003	Beer	23,144	20s; male and female		4119	2131	17.8%	51.7%
July 2003	Beer	13,772	20–30 years old; male and female; Greater Tokyo area		2164	1088	15.7%	50.3%
September 2003	Soft drink	10,437	Teenagers; male, Greater Tokyo area		1982	844	19.0%	42.6%
February 2004	Soft drink	10,294	10–30 years old; male and female; eastern Japan		1513	789	14.7%	52.1%
July 2004	Snack food	10,255	20s; female; Greater Tokyo area		1557	734	15.2%	47.1%
July 2004	Retail store	20,658	20–30 years old; female; Tokyo Metropolitan district		3222	1214	15.6%	37.7%
July 2004	Automobile	10,242	20s; female; eastern Japan		1595	699	15.6%	43.8%
November 2004	Satellite TV	10,531	40s; female; eastern Japan		1763	515	16.7%	29.2%
December 2004	Beer	10,323	20–30 years old; male and female; eastern Japan		1306	482	12.7%	36.9%

Source: D2 Communications

¹ All surveys used a dichotomous response format in the questionnaires² Response rate = (number of responses)/(number of clicks)

et al. 2004). The response rate was also stable: approximately 44% of those who ‘clicked’ survey notifications in a push message completed and returned the questionnaire. However, careful observation of the sample characteristics reveals that these studies covered primarily the younger population segment (between 20 and 30 years old). Given that the most active mobile users belong to this segment, these figures may have been slightly inflated. Moreover, although the response rates for dichotomous scale questionnaires have been relatively high, a question arises about the effects of multichotomous scale questionnaires. As discussed above, there is a strong research need to test the relationship between these variables.

Data quality

Perhaps the most important benefit of mobile-based surveys is that they ensure that respondents are actual mobile internet adopters. In this respect, the response quality has much more validity, because the surveys measure what the research ought to measure. This is important, because the literature reveals that much m-commerce research uses traditional methods, but without guaranteeing that the respondents actually use a mobile device for internet connection.

Prior research on online surveys provides useful information on email surveys that also seems relevant to mobile-based surveys: the confidentiality of the participants. This is perhaps the major difference between online and offline surveys, since email surveys always disclose the senders’ identity, whereas traditional postal surveys may be anonymous if desired (Llieva *et al.* 2002). This is important, because respondents’ candour is optimised when anonymity is guaranteed (Stanton 1998; Llieva *et al.* 2002). In this respect, the most relevant question concerning mobile-based surveys is how to guarantee respondents’ privacy through the opt-in function. The opt-in function may loosen the respondents’ psychological barriers, and may also influence how sincere they are in completing mobile-based questionnaires.

Another issue related to data quality is whether respondents fully complete a questionnaire or abandon it. Respondents’ ‘mortality’ can be tracked more easily in online surveys, because each click can be recorded as a completion (Gunn 2002). Incomplete questionnaires may significantly affect the data quality, because they create missing values that seriously distort statistical analysis. This mortality, of course, depends on the length of the survey, time to respond, device usability and respondents’ level of expertise, among other factors. However, a system can be created in which

respondents must complete the first question before proceeding to the next question, and so on.

In the context of e-commerce research, data quality can be verified using two qualitative criteria: practical considerations (data-collection process and completeness of data) and psychometric standards (reliability and validity). To meet the first criterion, the data-collection process must be reasonably rapid and efficient, while the data must be free of missing values. To meet the second criterion, structural equation modelling has been suggested as one of the most useful statistical methods for diagnosing random errors in research (Byrne 2001).

Pilot study

In an attempt to address these issues, a pilot study was conducted by creating a 'pseudo' mobile campaign in Japan. Specifically, a professional mobile advertising firm created experimental mobile advertising and a fictitious promotional mobile site. The target consumers were those who had signed up for, or opted in to, a periodical mobile advertising service, which included both textual and visual information in promotional messages.

Research model

In this pilot study, we examined a measurement model based on five constructs: brand trust, mobile advertising trust, attitude towards brand, attitude towards mobile advertising, and advertising recall. Prior research suggests that trust may lead to favourable attitudes, which in turn influence intention to engage in repeat purchases in internet commerce (Gefen *et al.* 2003; Kim & Benbasat 2003), including m-commerce (Lin & Wang 2006). We propose a structural model to examine trust in a mobile advertising context, given that brand trust and mobile advertising trust affect favourably attitudes towards brand and towards mobile advertising, respectively. In turn, both attitudes then directly and positively influence the level of mobile campaign recall.

As the structural portion of the model involves only relations between latent variables, the preliminary step in the analysis of full latent variable models is to test for the reliability and validity of the measurement model (Anderson & Gerbing 1988). Here, our primary interest in this pilot study is to demonstrate that the measurement model is psychometrically sound, based on the data collected by the questionnaire survey conducted via

mobile device. Assessing the extent to which the measured variables are internally consistent, and the amount of variance extracted from the data, would support our primary argument that the mobile-based online survey could indeed provide a sufficient level of data quality. In this paper, we therefore discuss only the measurement model assessment. Figure 1 shows the research model (i.e. measurement model) that we test in this pilot study.

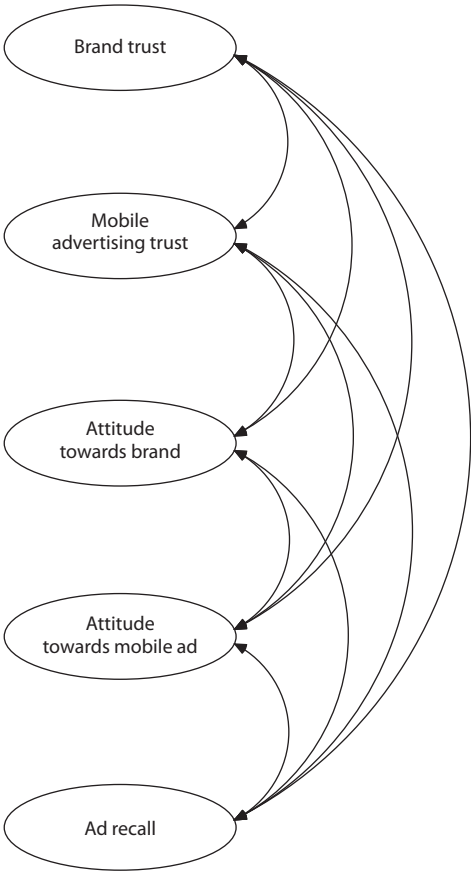


Figure 1 Research model (measurement model) of pilot study

Methodology

The pilot study was organised into two phases: (i) transmission of the ‘pseudo’ mobile campaign, and (ii) questionnaire survey via mobile device. Figure 2 summarises our research design.

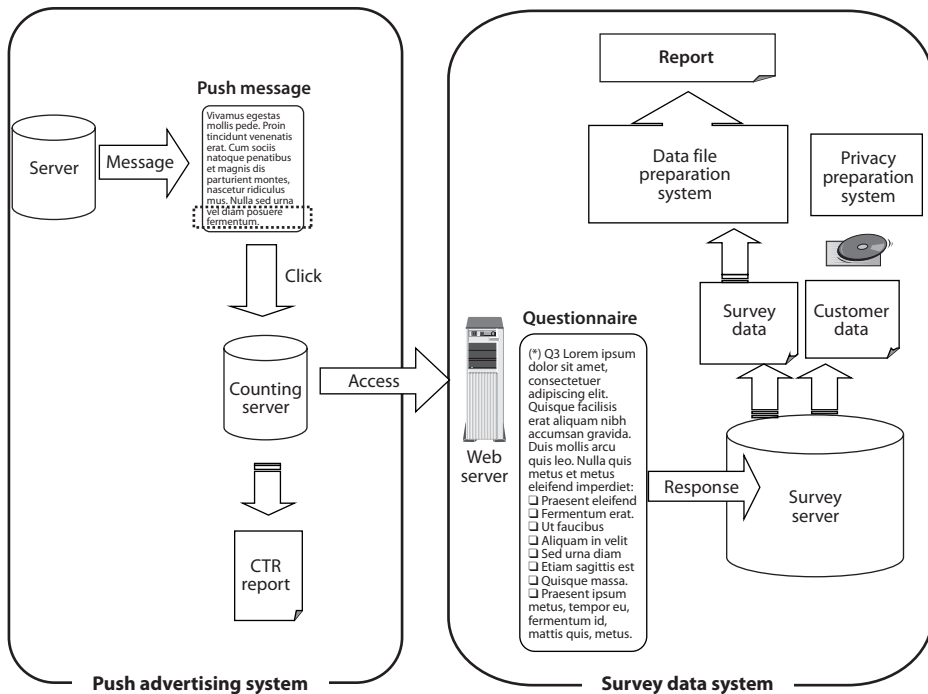


Figure 2 Data collection system of mobile-based online survey

In the first phase, we sent mobile advertising that contained pseudo campaign messages with hyperlinks to access further campaign information on the mobile site. D2 Communications (D2C), the largest mobile advertising agency in Japan, collaborated with this study and created the pseudo mobile advertising. It offered its 'Message F', a push service that delivers textual and visual information from advertisers to opt-in users only. This service has been used successfully as a campaign tool by many firms, including P&G, Sapporo Beer and Panasonic (Senden Kaigi 2004). The recipients of this mobile advertising were aware of neither the fictitious nature of the mobile advertising, nor our presence behind it.

In addition, we contacted one large Japanese manufacturer, listed in the first section of the Tokyo Stock Exchange, which agreed to collaborate in this experiment, and allowed us to use one of its most popular brands as a real stimulus in the campaign. This company manufactures sophisticated handheld audio players, and the brand we used is firmly established, both in Japan and internationally. After designing textual and visual information for the mobile ads, we created a promotional mobile site to

which respondents could jump by clicking a banner in the ads saying ‘Please click here for further information’. As an incentive to access the campaign site, we offered a free wallpaper download.

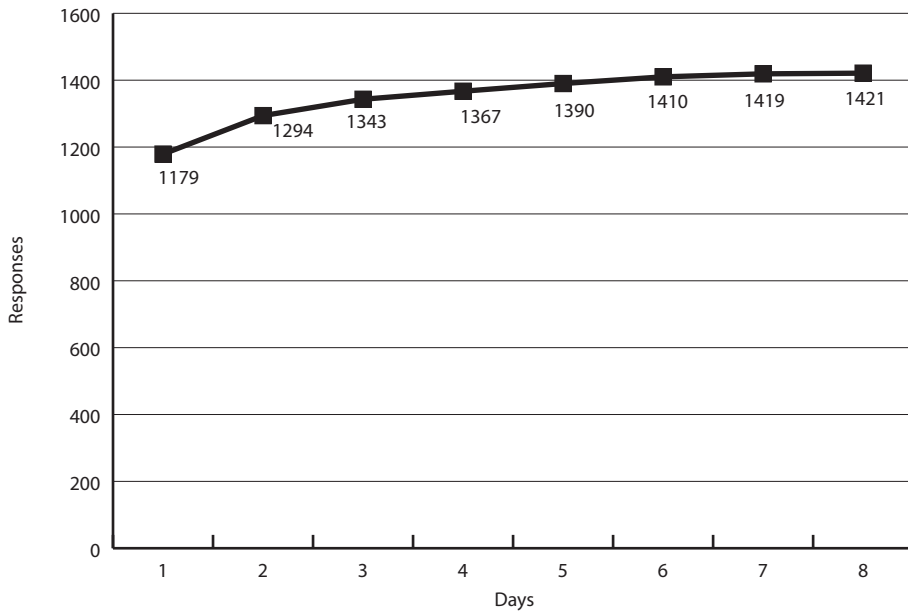
Questionnaire design

In the second phase, which took place approximately one week later, we contacted the customers by sending another mobile message containing a structured questionnaire, and asking for their impressions and perceptions of mobile campaigns. Because our research model requires that the variables be metrically measured, we decided to use a multichotomous response format, with a level of scale reliability properly assessed via multivariate analysis.

The questionnaire consisted of two parts. In the first, we asked about respondents’ demographic information, such as gender, age, occupation, media perceptions and media usage habits (i.e. usage frequency of traditional and non-traditional media). We assessed the demographic variables and media perceptions using a categorical scale, and the media usage habits with an ordinal scale. In all cases, respondents were asked to check the appropriate box to indicate their answer. In the second part, we included questions that corresponded to the five constructs: brand trust, push advertising trust, attitude towards brand, attitude towards mobile advertising, and mobile campaign recall (i.e. unaided recall). The majority of the scale items were adopted from existing e-commerce literature, and modified for the mobile context. All constructs were assessed using a multiple-item measure of five-point semantic differential scales, with three (‘cannot answer/determine’) as an anchoring point. To minimise the mortality, or abandonment rate, of questionnaire completion, we created a system that required respondents to complete each question in order to proceed to the next question. As an incentive to participate in the survey, we offered free entry to a book-coupon sweepstake.

Response rate

In total, 40,000 pseudo campaign messages were sent to opt-in users between 16 and 40 years old. The sample was randomly chosen from the customer database in the greater Tokyo Metropolitan District area, including three nearby prefectures (N = 380,000). The data collection process was rapid: almost 80% of the respondents returned the questionnaires on the first day (see Figure 3). Thus, data collection via



Note: The number of responses before data purification = 1421

Figure 3 Data collection process rate

mobile device seemed fast and efficient; this may reflect the device's ubiquitous nature.

The click-through rate was estimated at approximately 17%. Thus, approximately 6800 consumers actually 'visited' the link. In total, we received 1421 responses. Because responses must be consistent across all question items, missing values were first removed. Next, extreme outliers were deleted, because they might have been produced by a procedural error, such as a data entry error or a respondent's own mistake in coding. These outliers are not considered representative of any observations in the population, and were therefore deleted. As a result, 1335 usable responses were retained. The response rate, based on the total click-through on the survey invitation, was approximately 19.6%.

Results

Respondents' profile

Table 2 summarises the major demographics of the respondents in terms of gender, age, occupation and method of paying mobile phone bill.

Table 2 Characteristics of the respondents (%)

Demographics	% (n = 1,335)	Demographics	% (n = 1,335)	Demographics	% (n = 1,335)
<i>Gender</i>		<i>Occupation</i>		<i>Occupation (contd.)</i>	
Male	43.6	Junior high/high school	17.2	Self-employed	0.4
Female	56.4	University	18.1	Housewives	6.4
		Clerical/research	10.4	Unemployed	6.3
<i>Age</i>		Administrative	10.9	<i>Monthly bill</i>	
<20 years old	29.2	Sales/service	19.1	Fixed fee	55.1
20–24	26.7	Managerial	1.9	Non-fixed fee	44.9
25–29	20.8	Skilled			
30–34	14.3	professional	9.2		
35–40	8.9				

Female respondents outnumbered their male counterparts, which corroborates the fact that female consumers are the primary ‘market maven’ of electronic commerce (Okazaki 2004).

The sample was not stratified according to age, but we were not surprised to receive a ‘reasonable’ number of responses from older age groups. However, our results were consistent with prior research: few people over 35 replied to our survey invitations. Only 9% of total respondents belong to this age group. By contrast, respondents under 20 years old accounted for nearly one-third, and those under 25 made up the majority of respondents. In short, it appears that respondents to mobile surveys are more likely to be younger than those who respond to internet surveys.

With regard to occupational patterns, approximately one-third are students (35.3%), which reflects the majority of youth in the age distribution. At the same time, more than one-third (40.4%) are non-managerial white-collar workers in clerical/research, administration and sales/service. In contrast, managerial workers account only for 1.9%, while skilled professionals make up 9.2% of the total respondents.

In the profile of the customer database from which the sample was taken, male and female users make up 54% and 46%, respectively. In terms of age distribution, the database indicates that users under 20 years old account for only 15%, while users in their twenties and thirties account for 43% and 42%, respectively. Clearly, the proportions of ‘registered’ opt-in users in each age group do not correspond to those of the survey respondents – that is, people tend to opt in to various kinds of service when they start to use a mobile phone, but later do not use the service as planned. Therefore, the opt-in users who responded to this survey can be considered ‘regular’ mobile internet users.

Data quality assessment

Reliability is a key factor in determining the precision and coherence of a survey: it refers to the degree to which data are free from errors of measurement (Hair *et al.* 1998). To assess the reliability of the measurement, we performed two types of factor analytic model: an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA). The former is a preliminary data assessment tool, which attempts to identify the structure of relationships between variables, while the latter verifies the relationships between the observed variables and their underlying factors. The CFA model is concerned solely with the relations between the measured variables and their underlying factors, within the framework of structural equation modelling, and thus it represents a measurement model of the study (Byrne 2001).

First, an EFA was conducted with principal component method and Varimax rotation. Only factors with eigenvalue more than 1 were retained. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.8, which is considered superb. The Bartlett's test of sphericity was found to be statistically significant, suggesting the presence of a sufficient level of correlations among the variables. Table 3 shows the rotated factor matrix. As can clearly be seen, a five-factor solution has an almost identical structure to the one we suggest in the model: brand trust, mobile

Table 3 Results of exploratory factor analysis

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Q1	0.939	0.084	0.041	0.071	0.117
Q2	0.904	0.093	0.059	0.078	0.155
Q3	0.686	0.101	0.002	0.169	0.084
Q4	0.065	0.803	0.082	0.128	0.159
Q5	0.104	0.745	0.241	0.187	0.023
Q6	0.143	0.631	0.012	0.308	0.200
Q7	0.157	0.550	0.094	0.448	0.058
Q8	0.023	0.098	0.893	0.112	0.051
Q9	0.026	0.067	0.830	0.086	0.307
Q10	0.120	0.110	0.151	0.121	0.845
Q11	0.041	0.464	0.102	0.558	0.019
Q12	0.022	0.102	0.299	0.084	0.849
Q13	0.318	0.044	0.017	0.425	0.642

Notes

Extraction method: principal component analysis; Rotation method: Varimax with Kaiser normalisation
n = 1335

The items in bold are the variables of the proposed factor structure

Factor 1: mobile campaign recall; Factor 2: mobile advertising trust; Factor 3: brand trust;

Factor 4: attitude towards mobile advertising; Factor 5: attitude towards brand

advertising trust, attitude towards brand, attitude towards mobile advertising, and advertising recall. Approximately 71% variance is explained. The variables loaded significantly on each of the proposed factors, while one variable (Q13) was cross-loaded on to both Factors 4 and 5. Otherwise, the level of cross-loading seems negligible. Hence, this five-factor solution was further examined, as our measurement model, in terms of its reliability.

Next, we randomly split the total sample of 1335 observations into calibration and validation samples. This ensured that any ordering of the observations did not affect the processes of estimation and validation. Then a CFA was performed with the calibration sample. AMOS 5.0 with the asymptotically distribution-free estimation was used for all analyses (Byrne 2001). We made this choice because we detected a slight violation of multivariate normality based on Mahalanobis distance. For the same reason, the bootstrap was used to correct sampling variability (Hair *et al.* 1998).

The resulting absolute fit index was significant: $\chi^2 = 218.42$, $df = 55$, $p < 0.001$, indicating an acceptable fit. However, the literature suggests that this index becomes too sensitive to larger sample size. Thus, we calculated more pragmatic indices: Goodness-of-Fit Index (GFI) = 0.97; Adjusted Goodness-of-Fit Index (AGFI) = 0.94; Comparative Fit Index (CFI) = 0.95; Root Mean Square Error of Approximation (RMSEA) = 0.066. All indicate an acceptable fit of the model. In addition, all the items loaded positively and significantly on the corresponding factors, while the strength of the regression paths from the factors to the observed variables was notably high. All scores of the standardised coefficients exceeded 0.58 (see Table 4). Furthermore, squared multiple correlations were relatively high, with error variance acceptably low, thus confirming good convergent validity (Anderson & Gerbing 1988). We then re-estimated the factor models with the validation sample to test for comparability. The resulting fit indexes were acceptable, while the strength of factor loadings were similar to the calibration sample's results. On this basis, we deemed our factor models to be sufficiently validated with our data (iMedia Connection 2005).

Reliability was measured via Cronbach's alpha, composite reliability, and average variance extracted. For this calculation, the data obtained from the calibration sample were used. As Table 5 shows clearly, the alphas exceeded the generally accepted minimum level of 0.70, except for attitude towards brand (Hair *et al.* 1998). The composite reliability scores were higher than 0.85, and thus superior to what prior research

Table 4 Results of confirmatory factor analysis

Paths	Calibration sample (n = 668)	Validation sample (n = 667)	Total sample (n = 1335)
Brand trust → Q8	0.80	0.76	0.76
Brand trust → Q9	0.81	0.92	0.85
Mobile advertising trust → Q4	0.74	0.70	0.71
Mobile advertising trust → Q5	0.76	0.77	0.75
Attitude towards brand → Q10	0.59	0.54	0.52
Attitude towards brand → Q12	0.73	0.80	0.75
Attitude towards brand → Q13	0.65	0.67	0.68
Attitude towards mobile ad → Q6	0.59	0.64	0.58
Attitude towards mobile ad → Q7	0.66	0.71	0.66
Attitude towards mobile ad → Q11	0.71	0.73	0.69
Ad recall → Q1	0.95	0.94	0.95
Ad recall → Q2	0.97	0.96	0.95
Ad recall → Q3	0.58	0.59	0.59
Goodness-of-fit indices:			
Chi-square (<i>df</i>)	205.10 (55) *	280.56 (55) *	431.30 (55) *
GFI	0.97	0.96	0.96
AGFI	0.94	0.93	0.94
CFI	0.95	0.90	0.90
RMSEA	0.064	0.078	0.072

Notes

All standardised coefficients are statistically significant at $p < 0.001$

GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index; CFI = Comparative Fit Index;

RMSEA = Root Mean Square Error of Approximation

* $p < 0.001$

Table 5 Overall reliability and validity

Constructs	Alpha	Composite reliability	Average variance extracted
Brand trust	0.81	0.95	0.65
Mobile advertising trust	0.70	0.85	0.56
Attitude towards brand	0.61	0.90	0.44
Attitude towards mobile advertising	0.70	0.90	0.43
Advertising recall	0.84	0.98	0.73

Note: The data from the total sample

recommends (Hair *et al.* 1998). This indicates that the measured variables are consistent with their underlying latent constructs to a great extent. Finally, the scores for the average variance extracted were notably lower, especially with the two constructs of attitude towards brand and mobile advertising. This means that the question items of these constructs did not capture a sufficient amount of variance, because they may not truly represent what we intended to measure. Taken together, we consider that the construct of attitude towards brand was the most problematic, and its construct indicators must therefore be greatly revised or replaced with more meaningful questions, while that of attitude towards mobile advertising must be improved in future, probably by increasing the construct items.

The above findings clearly limit the generalisability of the survey to some extent, but the majority of the indicators exceeded the recommended guidelines. Thus, we concluded that the reliability and validity were sufficiently established for the study, and thus a sufficient level of data quality was achieved.

Discussion

Our pilot study has important implications for future mobile-based surveys. This is one of the first empirical studies to use mobile-based online survey techniques. One major problem in prior mobile advertising research was that researchers did not ensure the ability of the respondents to receive, read and evaluate the content of mobile ads, because most of the studies used 'self-reported' questionnaires. However, given that the mobile internet is still at an early stage, a traditional 'paper-and-pencil' survey may not be able to capture 'actual' mobile internet adopters. Hence, a push mobile messaging service can be used to track 'real time' data from opted-in subscribers. This tracking function of mobile messaging services should be explored further to capture a real picture of mobile users' behaviour.

First, with regard to the cost of a mobile-based online survey, it costs 0.2 Euro cents to send one packet (128 bytes) on DoCoMo's 2.5G i-mode network in Japan. Thus, a typical simple email might cost only 0.7 Euro cents, and be even cheaper on 3G where the average packet price is around 0.04 Euro cents/packet. Our data transmission cost in the pilot study was slightly higher, because the message included visual images. Thus, a mobile-based online survey is a very feasible alternative to a PC-based email survey. On the other hand, the survey costs largely depend on

whether a given market's wireless data transmission system offers a cost-effective messaging service. For example, on all four carriers in Germany (T-Mobile, Vodafone, E-Plus and O₂) it costs 19 Euro cents to send an SMS message of 160 characters, which is much more expensive than i-mode (Scuka 2003).

Second, our findings reveal that users older than 35 years old are not as willing to open questionnaires and respond to them as younger ones. This leads to the important question of the generalisability of target respondents. One way to look at this issue is to compare the respondents' media usage characteristics with those of the general population. Video Research Interactive has published a 'Media Contact Report' (MCR) of the active Japanese population since the 1970s (Video Research Interactive 2005). We found important differences in media usage patterns between the MCR and our sample, especially in such interactive media as PC-based and mobile internet. Our respondents were unlikely to read newspapers, but tended to watch television less often, due to more frequent use of interactive media.

Generally speaking, the characteristics of the respondents appear to be skewed towards younger generations, and those of our survey respondents under 30 years old seem to represent an especially heavy mobile user segment. This appears inconsistent with Kim *et al.*'s (2004) survey. Their results indicate that the age group over 30 years old accounted for more than 70% of the total Japanese respondents, with only 29% under 30 years old. Clearly, their findings contradict the majority of industry reports. The reason for this is that Kim *et al.* (2004) employed a web-based online survey method, which may not have been able to capture real mobile user segments.

Third, in this pilot study, the choice of a multichotomous response format generated an acceptable level of data quality, in scale reliability and convergent validity. This is somewhat encouraging for academics, because the multichotomous response format (in particular, semantic differential scale or Likert-type scale) normally offers more opportunities for data analysis, particularly latent-based multivariate analysis. The ability to establish both reliability and validity by using semantic differential, or Likert-type scales, would substantially improve the quality of research. However, researchers should be aware that the response quality would depend on the number of question items and on the wording of scaling. In particular, because of the space and scrolling limitations of the mobile device, the number of question items should not be inflated, unless this is justified both theoretically and economically.

Fourth, the response rate in our sample was substantially lower than the average rate of the previous surveys in Table 1. The difference appears large, and thus the use of the multichotomous response format seems to have caused important psychological rejection by the respondents. Researchers should therefore treat this result with much caution: because the multichotomous response format increases both the number and the complexity of questionnaire items, the respondents are forced to face longer connection time and hence higher fatigue. This creates a somewhat 'give and take' relationship between the decrease in the response rate and the increase in data analysis possibilities, because the multichotomous response format normally offers more opportunities in data analysis, particularly latent-based multivariate analysis. Clearly, the response rate would depend on the number and content of questionnaire items, including the wording. In particular, because of the space and scrolling limitations of a mobile device, the number of question items should not be inflated, unless this is justified theoretically.

Lastly, the assessment of the measurement model demonstrated the acceptable level of data quality. Despite the number of items included in the questionnaire, three measures of reliability – namely, Cronbach's alpha, composite reliability and the average variance extracted – appear reasonable. By definition, reliability is important because errors of measurement attenuate correlations among variables, which reduces 'precision'. In this regard, structural equation modelling has been considered an effective tool for detecting systematic error. Furthermore, an attribute of reliability is that it is a property of a scale score as it is applied in some specified population – that is, the reliability of our data depends on how well a measure performed in the sample collected in this survey. Therefore, our measurement assessment disclosed a source of error, and thus statistically demonstrated the level of quality achieved in our survey methodology.

Limitations and future research directions

To make our above discussion more objective, we must acknowledge a few limitations. First, because the transmission of mobile messages and campaigns is not only complex but also costly, the feasibility of mobile-based online surveys remains in its infancy. Although i-mode has been 'exported' to many countries (e.g. the UK, France, Germany, Spain, Belgium, Greece, Australia, Taiwan), the data transmission environment in Japan, and the psychological 'readiness' of people there to accept mobile

advertising, may not be found in other countries. Any generalisation of the findings must be treated with caution.

Second, although it seems inappropriate to rely solely on paper-and-pencil questionnaires to capture general mobile users who may not use the mobile internet very often, special caution is necessary in interpreting our survey results. Our response rates, based on total clicks, were relatively reasonable, but it should be noted that those respondents represent only a small portion of total mobile advertising subscribers. Therefore, any future extension may need to combine both offline and online survey methods to reach a core portion of mobile advertising subscribers.

Similarly, the heavy female skew in the sample may be due to females being more likely to take a survey than males, and not necessarily because females are more likely to be influenced by mobile advertising. This point should be noted.

Third, researchers should take into account usability engineering variables, such as device ergonomics, users' level of expertise, users' mobile context of use, and application-specific variables. For example, small screen size, limited screen resolution and complex input mechanisms are issues to be resolved in the near future.

Conclusion

In this study, we have offered a comprehensive evaluation of a mobile-based online survey method by conducting a pilot study of it. All the findings described above seem to suggest that this form of survey is, at a minimum, a useful alternative that ensures respondents' truthfulness: they are 'real' mobile internet adopters. Table 6 summarises some of the key features in traditional, internet and mobile-based survey methods.

As the use of mobile advertising campaigns expands in the future, it will be increasingly important to capture, examine and analyse mobile internet users' motivations and behaviours. Why do consumers accept or reject advertising messages sent via mobile device? Many questions remain unanswered, and often we simply have no access to relevant information. For this reason, future research is needed to implement and to improve the mobile-based online survey method.

Table 6 Summary of traditional, internet and mobile-based surveys

Key factors	Traditional	Internet	Mobile
Costs	High	Low	Potentially low Depends on the market infrastructure, messaging system, data-collection system set-up cost, high-speed connection, etc.
Target respondents	Unlikely to capture 'true' online users due to self-reported nature	Likely to capture regular internet users Skewed towards older than 30 years old	Likely to capture regular mobile internet users Skewed towards younger than 35 years old
Anonymity	Usually guaranteed	Compromised with permission Serious concern with spam	Compromised with permission Needs an effective opt-in feature
Response format	Varied scale types	Varied scale types	Combination of dichotomous and multi-chotomous scale types This weight depends on the number of items, device usability, users' level of expertise, applications, and time to respond
Questionnaire design	Primarily text-based with static image option	Primarily text-based with static and/or dynamic image option	Primarily text-based with static and/or dynamic image option
Response rate	Usually low Largely depends on the incentives, questionnaire length, follow-up techniques, among other things	Low-medium Largely depends on the incentives, questionnaire length, among other things	Low-medium Largely depends on the click-through of survey invitation, incentives, questionnaire length, perceived trust in mobile server, among other things
Data quality	Medium-high	Medium	Potentially high

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