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**Using Web-based Surveys for Information Systems Research: An
Experience Report**

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Abstract:

There has been much interest of late in the use of Web-based surveys. However, the methodological issues of Web-based surveys are poorly understood. This paper reports on the experiences gained from a recently conducted Web-based survey of software designers in Ireland which yielded a very satisfactory usable response rate of 45%. It describes the sampling method, pilot test procedures, response patterns, and the mechanisms engaged to authenticate participants and to filter duplicate responses. An outline is also given of how various factors with potentially beneficial affects on response rates were considered, as well as a breakdown of costs. Finally, the paper concludes with a summary of the main lessons learned.

Keywords: Survey methodology; Web-based questionnaires;
Information systems.

Using Web-based Surveys for Information Systems Research: An Experience Report

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INTRODUCTION

A substantial problem with survey-based research in recent years is dropping response rates, now typically of the order of 10% for postal questionnaires. Web-based surveys are less costly to implement than mail surveys and have been found to yield faster, more complete and more accurate responses (Klassen & Jacobs, 2001; McCoy & Marks Jr., 2001a; Schaefer & Dillman, 1998). In addition, they offer the advantages of real-time response validation, automated data entry, and programmable context-sensitive skip patterns. It would therefore appear that the Web has the potential to be the saviour of survey-based research. However, the rigorous execution of a Web-based survey necessitates a thorough consideration not just of methodological issues, but also technological, ethical, and cultural aspects (Lang, 2002). This paper reports on the experiences gained from a recent dual mode (Web+mail) survey of software designers in Ireland which yielded an overall response rate of 52% (45% usable).

DESIGN AND ADMINISTRATION OF SURVEY INSTRUMENT

Sampling Procedures

In software design research as in other domains, the definition of accurate sampling frames is often difficult. The starting point in compiling our sample was to collate a list, drawing from several industry databases, which included software development organizations as well as large organizations likely to have internal IT departments (e.g. banks). This list was then systematically refined by visiting the Web sites of these organizations to (i) filter out those organizations not engaged in the sort of activities we were interested in, and (ii) verify contact names and addresses. The eventual sample comprised 438 organizations.

When selecting a research sample, it is important that all members of a population have a fair and equal chance of being included or else "coverage" error may occur, potentially giving rise to bias (e.g. demographically skewed data). For Web-based surveys of the general

public, coverage error is likely to be high because respondents are typically younger, better educated, more computer-oriented, and more affluent than society as a whole (Batagelj & Vehovar, 1998; Zhang, 1999). However, this was not a problem for us because our survey was aimed at software designers, all of whom had access to and were familiar with the Web.

Pilot Testing

Web-based technologies are continuously changing at a rapid pace and users are adopting these changes at different rates. It is therefore imperative that Web-based surveys be adequately pilot-tested on a variety of browsers and operating systems. What the designer of a Web survey sees on his screen may be very different to what the respondent sees because of differences between device characteristics, visual distances, text wrapping, fonts, special characters, plug-ins and media formats, and support for languages such as Java, Javascript, and CSS (Bertot & McClure, 1996; Dillman & Bowker, 2001; Smith, 1997; Stanton & Rogelberg, 2001).

For our survey, the following measures were executed:

- The questionnaire was tested in various browsers (Microsoft Internet Explorer v5.0, v6.0; Netscape Navigator v4.7, v6.2; Mozilla; Konqueror; Opera), operating systems (Microsoft Windows 95, 98, NT, 2000; Red Hat Linux; Apple Macintosh OS7), and screen resolutions (800 x 600, 1024 x 768, 1152 x 864). According to global Web statistics from www.thecounter.com over the period of the survey, these tests covered about 95% of all permutations;
- All HTML and CSS code was tested using the W3C validation service (see <http://validator.w3.org/>);
- As the Web server was a Linux machine (i.e. case sensitive file names), it was necessary to ensure that the URL and username-password would function correctly regardless of whether they were typed in lower case, upper case, or the most likely combinations thereof. The Web server was also configured to return customized error pages rather than the unhelpful "404 File Not Found" default message;
- The Web server was apollo.nuigalway.ie, but an alias of www.apollo.nuigalway.ie was also set up because some users

might expect a URL to commence with “http://www.” and therefore experience an error if they wrongly entered it as a prefix;

- External access was tested to ensure there were no problems with firewalls or domain name servers;
- Web server performance was tested for download time, connection time, number of timeouts, and other critical parameters using a monitoring tool from www.netmechanic.com;
- The e-mail merge message used in the second follow-up round was tested by sending it to colleagues in order to ensure that features such as text wrapping and clickable URL links worked properly in a variety of email readers (e.g. Microsoft Outlook, Eudora, Mozilla Thunderbird, Webmail). Underscores were not used in URLs because some email readers automatically underline URLs, meaning that underscores could be mistaken as blank spaces;
- Before distribution, the questionnaire was pilot tested with a purposefully selected group using the “talk aloud protocol” advocated by Dillman (2000). A number of revisions were implemented across three rounds of testing.

Response Patterns

Respondents were mailed a package, giving them an option of responding by post or by Web. This package comprised a cover letter, stamped-addressed return envelope, and a professionally printed 8-page questionnaire (saddle-stitched booklet format). A sticker was affixed to the front of the paper questionnaire, giving the username, password, and URL to access the Web-based version.

After two follow-up rounds, a total of 215 valid responses were received. In addition, 23 questionnaires were returned undelivered or with a note that the organization had shut down. Only one response was solicited from each organization, but one company returned 2 separate responses. The overall response rate was therefore 52%*. However, 43 respondents indicated that they had no experience of the type of software design we were interested in so should therefore not have been included in the sample. Another 5 responses were insufficiently complete. Thus the

* $(215 \text{ valid} - 1 \text{ duplicate}) / (438 \text{ sample size} - 23 \text{ shutdowns}) = 214 / 415 = 52\%$

usable response rate is 45% based on the size of the true population**. A total of 167 usable responses were received in total (83 Web; 83 post; 1 other).

The response patterns are shown in Table 1 and Figure 1. Interestingly, although all of the survey participants were themselves Web designers, most of the responses received in the first 20 days were by mail, - the number of usable postal responses received during that period was almost three times the number of Web responses. Consistent with experiences in other studies, most of the Web responses received in this first phase were in the initial 7 days (Comley, 1996; Schaefer & Dillman, 1998; Zhang, 1999). The average response time for postal responses was 12 days, which also accords with previous mixed-mode surveys (Comley, 1996; Schaefer & Dillman, 1998).

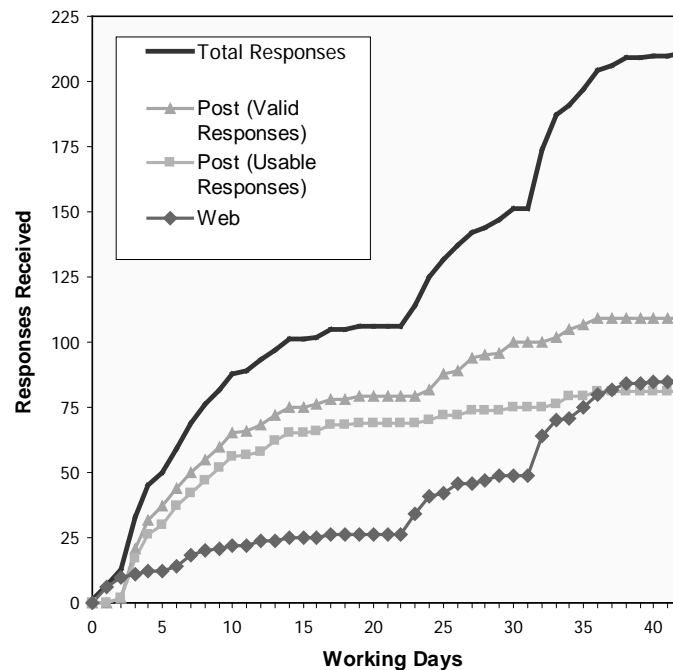


Figure 1. Survey Response Patterns.

** (215 valid - 1 duplicate - 43 irrelevant - 5 incomplete) / (438 sample size - 23 shutdowns - 43 irrelevant) = 166 / 372 = 45%

Phase	Post (Usable)	Web	Other	Total
Day 0 to Day 10	56 (68%)	20 (24%)	1 (100%)	77 (46%)
Day 11 to Day 20	13 (16%)	4 (5%)	-	17 (10%)
Day 21 to Day 30	6 (7%)	20 (24%)	-	26 (16%)
Day 31 to Day 40	6 (7%)	37 (45%)	-	43 (26%)
After Day 40	2 (2%)	2 (2%)	-	4 (2%)
Total	83	83	1	167
Mean Response Time	12 days	24 days	-	19 days
Median	7 days	28 days	-	13 days

Table 1. Survey Response Patterns.

Follow-up reminders were issued by post on Day 22, the affect of which is clearly visible in Figure 1. This consisted of a one page letter, reiterating the main points of the original cover letter, and again providing the Web URL. At the bottom of the page was a detachable slip whereby respondents could (a) request a replacement paper questionnaire or (b) specify a reason for not responding (thus giving insights into causes of non-response). Five participants requested replacement paper questionnaires, only one of whom subsequently submitted a response (notably, via the Web). Within 10 days of this initial follow-up, 6 usable responses were received by post (increase of 9%) and another 23 via the Web (increase of 88%). In addition, 20 detachable slips arrived by post with explanations for non-response; these are counted as valid but unusable postal responses, as shown in Figure 1.

A second follow-up was sent on Day 32, this time by email. Email addresses were available for 221 of the 287 participants from whom responses had not been received, though 180 (81%) of these were of a general form such as info@company.ie. A personalised message containing a respondent-specific URL link was generated using an e-mail merge tool. Within 10 days, 6 more usable responses were received by post (increase of 8%) and a further 37 via the Web (increase of 76%), as well as another 5 postal explanations of non-response.

Access Control and Treatment of Multiple Responses

If a Web-based survey is open to unsolicited, unidentifiable respondents, major doubts may hang over its validity (Dillman, 2000, p. 378). This is especially true where material incentives are being offered to participate because, in the absence of authentication mechanisms, fraudulent responses cannot be filtered out. We used a unique six-digit identifier

which was embedded into the URL e.g. <http://apollo.university.edu/survey/234567.php>. Following the recommendation of Schleyer and Forrest (2000), the digits 0 and 1 were not used because of potential confusion with the letters "O" and "I". A password-protected directory was also used (username: "anonymous", password: "guest"). An added advantage of having a separate URL for each respondent was that it was possible to look at Web server logs to investigate access difficulties. It was discovered that 15 participants mis-typed the username at least once, 11 of whom subsequently responded (8 by Web; 3 by mail). 2 participants mis-typed the password at first attempt, but both subsequently responded. There was one unsuccessful attempt to "hack" into the survey.

Another problem related to authentication is where a respondent either deliberately or inadvertently submits multiple responses to a Web-based survey (Klassen & Jacobs, 2001; Stanton & Rogelberg, 2001). We addressed this issue by recording a timestamp and the identifier for all responses. A number of "multiple" responses were indeed received, but it was clear from inspection of the data that in most cases what was happening was that respondents were clicking the "Next" button to have a preview of the screens, thus inadvertently submitting a response, or else the connection had timed out and a partially complete response was received. In such cases, all but the most recent responses were discarded.

Because the survey was dual-mode, it was also necessary to verify that no respondent used both modes. As the paper questionnaires had stickers affixed with the respondent's unique URL, it was a simple procedure to cross-check for duplicates. One such case was found, explained by the fact that the respondent started the Web-based questionnaire but dropped out and subsequently returned a completed paper questionnaire by mail.

Treatment of Factors with Potential Response Affects

Research on survey response affects reveals inconsistent findings; sometimes a particular strategy is found to be beneficial, elsewhere it might have a negligible affect (Dillman, 2000; Fox et al., 1988). Because this was a high-stakes research project (a doctoral study), all possible measures, however marginal the potential affects, were taken to boost the response rate. 36%* of non-responses can be explained, as shown in Table

* $96 \text{ explanations} / (438 \text{ sample size} - 166 \text{ usable} - 5 \text{ insufficiently complete}) = 96 / 267 = 36\%$

2. It is also useful to examine causes of delayed response (Table 3), for late respondents might be regarded as surrogates for non-respondents.

Cause of Non-Response	Frequency
No or inadequate experience of the type of activity addressed by the survey	43 (45%)
Organization has shut down	23 (24%)
Too busy to respond	12 (13%)
Named contact person has left organization	8 (8%)
Organizational policy not to respond	4 (4%)
Problems loading Web survey	4 (4%)
Questionnaire received by person in inappropriate role	2 (2%)

Table 2. Known Causes of Non-Response (n=96).

Cause of Delayed Response (later than Day 20)	Frequency
Named contact person has left organization	8 (57%)
Prolonged absence abroad / off-site	3 (21%)
Named contact not in appropriate role; passed to colleague	2 (14%)
Initial mailing not received	1 (7%)

Table 3. Known Causes of Delayed Response (n=14).

Major factors which have a positive impact on the response rate are the accuracy of the sampling frame and the follow-up procedures, both earlier described. Other possible factors, and explanations of how we treated them, are as follows:

- **Personalization of correspondence** (McCoy & Marks Jr., 2001a; Schaefer & Dillman, 1998; Smith, 1997): Of the 438 organizations, we had individual contact names for 425. The mail-out cover letter and postal follow-up bore a personalized greeting (e.g. "Dear John" rather than "Dear Sir/Madam") and each letter was personally signed. Recipients were asked to pass the questionnaire on to a colleague if they were not suitably placed to respond themselves. Although most of the follow-up emails were sent to general email addresses, they were personalized insofar as possible (by personal greeting if to an individual address, or by "FAO: <named contact>" in the subject line if to a general address). In 47% of responding cases, the questionnaire was indeed completed by someone other than the addressee. Inspection of the causes of non-response and delayed response reveals that, in quite a few cases, the named contact had actually left the organization. Interestingly, the usable response rate from organizations with no

named contact was 62% (8 of 13) as opposed to 45% overall. It is hard to draw clear lessons from this experience, but it seems that the absence of contact names is less of an issue for e-mail than it is for postal mail, because e-mail messages can be appropriately redirected more easily than written correspondence;

- **Use of material rewards:** Respondents were offered a summary report of the survey findings, and/or inclusion in a prize raffle for UK£200 worth of Amazon.com gift certificates (11 separate prizes). 131 (78%) of the 167 respondents opted for the raffle, a slightly higher cohort of 134 (80%) requested a copy of the findings, while 19 (11%) declined both;
- **Clarity and salience of questions:** (Dillman & Bowker, 2001; Lucas, 1991; McCoy & Marks Jr., 2001a): The questions were drawn not just from the literature but also from preliminary interviews with software designers in industry. Feedback from actual software designers was also incorporated during pilot tests;
- **Questionnaire format:** In line with ESOMAR's (1999) principle of voluntary participation in Web surveys, no question was obligatory. Most of the questions were closed, requiring the respondent to select values from drop-down lists or to choose from a constrained set of checkboxes, although an "Other" textbox was always provided where appropriate to trap responses lying outside these pre-specified sets. A number of introductory questions used textboxes for nominal data (e.g. job title, project cost) and two questions used larger textboxes for open-ended comments. Item response rates were as follows: drop-down lists / checkboxes 99%, "Other" category textboxes 8%, nominal data textboxes 94%, and open-ended comments textboxes 38%. For all questions, the item response rates of the Web survey were remarkably close to those of the postal survey. This is interesting given that many questions in the paper version used 7-point Likert scales, for which drop-down lists were substituted in the Web version. No response-mode affect was therefore observed;
- **Screen layout:** The Web survey consisted of an introductory page and 11 consecutive screens, all of which were designed to fit within an 800 x 600 display without any need for scrolling. A screen-at-a-time design was preferred because this was found elsewhere to have better item-response rates than single-screen instruments (Klassen & Jacobs, 2001; Smith, 1997);
- **Good visual design and Web survey usability** (Dillman & Bowker, 2001; Lazar & Preece, 1999; McCoy & Marks Jr., 2001a): A

template and Cascading Style Sheet (CSS) was used for the Web survey to ensure a consistent look-and-feel, thus minimizing the need for cognitive re-adjustments when navigating between screens. All Web screens had a progress indicator ("Screen *n* of 11"), all interface objects were clearly labelled ("Please select" for drop-down lists; "Next" and "Reset" for buttons), and the questions and response fields were separately color-coded so as to be visually distinct. The services of professional technical writers and graphic designers were engaged to assist with wording and visual layout;

- **Length of questionnaire** (Batagelj & Vehovar, 1998; Bertot & McClure, 1996; Falconer & Hodgett, 1999; Farmer, 1998; Smith, 1997). Web-based surveys must be efficiently designed so as to minimize completion time and effort, ideally taking 15 minutes or less. We recorded timestamps for the start and finish screens, as well as each interim screen along the way. Six respondents took more than 30 minutes, taking breaks mid-way through. One extreme case started the questionnaire at the end of a working day and returned the following afternoon to complete it. Setting these outliers aside, the average completion time was 13 minutes;
- **Endorsement by a university or professional body, and reputation of the researcher:** This survey was a joint venture between two universities and the logos of both were used on the cover letter, mail-out envelopes, and on all screens of the Web survey. All e-mail correspondence was from the university's domain (as opposed to an unfamiliar .com domain or freemail service such as yahoo or hotmail), the Web survey was hosted within the university (as opposed to surveymonkey.com or other third-party), and e-mail signatures provided the URLs of researchers' "home" pages so that respondents could assure authenticity;
- **Web server uptime:** The server was constantly monitored to ensure that it was on-line, but by unfortunate accident a power cable was severed by machinery on an adjacent construction site the morning after the initial follow-up notification, probably causing some Web responses to be lost;
- **Use of return SAEs** (Dillman, 2000; McCoy & Marks Jr., 2001a): In congruence with the theory of social exchange, stamped-addressed envelopes were included in the initial mail-out;
- **Advice of cut-off dates:** The cover of the paper questionnaire mentioned a cut-off date, but no cut-off dates were included for

the Web survey or mentioned in follow-ups because (i) it was anticipated that most would respond soon or not at all, and (ii) it was felt that expiration of a cut-off date might dissuade late responses. By Day 45, all but 3 of the eventual tally of usable responses had been received, the late arrivals coming by post (Day 47; Day 90) and by Web (Day 50).

- **Confidentiality** (Lazar & Preece, 1999; Stanton & Rogelberg, 2001): Concerns about privacy and confidentiality can negatively impact response rates, but this was not an issue in this survey, as attested by the fact that 91% of respondents gave their names plus email and/or telephone number in order to receive raffle prizes / summary report.

Survey Costs

The costs of implementing this survey are shown in Table 4, but this presents a misleading picture for two reasons. Firstly, expenditure on incoming postage and incentives for the postal survey was not strictly necessary and only incurred because of potentially beneficial affects on response rates. Secondly, the marginal costs of the Web-based version were nil because we had the necessary technical skills to design it ourselves (Dreamweaver, Photoshop), used software for which we already held licences or which was freely available (RedHat Linux, Apache, MySQL, PHP, GroupMail), and hosted it on an internal Web server. The additional overhead of €10 represents merely the price of a box of stickers, used for affixing a unique URL to the front of each paper questionnaire. However, even after taking unnecessary costs away from the postal survey and adding development costs to the Web survey, it cost less than half the postal survey. For larger populations, this fraction decreases exponentially.

Expense Item	Postal Survey	Web Survey
Stationery & Printing	€ 465	€ 10
Outgoing Postage	€ 394	-
Incoming Postage (SAEs)	€ 344	-
Incentives (Amazon.com certificates)	€ 317	-
Total	€ 1520	€ 10

Table 4. Survey costs.

CONCLUSIONS

As with all other modes of survey research, valid, reliable responses cannot be expected from Web surveys unless careful attention has been given to sampling procedures and other critical aspects of research design. Notably, the European Society for Opinion & Marketing Research (ESOMAR) warn that:

“Any Internet surveys which fall seriously below the high standards promoted by ESOMAR and other leading professional bodies will make it more difficult to use the medium for genuine research and could seriously damage the credibility of such research, as well as being an abuse of the goodwill of Internet users generally” (ESOMAR, 1999)

A number of lessons can be drawn from our experiences:

- The design of a Web-based questionnaire calls not just for questionnaire design and testing skills, but also Web design and testing skills. With dual-mode surveys, it may be tempting to believe that there is no more to the Web-based version than merely porting a paper version directly to the screen. However this is a gross over-simplification based on a poor understanding of Web design principles, and the conversion of a paper-based questionnaire to an on-line version should not be undertaken lightly;
- It would appear that, even amongst highly computer-literate populations, very many participants when given the choice of mixed response modes will opt for paper. This finding is consistent with previous mixed-mode studies (McCoy & Marks Jr., 2001b; Zhang, 1999);
- Most of the responses to later rounds arrived via the Web, but there are a number of possible explanations: (i) replacement paper questionnaires were not sent in follow-up rounds, unless specifically requested, (ii) the second follow-up round was by email and contained a direct clickable URL to the Web survey, and (iii) many participants, upon being reminded, might have opted for the Web survey because it was the most immediate medium and/or they might have discarded or mislaid the paper version;
- The absence of individual email addresses was not a problem. Although 81% of email addresses were of a general form (e.g. info@company.ie), the e-mail follow-up round boosted Web responses by 76%;

- If using password-protected folders, usernames and passwords that are likely to be mis-spelt (e.g. “anonymous”) should be avoided. To an extent, we got away with this because respondents had the fall-back of a paper mode, but otherwise we might have lost 10% of responses;
- 17% of non-respondents indicated that they were either “too busy” or that it was “against policy” to respond to surveys. Hence, there is a greater need than ever for elegant questionnaire designs which prioritise the most salient questions and demand no more than 15 minutes of the respondent’s time. Our initial follow-up letter mentioned that the average Web completion time at that point was 11 minutes, but this was obviously more than very many participants were willing or able to give;
- The use of material incentives means that authentication procedures need to be engaged, but in retrospect it seems that there was no benefit in offering material incentives here because more respondents were interested in a copy of the survey findings than in a prize raffle, while 11% declined any reward;
- For both Web and postal modes, very high item response rates were received for closed questions, with much lower rates for open-ended textboxes;
- If sending follow-up notifications for Web surveys, one should always check for scheduled network downtime or scheduled power outages, and ideally use a Web server with an uninterruptable power supply.

The potential of Web-based surveys has been dealt a serious blow by the spread of pernicious direct marketing and “spamming” technologies in recent years which have come to pervade all forms of electronic and traditional communications. Legislation has been recently introduced in the European Union (Directive 95/46 on Data Protection, Directive 2002/58/EC on Privacy and Electronic Communications) and the United States (Unsolicited Commercial Electronic Mail Act of 2001, CAN-SPAM Act of 2003) to protect privacy and restrict unscrupulous direct marketing, but in practice these laws are difficult to enforce because of the borderless nature of cyberspace. More than ever, an aura of suspicion surrounds any stranger-to-stranger communication on the Internet and the use of Web surveys for business-to-consumer research is likely to yield very low response rates, as well as being susceptible to coverage error. It would appear that Web-based surveys have most promise for intra-organizational research (including within the closed memberships

of trade associations), but for all other contexts, it is likely that Web surveys need to be complemented by mail, telephone, and/or fax modes.

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