

Mixed-mode Surveys Using Mail and Web Questionnaires

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Abstract: With the Internet now being a part of everyday life mixed-mode surveys that use the world wide web can be seen as an opportunity to increase the response rate of surveys. This paper looks at the advantages and disadvantages of different response modes suitable for mixed-mode surveys. Based on this consideration the paper addresses the influence of a mixed-mode approach using conventional mail and web based questionnaires on coverage, sampling, measurement, and non-response error as well as pitfalls and opportunities specific to this type of survey. It discusses mixed-mode and web specific issues such as technological aspects, security, convenience and similarity. The paper proposes that this approach has no apparent potential error consequences if certain requirements are fulfilled. The use of mixed mode questionnaires is exemplified by a survey conducted with 1000 SMEs in the North West of England in 2002. After analysing the findings the paper concludes by looking at the relation between the mode of response and the answers provided by the respondents and by summarising the insights gained from the study.

Keywords: Questionnaires, Surveys, Mixed Mode, World Wide Web, Quantitative, Research

1. Introduction

A number of problems arise when researchers send out questionnaires. On the one hand they require a high response rate, accuracy and consistency and they prefer convenience when transferring the responses into a machine-readable format. They would also prefer a low cost when sending the questionnaires out and want responses back as fast as possible. The increasing use of the Internet as a means of survey collection has enabled this to happen (Couper 2000). On the other hand everything should be scientifically correct so researchers still favour accepted approaches such as the traditional mail survey method. Dillman (2000) has suggested a mixed mode strategy (Web and Mail surveys combined), although mixed-mode methods can suffer from the problems of measurement.

Providing an electronic version of the questionnaire additionally to the paper version of the questionnaire adds another mode of response. There is no academic literature that compares parallel and sequential mixed-mode surveys directly. Having studied a parallel mixed-mode situation using mail and telephone, Dillman et al. (2001, p. 3) state that "giving respondents a choice of which mode to respond to does not necessarily improve response rate". In a mixed-mode survey

using mail, telephone and personal interviews with college graduates, conducted by Shettle and Mooney in 1999 (see Dillman et al. 2001, p. 3-4) it was found "that a sequential strategy of making multiple contacts to ask people to respond to a particular mode, and then switching to multiple contacts by another mode, will improve response rates" (Dillman et al. 2001, p. 3). However, as described by Dillman (2000, p. 220) measurement differences are a potential error consequence when collecting panel data from the same respondent at a later time.

The research reported here examines the effect of a sequential mixed mode survey method on response rates and on the responses to the questions asked. The research is concerned with the study of Small and Medium Enterprises (SMEs) and their attitude towards e-business and strategy.

2. The sample

The survey was conducted in 2002 and was concerned with Small and Medium Enterprises (SMEs) based in the North West of England and their attitude towards e-business and strategy. The definition of the Commission of the European Communities (1996) was used where possible to make comparisons with similar studies easier.

There can be special difficulties when researching SMEs as described by Curran and Blackburn (Curran & Blackburn 2001, p.61). One of these difficulties regards the data source: They indicate that there are rarely up-to-date lists of relevant small businesses available from which a convincing representative sample could be recruited and that there is "no single publicly accessible register of businesses in the UK". Although there is an official Inter Departmental Business Register from 1998, the DTI (Curran & Blackburn 2001, p.61) states that it fails to pick up many micro or small businesses and that it is not up-to-date. It was decided that the survey will be regionally based in the North West of England to make it possible to conduct more in-depth qualitative research with selected key enterprises in the second stage. A database provided by the University of Central Lancashire Business Services was used and companies were selected from this database using simple random sampling as described by Clark et al. (1998, p.77) and Fink and Kosecoff (1998, p. 41).

3. A mixed mode survey

3.1 Choosing modes

Griffin, Fischer, and Morgan (2001, p. 5) wrote that "mixed mode surveys try to take advantage of respondents' preferences in order to reduce levels of survey non-response". Mixed-mode studies can offer the different response modes in either parallel or serial mode. In our research study it was decided to use a parallel mixed mode survey, where the respondents are given a choice of how to respond in order to avoid possible measurement differences. Since as many recipients as possible should be able to use the electronic version of the questionnaire there are two main choices available: e-mail and the web.

3.1.1 e-mail

When looking at the distribution of questionnaires via e-mail, Dommeyer & Moriarty (2000) describe three ways of distribution:

- embedding the questions in the e-mail,
- attaching the questionnaire to the e-mail and
- attaching a survey program to the e-mail.

Embedding the questions in the e-mail can take the form of plain text or HTML code. The respondent has to be instructed how to mark their answers in the questionnaire. Answering such a questionnaire is not very convenient for the respondent because it cannot be done with a simple mouse click. If the respondent makes a mistake, e.g. using a wrong character to mark a multiple choice question or not placing this character at the exact position required, the answers in the questionnaire might no longer be machine-readable and manual entry of the respondents answers may be hampered. When looking at plain text questionnaires Dillman (1998) describes the problems arising from different e-mail formatting, e.g. line widths. If the embedded questionnaire is sent as HTML code it cannot necessarily be assumed that the recipient is able to view the questionnaire, since not all e-mail programs support HTML. Even if the recipient can see the e-mail there is no way of telling how it will be displayed because there is no standard minimum pixel resolution used by e-mail programs to display HTML code. Ranchhod & Zhou (2001) discuss four other factors raising problems when using e-mail for surveys:

- Lack of anonymity,
- Lack of authoritative image,
- Lack of incentive
- Lack of design features.

Lack of anonymity and authoritative image present a possible reason for recipients refusing to respond. It is much more difficult to address these problems by e-mail than it is on the World Wide Web.

In this study the lack of tangible incentives was not disadvantageous because the only incentive offered was the sending out of the study findings if requested.

The lack of design features as discussed by Ranchhod & Zhou (2001) does not take HTML e-mails into account, but as discussed earlier the use of HTML e-mails will create other problems. The great benefit of e-mails is speed of response (Bachmann, Elfrink, & Vazzana 1996; Tse 1998), which was, however, not an important issue for this study.

Attaching the questionnaire to the e-mail does not really improve on the situation compared to an embedded questionnaire: when it is attached as a plain text or as

HTML, the respondent will have to deal with the same difficulties that appear if the questionnaire is embedded. Other formats, like PDF, offer benefits but also create serious problems as discussed later in section 4.3.1.

Attaching a survey program also creates new problems, because the program must be compiled for the type of computer on which it is intended to run. Alternatively an interpreter program will have to be installed on the respondents' computers to run the survey program.

3.1.2 World wide web

Web surveys "not only have a more refined appearance to which colour may be added, but also provide survey capabilities far beyond those available for any other type of self-administered questionnaire" (Dillman 2000, p. 354). Dillman, Tortora, & Bowker state that "collecting responses via the web eliminates printing and mailing costs, and makes near automatic compilation of results possible" (Dillman, Tortora, & Bowker 1998, p.1). Another big advantage is that, if the questionnaire is carefully designed with HTML, it can be displayed as intended by the designer on nearly every machine that can access the World Wide Web as discussed in 4.3.1. Another advantage is the close similarity to the paper version of the questionnaire as discussed in section 4.3.4 which cannot be achieved with plain text e-mails. A World Wide Web survey can also be designed to be very convenient for the respondent, e.g. by clicking on the answers seen on screen, as well as for the researcher, as the answers can be saved and easily converted into the format necessary for statistical software packages as discussed in section 4.3.1.

3.1.3 Fax

Cobanoglu, Warde, & Moreo (2001) compared mail, fax and web-based survey methods; they state that fax surveys had a high speed of response and low cost, but also the lowest response rate. In this study fax is seen as just another way of returning the paper version of the questionnaire, not as a real electronic version, so no additional attention was paid to fax as another mode of the survey. Although a fax number was provided in the letter head, the cover letter did not

mention the possibility of sending replies to that number specifically.

3.2 Theoretical considerations

Dillman (Dillman 2000, p. 197) describes coverage, sampling, nonresponse, and measurement as "the four cornerstones of survey precision and accuracy". The mixed mode approach uses the same sample as a single mode survey, so it can be assumed that there are no implications for coverage error and sampling error. Couper (2000, p. 467-473) writes about the problems of coverage and sampling error in the context of web surveys, but since the sample used is the same for both modes, the coverage error should not increase, because the number of people missing from the frame is not affected (meaning that those without Web access can reply on paper) and sampling error should not increase, because the process of selecting a sample of the frame population is not affected either. Since using a mixed mode approach is not likely to negatively affect the number of replies to the survey or the differences between respondents and nonrespondents on the variables of interest, there should not be any negative effects on non-response error, leaving measurement error as the greatest area for potential problems in a mixed mode survey. The problem of potential measurement error caused by an additional mode was tackled by keeping both modes as similar as possible as described in section 4.3.4, leaving only the original measurement error reduced by providing the explanation sheet indicated in section 4.

3.3 Pitfalls and opportunities

One of the problems with mixed mode surveys as described by Dillman et al. (2001, p. 2) is the concern "whether people who respond by one mode provide the same answers as would have been the case had they responded by another mode". In another paper Dillman (2000, p.219) described different mixed-mode situations for surveys and found that only two of these situations have no potential consequences for error:

- the collection of different data from the same respondents during a single data collection period
- the use of one mode only to prompt completion by another mode.

Several advantages make a mixed-mode survey with an additional World Wide Web version of the questionnaire interesting for researchers.

- Unlike paper questionnaires, where the answers have to be scanned or typed in to provide them in a machine-readable format, the answers from web questionnaires are already machine-readable. They are typically stored in a database and only have to be converted into a format readable by a statistics package, e.g. SPSS. This not only saves time and work for the researcher but also eliminates the chance of incorrectly transcribing the respondent's answers.
- Cobanoglu, Warde, and Moreo (2001) compared mail, fax and web based survey methods and received the highest response rate, the second highest response speed, the lowest cost and the highest response quality for web surveys in their experiment. Although a parallel mixed mode survey alone seems to offer no increased response rate (as described with a paper / telephone example by Dillman et al. 2001, p. 3), including a web-based questionnaire might offer the benefits described by Cobanoglu, Warde, and Moreo (2001).

4. The survey

This study, using a mixed-mode approach, invited 1000 enterprises in the North West of England to participate in a survey in the summer of 2002. They were sent a paper version of the questionnaire as well as a link to a web page where they could complete a World Wide Web version of the same questionnaire. By autumn 2002, after two reminders were sent, 244 enterprises returned the paper version of the questionnaire and 60 enterprises completed the questionnaire online.

The questionnaire distribution consisted of three main phases:

- Sending out the initial contact consisting of the cover letter, the questionnaire, the paper providing extra space for the open-ended questions, four pages of explanations for the questions asked, the list with UK SIC(92) classifications, a form to request a summary of the findings and the pre-paid business reply envelope.

- Sending out the first reminder consisting of the first reminder letter, to all addresses except those that replied, those where the initial contact was returned by Royal Mail because the addressee has gone away or those where the addressee gave notice that the enterprise had closed down. This first reminder letter contained the details necessary to fill in the World Wide Web version of the questionnaire.
- Sending out the second reminder consisting of all the documents from the initial contact with a second reminder letter instead of the cover letter to all addresses except those that replied, those where the initial contact or first reminder was returned by Royal Mail because the addressee has gone away or those where the addressee gave notice that the enterprise closed down.

4.1 The cover letter

The questionnaire was accompanied by a covering letter addressing its purpose as described by Hoinville & Jowell (1977, p. 132-133):

- explaining the aim of the survey
- providing assurances about confidentiality
- conveying importance and urgency of the study
- anticipating likely causes of non-response and encouraging recipients to reply.

Dillman (2000, p.158-170) indicates the essential elements for an efficient but effective covering letter. These elements provide a guideline corresponding with Hoinville's & Jowell's (1977, p.132-133) purposes, but in more detail. The covering letter sent out together with the questionnaire tried to address these issues by:

- trying to make the letter as short as possible, i.e. limiting the cover letter to one page, trying to personalise the letter (e.g. with the date at the top of the letter (Dillman 2000, p.159), salutation of the recipient using his / her name and title where possible (Dillman 2000, p.160))
- giving basic information about the survey (who is surveyed, how big is the sample size, what organisations are involved, what is the purpose)

- explaining why and how to answer and what to do if the recipient is not the right person in his/her company
- assuring confidentiality (including an explanation about personal questions, why questionnaires are identifiable and that names and addresses will not be passed to third parties)
- offering a summary of the findings

An additional purpose of the cover letter in our research was to indicate both modes of data collection, mail and web, to the recipients. The identification number and the password were printed on the paper version of the questionnaire.

As described by Hoinville & Jowell (1977, p.132) it is inadvisable to give respondents a deadline for completion since some recipients might wait for the deadline instead of replying immediately whereas recipients who missed the deadline might throw the questionnaire away. Hence no deadline for completion was given in the covering letter.

4.2 The questionnaire - Paper version

The questionnaire itself consisted of four A4 pages copied onto a folded A3 sheet. The questions were grouped into three sections, suitable for the researched topic.

As described by Dillman (2000, p.165) and Clark et al. (1998, p.98) questionnaires should be identifiable, so that follow-up mailings can be sent to non-respondents. The questionnaires for this survey was identifiable by the identification number, the company number plus a check digit as described in section 4.3.3, printed on each first page used to identify the respondents who filled in the web version of the questionnaire.

4.3 The questionnaire - Web version

Since the main reason for providing a web version of the questionnaire was to increase the response rate, the web version was made as easy as possible to handle. Also, to ensure that respondents answer the questions of the web version in the same way as they would answer the paper version, the web version was made as similar to the paper version as possible.

4.3.1 Technological aspects

To avoid a possible influence on the answers through different ways of presenting the questionnaire, the layout of both versions was kept as similar as possible. However this only makes sense if the respondent is able to display the questionnaire as it was intended to be displayed and if replies to the questionnaire can be received as they were intended by the respondent. Using a non-proprietary standard offers some advantages over using a proprietary standard such as PDF which makes it harder to use a specific functionality, because it can be implemented differently or sometimes not at all in different versions of Acrobat Reader [the software necessary to use this format.] McCalla (2002, p. 59) describes how relying on the implementation of the same functions in different versions of the software causes problems in an on-line survey. Using HTML for the construction seems to be a good choice because, as a non-proprietary standard, there are no hidden revisions that could cause unexpected surprises with different implementations of browsers, the necessary software to display HTML code. Another great advantage is that, since HTML is the format in which web pages are constructed, virtually every computer that can access the web can work with HTML directly, making it unnecessary to use the web for transporting questionnaires in other formats such as PDF or Microsoft Word documents, where the necessary software might or might not be installed in the correct version to work with the files as intended. Using the server side script language PHP, the replies from the World Wide Web questionnaire were saved in a MySQL database from where they could be easily imported into statistical software packages such as SPSS via CSV files. Easy exchange between SPSS and the database was further facilitated by using the same structure in the database and in SPSS.

4.3.2 Security

Unlike the paper version of the questionnaire only available to recipients to which it was sent, the World Wide Web version was available on the Internet. Without additional means of security everybody who can access the World Wide Web can potentially access this

survey. To ensure that only the selected recipients can answer the questionnaire they were provided with a unique identifier (here called identification number) and a password. Dillman (2000, p.378) suggests a PIN number, which is basically the same as the unique identifier, Zhang (1999, p. 60) refers to it as a "unique case ID". The purpose is always to limit access to authorised recipients. To decrease the risk of successful malicious logins by unauthorised users by just finding a valid PIN number, users additionally had to enter a password that was provided to the selected recipients. The passwords were randomly created numbers between 100 and 999. Numbers were used instead of letters to avoid the random generation of passwords meaningful in the English language. The login mechanism was programmed in a server side script language (PHP). The use of a client side script language was considered, but rejected in order to reduce the risk of users being able to gain access to the system by tampering with the programming code.

4.3.3 Convenience

Check digit

To increase the convenience for the respondents, a check digit was used in the identification number, appended to the company number. The check digit can be used to check for errors after the number has been transmitted (Kirtland 2001, p.5). Using the three digit company number (000 – 999) for the login would cause problems if a respondent mistypes this number together with the correct password, e.g. 156 instead of 165 as the company number. In this case, the system cannot find out whether company 156 tried to log in using a wrong password or whether company 165 tried to log in mistyping the company number. To solve this problem, a check digit is prepended to the company number $a_2a_3a_4a_5$ such that the following equation is satisfied: $(1,3,7,3,1) \cdot (a_1, a_2, a_3, a_4, a_5) = 0 \pmod{10}$. This enables the script to determine whether a user entered a valid identification number or not. If, for example, a wrong identification number is entered, it is very unlikely that this wrong identification number satisfies the prior equation, thus the script can tell the user that the identification number is wrong (and not necessarily the password).

Saving intermediate results

After each section of the questionnaire (displayed on a separate page) the answers to the new questions are saved automatically. If a user logs in again after the questionnaire is completed or partially completed, the previous answers will be pre-selected in the questionnaire. This makes it easier for the respondents to correct wrong answers or to continue with the questionnaire if not completed at the previous attempt.

4.3.4 Similarity

As described by Dillman (2000, p.385) "differences in the visual appearance of questions" should be avoided "that result from different screen configurations, operating systems, browsers, partial screens displays, and wrap around".

To ensure that the web version of the questionnaire looked similar to the paper version and that the questions and answers were fully visible, the web version was designed to be fully visible at a screen resolution of 640 x 480 pixels, the lowest commonly used for computers. Dillman (2000, p. 357) states that "a full screen view of a Web questionnaire or a partial (tiled) screen view may affect whether the entire question stem plus categories may be seen without scrolling and whether lines wrap around (break into shorter lengths)." Additionally, the welcome screen of the web version as mentioned by Dillman, Tortora, & Bowker (1999, p. 7) instructed the respondents to use their browser in full screen mode to avoid partial screen displays.

Dillman (2000, p. 360) indicates that "the designer and respondent may see different images because of different operating systems, browsers, screen configuration, tiled vs. full-screen displays, and individual designer decisions (e.g., color and text wrap-around)." To avoid possible bias, several steps were taken to ensure a look as similar as possible on different computers.

As we had full control over our web server, but no control over the respondents computers, the World Wide Web version of the questionnaire used the server side script language PHP, rather than a client side script language like JavaScript that might result in different results for different respondents, arising from different versions of the client side scripting

language interpreter being installed. Additionally the HTML code only contained the most common HTML tags such as <table> and included no tags that are implemented differently or not included in all browsers, e.g. <blink>. The use of colours was restricted to reproducing the look of the paper version of the questionnaire, to avoid problems with different colour palettes on different computers.

The resulting script was tested on different operating systems, including Windows 3.1, different versions of Windows NT, Windows 95, 98, ME, Windows 2000 and Windows XP. It was also tested on Mac OS 9 and different Unix derivatives such as Linux (Debian, Mandrake and S.u.S.E) with different desktop platforms (KDE, gnome) and BSD (Max OS X). Furthermore it was tested on different browsers such as Netscape / Mozilla, Internet Explorer, Opera and OS specific browsers (Konqueror, Chimera). The greatest difference in appearance was noticeable with the latest version of Internet Explorer which provided shaded colours and shadows to create a 3D like

appearance of the check boxes and radio buttons in the questionnaire.

5. Findings

Altogether 304 responses were received, 244 (80.3%) on paper and 60 (19.7%) from the World Wide Web. 27 of the received responses were screened out because the company did not meet the criteria for an SME set by the Commission of the European Communities (1996), that was used for this research.

The highest number of responses per day were always achieved after a contact was made, supporting Dillman's (2000, p.149) statement that multiple contacts increase the response rate (see Figure 1). The first contact was made on 21/06/02, the second on 12/07/02, and the third contact was made on 9/08/02). However only 19.7% of the recipients used the opportunity to reply on the World Wide Web with most of these responses submitted as a reaction to the first reminder that contained only the information necessary to fill in the web version of the questionnaire

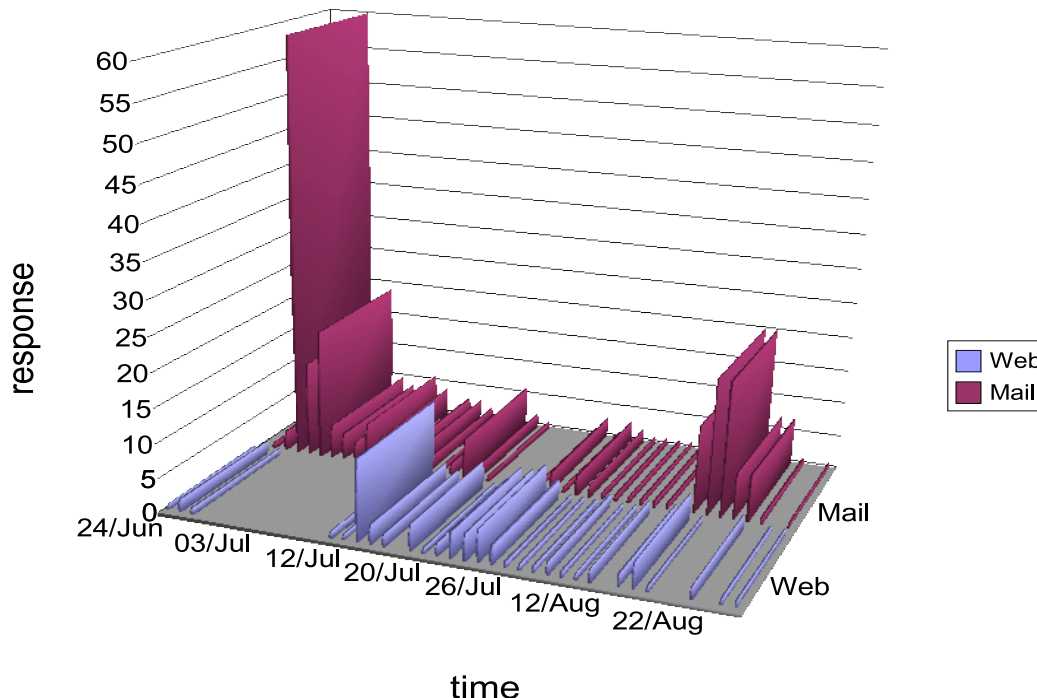


Figure 1: Responses per day

Couper discusses offering a web option in mixed-mode surveys and writes that this “approach also raises questions about the

equivalence of measurement across the two media [web and mail]” (Couper 2000, p. 487). To address this issue the

statistical significance of differences in the answers between the two media are examined.

The questionnaire contained 31 questions about general aspects, e-business aspects and strategy aspects, measuring altogether more than 100 variables. Table 1 below shows the statistical significance of differences in these variables between respondents using the web questionnaire and those using the paper questionnaire. Assuming a minimum level of 0.01 for significance, there was a significant

relation between the mode of response and five of these variables. The web presence plans also seems to be significant at the 0.01 level, but due to the fact that chi-square has a tendency to indicate significant differences when the sample size exceeds 200 respondents as in our case (see Hair et al. 1998, p. 655), it could be argued that the influence of web presence plans is statistically not significant. Figure 2 – 5 explain the relation between the mode of response and these five variables in more detail.

Table 1: Statistical significance of differences between respondents using the web questionnaire and the paper questionnaire (Likelihood Ratio Chi-Square)

Variable (Question areas)	Number of valid cases	Value	Degree of Freedom	p
Internet Access	278	14.202	4	.007
First Internet Connection	242	12.368	3	.006
Web Presence Plans	273	13.173	4	.010
No major advantage from e-business	188	12.795	1	.000
High initial costs as disadvantages for e-business	186	20.423	1	.000

As expected the type of Internet access had an influence on the mode of response (see figure 2). Enterprises with a better Internet connection were more likely to

reply online. In cases where the enterprise did not have Internet access but replied online it is believed that an employee filled the questionnaire in at home.

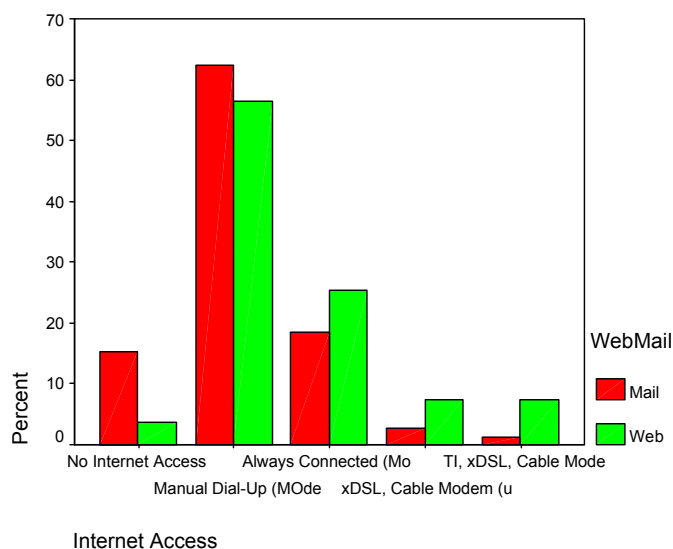


Figure 2: Internet access and response mode

The length of time a company had Internet access also influenced the mode of response (see figure 3). Employees might

get used to doing things online over time, which makes them more comfortable with replying online than filling in a paper.

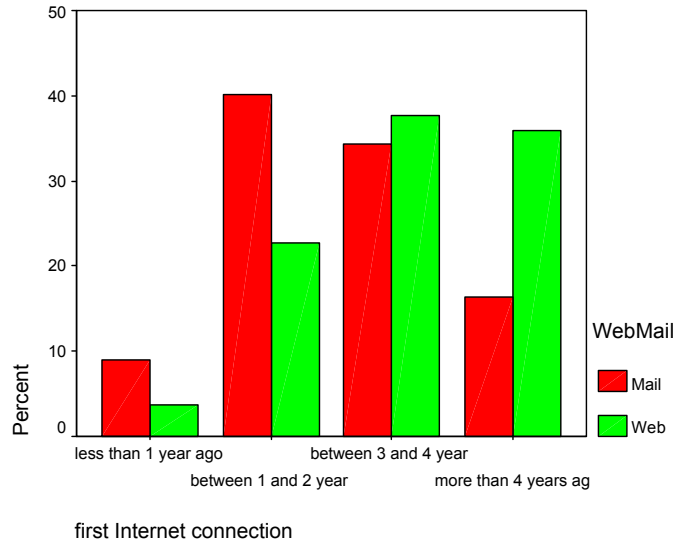


Figure 3: First internet connection and response mode

Enterprises that do not expect any major advantages from e-business (see figure 4) and enterprises that see high initial costs as a major disadvantage of e-business (see figure 5) were less likely to reply

online. The questionnaire offered a choice of 17 advantages and disadvantages but these two were the only two with a significant relation to the response mode.

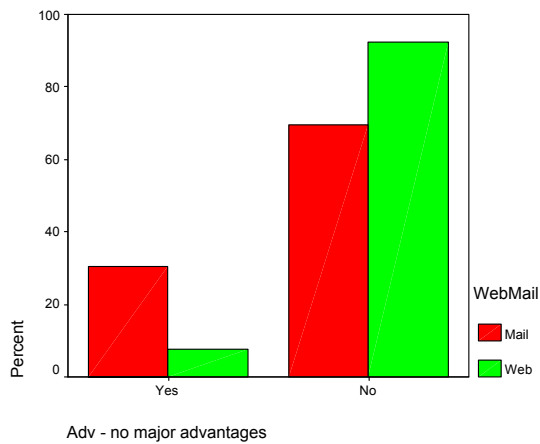


Figure 4: Major advantages and response mode

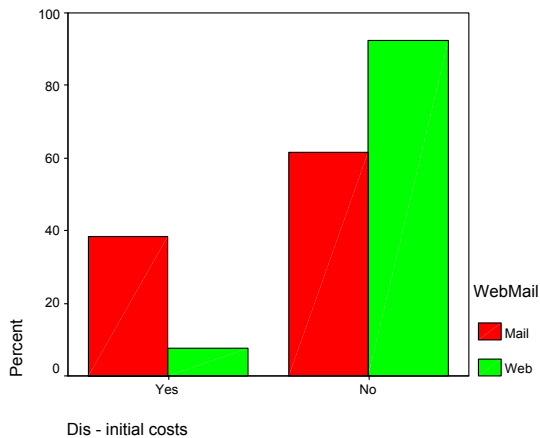


Figure 5: Initial cost and response

6. Conclusion

Schonlau, Fricker, and Elliott (2002, p. 86) write that "the number of studies that allow respondents to choose either a Web or postal response mode is small." This paper attempts to help researchers by describing a mixed mode survey using both traditional mail and a web version of the same questionnaire. Initially the response rate through the web was much lower than anticipated. A higher number of responses however, was received on the web only after the first reminder, when the respondents were not given a new paper version of the questionnaire but only the details necessary to fill in the web version. The number of responses on the web was low after the initial contact and after the second reminder. It is possible that offering the web version of the questionnaire did not increase the response rate, but only shifted replies from the paper version of the questionnaire to the web version of the questionnaire, a result similar to the parallel mixed mode survey using mail and telephone by Groves and Kahn, mentioned by Dillman et al. (2001, p. 3).

As outlined earlier, Dillman proposes several techniques to increase the response rate from questionnaires. One particular technique was to increase the contact with the respondents. In our particular study this had a marked effect as evidenced by Figure 1. There were two reminders sent as part of the contact process. The first only reminded the potential respondents about the web based version but did result in an increase in response. The second reminded about the web version but also included another paper version of the questionnaire. This also elicited a response increase. This could lead to the conclusion that both, web and paper modes are effective means of gathering data. What we do not know is whether those who filled in the web-version would have completed the questionnaire if it was only paper based and vice versa. There was no control group since the main aim of the study was to find out more about SME's attitude towards e-business and strategy rather than investigating mixed-mode surveys. Using web questionnaires as part of a mixed-mode survey was only an attempt to increase the response rate. Without a control group it is not possible to state

whether the nature of responses was influenced by the mode of response. We feel however, that the difference in the response mode may not have made any difference to the quality of replies. What matters in our opinion, is the attitude of the respondents. A different attitude of the respondents towards technology and strategic thinking can influence their choice of the mode of response. A more technology-accepting and strategically thinking person might fill in the web version of the questionnaire, not the paper version. The answers given might not be influenced by the mode of response but more from their attitude which caused them to choose a 'web-based' response.

Overall the use of a mixed-mode survey as an alternative to a paper only survey seems to be a good choice. The response mode seems to impact on only five out of more than 100 variables and since this impact might be caused by the underlying attitude of the respondents the potential benefits of a mixed-mode survey, namely an increased response rate and the easy transfer of electronically collected data into statistical packages, seems to justify the disadvantages caused by additional work and an undetermined potential influence of the response mode on the answers given by the respondents. The authors will certainly use mixed-mode surveys again in the future and plan to examine the use of mixed-mode surveys with a less restrictive choice of respondents on a survey about attitudes towards online grocery shopping.

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