CHARACTERISTICS OF WEB BASED SURVEYS AND APPLICATIONS IN TRAVEL RESEARCH

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ABSTRACT

Traditional survey methods are fast reaching their “use by” dates. It is much harder for researchers to contact households through the telephone as a result of call screening and answering machine devices. In relation to face to face interviews, housing estates and buildings are increasingly becoming fenced off and protected by security systems making it virtually impossible for the researcher to enter the premises, if not expected, as well as the fact that more often than not, householders are not available at the time when the survey is being conducted. In addition, the over use of marketing surveys has led people to believe that every survey they are asked to complete is of this type. Together, these difficulties have led to rising item and unit non-response, and consequently, rising unit costs. This is not only a phenomena associated with travel surveys, but rather the entire realm of social science research.

Development of the World Wide Web has had some dramatic impacts on the global environment, in relation to communication, information and research. The development of web based surveys (internet-based or e-mail), is commonly seen as a combative measure to rising costs and the declining response problem faced by most survey practitioners. Despite the phenomenal uptake of this technology by industry and individuals, some people are still to embrace this new medium. This poses some interesting questions for researchers wanting to utilise this technology to combat low response rates.

One of the major concerns today, in relation to Web based surveys, is sample bias. Internet users are usually of higher socio-economic status. In addition, people who have access to the Internet are not always certain of their ability to utilise the Internet, let alone complete a Web based survey. These are important issues that need to be considered if Web based surveys are to be more widely used.
Introduction
Over the last decade, when conducting surveys by telephone, more calls had to be made to achieve contact (Zmud, 2003; Dillman, 1998). However, a high number of calls remained unresolved. This is a result of households adopting new technology such as answering machines, caller id, increased cell phone use (some households only have cell phones and not a land line; it is costly to obtain these numbers if wanting to contact these households by telephone) and multiple phone line households. In addition, thirty percent of households in the U.S. have unlisted telephone numbers (Dillman, 1998). These factors make it much harder for the researcher to successfully contact the household, resulting in greater survey costs (Zmud, 2003; Groves and Couper, 1998; Dillman, 1998; Cook et al., 2000).

Due to increased difficulties in contacting prospective respondents, thus contributing to low response rates for both mail and telephone surveys, and advances in technology, new survey modes have emerged that are relatively cheap to administer. For example, e-mail surveys require the same level of effort to respond as telephone surveys (Dillman, 1998). There is no need for reply paid envelopes; e-mail and web surveys decrease respondent burden, in relation to self-administered surveys (Dillman, 1998).

However, some problematic issues have been identified in relation to Web-based surveys. The most important of these are sample representativeness, data quality, anonymity (e-mail based surveys) and information security, technological incompatibilities and disruptions. This paper will look at the evolution of survey methodologies in social science and transport research. Design issues in relation to Internet surveys will be discussed along with the advantages and disadvantages of Internet based surveys. Experiences of the author will shed some light on important design features of Internet based surveys, in a travel context. Furthermore, special issues in terms of travel surveys will be discussed.

Survey Methodology and Response Rates
Social science survey methodology has evolved to adapt to new technology and the benefits that arise from using this technology. Figure 1 shows the evolution of data collection methods.

<table>
<thead>
<tr>
<th>Standard Data Collection</th>
<th>Evolving media of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postal</td>
<td>E-mail and web-based surveys</td>
</tr>
<tr>
<td>Telephone</td>
<td>Computer-Assisted Telephone Interviews (CATI)</td>
</tr>
<tr>
<td>Interview</td>
<td>Computer-Assisted Personal Interviews (CAPI)</td>
</tr>
</tbody>
</table>

Figure 1: Evolution of Data Collection Methods
Source: Adapted from Illieva et al., 2002

Survey methodologies have changed as a combined result of the following of changes in societal organisation and culture; available technology; sources of cost and efficiency; and acknowledgement of contributing factors to survey error (Dillman, 1998).
The adoption of new data collection modes is viewed as a way to combat decreasing response rates. Travel surveys have long had the problem of poor response rates and increasing high unit costs. The complex nature of data required often leads to the development of a rather complicated survey instrument. This, in addition to the survey environment, contributes to the high incidence of non-response. The non-response issue for travel surveys has resulted in biased data sets because characteristics of non-respondents are different to characteristics of respondents (Richardson, 2000; De Heer and Moritz, 1997). For example, characteristics of non-respondents to travel surveys, found in numerous studies, are very low and very high income; high and low mileage drivers; young single males and females; zero vehicle use; people residing in metropolitan areas, and households with children (De Heer and Moritz, 1997; Richardson, 2000; Kam and Morris, 1999).

Non-response bias must be minimized to obtain a more accurate picture of people’s travel behaviour. Given this and other problems encountered in travel and social science research, researchers have embraced the idea of Web-based surveys for the following reasons:

1. Low distribution and retrieval costs;
2. Automated data entry;
3. The ability to include visual aids and animation to assist in the respondent’s recollection of travel over the assigned travel days;
4. Quick response times;
5. Automated skip patterns and randomisation of questions (particularly important in stated choice experiments); and
6. Researchers can obtain information about response behaviour (Gunn, 2002; Illieva et al., 2002; Lazar et al., 1999; Bosnjak and Tuten, 2001; Couper, 2000; Schonlau et al., 2001; Thompson et al., 2003; Stopher et al., 2004).

Despite the benefits of Web based surveys, the application of these in the present survey environment results in coverage error because not everyone has access to the Internet (Dillman and Bowker, 1999). This results in relatively low response rates to Web based surveys, especially for surveys of the general population. For example, Table 1 shows that the average response rates for eleven studies which used both mail and e-mail data collection methods were 46.16 and 38.72 respectively. Given that these studies were not of the general population, response rates were not especially high. This may be related to internet user ability; internet users with less internet experience and ability, may have not responded to the survey, or may have been unsure how to return the completed survey.
Table 1: Response time and response rate: e-mail vs. mail

<table>
<thead>
<tr>
<th>Authors</th>
<th>Technique</th>
<th>Response Time (days)</th>
<th>Response Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranchhold and Zhou (2001)</td>
<td>E-mail</td>
<td>N/A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Bachman et al. (1996)</td>
<td>E-mail</td>
<td>4.68</td>
<td>52.5</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>11.18</td>
<td>65.6</td>
</tr>
<tr>
<td>Weible and Wallace (1998)</td>
<td>E-mail</td>
<td>6.1</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>12.9</td>
<td>35.7</td>
</tr>
<tr>
<td>Schaefer and Dillman (1998)</td>
<td>E-mail</td>
<td>9.16</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>14.39</td>
<td>57.5</td>
</tr>
<tr>
<td>Tse et al. (1995)</td>
<td>E-mail</td>
<td>8.09</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>9.79</td>
<td>27</td>
</tr>
<tr>
<td>Mehta and Sivadas (1995)</td>
<td>E-mail</td>
<td>2.3</td>
<td>54.3</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>21</td>
<td>56.5</td>
</tr>
<tr>
<td>Wygant and Lindorf (1999)</td>
<td>E-mail</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>9.16</td>
<td>32</td>
</tr>
<tr>
<td>Parker (1992)</td>
<td>E-mail</td>
<td>N/A</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>Schuldt and Totten (1994)</td>
<td>E-mail</td>
<td>N/A</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td></td>
<td>56.5</td>
</tr>
<tr>
<td>Tse (1998)</td>
<td>E-mail</td>
<td>2.58</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>8.49</td>
<td>52</td>
</tr>
<tr>
<td>Kiesler and Sproull (1986)</td>
<td>E-mail</td>
<td>9.6</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Mail</td>
<td>10.8</td>
<td>67</td>
</tr>
<tr>
<td><strong>E-mail average response time and rate</strong></td>
<td>5.59</td>
<td>38.72</td>
<td></td>
</tr>
<tr>
<td><strong>Mail average response time and rate</strong></td>
<td>12.21</td>
<td>46.16</td>
<td></td>
</tr>
</tbody>
</table>

Source: Illieva et al., 2002

Furthermore, it appears that the response rates, shown in Table 1 are based on the number of completed surveys (retrieval stage only). Transport surveys are usually two stage surveys: a recruitment stage and a retrieval stage. Thus, for comparison, the retrieval response rate for a recent study conducted by the Institute of Transport Studies (ITS), The University of Sydney, was 54.5 percent. This is much higher than the average response rates for the mail and e-mail studies shown in Table 1. Importantly however, the methodology behind the Internet survey conducted by ITS was different to those of the studies listed in Table 1. This Internet study involved telephone recruitment and this enabled an e-mail message to be sent to recruited respondents, housing the URL and password required to access the survey. The studies listed in Table 1 did not utilise this methodology, or the same type of survey. However, it is unlikely that a difference in measurement, arising from the different data collection modes alone, resulted in the relatively large difference in response rates. Topic salience is more likely to be the major factor affecting response rates given that respondents to the ITS study were households recently affected by bushfires and these households were asked to take part in a bushfire evacuation study. Different survey methodologies, different survey types, as well as the survey topic and the
survey environment, affect response rates (Ettema et al., 1996; Melevin et al., 1998; Schneider and Johnson, 1994).

Types of Web Based Surveys
There are essentially three types of Internet questionnaires:

1. Open to any visitor – There is no control over who visits or completes survey, other than the fact that the sample is only of internet users;
2. Closed – Respondents are invited to visit the website and complete the survey which is usually password protected. Respondents may be recruited through the telephone, or e-mail, and provided with the URL and password, through an e-mail or letter. This survey type is most likely to be used in a two or more stage survey. The first stage is the recruitment stage and this may be through mail, CATI or e-mail. Travel surveys are usually 2 stage surveys whereby recruitment is through CATI and retrieval traditionally through mail back or CATI; and
3. Hidden – This is better known as a pop-up survey. Visitors to the web site are randomly selected to participate in the survey. A hidden window pops-up alerting people of the survey and asks whether viewers would like to participate. Obviously, this type of internet survey is only viewed by people visiting the web site (Bradley, 1999; Gunn, 2002; Couper, 2000).

In terms of E-mail surveys, there are only two types:

1. Simple e-mail message with questions; and
2. E-mail message which acts like a cover letter, and includes the survey attachment.

An e-mail message with an embedded URL is not an e-mail survey, described as such in some of the literature consulted (Bradley, 1999). The respondent is requested to participate through an e-mail message and asked to access the survey through the included URL. Essentially, this is e-mail recruitment for an Internet survey.

With Internet based surveys, the assumption is that the respondent has Internet access and is confident in the use of this technology. However, in the U.S. in 2002, Internet penetration was only 65 percent of households (Resource Systems Group Inc., 2002). This has important implications for Web based surveys in relation to sample representativeness, especially if the survey is of the general population. For example, in a study by Myles and Tibert (1998), it was found that the Internet sample was not representative of the population in relation to an election outcome, even after weighting. In addition, if respondents are recruited through e-mail, problems may arise because people may change their Internet Service Provider, and in turn, change their e-mail address and their mailboxes may also become full, which prevents any messages from being read. This usually results in more non-deliverables when compared to traditional mail-out surveys (Cobanoglu et al., 2001), and is a reason why e-mail surveys are not as popular as Internet based surveys. The rest of this paper will predominantly refer to Internet based surveys.
**Sampling and Representativeness**

Probability based sampling is when the sample is selected by chance, and population members have an equal and known chance of being selected. Most common types of probability based sampling include simple random, systematic, stratified and cluster. Statistical inference is only possible with probability based sampling; hence, is most commonly used in scientific research applications (Couper, 2000; Schonlau *et al.*, 2001).

In relation to closed Internet surveys, the sampling frame is often referred to as an external sampling frame; respondents are recruited from other sources and invited to the Internet (Bradley, 1999). This may reduce coverage error somewhat, compared to the other Internet survey types, because people are recruited from sources other than e-mail lists and visitors to websites. However, only people with access to the Internet are able to respond to the survey.

However, despite the use of probability based sampling, various forms of error and bias arise in the resultant data set from Internet surveys, such as:

1. **Coverage bias** -- This is a function of both the proportion of the target population that is not covered by the frame and the difference on the survey statistic between those covered and those not. Many people still do not have access to the internet;
2. **Sampling error** -- The result of surveying a sample of the population rather than the entire population. This is a major concern for internet surveys of the general population because the sample obtained is not representative of the population;
3. **Measurement error** -- The result of inaccurate responses that stem from poor question wording (poor survey design), poor interviewing, survey mode effects and aspects of respondent behaviour such as the lack of motivation and deliberate false answers. Measurement error could also rise from the effects of different browsers; respondents see different structures of the survey according to the capability of their internet browser (Couper, 2000; Dillman and Bowker, 1999; Thompson *et al.*, 2003); and
4. **Non-response bias** -- Demographic characteristics of internet users are different to those of non-users. For example, online surveys over represent males, college graduates and the young (Couper, 2000; Resource Systems Group Inc., 2002; Woong Yun and Trumbo, 2000; Bradley, 1999; Thompson *et al.*, 2003). Males were more likely to respond to Internet surveys whereas females were more likely to respond to telephone surveys (Dillman *et al.*, 2001).

As previously mentioned, not everyone has access to the Internet, and of those who do, it is not known how competent these individuals are in relation to Web navigation. The following section lists the different types of computer user and describes the issues that accompany this.
Respondent and Equipment Capabilities

Computers with Internet connection have different capabilities (Bradley, 1999). This effects how respondents access and view the Web based survey. This is shown in Table 2.

Table 2: Types of Computer User

<table>
<thead>
<tr>
<th>type</th>
<th>User Capability</th>
<th>Equipment Capability</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E-mail able</td>
<td>Browser able</td>
<td>E-mail able</td>
</tr>
<tr>
<td>1</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>4</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>5</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>6</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>7</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>8</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>9</td>
<td>yes</td>
<td></td>
<td>yes</td>
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<tr>
<td>10</td>
<td>yes</td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>yes</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td>yes</td>
</tr>
</tbody>
</table>


In Table 2, it appears as though developments in technology have outpaced user ability, further emphasising the need to understand computer user familiarity with the Internet. In addition, the thirteen different types of computer user identified, with respect to Web based surveys, have not been adequately addressed, or acknowledged by some survey practitioners. Yet, understanding the types of computer user would result in better survey design and better application of survey methodology. For example coverage error results because not everyone has access to the Internet, and of those who do, the capability of users varies greatly (Bradley, 1999). In addition, some people’s experience in computer use may be so limited that they are unable to complete the survey. This type of computer user may have certain demographic characteristics, thus adding to coverage and non-response bias. Obviously, more research is required to obtain the current status in relation to user capability. Also, an understanding of the concept of confidence in Internet use is necessary to facilitate the development of more appropriate Internet survey instruments.
Quality and Validity of Web Based Surveys

It is important for survey research to obtain data of good quality; poor quality research usually stems from bad survey design and inappropriate use of survey modes. Thus, data quality is a combination of low unit and item non-response; honest responses; completeness of responses in relation to open ended questions; and the absence of data entry errors (this should not be an issue for Internet surveys due to the automation of data entry; Shonlau et al., 2001).

Usually, however, data quality is measured by the percentage of non-responses, item and unit, in the final data set. Interestingly, researchers readily accept that face to face and Computer Aided Personal Interviews yield data of better quality due to relatively high response rates. However, these interview methods are also more likely to produce socially desirable responses and this does not necessarily equate to better quality data (Dillman, 1998).

One study, wherein the sample was experienced in Internet use, claimed that Web responses contained fewer random and systematic errors than telephone responses (Gunn, 2002). According to a study conducted by Cobanoglu et al. (2001), it was found that the data of highest quality was for Web-based surveys; however, the target population was a sample confident in Internet use and Internet users have been identified as having higher levels of socio-economic status than non-Internet users (Dillman et al., 2001; Resource Systems Group Inc., 2002; Alvarez and VanBeselaere, 2003; Arentze et al., 2004). Miller et al. (2002) found in their study that Web-based surveys did not compromise data quality nor was a measurement difference observed in relation to pen and pencil surveys with respect to test reliability of the key statistics. However, more research is needed to confirm these findings in relation to studies of travel behaviour.

Interestingly, some researchers question the sincerity of Internet responses (Ilieva et al., 2002). A possible reason for this is that many Internet surveys are designed so that respondents are not allowed to leave questions unanswered. This is one of the reasons why the Internet survey mode is gaining popularity; lower item non-response rates and a perception that the data collected is of good quality. However, it is not known whether respondents enter true or false responses to questions they prefer not to answer.

A major concern with online surveys, especially if of the general population, relates to the validity of data due to the sampling frame; the issue of representativeness arises as well as that some people are more computer literate than others and this may contribute to measurement and non-response error. In addition, a complex online survey will add to computer literacy problems and increase the rate of unit and item non-response.

However, despite these concerns, the benefit of online travel surveys is that they may capture a group of traditional non-respondents to conventional travel surveys: the larger households and households of higher socio-economic status. For example, the results of two studies using the Internet for data collection, showed that respondents to Internet travel surveys were predominantly larger households and households of higher socio-economic status, compared to the households which responded through the mail, or telephone interviews (Resource Systems Group Inc., 2002; Arentze et al., 2004). Households responding over the Internet recorded higher trip rates than the households which responded through the mail (Resource Systems Group Inc., 2002). Larger household size should
naturally equate to more trips and the number of adults in the household has a positive relationship with number of trips made; hence, the results observed (Resource Systems Group Inc, 2002; De Heer and Moritz, 1997; Richardson, 2000; Kam and Morris, 1999).

In addition, it may be that busy people, traditionally non-contactable households, find the Internet option more appealing because they are not bound to sit and respond at a certain time, which occurs during a CATI or personal interview. They are also not required to send anything back physically: something which they do not have time to do. Busy people, also, are usually not at home; hence, the non-contact status when the survey is being undertaken.

However, it cannot be stated that Internet travel surveys, as the single survey mode used, result in a better measurement of trip rates because higher trip rates can be calculated. The instrument may be useful to capture trip rates of larger households and households of higher socio-economic status, because these households prefer to respond through the Internet, but other demographic groups are not captured by this survey mode. Internet surveys, as single mode surveys, should only be conducted if all of the target population have access to the Internet. (Dillman et al., 1998). Of equal importance, if not more so, is how to assess computer literacy amongst people with access to the Internet (Dillman et al., 1998). Households may have access to the Internet, yet certain members asked to participate in the survey may not be experienced in Web navigation (Lazar and Prece, 1999). Survey practitioners often overlook this.

### Strengths and Weaknesses

#### Single mode and multimode

In the past, travel surveys were often single mode mail surveys. This was because technology was not available to support other survey collection methods. Further enhancements to Computer Assisted Telephone Interviewing (CATI) techniques, first implemented in the 1960s, led to the wide use of CATI during the 1980s and 1990s for most national surveys in the U.S. (Dillman, 1998). However, as previously mentioned, the usefulness of both mail and CATI recruitment and data retrieval methods decreased dramatically over the last few years. This is due to public annoyance of research surveys in general, a likely outcome of the over surveying associated with marketing, and increased difficulties in contacting households personally, or through the telephone, due to more call screening devices, multiple phone lines, and increasing use of mobile phones.

Despite this, however, some people still prefer to respond through mail and telephone surveys. For example, a Non-Response Study conducted in the United States, by ITS in conjunction with NuStats\(^1\), offered non-respondents to a travel survey, the choice of four data retrieval methods: mail, Internet, telephone and personal interview. The initial respondents chose to respond through the mail (77.8 percent). This was not surprising given the low socio-economic status of the areas investigated. Internet usage, and hence Internet surveys, are linked to households of higher socio-economic status; the mail survey option is often linked to households of lower socio-economic status (Dillman et al., 2001; Resource Systems Group Inc, 2002; Alvarez and VanBeselaere, 2003; Arentze et al., 2004). In addition, the survey modes were applied in a hierarchical manner. The mail option was offered first; for the households that did not respond through mail or the Internet, CATI was then offered, etc. However,

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\(^1\) A survey firm in the U.S.
the Internet option was offered at the same time the mail option was, and respondents preferred the mail option.

From the results just described, and findings in the literature, it is advised that Internet based travel surveys be part of a mixed mode travel survey (Couper, 2000; Gunn, 2002; Schonlau et al., 2001; Schaefer and Dillman, 1998). This will overcome representation problems associated with Internet based travel surveys in the present survey environment, and in turn, improve response rates (Ilieva et al., 2002; Schonlau et al., 2001; Lazar and Preece, 1999). In addition, mixed mode surveys allow for the introduction of Internet surveys to households not accustomed to this technology; people may become more aware of the uses of the Internet, and in the future, they may readily embrace Internet surveys by gaining an understanding about the Internet prior to being asked to participate in future Internet surveys (Cobanoglu et al., 2001).

Some arguments against the use of multi-mode surveys are due to concerns about social desirability, acquiescence (especially in relation to face to face interviews), primacy and recency effects, and question order effects (Dillman, 1998; Woong Yun and Trumbo, 2000). However, differences between modes can be insignificant if a simple survey design is adopted (Cobanoglu et al., 2001). Responses to Internet surveys are expected to resemble responses to mail surveys because both survey modes are self administered survey modes (Dillman et al., 2001). In addition, whether a particular survey mode results in data of better quality, ultimately depends on the survey design, survey methodology, and the research topic under investigation. The likelihood of problems associated with the use of multi-modal surveys can be reduced if a simple and coherent survey structure is adopted for all survey modes to be employed.

**Advantages of Internet Surveys**

Internet surveys are popular because:

1. They are easier to execute – it is simple to send e-mail reminders to recruited respondents, and multiple mail outs to respondents are not required;
2. Faster response time – enables reminders to be sent sooner rather than later and this should positively affect response rates;
3. Automation of data entry saves times and other resources, as well as the likelihood of correct data entry. Automation of data entry allows for a dynamic error checking ability; and
4. This medium is much cheaper especially if large samples are required (Ilieva et al., 2002; Schonlau et al., 2001; Lazar and Preece, 1999; Couper et al., 2001; Thompson et al., 2003; Gunn, 20002).

In addition, complex skip patterns in Internet surveys, are not seen by respondents, improving their cognitive ability and increasing the likelihood of good quality data (Gunn, 2002). However, given the current survey environment, measurement error may prevail if mail and Internet survey modes are only used in a mixed mode survey: if there are complex skip patterns, than the mail mode is likely to suffer from high levels of item and unit non-response. This may be exacerbated if most of the respondents to the mail survey are of lower socio-economic status. This problem may be overcome if a simple survey design is employed.
Surveys incorporating Stated Choice experiments benefit greatly from the Internet mode because the Internet survey allows for the automatic randomisation of choice sets that each respondent sees. This is very important and reduces the burden associated with the randomisation of choice sets in pen and paper surveys, which require numerous forms of the same survey to be printed to incorporate all the randomization of choice set possibilities. This consumes a lot of precious resources, adding to survey costs.

Another advantage of Internet based surveys to the survey practitioner is getting a better understanding of respondent behaviour. Internet based surveys can supply metadata in addition to the responses given to the survey questions: a reconstruction of the response process (Bosnjak and Tuten, 2001). However, in order to obtain the complete log for each individual, each question needs to be displayed separately, and each page of the questionnaire must be downloaded separately from the server and not reside in the Web browser’s cache (Bosnjak and Tuten, 2001). This area requires further investigation, especially in relation to Internet travel surveys.

An advantage of electronic surveys from the respondent’s perspective, over traditional survey modes, is that they can be completed at the respondent’s discretion, they can be visually pleasing and easy to complete (Cook et al., 2000). One aspect of respondent burden is reduced because respondents are not required to physically return anything; they do not have to send anything through the mail. This may be especially appealing to busy people who simply do not have extra time to do this and would actually perceive this as a chore. For example, two reasons stated by respondents, familiar with the Internet, for completing a travel survey over the Internet, were convenience and that the Internet was a faster method and less time consuming way to respond (Resource Systems Group Inc, 2002).

Disadvantages
Coverage bias is major disadvantage of Internet surveys (Cook et al., 2000; Dillman and Bowker, 1998). Interestingly, however, one paper claimed that Internet surveys provide access to a wide audience (Ilieva et al., 2002). This may be so if the survey is not of the general population and if the majority of the target population is known to have access to the Internet. Also stated in this paper was that researchers have less control over who accesses the survey than for mail surveys (Ilieva et al., 2002). This is not necessarily so; the method of recruitment employed, and the type of Internet survey used are the determining factors. For example, if respondents are contacted through e-mail and the URL is embedded in this message, then researchers have control over who enters the survey.

Technological problems are also a major disadvantage associated with Internet based surveys (Thompson et al., 2003; Couper, 2000). Server disruptions can occur without the researcher’s knowledge. This leads to a loss in online survey time and results in many avoidable survey terminations. In addition, technological problems can be exacerbated if complex survey designs are employed: surveys may appear differently in different browsers. The different appearance of the survey may distract from the respondent’s cognitive ability. This may increase the likelihood of measurement error because people with different levels of computer literacy may answer questions differently. Also, technological problems may compound measurement error if more than one survey mode is used. This is so because if a combination of self administered survey modes and interview aided survey modes are used for the same survey, a complex survey design will most likely lead to incorrect and missing information coming from the self administered survey modes.
Complex Internet surveys, coupled with technological limitations (e.g., old personal computers, incompatible browsers, etc.) can make it impossible for the respondent to download the survey. In addition, it may take a copious amount of time to download the survey that the respondent closes the survey before the download is complete (Dillman and Bowker, 1999; Gunn, 2002). The likely outcome is a biased sample because of the high number of Internet survey terminations. In addition, Internet surveys with complex skip patterns need to be vigorously tested to ensure that skip patterns are behaving as required and that data entry is occurring correctly (Schonlau et al., 2001).

Table 3 depicts the some of the advantages and disadvantages of Internet based surveys in relation to mail surveys.

Table 3: Comparison of Mail and Internet Surveys

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mail</th>
<th>Internet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Speed</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Return Cost</td>
<td>preaddressed/pre-stamped envelope</td>
<td>no cost to the respondent</td>
</tr>
<tr>
<td>Incentives</td>
<td>Cash or other incentives can be included</td>
<td>coupons may be included*</td>
</tr>
<tr>
<td>Wrong addresses</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Labour needed</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Expertise to construct</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Variable cost/ survey</td>
<td>about $1.00</td>
<td>minimal</td>
</tr>
</tbody>
</table>

* Cash incentives may be offered to participants during the recruitment phase if mail or CATI recruitment is employed (pre-incentive).

Source: Adapted from Cobanoglu et al., 2001.

Costs of the return of the survey borne on the respondent are usually minimal: however, this is a function of size of the survey file(s) and the Internet connection. For example, an individual may be connected to the Internet with a Broadband Internet connection, but Internet usage is capped at monthly intervals. If download of the survey consumes the monthly download limit imposed by the Internet Service Provider, then the respondent will incur a cost as a result of completing the survey: the cost of downloading other material during that month. This is an important issue for travel surveys containing maps and other visual aids. If the respondent is connected to the Internet with a dial-up connection, asking respondents to complete travel surveys housing maps and animations will be even more problematic; download times will be excessive and result in many survey terminations.

Table 4 shows examples of costs associated with mail and internet surveys.

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2 In a Non-Response Study, conducted by ITS, cash incentives were found to be the most preferred by respondents; hence, likely to be the most effective in boosting response rates.
Table 4: Summary of Costs

<table>
<thead>
<tr>
<th>Method</th>
<th>Fixed Cost</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Variable Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mail</td>
<td>$67.50</td>
<td>$1.93</td>
<td>100</td>
<td>$193.00</td>
<td>$260.50</td>
</tr>
<tr>
<td>Web</td>
<td>$107.50</td>
<td>*$0.00</td>
<td>100</td>
<td>$0.00</td>
<td>$107.50</td>
</tr>
</tbody>
</table>

* Assuming that the survey files are not sizable

Source: Adapted from Cobanoglu et al., 2001.
Table 4 shows that the fixed costs for internet surveys are much higher than for mail surveys due to the level of expertise and time required to develop these surveys (Schonlau et al., 2001). If a small sample is required, Internet surveys are likely to be more expensive than traditional survey modes due to high fixed costs associated with programming the survey. To some extent this fixed cost can be reduced by using templates of previous Internet surveys or highly reusable software. For example, ITS uses a system where the survey components can be specified from an XML file. This means that an Internet survey can be constructed by a person of only moderate technical competence, in a reasonably short period of time. Any additional capabilities that need to be programmed into the system can be reused in future surveys: they do not need to be programmed again. Additionally, reusable software is more reliable and so requires less testing, which further reduces fixed costs. Therefore, a high fixed cost for the first Internet survey led to significantly lower subsequent fixed costs. Also, variable costs are negligible for Internet surveys compared to the variable costs for mail surveys. In the end, total costs for Web based surveys are much less than for mail surveys.

From the perspective of respondents, a major disadvantage of Internet surveys relates to anonymity and data security, despite that the personalisation of contact was sometimes favoured by respondents (Woong Yun and Trumbo, 2000; Thompson et al., 2003; Illieva et al., 2002). This is also a concern of survey practitioners because data recorded should not be tampered with or seen by external sources. Placing the survey on a secure server should alleviate security problems.

Design Considerations

In the early days of Internet surveys, design traditionally focused more on programming than survey methodology. Nowadays, navigation and flow are realised as important elements in the design of Internet surveys because of the visual stimulus and the fact that respondents have control over the comprehension of questions read. Design is also important for face to face and CATI interviews; however, the interviewer can help the respondent through the questions, whereas for mail and Internet surveys, interviewers are not available. Therefore, good survey design is crucial, as it is for all self administered surveys.

There are a myriad of ways to develop and structure Internet surveys due to colour, fonts and styles, etc. However, fancy Web surveys usually require a longer time to download and may accentuate browser incompatibilities (Gunn, 2002; Dillman et al., 1998). Plain Internet surveys give a better response rate than those with a fancy design and structure (Dillman et al., 1998). A fancy design may distract the respondent from the survey task: cognitive research has found that surveys with complex skip patterns confuse the respondent if questions are not numbered appropriately because respondents believe they are to answer every question (Couper et al., 2001; Gunn, 2002). In addition, in a multi-modal survey, the mail survey cannot have a complex skip pattern. This contributes to the increased likelihood of measurement error.

Longer questionnaires are associated with lower response rates and take longer to download; people get annoyed with this and close before the download is complete (Gunn, 2002). The results of a Non-Response Study conducted by ITS, showed that shorter surveys, requiring less time to complete (under 20 minutes), were preferred by respondents: it is important to keep the questionnaire brief and concise, and to break the survey into sections, if required. For example, another Internet survey, devised to understand household evacuation behaviour during an urban bushfire emergency, was divided into
three sections. The first asked about household demographics. This is not typical; however, given that no income related questions were asked (most often the questions causing households to terminate or refuse), demographic questions were asked first to ease respondents into the survey. The second section related to the respondents’ most recent bushfire experience, and the third section was the Stated Choice experiment.

Before beginning to design the survey, the researcher must be aware of the research environment at the time that the survey is to be conducted, the population to be surveyed (this should be well planned and described in the research methodology stage), and technological limitations associated with Internet surveys (Schonlau et al., 2001). According to Dillman et al. (1998), there are three criteria associated with good Internet survey design:

1. Internet survey design should consider technological and user limitations;
2. Logic of how computers operate and how people expect surveys to operate must be considered; and
3. Internet surveys should be designed to enable their incorporation in a mixed mode survey.

With this in mind, the successful implementation of Internet surveys involves three crucial steps:

1. Design the survey on paper – This is essential if the survey is to be used as part of a mixed mode survey; other survey modes will be adapted from the pen and paper survey. This will help minimise measurement error. Both Internet surveys mentioned, undertaken by ITS, were designed on paper first;
2. The survey methodology should be pre-determined, and
3. The survey should be carefully transformed from its pen and paper status to the Web. The survey must be error proof, and should be accessible from all browsers to reduce respondent burden and download time (Lazar and Preece, 1999). This reinforces the need to adopt a simple survey design.

Other factors that also need to be accounted for before the survey is designed relate to use of panel surveys and incentives. However, the effects of panel conditioning, in relation to Internet panel surveys are not really known (Couper, 2000), nor are the effects of monetary incentives on non-response rates in relation to Internet surveys. These areas require investigation. Overall, addressing the issues mentioned will help in the development of a good survey instrument and this is most useful when adopting a mixed mode survey strategy.

**Design Principles**

The following are design principles specifically for Web-based surveys. These principles may also be applied to the design of other mode type surveys, with slight modification.

Firstly, an introduction to an Internet survey should be welcoming, motivational, convey the ease of responding, and instruct the respondent how to proceed (Dillman, et al., 1998; Lazar and Preece, 1999). Figure 2 and 3 show the introduction and welcoming screens of the Bushfire Survey, conducted by ITS.
A key feature was that respondents were informed of the time it will take to do the survey before they actually entered the survey. This enabled the respondent to close the survey if they did not have the time to complete the survey at that moment. This helped ease respondent frustration and reduce avoidable terminations.

Instructions to navigate through the survey should be clear and shown throughout the survey, and should be placed before the proceeding question or section is shown, and depending on the research, the survey and target population, respondents may not have to answer every question to progress through the survey. This may be achieved through the use of scroll down screen surveys (Dillman et al., 1998). However, allowing respondents to view all the questions may lead to respondents believing that the survey will take them longer than specified and this may result in avoidable terminations. In addition, when scroll down surveys are used, it cannot be determined if a respondent opens the survey and decides not to complete it or whether the respondent has completed all the survey but forgot to send it (Couper et al., 2001; Bosnjak and Tuten, 2001).

If question order and logical progression are features of the survey, then every question will have to be answered; therefore, scroll down screen surveys cannot be used. Question length and wording become even more important because the respondent’s level of comprehension must be maintained to enable high quality data to be obtained, given the increased level of respondent burden.

Two recent Internet surveys, designed by the Institute of Transport Studies, were not scroll down screen surveys because both incorporated a Stated Choice Experiment. Given that respondents could
not scroll down to view the entire survey, for flow and logical reasons, the survey was programmed to allow respondents, who chose to exit the survey before completing the stated choice task, to re-enter the survey. They were directed to the beginning of the scenario sequence that they previously did not complete, to rekindle the logical thought process. This extra programming helped decrease respondent burden because respondents did not have to re-enter previously entered information. This also reinforced the password protection ability because previously entered data could not be changed.

Data entry boxes should be used sparingly to reduce respondent burden. For example, respondents who completed the bushfire survey actually enjoyed participating because the survey did not take much of their time to complete (around 12 minutes), the questions were straight forward and the survey did not require much data entry at all (minimum use of entry boxes).

Lastly, the word “Finally”, should be shown at the beginning of the last section of the survey to inform respondents that they have almost completed the survey. Indicating to respondents how far along they are into the survey is preferred by respondents. This may be achieved simply by showing the question the respondents are up to, i.e. q12 of 26 (Gunn, 2002).

Importantly, before the study is undertaken, a pilot test should be conducted to assess the survey’s appearance, flow, design, and respondents’ comprehension of the questions asked. This will enable any revision of the survey instrument to be made before the main survey is due to commence.

**Recruitment and Repeated Contacts for Web Based Surveys**

Interaction with the respondent can be classified as three distinct phases: contact, response and follow-up. Each of these phases may be conducted using a different medium; telephone, mail, Web or face to face (Schonlau *et al*., 2001). For initial contact, this should not be by e-mail because it is not known how often people check or if people access their e-mail regularly (Bradley, 1999). For surveys of the general population, this will add to the coverage bias problem encountered by Internet surveys in the present survey environment. In addition, it may be best to use a number of recruitment modes in order to achieve a higher contact rate.

Past research has indicated that increasing the number of contacts will result in higher response rates: it was found that the number of contacts increased response rates regardless of the survey mode(s) used (Dillman and Bowker, 1999). Pre-notification (as for traditional mail out and telephone surveys), simple survey design, personalised cover letters and follow up reminders have been shown to increase response rates to Internet surveys (Cook *et al*., 2000). A cover letter should be sent out before the main data collection period begins. Cover letters legitimise the study in the minds of respondents, given that the research agency undertaking the study is clearly shown, and respondents are provided with a number to contact to voice any concerns or questions. In addition, confidentiality assurances must also be stated in cover letters and this further enhances the study’s legitimacy from the perspective of the respondent. For example, pre-notification of an online survey resulted in a faster response time (Cook *et al*., 2000). This usually relates to higher response rates and data of better quality (Richardson, 2000). Response time to Internet surveys can also be controlled by the researcher to a certain degree, by informing respondents that the survey will remain online for a limited time (Illieva *et al*., 2002). ITS adopted this approach for two of its recent internet based surveys.
If respondents have been recruited through a telephone interview and it has been determined that the respondents have Internet access and are contactable at the e-mail address provided, an e-mail contact with an embedded URL adds the personal approach and this improves response (Dillman, 1978; Dillman, 2000). For example, respondents to the bushfire survey were recruited using the telephone and e-mail addresses were obtained during this conversation allowing for the URL and password of the survey to be sent to the respondents through e-mail. Given that no incentives were offered, and that respondents could only respond over the Internet, the response rate was relatively high. It may have been even higher had technical problems with the server, on which the survey was located, not arise. This prevented a number of respondents from accessing the survey and, because of their frustration and lack of knowledge about the actual problem, these respondents did not re-attempt to access the survey. This emphasises the importance of the use of multi-modal surveys in surveys of the general population, especially when one of the modes offered is the Internet, despite that the above example was not a study of the general population. In addition, it is important to give people the option to choose how to respond. Respondents appreciate this and therefore, data obtained is likely to be of better quality.

**Review of Recent Internet Travel Survey Applications**

Over the last few years, a few Internet based travel surveys were developed. Extensive documentation for many of these applications is not readily available. However, this section briefly describes recent Internet travel surveys as well as the associated strengths and weaknesses of these surveys.

Internet travel diaries were developed by the Resource Systems Group, Inc. primarily to test the concept of respondent-interactive geo-coding as well as the likelihood that the highly affluent, highly educated and mobile would respond over the Internet; given the difficulty to contact this group using traditional CATI recruitment (Resource Systems Group, Inc., 1999).

To enable interactive geo-coding, a specific GIS package, MapObjects®, was used. Maps were graphically displayed and respondents were asked to enter the specific location information. Given that the target population for this survey was the highly educated, it was not expected that respondents would have difficulty with reading the maps. However, this is likely to be a problem if this survey is to be used as a single mode survey for the general population because not all individuals are able to read maps and understand these.

Overall the actual design of survey looked cumbersome. This gives the impression that more effort than that needed was required to complete the survey. Respondent burden was considered an issue: design of a survey is very important especially when the target population is a group with limited spare time. Importantly, it was acknowledged that the Internet survey option should be offered as part of multi-modal survey approach given that Internet users are not representative of the population (Resource Systems Group Inc., 1999).

An Internet household activity survey, called the Internet Computerized Household Activity Scheduling Survey (iCHASE), was developed soon after the computerized version of the CHASE survey (CHASE) was developed (Doherty and Miller, 2000; Lee et al., 1999). Before respondents were asked to complete the CHASE survey, an up-front interview was conducted with the household to obtain the household activity schedule. This information was entered into the database so that it could be used in the week long CHASE survey.
The CHASE survey was a burdensome exercise; average time taken for respondents to complete each day’s entries was 16 minutes. This equated to an average of 112 minutes per respondent to complete the entire survey. This definitely is too long a survey task.

The iCHASE survey was based on the CHASE survey; however, revision of the survey task was not conducted because the authors did not regard the CHASE survey as a burdensome exercise for the respondents (Doherty and Miller, 2000). This is surprising given that most people who are likely to participate in travel surveys over the internet are very busy people who are not likely to complete long surveys. Unfortunately, results of a pilot of the iCHASE survey are not known.

Another Internet travel survey application was developed to obtain traveler responses to Advanced Traveler Information Systems (ATIS) (Kraan et al., 2000). Respondents were recruited through e-mail; therefore, the sample was biased because Internet users are not representative of the general population. The authors acknowledged that the Internet mode is good for specific studies but that it should be used with other data collection modes for studies of the general population, given the sample bias issue (Kraan et al., 2000). However, an important point raised is that it is not known how CATI responses differ from Internet responses in terms of data quality. This requires investigation especially given that the CATI survey is the dominant survey mode used in travel research.

An Internet based Origin Destination Travel Survey was developed by Abdel-Aty (2003). This study involved mail-out and roadside distribution of the survey instrument but offered mail back and Internet retrieval options to respondents. Like other Internet travel surveys, it was stated that the Internet survey was easy to navigate for those familiar with the Internet (Abdel-Aty, 2003). In addition, the sample obtained was biased – more males, the more affluent and those with higher levels of tertiary education responded. In the concluding comments, the author stated that the Internet could be used as a supplementary data collection mode; this is a familiar recommendation given Internet penetration and use.

A completely different Internet based travel survey is the Prompted Recall Survey. ITS has been pioneering the use of Global Positioning Systems devices as a means to provide more accurate data on where people go, when they travel, the route they take, and the distance and time taken to travel. However, the GPS device is limited in what data it can collect, and it provides no information on the number of people traveling together in a vehicle, the purposes of their travel, and the costs associated with that travel. ITS has pioneered the development of a method of collecting this additional information called the prompted recall survey (Stopher et al., 2004). This survey is to be conducted a week or two after the GPS data are collected (two weeks is the time limit believed that respondents are able to recollect travel information), and uses maps and tabular presentations, developed from the GPS records, as the basis of prompting the memory of the traveler (Stopher et al. 2004).

The Internet based prompted recall survey was first developed as a pen and paper survey. A primary goal for developing an internet-based version of the survey was to provide animation of each trip measured in the initial GPS survey, and to allow the survey respondent to be able to stop the animation part way through the trip, to indicate a trip end that the analysis of the GPS data had not detected, to restart the trip animation, pause in the trip, slow down or speed up the display of the trip, and to indicate that a stop shown on the screen was only a traffic stop, and not a destination (Stopher et al., 2004).

A disadvantage to this type of Internet travel survey is that it requires Java to run. Java is a complete programming language that allows programs to run from within a Web browser. Unfortunately, the
Java program needs to be installed first, and it cannot be assumed that Java will be installed on all respondents’ computers (Stopher *et al.*, 2004). In addition, there are numerous versions of Java and the respondent may not install the most suitable version. Therefore, to avoid this problem, a specific version of Java was selected and this required respondents to specifically install this version (Stopher *et al.*, 2004). This led to large respondent burden because respondents were required to install this version from a CD, provided to them from ITS, together with installation instructions (Stopher *et al.*, 2004). However, many people do not have the time, patience or computer access privileges to do this, and therefore drop out of the survey process.

In addition, due the use of maps, download times were significant for dial-up modem connections (Stopher *et al.*, 2004). However, this too can be a problem for respondents on Internet plans with download or time limits. Therefore, despite the usefulness of this survey and the potential benefits of such an instrument, the present technological environment is not conducive to a large scale application of this survey. However, further testing and technological advancement will see this survey tool become more widely used in the future.

The Resource Systems Group Inc. (2002) designed Web based survey templates for household travel diary surveys, travel origin/destination surveys, travel mode choice surveys and transit customer satisfaction surveys. These incorporated the following components:

- The flow and design of the templates was developed to exploit the capabilities of the Web; the templates were not adapted from paper or CATI designs. This contradicts Internet survey design principles developed by Dillman *et al.*, (2002), Dillman *et al.*, (1998) and Gunn (2002);
- Detailed survey based logic and consistency checks;
- Respondent interactive geo-coding. This adds to respondent burden and assumes that people are able to read maps without difficulty. Again, this poses problems if the sample is drawn from the general population;
- Detailed instructions/help;
- Multi-lingual instrument options; and
- Web-based administration tools to help facilitate web based survey administration processes.

Also, in the study conducted by the Resource Systems Group Inc. (2002), in relation to the Internet household travel survey, respondents were asked to provide a unique identifier (first name or initials) for each member of the household. This may add to respondents’ privacy concerns. It is better to provide households with an identification number and each household member with a unique person number.

Internet travel surveys are not really user friendly for novice computer users. In addition, principles of survey design let alone principles of Internet survey design have not been readily applied; the appearance of Internet travel surveys is cluttered, giving the impression of a burden riddled survey which is more likely to contribute to the problem of non-response (see Resource Systems Group Inc., 2002, for an example of such an internet travel survey). In the study conducted by the Resource Systems Group Inc. (2002), it was interesting that none of the respondents encountered any browser problems. In contrast, problems were encountered by some of the respondents to an Internet survey conducted by ITS. Some respondents could not access the survey due to browser incompatibilities. This further demonstrates the coverage and measurement problems with Internet surveys, and therefore Internet travel surveys, in the present survey environment.
The travel survey templates developed are a good starting point yet much work is needed: refinement to the survey design and further improvements in software will lead to the development of a better Internet travel survey. At present, no studies have addressed the rate of completion of Internet based travel surveys to those using CATI recruitment and retrieval procedures; the most common survey mode used for travel surveys.

**Issues for the Future**

Household travel surveys are complex instruments which try to obtain a lot of demographic and travel information from households. Obtaining all this information over the Internet is likely to lead to a relatively long survey task. This will create problems for people with limited download and time access to the Internet. In addition, anecdotal evidence suggests that respondents choosing to respond over the Internet have shorter attention spans (Schonlau *et al.*, 2001). If this is true, this has great implications for Internet travel surveys. People with shorter attention spans are therefore less likely to complete the survey or if they do complete the survey, we cannot be sure that answers provided are in fact true answers. However, more research is required to confirm or deny this.

The present survey environment limits the use of Internet surveys, for studies of the general population, due to problems with population coverage and the fact that Internet user ability, and the type of Internet access respondents have, is unknown. Given these obstacles, Internet travel surveys should be part of mixed mode travel surveys. The Internet mode may be useful to capture traditional non-respondent groups to travel surveys, such as the households that are difficult to contact. Traditional survey modes, such as mail and telephone, will capture other respondent groups better than the Internet option at this stage. In addition, the use of multi-modal surveys will provide respondents with a choice as to how they would like to respond and this should increase response rates; a low response rate is a common problem encountered by most travel surveys.

There is a need to investigate Internet respondent behaviour, and to identify if any particular socioeconomic group behaves in a particular manner when responding to surveys over the Internet (Bosnjak and Tuten, 2001). This knowledge would enable the development of a better Internet survey instrument, especially in relation to Internet travel surveys. In addition, Bradley (1999) found that Internet surveys released at a particular time of day may result in a certain sample profile. However, research is required to confirm or deny this finding, especially in relation to travel surveys.

Internet travel surveys are useful but much work is still needed to improve the paper instrument let alone the Internet instrument. Internet versions of travel surveys may also require accompanying compact disks, housing maps and other relevant information, to participating households to avoid browser and downloading problems. Overall, much research and development is still required in relation to Internet surveys, and especially Internet travel surveys.

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References


