Section 2:

Background Papers for Workshop

An Overview of the Potential for Electronic Reporting in Census Bureau Surveys and Censuses

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Introduction

The technological environment in which the Census Bureau conducts surveys and censuses is being transformed by the increasing availability and use of computers and the Internet in homes and businesses. This change has created new opportunities for innovations in methods and modes of collecting and distributing survey data that the Bureau began exploring over a decade ago.

The President's Management Agenda for fiscal year 2002 listed "expanded electronic government" as one of five government-wide initiatives to improve the management and performance of the federal government. The goal of this initiative is to "champion citizen-centered electronic government that will result in a major improvement in the federal government's value to the citizen."

One form this initiative might take is an expanded use of electronic reporting in data collection by the Census Bureau, and that is the focus of this paper. In keeping with the citizen-centered goal of the initiative, it *takes the respondents' point of view* to assess the current potential for expanded use of Internet and Web reporting in Census Bureau programs.

This paper summarizes some of the Census Bureau's considerable experience with Internet and other electronic modes of reporting in its business and household surveys. It evaluates evidence related to three factors which influence the feasibility and likely success of electronic reporting: respondents' <u>access</u> to the Internet or other means of electronic reporting, their <u>preferences</u> or attitudes about different modes of responding, and their <u>behavior</u> when offered the option to report electronically. Finally, areas where knowledge is lacking and research is needed are noted.

The cost implications or the technological requirements of expanded electronic reporting are beyond the scope of this paper. To date, research has not adequately addressed questions about

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the cost, quality, and timeliness of electronic reporting. This paper addresses respondent acceptance and response rates using electronic reporting and the Internet in particular.

**Evidence on Respondents' Access, Preferences, and Use of
Electronic Reporting**

The Census Bureau has rather recently begun to implement electronic reporting in its major population surveys and censuses. In Census 2000, it was possible to submit a census short form electronically, although the Census Bureau chose not to publicize the availability of the Internet reporting option. Given the lack of publicity, it is not surprising that very few forms were submitted this way (there were about 89,000 attempts to submit Internet questionnaires and about 66,000 valid, unique Internet forms were processed through to the census; Whitworth, 2002). Over 90 percent of a sample of Internet respondents said they were very satisfied with the Internet reporting option (Stapleton and Irwin, 2002). Preceding the census, there was also experimentation with data collection using automated speech recognition. Currently, a variety of electronic response options are contemplated for 2010 and were tested in a 2003 test (described below).

For establishment surveys, work to develop electronic reporting options dates back to the 1970s, when respondents in the Economic Census could submit their data using large tape reels. In the late 1980s, a variety of technologies were introduced and tested, including touchtone-data-entry (TDE), FAX, and diskette-based electronic questionnaires.   Subsequent research has focused on Internet reporting. The 2002 Economic Census currently permits electronic reporting, and by the end of February 2.4% of all returns (and 8.1% of returns from multi-unit companies) were submitted via Internet. In the employment phase of the Census of Governments, over 10 percent are reporting electronically, most through the Internet. Other establishment surveys obtain higher rates of Internet reporting, and several surveys of governmental units are conducted entirely by Internet.

Electronic reporting doubtless would have been implemented on a larger scale, except that feasibility tests and experimental pilot studies have not encouraged its wholesale adoption.

Three limiting factors influence the feasibility of reporting by Internet and other electronic modes: access to the mode, attitudes and preferences, and respondent behavior when presented with an electronic reporting option. Evidence from both establishment and population surveys is summarized below.

1. Access

Americans' use of computers and access to Internet have grown tremendously in recent years, according to results of a periodic supplement to the Current Population Survey conducted by the Census Bureau. More than half of U. S. households (50.5 percent) reported Internet access in September 2001, up from 41.5 percent in August 2000 and 18.6 percent in October 1997 (U. S. Department of Commerce, 2002). Broad increases in access and use have occurred across all groups in the population, although the most recent survey still shows large differences by

age, education, and income.   Access and use drop sharply after age 55, and at lower levels of income and education. Non-users are likely to be poor, have low levels of education, and to be Black or Hispanic (with particularly restricted access in Hispanic households where only Spanish is spoken).

Telephone surveys conducted for the Pew Internet Project find that most non-users report various reasons for not having access to or using the Internet, including expense (30%), worry about online pornography, credit card theft or fraud (43%), lack of time (29%), and the complexity of the Internet (27%).   Lenhart et al. (2003) report that Internet use leveled off between 2002 and 2003, with the number of people dropping offline roughly equaling the number coming online each month.

The fact that half of households still do not have access to the Internet limits its use in surveys of the general population. Currently, it is most suitable as an option in mixed mode surveys, or in surveys of special populations with high rates of Internet coverage. However, the enormously high Internet use by children and teenagers (over 90% by teenagers in 2001; DOC 2002) implies that, over time, the population will become more uniformly fluent in its use and it potentially may become a primary rather than secondary mode of responding to surveys.

Rates of Internet access are higher for establishments than for households, but still not universal. For example, 75% of manufacturing plants reported having Internet access in a supplement to the 2000 Annual Survey of Manufacturers (U.S. Census Bureau, 2002a). Larger plants are more likely to have Internet access, which ranges from 40% of plants with 1-4 employees up to 96% of plants with over 2,500 employees. In 2000 87% of respondents in the Manufacturers' Shipments, Inventories, and Orders survey (M3) had Web access (Sedivi, Nichols, and Kanarek 2000). Governmental units and academic institutions probably have the highest rates of access, but information is unavailable.

2. Preferences

One constraint on implementation of Internet reporting is suggested by what respondents themselves tell us about their preferences for responding by Internet and other modes. In a Census 2000 evaluation conducted for another purpose[3], respondents were asked how they prefer to be enumerated in the next decennial census:

1. "Now that we have collected information about you and your household, I'd like your opinion about how we might conduct the next national Census, in 2010. In the next census, would you prefer to be contacted by mail, in person, over the telephone, or on the Internet?"

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[3] The B3 study was designed to assist data users in comparing race data from Census 2000 with race data from other sources (see Bentley et al. 2003). The questions were administered in telephone or personal visit interviews conducted by the Census Bureau in about 50,000 households in August-October 2001, after respondents had returned a mail questionnaire.

2. "Which do you think would best protect the privacy of your census data? Mailing in the form, being interviewed in person, being interviewed over the telephone, or sending your information over the Internet?"

Results for both questions are shown in Table 1. All differences discussed in the text are statistically significant at $p < .05$.

Table 1. Mode Preferences for the 2010 Census

Mode	Percent prefer to be contacted this way	Which mode best protects privacy?
Total	100.0%	100.0%
Mail	66.7% (.91)	65.2% (.93)
Personal visit	7.9% (.52)	16.3% (.72)
Telephone	10.0% (.57)	10.7% (.61)
Internet	15.4% (.70)	7.8% (.52)

Source: B3 survey. Standard errors (shown in parentheses) were calculated using stratified jackknife methods in VPLX.

Clearly, mail is the dominant mode, preferred by two thirds of survey respondents (and perceived as the most private by about the same fraction). Internet is second most often preferred, telephone third, and personal visit least often preferred.[4]

The second column of the table shows that, when respondents are asked which mode best protects their privacy, personal visit gains adherents and Internet loses them. Less than half of the people who preferred Internet perceived it as the mode that would best protect the privacy of their data. (This result is not shown.) These results are consistent with other evidence that the Internet raises more concerns about privacy and confidentiality than other modes. For example, about half of respondents in a 2001 survey said they were more concerned about

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[4] Similar results were found in a 1999 NORC survey conducted mostly (84%) by telephone and by mail, with no preceding mail questionnaire. When asked how they preferred to be interviewed, 69% preferred to fill out a questionnaire themselves, 18% preferred telephone, and 6% preferred an interviewer to visit them at home (Brittingham et al., 1999). (Internet was not an option.)

providing personal information over the Internet than over the telephone, with about 8 percent less concerned and 41 percent equally concerned (DOC 2002).

Concerns about loss of control of information are at the heart of many peoples' concerns about providing information over the Internet, according to ethnographic interviews conducted by Gerber (2003).

Demographic correlates of response mode preferences may provide guidance about which population groups are likely to be most responsive to an Internet reporting option. Charts 1-5 (attached) show mode preferences by gender, age, income, education, and English language ability. Mail is preferred among almost all groups[5], but the extent of the preference varies, as do preferences among other modes. (In part, preferences reflect access, since a respondent who does not have access to it is unlikely to prefer being contacted by Internet.)

Males are more likely to prefer Internet and less likely to prefer mail than females, as shown in Chart 1 (even though their access is equal; DOC 2002). Preference for Internet declines and preference for mail increases the older a respondent is, although a negative association between Internet preference and age doesn't emerge strongly except in respondents 50 and older (Chart 2). People with higher levels of education and/or income are much more likely to prefer Internet and somewhat less likely to prefer mail than people with less education or income (see Charts 3 and 4), consistent with patterns of access. The modes that involve some contact with a person—personal visit and telephone—are more popular among people with lower education or income than among more educated or affluent people. This likely reflects their concerns about the difficulties of filling out a form on their own, leading to a desire to have an enumerator help them. A preference for personal modes (especially telephone) over self-administered modes shows up even more starkly among people who speak a language other than English at home and do not speak English very well (this information was collected in census long forms and merged with results of the survey). As shown in Chart 5, preference for Internet drops out completely for people who do not speak English at all, and preference for mail declines drastically.

These survey results are consistent with Gerber's (2003) ethnographic study of privacy attitudes. She found that more affluent respondents prefer mail and the Internet because these modes allow them to stay in control of their time and living space. However, the poorest respondents prefer face to face interviews, because "they like to be able to assess an interviewer in person, in order to be able to decide if [he/she] is trustworthy. They have, perhaps, more confidence in their ability to read individuals than to determine if written promises of confidentiality are dependable. In addition, some respondents see the interviewer as a source of explanations of difficult material and a possible helper if giving the information proves somehow damaging" (2003:21).

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[5] Response by mail is preferred even among people who are the most favorably disposed to Internet. For example, 53 percent of males with bachelor's or advanced degrees making $70,000 or more a year prefer mail compared to 41 percent who prefer Internet.

In assessing the potential for Internet responding, it is of some interest to examine the mode preferences of people who in Census 2000 failed to respond by mail and were therefore enumerated in the nonresponse followup operation. Their preferences, shown in Table 2,

Table 2. Mode Preferences Among Census 2000 Mail Respondents and Nonresponde nts

Preferred Mode	Responded by mail in Census 2000	Did not respond by mail in Census 2000
Total	100.0%	100.0%
Mail	70.5%	55.7%
	(1.07)	(2.11)
Personal visit	6.2%	12.9%
	(.57)	(1.42)
Phone	8.1%	15.1%
	(.63)	(1.54)
Internet	15.1%	16.4%
	(.85)	(1.55)

Source: B3 survey.

provide some indication of whether an Internet option might improve response rates among mail nonrespondents.

Perhaps not surprisingly, people who failed to respond by mail in the last census are much less likely than mail respondents to prefer being enumerated by mail in the next one. However, most still prefer mail. Mail nonrespondents were more likely to prefer personal visit or telephone enumeration than mail respondents. Interestingly, the two groups were equally likely to say they prefer Internet. Thus, we conclude that an Internet option might succeed in reducing the follow-up workload among the 16% of mail nonrespondents (representing almost 7.3 million people) who say they prefer it.

3. Respondent Behavior

Information about how respondents actually behave when electronic reporting is available comes from a great deal of research and testing conducted by the Census Bureau. Internet and other electronic response modes have been implemented for different purposes in different survey designs. Rarely is Internet the sole mode of responding to a survey. More often, it is offered as an alternative mode of response that respondents may choose at an initial contact or during nonresponse followup. Sometimes it is offered as a means of conducting follow-on surveys or panel surveys, with respondents switching to Internet after initial interviews in another mode.   The sections that follow summarize research on these applications in establishment and population surveys. The focus here is on the response rate implications,

since that question is so fundamental to their implementation, but many other issues are addressed in these studies. Several conclusions emerge:

- Offering an electronic option does affect respondent behavior, with more respondents responding by Web or Internet when encouraged to do so.
- In most tests to date, offering an Internet option has *not* improved overall response rates, and sometimes is associated with *lower* response rates.
- Available evidence suggests that Internet surveys have the advantage of speed, and can be completed quicker than traditional modes of response.
- The effects of Internet reporting on data quality are unclear, although anecdotal evidence suggests it may lead to improvements; research is needed to address this issue.

Internet or Other Electronic Mode as the Only Mode of Response

Most surveys that rely exclusively on electronic reporting cover special populations with very high rates of Internet access, such as university faculty (Schaefer and Dillman, 1998) or government employees. Couper, Blair, and Triplett (1999) experimentally compared e-mail and mail modes in an organizational climate survey of employees of federal statistical agencies conducted in 1997. E-mail produced significantly *lower* response rates, probably in part due to technical difficulties affecting access. Bates (2001) compared Internet and mail reporting in a organizational assessment survey of Census Bureau employees conducted in Fall 2000.   The Internet had a significantly *higher* response rate (66.6% compared to 62.8% for mail) and response was faster (6 versus 13 days, on average), but item nonresponse rates were higher in the Internet returns.

One unusual application of a Web-based survey of the general population was conducted by Knowledge Networks in partnership with the Census Bureau during Census 2000.   A series of 5 cross-sectional surveys was conducted between March 3 and April 13, 2000, by Knowledge Networks under the sponsorship of private foundations (Nie and Junn, 2000; Martin 2001). Households were recruited using an RDD sample of household telephone numbers in areas with access to the Web TV network. Those agreeing to participate (57% did so) were provided free hardware and Internet access, allowing surveys to be self-administered using a Web browser and to include multimedia content.   The Census Bureau participated as a partner in the project in order to gain experience with Web surveys and obtain immediate feedback on public reactions to the census. Results were available within a week of fielding and the Director of the Census Bureau made extensive use of them in communications with stakeholders and testimony before Congress.   An important limitation was the low cumulative response rate of about 30%, taking into account recruitment success and survey response. This is much lower than the Census Bureau would accept in its own surveys. The characteristics of respondents corresponded fairly closely to population data from the Current Population Survey, except that individuals with less than a high school education were under-represented .

Currently, Web-based surveys of the general population are not adequate as a basis for statistical estimates, but do provide a useful method for monitoring short-term trends in attitudes and awareness and providing immediate feedback about public reactions to current

events. It is important for users to be cognizant of the likely coverage and nonresponse biases that may affect such surveys (see Couper 2000).

On the establishment side, an experimental test of an Internet-only option was conducted in a short supplement to the 1999 Annual Survey of Manufacturers about e-business (Dodds 2001). One half of the sample received a letter containing the URL and directing that the survey be

completed over the Internet. The letter also explained that a form would be mailed to those who did not report over the Internet.   The other half sample received the customary mailing package containing a paper questionnaire as well as the URL. There were mail follow-ups (including a paper questionnaire and a URL) to nonrespondents in both panels. The Internet-only panel obtained a significantly *lower* response rate of 79.5%, compared to 84.4% in the mail + URL panel. About 39% responded by Internet (rather than paper) in the Internet-only panel, compared to about 9% in the mail + URL panel.

A number of Census Bureau surveys of governmental and educational institutions are successfully conducted entirely by Internet. For example, the Academic Libraries Survey permits only Internet response, and obtains an 88 percent response rate.

Internet as an Alternative Mode that a Respondent Might Choose in an Initial Contact

During Census 2000, the Response Mode and Incentive Experiment (RMIE) was conducted to examine the effects of offering one of three alternative modes of responding (Internet, call in for a computer-assisted telephone interview, or call in to an interactive voice response system or IVR) in addition to the option of mailing back a census short form questionnaire (Westat, 2002). For a random half of households, an incentive (a calling card) was offered to respondents who used the designated mode. The incentive was associated with a lower overall response rate, but it did induce respondents to choose the proffered mode in greater numbers. In the absence of an incentive, the panels offering Internet or reverse-CATI had slightly but significantly *higher* overall response rates (by about 2 percentage points) than the mail-only control. Respondents who were offered the Internet option but instead returned mail questionnaires gave as reasons the greater ease of completing the paper form, concern about privacy, or their lack of access or knowledge of the Internet.   Data quality was highest on reverse-CATI, second highest on the Internet, third on mail forms, and lowest in the IVR.

In 2003, a National Census Test offered IVR and/or Internet as alternatives to mailing back a paper census questionnaire (Stapleton, Brady, and Bouffard, 2003). Three separate experimental treatments offered choices between paper and IVR, paper and Internet, or paper, Internet, and IVR. (A paper replacement questionnaire was mailed to nonrespondents in all three panels.) The three treatments obtained about the same cooperation rates as the control treatment (paper initial and replacement questionnaires). About 90 percent of respondents who were offered a choice responded on paper, and the remainder by Internet or IVR.

Data were returned much more quickly using the electronic modes. A week after the initial mailing, 40 percent of Internet forms and 23 percent of IVR returns had been received, compared with 10 percent of paper questionnaires.

This study also experimented with "pushing" respondents toward electronic responding, by not offering a paper option in the initial mailing. (Paper replacement questionnaires were mailed to nonrespondents, however.) The "push" treatments succeeded in obtaining more electronic responses (about two-thirds of responses were electronic) but also obtained significantly lower overall cooperation rates.

Another experiment offering Internet as an alternative to mail response was conducted for the American Community Survey (Griffin, Fischer, and Morgan, 2001). For a random half of households, the envelope and the long form questionnaire informed respondents of the Internet option, and a card with instructions on how to respond by Internet was added to the mailing package. In this experiment, offering the Internet option significantly *lowered* the response rate by nearly 6 percentage points. The authors suggested that privacy concerns and frustration with the Internet instrument may explain some of the effect. They hypothesized that offering a mode of response other than mail in conjunction with a mailing package contributed to a break in the response process.

An experiment involving an establishment survey was conducted in a 1999-2000 mail survey of libraries in elementary and secondary schools (Nichols, Marquis, and Hoffman, 2001). A random sample of cases received information about the benefits of responding by Web, which was printed on the questionnaire and on a special insert, and the other half did not. (All sample cases received information about Web access in the initial mailing.) Respondents who were encouraged to respond by Web were more likely to do so (21 percent, compared to 9 percent in the control panel). However, this study too saw a suppressed response rate in the treatment that encouraged Web reporting (a 36% initial response rate compared to 45% for the control) which was only overcome through extensive telephone followup. The authors note that four additional tasks were required to respond by Web, adding burden and perhaps explaining the low initial response.

Another experiment was conducted in the Private School Survey, which is conducted by mail with CATI and field follow up of nonrespondents. Three approaches to improving Internet response (and thereby reducing follow up costs) were tested in the 2001-2002 survey. In one, mail and Internet were offered concurrently; in a second, an invitation to respond by Internet was offered, with a mention that a paper questionnaire would be sent soon; and in a third, an invitation to respond by Internet was offered with no mention of a paper questionnaire (although one was later sent). Initial response rates were significantly higher in the second and third experimental treatments, but final response rates did not vary significantly among the treatments or the mail control. The fraction responding by Internet varied from 11% in the first to 19% in the third experimental treatment.

A non-experimental study tested the feasibility of moving establishment respondents to specific modes of electronic reporting in a monthly economic indicator survey, the Manufacturers' Shipments, Inventories, and Orders survey (M3) (Anderson et al. 2003). Respondents were called and asked to switch from fax reporting to either TDE (touchtone/speech recognition) or Web. About 80 percent agreed to try TDE or Web, but

fewer than half actually did so.   Follow up contacts revealed that submission by fax was generally much easier and more convenient than either of the other modes, especially TDE. Although most respondents preferred fax and resisted changing to another mode, those who could be persuaded to try Web reporting liked it (even though it was slightly more burdensome) and intended to continue reporting in that mode.   No evaluation of the mode switching attempt on overall response rates was done.

Export statistics (excluding exports of merchandise to Canada) are received by the Census Bureau on paper forms or electronically through its Automated Export System (AES).   In 2001, 85 percent of the export transactions were received electronically, and the increase in electronic reporting is associated with improved data quality. Prior to AES, an average of 27 percent of all export transactions contained reporting errors, but this has declined to 17 percent as more filers have opted to use the AES. About 56 percent of export records captured on paper contain errors, compared to 20 percent of records received and pre-edited electronically (U. S. Census Bureau, 2002b).

Finally, the Quarterly Financial Report is based on data collected from manufacturing, mining, and trade corporations electronically and on paper. A diskette containing a computer self-administered questionnaire (CSAQ) is sent to respondents, who can then respond by transmitting it by Internet, by sending a disk, or by a paper form. Most respondents mail or fax back a paper form (which can be downloaded from the Website) with 28 percent using the CSAQ to respond. There is evidence that the CSAQ obtains better data, as indicated by fewer items changed by the analysts (Evans, 2003).

As an Alternative Mode in Nonresponse Followup – A second component of the response mode experiment conducted in Census 2000 (RMIE, described above) offered an Internet option to households that had failed to respond to the initial mailing.   A follow up letter offered one of three modes, and again, a random half was offered a calling card incentive to respond in the designated mode.   In the absence of an incentive, computer-assisted telephone interviewing elicited the highest response from mail nonrespondents (6.7%) followed by interactive voice response (3.4%) and Internet (3.4%) (Casper and Shaw, 2003).   None of these modes achieved the approximately 10 percentage point increase typically obtained by mailing a replacement questionnaire (Dillman, Sinclair, and Clark 1993), although all resulted in significant response improvements over the initial contact by mail.

As a Mode of Responding in Subsequent Waves of a Longitudinal Panel Survey or in a Follow-on Survey. **–** Another possible use of Internet reporting is in interviews after the initial one in a panel survey. A test of the feasibility of an Internet option in a complex demographic survey was conducted in conjunction with the Methods Panel Survey of Income and Program Participation (Griffin and Holbert 2001).   Eligible households (those with at least one college graduate) were pre-screened to determine their ability and willingness to respond by Internet. Only 17% reported Internet access; of those, 61% were willing to complete an on-line survey, but only 22% of those who said they were willing actually completed the survey.   About half of nonrespondents had attempted to access the survey but did not complete it due to lack of time or difficulty logging in and other technical problems. Over half of nonrespondents said they preferred mail surveys, followed by a third who preferred on-line surveys and 6 percent

who preferred telephone or personal visit. Both Internet respondents and nonrespondents expressed concerns about the security of data transmissions.

Similar negative results were obtained initially with a similar pre-screening procedure in a business survey, the Computer Organization Survey, which in 1998 obtained a response rate of 27 percent of the respondents who had expressed ability and willingness to respond by Internet.

At the time, stringent security requirements severely restricted what browsers could be used. When the browser constraints were relaxed, the 1999 COS Internet response rate jumped to 74% of those willing and able to respond by Internet (Sedivi, Nichols, and Kanarek, 2000).

Conclusions

The research on Internet reporting in establishment and household surveys appears to support broadly similar conclusions in both types of surveys. This suggests that knowledge gained in one may shed light on problems in the other, and that researchers should communicate findings across these two areas.

Several general conclusions emerge from the research to date on electronic reporting options in Census Bureau establishment and household surveys and censuses.

- Internet access is high and increasing in the population at large, but is by no means universal. People with lowest access to Internet tend to be less educated and poor.
- Internet access is higher in economic establishments than in households, but still not universal. It may be highest in governmental units and educational institutions.
- Exclusive reliance on Internet reporting is rarely an acceptable option. Internet cannot replace personal visit and telephone interviewing in most Census Bureau surveys and censuses. The exception would be surveys of groups with very high Internet coverage.
- The Internet is second only to mail as the preferred mode of responding to the decennial census. The Internet appears to raise more privacy concerns than other modes; more research on this topic is needed.
- Respondents can be pushed to report electronically in greater numbers by e.g., offering incentives or restricting their choice of mode (esp., taking away the preferred paper option). The cost is likely to be a drop in overall response rates.
- Internet reporting has promise when offered as a choice in either an initial contact or in nonresponse followup in mixed-mode designs. However, pilot tests and experiments do not show the response rate improvements that might have been hoped for, and in fact more often show declines than increases in response rates in research to date.
- Using Internet to administer a follow-on survey among respondents pre-screened for their willingness and ability to access the survey by Internet has not worked very well in Census Bureau studies to date.
- Internet, and to a lesser extent IVR, appear to increase the speed of response compared to mail or traditional modes.

Several factors in addition to access appear to be influencing the results of tests to date. Respondent preferences for simple and convenient modes appear to be a powerful constraint on implementation. In the decennial census, the dominant preference for mail helps explain why people persisted in filling out mail forms even when offered other options. Yet, a substantial minority claims to prefer Internet, and it ought to be possible to translate this preference into response improvements. Although less information is available about establishment respondents' preferences, research suggests many also strongly prefer the simple modes of fax and mail, at least in short surveys.

Intuitively, one might expect that offering an additional mode of responding can only help respondents, and improve response. Clearly, this is not the case. Tests to date suggest it is possible to do serious harm to response rates in survey designs that offer electronic reporting options. In other cases, there are slight improvements or no effects when respondents are offered a choice to report electronically. The surprisingly variable effects of an Internet option on overall response rates lead to the conclusion that the details of implementation need very careful design attention and usability and field testing prior to implementation.

Perhaps not surprisingly, early tests of Internet reporting were often plagued with technical difficulties and usability problems that affected respondents' ability to receive, complete, and return electronic surveys. (Such problems may account for adverse effects on response rates in some studies reviewed here.) Performance is likely to improve as user interfaces are improved through continuing usability research and improvements in technology. (For discussion of research on usability conducted by the Census Bureau, see, e.g., Murphy et al. 2001.)

One factor that should be considered in evaluating results to date is that respondent acceptance appears to increase with experience. Respondents often need to be trained to report electronically. This suggests that the performance of electronic reporting is likely to improve over time, and that surveys with repeated contacts with the same respondents may have more to gain from implementing it than one-time surveys.

Research is needed to learn how offering an Internet option affects the response process. Several possibilities exist, such as:

- Adding text and instructions may increase the (perceived or actual) complexity of a mailing package.
- Responding by Internet may add steps to the response process, hence increase burden.
- Offering an alternative response mode may in effect add a task (choosing a response mode) to the response process, which if difficult may inhibit some from responding at all.
- In both household and establishment surveys, Internet reporting appears to raise more privacy concerns than other modes, and these need to be better understood.
- Anecdotes and some evidence suggests that electronic reporting may reduce errors and post-collection editing, but more systematic evaluation is needed to better understand the effects on data quality.

These and other issues need careful attention in laboratory studies, debriefing interviews after a survey is completed, or field experiments.

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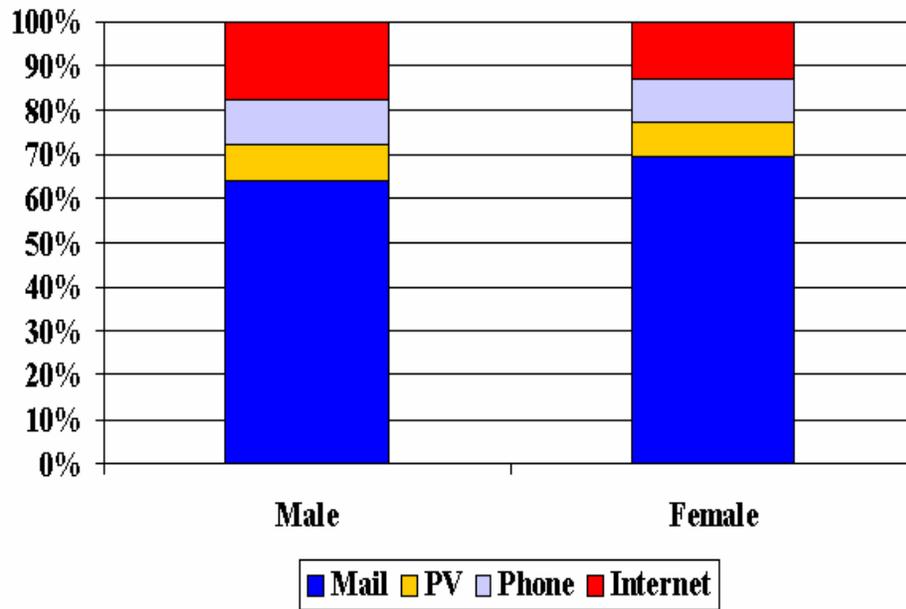Chart 1. Mode Preference, by Gender
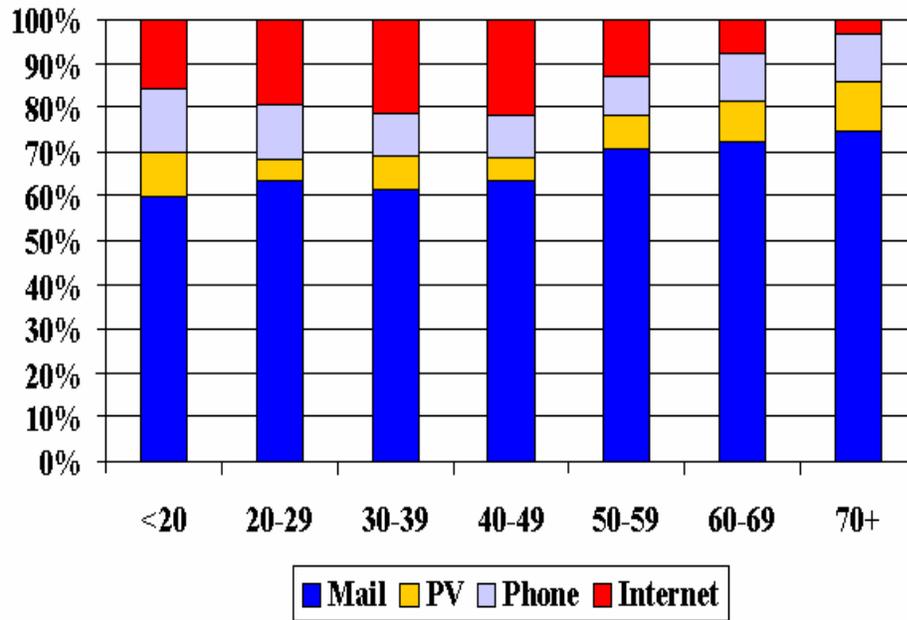
Chart 2. Mode Preference, by Age

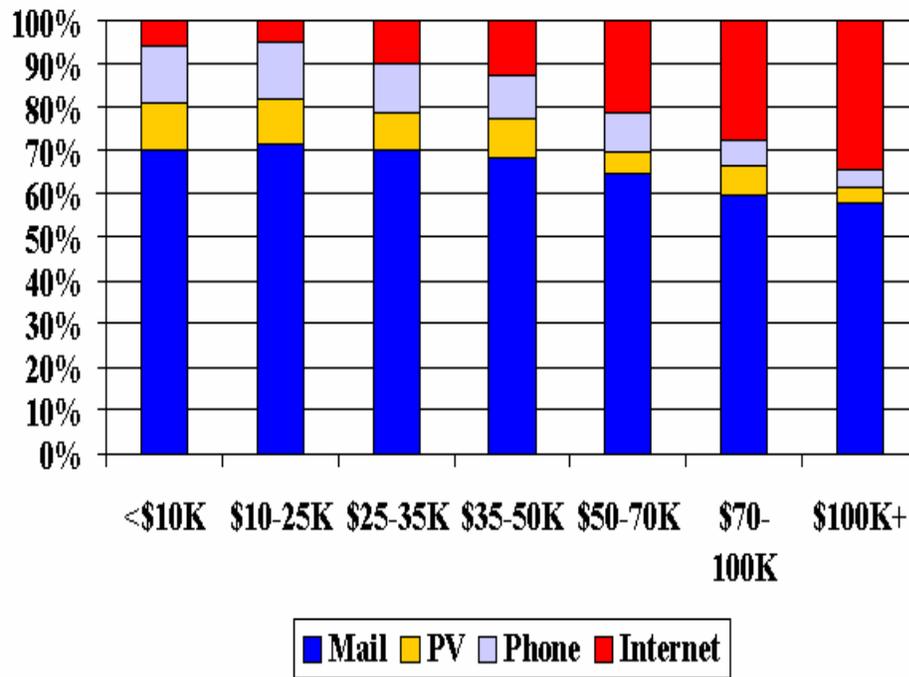Chart 3. Mode Preference, by Income
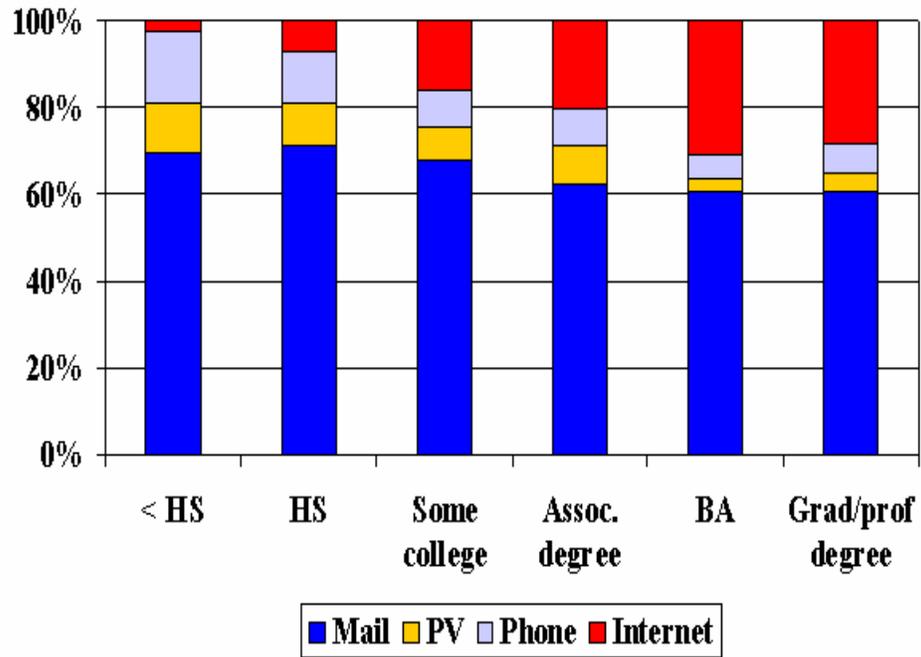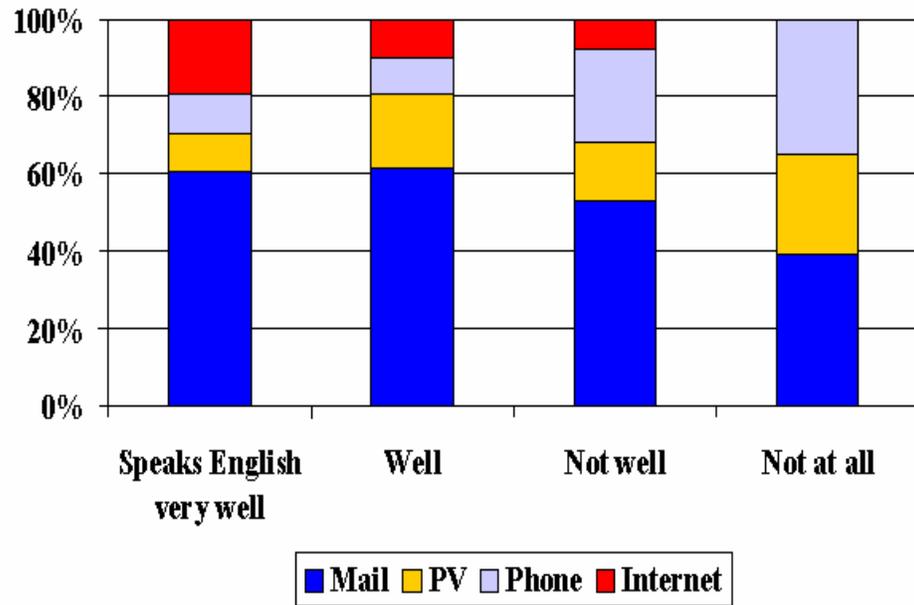
Chart 4. Mode Preference, by Education

Chart 5. Mode Preference among Non-English Speakers, by English Language Ability

Usability Issues Associated with Converting Establishment Surveys to Web-Based Data Collection

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1. Introduction

In an effort to combat non-response, survey managers continually seek new ways to encourage respondents to participate in their surveys. One approach is to offer respondents the option of selecting from multiple reporting modes so that they can select the mode they prefer. The Internet is one of the newest modes available and offers a variety of benefits. For example, respondents can access the Internet easily from their desktop PCs, so they can complete the survey at their convenience. Properly designed surveys can introduce instructions, edits, and help screens that simplify the respondents' task by guiding them through the completion process. From a survey manager's point of view, the Internet eliminates or reduces data entry costs, because respondents enter data themselves. Further, Web surveys can check data as the respondent works, so the need for follow-up phone calls or post-data collection processes is minimized. With these obvious benefits, the Internet offers the potential for enhancing response rates, improving data quality, and improving timeliness of reporting. In addition, the potential for cost savings also exists, although in some cases offering an additional data collection mode might actually increase costs.

On the other hand, there are some possible drawbacks to Web data collection. One major problem is that the use of multiple data-collection modes complicates data integration and survey operations, such as follow-up efforts. Further, developing Web surveys can actually raise up-front costs. The cost of building, maintaining, and integrating different systems is expensive. Moreover, preliminary research with Web surveys indicates that rather than enhancing response rates, offering multiple modes can actually depress overall response rates (Griffin et al. 2001). For a detailed discussion of these and other problems, see Fricker and Schonlau (2002).

In establishment surveys, the Internet is likely to be one of several reporting options that may include mail, phone, and fax. While respondents may select another reporting mode if a Web survey is too difficult to complete, they may also decide not to report at all. Further, since respondents often participate in more than one government survey, a respondent may generalize from a negative experience on one Web survey to others, even though different agencies may be involved. Therefore, to encourage participation, survey managers need to design Web surveys that will provide as positive an experience as possible for the widest range of respondents. A key element of that design is ensuring the usability of Web surveys.

This paper focuses on the usability of dedicated Web-based government surveys, where usability is defined as the effectiveness, efficiency, and satisfaction experienced by respondents as they provide the requested survey data. At BLS, we are dedicated to developing usable Web surveys. This paper describes our experiences and lessons learned in designing Web surveys for establishments.

2. Usability Issues in Web Survey Design

As with any new technology, early attempts to develop Web surveys have relied largely on existing conventions for Web design, coupled with research on designing surveys for other modes, and the personal preferences of designers. This heuristic approach is understandable, because research regarding the design of large government Web-based surveys is still limited. However, after some experience at BLS, we have identified several important issues related to the usability of Web surveys. Following are some of the design considerations and constraints that we believe federal survey managers should be aware of when considering the use of Web-based surveys.

2.1   *Importance of Standardization across Surveys*

Many government agencies conduct numerous establishment surveys, which means that in some cases, the same establishment (and respondent) responds to more than one survey. From a respondent's perspective, it is logical to expect that the look and feel of all Web surveys from the same agency will be similar. To accommodate respondents and allow for adequate security, the Bureau of Labor Statistics offers a common portal or gateway into its data collection Website, called the "Internet Data Collection Facility" (IDCF).

In addition to a common gateway, the IDCF requires that all surveys meet internal standards for user interfaces.[6] One of the challenges of applying these standards was that the early adopters (i.e., surveys introducing Web collection first) were designing their Web survey as the standards were being developed. Therefore, these survey managers had the extra responsibility of providing input to determine appropriate standards. On the other hand, later adopters were faced with some established standards that were not quite appropriate for their purposes. Once standards are in place, they are often difficult and costly to change. At BLS, we are just beginning the process of reviewing our standards. We expect that support for changes will come from research, from respondents, and from requests made by survey managers using Web-based data collection.

2.2   *Consistency across Survey Data-Collection Modes*

Research has found that different modes of data collection for identical content can produce different results (e.g., Dillman, 2000; Dillman et al., in press). As noted by Couper[7], design of Web surveys is important because they are self-administered, interactive, visual, potentially multimedia, and are distributed over a wide variety of hardware and software systems. This

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[6] *GUI and HTML Standards.* Internal Bureau of Labor Statistics document.
[7] Workbook for JPSM seminar in Web Survey Design, February 18-19, 2003.

last characteristic is especially important because the most carefully laid out design can appear quite different depending on the respondent's hardware and software configurations.

Therefore, if a survey uses multiple data collection modes, survey managers need to ensure that comparable data are being collected using the different modes. Since federal establishment surveys deal largely with reports of factual information, some survey managers may discount research findings on multi-modal differences, because these studies have dealt primarily with attitude questions or question formats not typically used in establishment surveys. However, caution is warranted. Assuming that different data collection modes do not affect the reporting or accuracy of establishment data may be a questionable hypothesis until the necessary research is done.

2.2.1 Creating a Unique Design for the Web vs. Reproducing the Paper Form – Some survey managers make the immediate assumption that the best Web design when converting a paper form to the Web is one that simply adopts an electronic copy of the paper form already in use. The argument for this approach is that respondents who are already familiar with the paper form will transfer their knowledge of the paper form to the Web version of the form and, therefore, have little difficulty completing the Web version. Also, it may be tempting to believe that using an electronic copy of the paper form will result in similar data collection results across all collection modes. However, as mentioned above, the representation of the form may be affected by the respondent's hardware and software configurations. At a minimum, a computer screen and a piece of paper are very different types of displays and may require different types of behaviors from the respondent.

The "direct copy" approach would seem to work best when the form is fairly simple, it can be displayed with little or no scrolling, and screen display concerns have been addressed. Surveys that are longer and more complex often need a different interface for the Web version to avoid usability concerns. These surveys can also take advantage of automated skip patterns and edits to streamline the respondent's effort.
Another concern is that the direct copy approach may discourage Web reporting. If respondents are completing exactly the same form, they might wonder why they should expend the additional effort necessary to enter data on a computer, which requires the additional step of signing or logging on.

Since the Web and paper are two different modes, they each have their own advantages, which should be exploited. For example, paper allows more of the survey to appear on a single page, and affords more flexibility in layout and formatting. The Web allows you to walk respondents through the process using automated skip patterns, exposing them only to the relevant parts of the survey, and also providing validation checks, where appropriate. Our experience at BLS has been that program managers prefer to start with the "direct copy" approach, but then once they see the actual product, readily make the transition to designs that take better advantage of the computer.

2.3   Security and Confidentiality on the Web

Our gateway requires identical log-on procedures for all surveys, but two security options are offered: (1) Personal ID Number (PIN) and password or (2) digital certificate. A digital certificate offers a higher degree of security, but is somewhat complicated for respondents to obtain. Initially, digital certificates were confusing to users, but after usability testing and a change of vendors, the process was simplified substantially.

Although easier to use, the PIN & password approach also presents possible difficulties. The log-on information must be sent to respondents, which, in itself, presents some security concerns. Existing security requirements also demand the creation of a fairly complicated permanent password (it must meet multiple criteria) that many users are not used to, and which many find confusing. Finally, respondents must be able to recall permanent passwords for future access to the system. To help minimize confusion with temporary passwords, we have found that it helps to provide passwords that do not contain 0 (zero) or o (oh), or 1 (one), l (el), or I (eye), as they may be difficult to differentiate.

Although necessary to protect respondents' confidentiality, Web security procedures introduce an additional hurdle compared to other response modes. In addition to increasing respondent burden, the net impact of security procedures associated with Web reporting is that these gateway functions will increase operational demands on the surveys and require a larger support or help staff. For example, Web reporting for the Current Employment Statistics survey generates 'trouble tickets' from about 15 percent of the sample each month, versus about 4 percent for the long-established touchtone data entry help desk.[8]

2.4   Validation Checks

Obviously, paper forms lack any type of validation checks or edits. Therefore, one might assume that any editing done in a Web form would automatically result in improved data quality, as well as save money by reducing the number of follow-up phone calls. On the other hand, a delicate balance exists between the survey designer's need for the highest possible data quality and the burden imposed on a respondent when trying to respond to edits. If the scale tips too far, the overuse or improper use of edits could lead to frustration, increased burden, and either possible premature exits from the survey or refusals to report in the future. What is important to keep in mind is that edits are critical to the overall design and should not be viewed an afterthought to be dealt with as a last step in the design process.

Although the use of some edits may seem perfectly justified, another issue concerns their enforceability. Surveys use both hard and soft edits to distinguish between required and recommended changes. If a *hard* edit is triggered, respondents must address the problem to continue. On the other hand, if a *soft* edit is triggered, respondents are notified that there may be a problem, but they are not required to make any changes. A related question regarding edits in Web surveys is when they should be used. Possibilities include (1) immediately after an entry is made, (2) after a table (grid) of entries is completed, (3) after a complete screen of

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[8] Personal communication with Richard Rosen, Program Manager for the Current Employment Statistics program.

entries, or (4) at the very end of a survey, when the respondent submits the data. Each option imposes different demands on the respondent.

Edits can be implemented in several different ways. For example, the edit message could appear in a separate window (pop-up box), as text next to the entry field, or on a separate page. A common problem when edit messages are displayed on the same screen is that respondents may fail to see them, even when different color text is used. When this happens, respondents think they either failed to click a button properly or that the same screen has redisplayed in error, so they simply click *Continue* again. In general, it is usually better to let respondents know about problems or potential problems as soon as possible. However, some edits can only be run when respondents indicate that they are finished, such as checks for consistent data across multiple entries.

Because there is a lack of research that addresses the general issues of how and when to use survey edits, there is no ideal solution at this time. However, some general guidelines may be helpful. For example, to be useful, edits must be noticed, read, understood, and then acted upon. Moreover, they cannot be overly burdensome. With these common sense goals in mind, the following general design guidelines are proposed:

- Take steps to ensure that edit messages are noticed (e.g., through good screen design).
- Use plain English (avoid jargon), and keep the explanatory message as brief as possible.
- Give control to users. Allow them to either change the answer or leave it as is, and to move on when ready.
- Consider offering a comment box, so the respondent can explain the entry.
- Err on the side of introducing too few edits into the initial Web survey. Study the resulting data and then gradually introduce edits into future releases to see if data quality issues are addressed.

Admittedly, these are rough guidelines, but until definitive research is done, they provide a useful starting point.

2.5   *Navigating Among Survey Questions*

Any Web application requires some basic level of navigation. An important point to keep in mind is that respondents do not approach the task of completing a Web survey with the same expectations elicited by other on-line tasks, such as ordering merchandise or searching for information about a topic, tasks which people do because they want to (Schober, Conrad, Ehlen, and Fricker, 2003). Numerous observations in usability tests indicate that when respondents encounter a survey question or survey form, they expect a structured task, where a question is posed and they provide an answer.

Respondents also approach tasks with behaviors and expectations acquired from previous experience on the Web. For example, they are likely to do things like use the Back button on the browser, click X to close the application, click on underlined words for additional

information, or try to tab among multiple answer fields. Moreover, many respondents will know how to use radio buttons and check boxes for choosing answers. Therefore, a Web survey designer must expect that respondents are likely to engage in expected, conventional behaviors when completing a Web survey. If the interface responds differently, then respondent confusion is likely, which could lead to error.

In terms of navigating a survey questionnaire or form, at a minimum the respondent should be able to move from one question or answer field to another, either automatically (cursor is controlled by the survey) or with the use of a mouse or tab key; leave (exit) or be able to close the survey before it is completed and return to the same point; back up to a previously answered question, and either review or change the answer; access question-specific help and return to the same point in the survey; and access a survey home page from within the survey as a navigational anchor.

2.6   Section 508 Requirements

A critical issue in the development of government Web surveys is the need to meet Section 508 requirements. Section 508 is a federal law that requires electronic and information technology (including Web sites) that are developed, procured, maintained or used by the federal government to be accessible to people with disabilities. This law also applies to self-administered, Web-based surveys, where a major concern is the accessibility by visually challenged respondents. Some of the most important guidelines are the following:[9]

- images must have equivalent ALT text (text assigned to a graphic, which screen readers can interpret)
- color and stylesheets must not be mandatory to view the site,
- data tables must be properly coded with headers,
- frames should be named properly,
- alternatives must be provided for scripting languages,
- if plug-ins are used, a link to the download page must be included,
- forms should be coded properly and logically, and
- repetitive navigation should be coded so that it can be skipped.

2.7   Other Screen Design Principles and Issues

There are a variety of other screen design issues that affect the usability of Web surveys. Although there are many sources of guidelines for designing Web applications, very few focus on surveys. Dillman and Bowker (2001) is one of the few sources that specifically address

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[9] See http://www.Webaim.org/standards/508/checklist for a Section 508 checklist.

Web surveys. They propose 14 principles for guiding Web survey design and addressing four major sources of survey error.

Unfortunately, many issues specific to Web surveys have not yet been resolved. For example, designers of federal surveys may face the following questions:

- Which is better, a page-by-page approach or a single scrolling page?
- Which labels should be used for navigation buttons (e.g., "Submit" vs "Save" vs "Continue")?
- What is the optimal way to present on-screen instructions or validation checks?
- How should "help" functions be presented?

At present, the best we can do for many of these questions is to follow general Web design practices. Sources for helpful information include the *Research-Based Web Design and Usability Guidelines* (available online at www.usability.gov), *Shaping Web Usability* by Albert N. Badre (2002), and *Designing Web Usability* by Jakob Nielsen. Other useful sources include Nielsen and Tahir (2002), Spool, Scanlon, Snyder, DeAngelo, and Schroeder (1998). There are many other good books on designing and building Web pages as well. We have included some general Web design guidelines relevant to Web surveys in Appendix A.

3. Incorporating Usability into Your Development Culture

Many large survey development projects follow the "waterfall lifecycle," where one stage of development follows the previous, with little or no feedback to repair problems in earlier stages (Royce, 1970). For example the development team would (1) prepare the specifications, (2) design the survey and associated database, (3) build the system and program the survey, (4) test it, and (5) deploy it. Fraser (2002) adds that in newer incarnations of the waterfall model, the development team would have a contractor conduct a usability test just before deployment to ensure that user requirements were met. If you follow this approach, you will probably find that the resulting survey may still contain numerous usability problems, potentially leading to inaccurate data or non-response.

Boehm (1988) noted that the waterfall lifecycle model is inflexible and risky. He found that the cost of making changes increases exponentially from one stage to the next, and, the likelihood of having major problems is very high because there are few opportunities to fix problems as they occur. Fraser (2002) added that the waterfall approach to usability testing leads to a poor user interface and reliance on outsiders. Since production schedules will often not permit major changes late in development, a common strategy using the waterfall approach is to make the easy, more cosmetic changes in the current release, but to save the major changes for the next release. Unfortunately, this list often grows rapidly as users find more and more problems.

In response, Boehm (1988) created the "Spiral" lifecycle model. In this model, development starts small, at the "center of the circle." Each cycle around the center consists of analysis, development, and testing. Each cycle, or iteration, includes more and more functionality,

building on previous iterations. This method not only helps developers find problems earlier, but also makes it possible to incorporate feedback from users before development is nearly final.

One process often utilized as a way to focus on the users is known as *user-centered design* (Norman and Draper, 1986). Within BLS, survey programs are strongly encouraged to

implement a user-centered design approach (Fox, 2001; Mockovak and Fox, 2002). Simply defined, this process ensures that the needs of the users are incorporated into the design of the software from the beginning and throughout the design process. User-center design activities can be easily incorporated into the development, testing, and feedback cycles of the spiral model.

Gould (1988) lays out four principles for designing usable systems:

(1)   Early and continual focus on users
(2)   Integrated design (coordinate work on all components)
(3)   Early and continual user testing
(4)   Iterative Design.

It is important that the user-centered design activities be led by those who are skilled and experienced in the field of usability. They have to know (1) which methods are appropriate at each stage of development, specifically within a particular development schedule, (2) how to implement the methods, (3) how to interpret the results, and (4) how to present the results to the development team and management. Although the methods themselves may seem straightforward, these four challenges highlight the specialized skills that are required. For example, Nielsen and Molich (1990) created the "Heuristic Evaluation" as a method that could be applied by developers knowledgeable about the product but not necessarily about usability. Nielsen (1992) later found that the method was most successful when conducted by usability specialists.

Incorporating a user-centered design approach does not have to be expensive. It is always possible to incorporate some level of effort within the expected development schedule. When the effort is made early on, it can prevent expensive problems later in development.

Usability testing is one of the most common tools of user-centered design. Ultimately, it is highly desirable to test actual users, but users with roughly comparable characteristics will suffice in early stages of the testing. Moreover, in most situations it is not necessary to test a large number of users. For example, Virzi (1992) argues that five users will often be satisfactory, with diminishing returns from testing additional users. Members of the development team should observe the usability test, so that they can see firsthand the types of difficulties that users are encountering.

The frequency of usability testing depends on the application being built. At BLS, we generally test Web surveys every 2-3 months or so, giving developers the time to incorporate

design changes. As Gould (1988) suggests, we have also found that it is critical to test all parts of the system. Therefore, we also evaluate advance mailings, instructional brochures, or e-mails, since they will directly impact use of the system and the users' experiences.

4. Summary

To make effective use of the Web for conducting surveys, survey managers must address a variety of issues, many of which are currently unresolved. This paper summarizes key issues that survey managers should be aware of when they design new surveys for Web collection or convert existing surveys. At BLS, we have found that a process called *user-centered design* is extremely helpful to ensure that Web surveys are easy for respondents to use. This paper provides some basic suggestions for incorporating a user-centered design approach into the development of government surveys.

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Appendix A

These are some general Web design guidelines that may be useful to those designing Web surveys for federal agencies.

Basic Web Guidelines
- Be consistent within the Web site.
- Use standard interface controls as they are supposed to be used (e.g., radio buttons for "Check one" and check boxes for "Check all that apply").
- Use a simple URL that people can remember.
- Limit requirements on User names and passwords to keep them simple; avoid 1 (one), i (eye), and l (el), as well as 0 (zero) and O (big oh) and o (little oh). However, your agency may have specific security requirements you must follow.
- Consider how the page will print out. Some respondents may print it, fill it out, then transcribe the data.
- Provide information on privacy, confidentiality, and ADA issues.
- Provide links to sites that show how your "products" (i.e., data) might be useful to the respondent.
- Provide easy access to help (e.g., an email address or phone number).

Navigation
- Make it obvious what respondents should do next.
- Label links clearly so respondents understand them.
- Make it easy to correct mistakes.

Layout
- Put important information at the top, left-hand side of the page.
- Limit the use of graphics (minimizes download time and helps meet Section 508 requirements).
- Do not use animation, unless it helps the respondents.
- Eliminate horizontal scrolling.
- Minimize vertical scrolling where possible.

Data Entry
- Use appropriate data entry tools (e.g., radio buttons vs. check boxes).
- Make text boxes large enough to accommodate the longest possible response (use scrolling on very long fields).
- Drop-down lists can be helpful in limiting the responses to valid values. However, some responses may be "hidden" if respondents don't scroll the list.
- Label each data entry field clearly.
- Don't make respondents enter data twice (e.g., birthdate and age) unless you are using it to verify a value.

- If respondents need responses from one question to answer another, display the questions together.

Text
- Use short, simple sentences and paragraphs.
- Avoid jargon and acronyms, unless they are very familiar to the respondents.
- Use well-designed headings to guide the respondents.
- Use a sans serif font, as the serifs don't display well.
- Don't make the lines of text too long, as it's hard to find your place when going from one line to the next.

Color
- Use high contrast colors (e.g., black text on a white background).
- Use color coding appropriately and consistently, without overusing color.
- Do not rely on color coding as the only way to convey information.

Editing by Respondents and Data Suppliers

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Abstract: This paper contains an analytic summary of the content of the session *Editing by respondents and data suppliers* of the UN/ECE Work Session on Statistical Data Editing (SDE) held at INE, Madrid in October 2003. The aim of the session was to collect information about recent trends at Statistical Agencies to change their traditional view on editing as a post-data collection phase under the complete control of survey methodologists to preventing and eliminating errors by moving some of the editing processes directly onto the respondents and data suppliers. The session focused on aspects relating to the integration and optimisation of the editing in the data collection phase taking into consideration the overall respondent burden, and the harmonisation of editing processes performed at both the data capturing and data editing stages by balancing expected levels of quality, time and available resources. The session also covered aspects relating to editing when administrative or external sources of data are used for statistical purposes. Based on the papers presented at the session, a new "mixed" perspective is emerging where editing and imputation is spread over the entire survey process. This paper summarizes and discusses from theoretical, operational and methodological points of view the main aspects and problems presented in the various papers of the session. In particular, this paper concentrates on the following aspects: evaluating the editing effectiveness when editing activities are spread over different survey phases; managing survey processes when more than one source of information (statistical or administistative) is used for statistical purposes; rationalizing survey processes when different modes of data collection are combined; improving cooperation with data providers.

Key words: editing and imputation, electronic data collection, external and administrative data, mixed editing strategies.

1.   Introduction

In Official Statistics, critical quality dimensions are the accuracy of final data and the processing costs. The definition of accuracy mainly depends on the particular survey objectives, while costs are generally defined in terms of timeliness, resources spent during the survey process and the burden on respondents. Since accuracy and costs are strictly related, one of the most crucial problems of Statistical Agencies is to find the balance between them. This optimal point is not unique, but depends on the survey characteristics and available resources.

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It is well known that the editing and imputation process (E&I) is one of the most time and resources consuming survey phases, in which residual non-sampling errors from other survey phases are dealt with. When a non-effective E&I strategy is adopted, well known problems arise such as over-editing, high respondent burden due to re-contacts, increase of editing time, higher costs, risk of introducing new errors in the data and low data accuracy.

For editing to be cost and quality effective, attention has to be paid to its rationalization during the overall survey process (Granquist, 1995). This can be done, for example, by preventing errors from arising (e.g. by improving the questionnaire design and by moving editing closer to data collection), by targeting editing resources at significant errors, by eliminating unnecessary editing and by monitoring statistical effects and costs of editing in order to identify possible inefficiencies.

In recent years, Statistical Agencies have progressively changed their traditional view on editing as a post-data collection phase where, under the complete control of survey methodologists, the data collected, coded and entered in previous survey phases are checked and validated to produce coherent and complete data. In order to reduce high costs and improve timeliness of the surveys, Statistical Agencies have concentrated their editing efforts on preventing and eliminating errors altogether. This is carried out in two main directions:

- moving editing to the early stages of the survey process, i.e. to the data capture phase, making the respondents part of the data verification process, and thus increasing the accuracy and timeliness of collected data;

- exploiting as much as possible available external and administrative information, thus reducing respondent burden and high costs by eliminating the need for surveys to collect information that is already available in electronic databases (either statistical or not).

Concerning to the first point, the continuous progress in the area of Information Technology (IT) and increasing use of computers and Internet has stimulated the use of electronic data transmission and computer aided modes of data collection. With regard to the second point, the availability of a high amount of information in external electronic databases encouraged Statistical Agencies to increase the use of these archives for their statistical purposes.

As a result of methodological, technological and operational advancements, and the need to increase accuracy under low response rates, high costs and time requirements, both the traditional survey process and the usual post-data collection view on editing have been progressively replaced by a new "mixed perspective". The editing processes consist more and more of an integrated set of activities (not always under the control of the statistician), spread over the whole survey process, that are to be harmonized together. In this new perspective, data providers are increasingly involved in the survey process not only as a source of information, but also because of their data verification capability. This capability needs to be exploited as much as possible for improving data accuracy, timeliness and lowering costs while maintaining

high cooperation levels. Multiple data collection strategies are usually adopted, in which different modes of data capture are used depending on the respondent's characteristics and technological capabilities, and the nature of the surveyed information. Furthermore, data collected for different purposes (statistical, administrative, or other purposes) are increasingly used to fulfill specific survey objectives.

To discuss the complex E&I strategies where mixed modes of data collection are adopted and where part of the editing activities either are not under the Statistical Agency's control (as for administrative data), or are directly performed by respondents or data suppliers (as in Web surveys or computer aided data collection), the session *Editing by respondents and data suppliers* has been organized for the UN/ECE Work Session on Statistical Data Editing (SDE) held at INE, Madrid in October 2003 (see http://www.unece.org/stats/documents/2003.10.sde.htm for further information).

In preparing for the session, papers were solicited discussing the problem of managing, improving and evaluating the editing effectiveness when editing activities are spread over different survey phases and data providers have a role in the data verification process. The session involved aspects of rationalizing and improving the effectiveness of editing, as well as fulfilling quality requirements when either administrative data or information from external sources are used in statistical survey processes.

In general, presentations made at the session dealt with different aspects and problems of designing complex statistical processes and integrating editing strategies when different sources of information (either statistical or administrative) and/or different modes of data collection (both traditional and electronic) are combined. Contributions highlighted new methodological and operational challenges and described specific experiences and solutions adopted at Statistical Agencies in this area. The main goals of Statistical Agencies when building their overall data collection and editing strategies are to encourage data suppliers to perform editing and checks on their own data, to improve the quality of their own editing strategies, to accurately document their editing activities, and to optimize data accuracy and survey costs by rationalizing available resources.

Two main sub-topics were identified for the session: *editing strategies when editing is anticipated at the data collection stage* and *editing strategies when external and administrative data are used in the statistical survey process*. The overall organization of the session and the discussion afterwards revolved around these two sub-topics.

Concerning the sub-topic of designing editing strategies for the data collection stage, different alternatives are adopted in current surveys. Computer Aided Interviews (CAI) contain built-in editing rules that are incorporated into the data capturing instrument so that the interviewer is notified of a response that fails one or more edits during the interview. Computerized self-administered questionnaires delivered to respondents by mailing disks or CD-ROMs, or electronically transmitted over the Internet's World Wide Web shift part of the editing activities to the respondents.

In relation to the sub-topic of designing editing strategies when external and administrative data are used in the statistical survey process, Statistical Agencies are progressively using more external sources of information to fulfill as much of the statistical requirements as possible while reducing response burden and minimizing costs. In order to make external data useful for statistical purposes, Statistical Agencies have to analyze the benefits and drawbacks of the data and develop methodologies for the logical checks and edits, and for identifying and correcting messy data. Different approaches can be adopted for the E&I of external and administrative data depending on the objectives and the use of the data which include: building registers, censuses and frames; incorporating administrative and external data to produce statistical target indicators in surveys; using administrative and external data to enhance and improve editing processes of survey data.

Obvious advantages of this new survey organization are the reduction of most of the drawbacks affecting traditional survey processes. On the other hand, the design of editing strategies has become a more complex task and it depends on the specific survey characteristics and objectives. In particular, Statistical Agencies have to face some critical points such as:

- high initial costs for integrating new sources of data/new technologies in survey processes;
- managing and improving cooperation with data suppliers;
- integrating information, concepts and definitions from different sources (statistical, administrative, other);
- revising information needs and quality requirements in order to adapt them to data providers characteristics, technological and editing capabilities;
- designing complex mixed survey/editing strategies in which different data collection modes/data editing approaches are to be integrated in an efficient and coherent way;
- allocating resources for editing throughout the survey processes;
- balancing quality dimensions such as timeliness, costs, accuracy and response burden.

This paper discusses, for each above mentioned sub-topic, specific aspects and problems from theoretical, operational and methodological points of view. Discussion points and issues raised in presentations and in the open discussion at the 2003 SDE Work Session are highlighted and analyzed. The paper is structured as follows. Section 2 discusses designing editing strategies when editing is anticipated at the data collection stage through computer assisted or other IT approaches to data capturing. The Section 3 analyzes designing editing strategies when external and administrative data are used in the statistical survey process. In both sections, the relevant points and issues that were elaborated in the presented papers as well as the general discussion at the work session itself are reflected. Concluding remarks, open problems and future research can be found in Section 4.

2. Editing Strategies When Editing is Anticipated at the Data Collection Phase

Experience shows that preventing errors is preferable to correcting them in the editing phase. In the design and planning phase of a survey, a researcher can take steps to ensure that the

question-answer process proceeds as accurately as possible, thus avoiding errors and improving data quality. Despite these efforts, errors generally occur in data entry, coding and editing phases, due to the following sources: the mode of data collection, the questionnaire, the respondent, the interviewer, and the data processing (De Leeuw et al., 2003). Some of these factors can be better controlled through the use of computer-assisted modes of data collection and integrated systems for survey processing, where part of data editing is anticipated at the data capture stage.

The impressive developments of Information Technology (IT), the increasing use of Internet, the growing availability of electronic data on both individuals and businesses, are all factors encouraging Statistical Agencies to exploit as much as possible the use of IT-based approaches to data collection. Two main modes of electronic data collection can be identified:

- Computer Self-administered Questionnaires (CSAQ) via Web or other forms of electronic data transmission (downloadable software, e-mail attachments, diskette/CD electronic forms);

- Computer Aided Interviews (CAI): Computer Aided Telephone Interviews (CATI) or Computer Aided Personal Interviews (CAPI), Computer Aided Self-administered Interviews (CASI).

The recognized main advantages relating to the use of IT modes of data capturing are:

- reducing non-response by increasing cooperation and offering benefits to data providers;
- reducing organizational costs (questionnaire delivery, coding, data entry, data editing);
- improving data quality and timeliness, reducing respondents burden.

Under given survey conditions (type of electronic tools, characteristics of respondents, the questionnaire, information required and confidentiality guarantees), CAI and CSAQ generally result in less item non-response than paper-and-pencil surveys. Using these approaches allows the optimisation of the effectiveness of both data capturing and survey process. Timely information from data suppliers (persons, enterprises, private agencies or public administrations) is obtained with higher guarantees on data quality and lower response burden. Furthermore, survey costs due to delivering, coding and entering questionnaires are eliminated. Time and costs of post-data collection editing activities are reduced due to preventing typical errors at the data capturing stage, such as routing errors, range errors and some types of inconsistencies.

Various implementations suggest solutions to designing integrated editing strategies when different modes of data collection are combined in a survey process, and data suppliers participate in the data verification activities at the data capturing stage. Focusing on the editing area, the following ones highlight the advantages and new problems derived from adopting this sort of mixed approach:

- National Statistical Institute of Spain (INE) uses Total Quality Management as a method to improve production processes and to obtain higher quality output, while using electronic

data delivery via Web (Revilla et. al., 2003). Enterprises are considered part of the statistical production process both as data providers and data users; therefore they are to be directly involved in the data verification process at the data collection stage. Efforts are being made to improve the dialogue between Statistical Agencies and respondents, in order to improve cooperation and data quality.

- The Federal Statistical Office of Germany tackled the problem of optimizing the overall data quality by adopting the so-called "plausibility improving measures" at the data collection stage (Wein, 2003). These measures include the use of electronic tools (Internet, IT, CAI), and the adoption of an "outsourcing" philosophy: making data providers perform part of the editing on their own data, in order to efficiently capture and check data at the collection stage. Depending on the origin of the data, two approaches of data retrieval are used: the traditional processes in which data collection is largely under the control of statisticians, and the new survey processes that capture data from external sources which are collected without the control of statisticians.

- The US Bureau of Labor Statistics (BLS) uses different modes of electronic data collection (self-administered questionnaires and Web-based tools) depending on the survey's purposes and the characteristics of respondents. An effort is made to provide respondents with the most appropriate option for submitting their data. Readers interested can find an analytic description of the editing strategies adopted for BLS surveys where Web-based data collection is implemented (Cohen, 2003).

- The US Energy Information Administration (EIA) also performs data editing at the data capturing stage via electronic methods such as Web surveys, downloadable software and e-mail attachments. Most of the 65 surveys conducted by the EIA are business surveys. Editing strategies are implemented, in the EIA, at both the data capturing and the traditional editing stages. Readers may be interested to read a review of the development of Web-based questionnaires and to an analytic discussion about advantages and drawbacks of the different modes of electronic data collection (Weir, 2003).

- The US Bureau of Economic Analysis (BEA) achieved progress in converting paper-based collection modes to electronic modes over the Internet, for example in collecting data on American direct investments abroad and foreign direct investments in the United States, on the financial structure and operations of parents and affiliates and on balance of payments transactions between parents and affiliates (Walker, 2003). The Automated Survey Transmission and Retrieval System (ASTAR), used by the BEA, has facilities for ensuring data security and confidentiality as well as an import facility allowing respondents to link directly to their accounting systems to improve timeliness and quality of the data transmission process.

From all experiences it can be concluded that the extent and the type of editing performed at the data entry stage depends on five main elements (Weir, 2003):

- the sophistication of the electronic option selected,

- the amount of available development resources,
- the required quality of the data,

- the acceptable respondent burden,
- the required security of the transmission.

The use of computer-assisted techniques and other electronic modes of data collection and transmission have a technological impact. It concerns, first of all, identification of the most suitable technique (CATI, CAPI, Internet, etc.) for the specific type of respondents and their technological capabilities, the required information, and the survey targets and constraints in terms of time and costs. It is well known that costs related to traditional paper-and-pencil mode of data collection (e.g. questionnaire reproduction, mailing, data coding, data entry) can be considerably reduced, and the timeliness of data transmission and further data processing can be increased when using the IT approach to data collection. In the EU context, for example, timeliness has become a crucial element because of regulations imposed to Member Countries to provide both preliminary and final results by predefined deadlines. Statistical Agencies are concentrating efforts towards the design of survey processes using IT data capturing methods and electronic questionnaires. Particularly for Web-based data collection with self-administered questionnaires, high resources and time are required to develop, test and implement the IT data collection process, to redesign the overall survey process and adopt an editing strategy where respondents are directly responsible for data checks.

The use of electronic modes of data collection is changing the way Statistical Agencies build their statistical survey processes, with an increasing need to develop methodologies and strategies for adapting traditional processes to the new technological context and to the increasing demand for high quality information. The main problems for Statistical Agencies are not only defining and obtaining the minimum level of quality for electronically provided data, but also integrating the use of IT in traditional survey and data treatment processes. Integrating the use of electronic/CAI approaches in data processing implies an overall redesign of the survey in a *quality assurance* context, i.e. developing editing strategies where timeliness, costs, quality requirements and respondent burden are properly balanced. Finding this balance requires an accurate design not only of the electronic questionnaire, but also of the edits to be used throughout the computer-assisted data collection. This concerns, for example, the type of edits (either logical or statistical, either hard or soft depending on whether respondents can skip incoherent situations, etc.), and the amount of rules to be prioritized at the data capturing phase in order to prevent the most critical errors on the most relevant items while preserving timeliness and the cooperation level. These elements all must be defined taking into account the survey objectives and the nature of investigated variables.

Other critical aspects that deserve further consideration:

- need of increasing the cooperation between questionnaire developers and editing methodologists for optimizing the overall questionnaire design; editing methodologists should be involved in any pre-testing and post-testing of the questionnaire (Weir, 2003);

- need of collecting information during the data processing through the use of metadata to further improve questionnaires and editing strategies and to prevent errors in next survey repetitions.

These aspects are strictly related to controlling and reducing the overall respondent burden and increasing the cooperation level and response rates. Statistical Agencies have to make maximum effort in designing electronic questionnaires that are efficient in terms of the type and amount of questionnaire items, structure of the questionnaire, adopted classifications, definitions and wording of questions, in order to simplify the data capturing process. In addition, questionnaires should be adapted as much as possible to the technological and informational capabilities of data providers (for example, allowing businesses to capture electronic information directly from their own databases). Questionnaires should be tailored depending on the type of respondent (private citizens, businesses, private agencies) and the type of information required (economic information, sensitive information like health or social attitudes, etc.). Important elements for increasing the cooperation level and reducing non-response can be implemented through some more technical aspects: providing options and help facilities for respondents (e.g. information from previous schedules, help systems, automatic calculations, etc.); designing and managing appropriate error messages and information to data suppliers, especially for complex edit-failure feedback information; determining how to present edits and the optimal timing of when to perform them (e.g., while filling out the questionnaire or just before the questionnaire is submitted), simplifying the task of making corrections (Cohen, 2003). In order to improve cooperation with data suppliers and their availability to edit their own data, the connection between the use of incentives, response rates and data quality has to be further investigated (Revilla, et al., 2003).

A typical problem in the case of electronic data capturing, and in particular Web-based questionnaires, relates to data security and confidentiality. User concerns about confidentiality, privacy and data security could have an impact on response rates. In general, it is not easy to assess what is the relation between the level of security and confidentiality and the level of cooperation. Aspects relating to this point are discussed in Weir (2003).

A growing tendency at Statistical Agencies consists in developing more complex strategies to increase data quality and response rates by using multiple questionnaires and different modes of data collection for sub-groups of respondents having different characteristics and technological capabilities. The resulting *mixed* approach implies an increasing complexity in terms of designing, harmonizing and managing the overall information flow, as well as rationalizing the available resources on the whole survey process.

3. Editing Strategies When External and Administrative Data Are Used in the Statistical Process

Due to technological advancements in recent years and the development of sophisticated modes of data collection based on IT, Statistical Agencies are making efforts to collect data from external and administrative sources to fulfill some of their requirements for statistical data. The use of accurate and coherent external and administrative data can reduce the scope and even replace some of the surveys needed for statistical target indicators, thus reducing respondent burden and costs while increasing the quality and timeliness of the data. In many business surveys carried out by Statistical Agencies, the data collected on smaller enterprises are based entirely on administrative sources such as Tax Authority Files. This allows more resources to be used for collecting survey data on the larger enterprises and dealing with non-

respondents. New regulations for member countries of the EU with respect to having comparable data and uniform definitions and classifications at an international level have also increased the need and awareness of using available external and administrative data. In addition, external and administrative data can be used for increasing the quality of data, such as identifying coverage errors in existing frames and registers and improving the E&I processes for missing or erroneous survey data.

External and administrative data are never automatically ready for use in the statistical process since they are collected for different purposes. Classifications and definitions of variables are often inconsistent with the needs of the statistical agency and data suppliers are not necessarily responsible for the quality specifications that meet the requirements of the statistical agency. Usually, the data must undergo extensive editing and preparation before incorporating them into the statistical process. Data suppliers have different organizational and technological capabilities, thus making the data collection of external and administrative data a complex processing system. Resources are needed to develop new methodologies for the collection and preparation of the external and administrative data, for measuring the accuracy and possible biases that may be introduced into the data, for statistical modeling to compensate for missing data, and to develop effective and efficient E&I processes when using multiple sources of both survey and administrative data.

The goal is to fulfill as much of the statistical requirements as possible for external and administrative data at the point when the data is collected (Laaksonen, et al., 2003). Thus it is necessary to increase cooperation and interaction with data suppliers and get them to conform to the quality requirements of the statistical agency and perform editing on their own data. Incentives can be provided to data suppliers to get them to perform edit checks and increase the quality of their own data. One form of incentive is to improve interaction and feedback and provide assistance to data suppliers with new and innovative software and methodologies for statistical editing, imputation and modeling.

Statistical Agencies are gaining experiences with using external and administrative sources of information for statistical purposes either separately or in combination with survey data, as demonstrated by the following examples:

- Statistics Finland uses multi-level and longitudinal registers including the central population register, businesses, taxation authorities, employer and pensioner organizations and others (Laaksonen, et al. 2003). In addition, administrative data in the business area are used for efficiently developing and updating business registers. A method of profiling is undertaken where external information is integrated into the statistical process in order to identify enterprises, their legal and operating structure and production units. Due to increasing cooperation with data suppliers and their availability for improving their own editing practices, the data verification process is an interactive and integral part of the editing strategies at the agency.

- Statistics Sweden is using administrative tax data to estimate economic indicators produced by the Swedish Structural Business Statistics (Erikson, 2003). Statistical modelling is

  undertaken to compensate for gaps on particular indicators or on target population subsets. The focus is on preparing the administrative data for use in the statistical process, choosing the most appropriate source with regard to quality, the level of detail, the similarities of the definitions and concepts, and the level of coverage. The Agency also uses its administrative data to quantify frame errors and specifically to check for under and over coverage problems particularly crucial in business statistics.

- The US National Center for Health Statistics also aims at moving editing as close as possible to data providers during the data capture stage or very near to that stage (Harris, 2003). Their method is called the "source point data editing". Different approaches to data collection and the control on data quality for the various surveys carried out at the Agency depend on the type of information asked (sensitive questions such as attitudes, illnesses or social behaviours or demographical questions such as births and deaths), whether the respondent is an individual or another agency, and the respondent's technological capabilities. Editing strategies are often combined and harmonized especially for mixed modes of data collection and the different sources of information flowing into the survey process.

- Statistics Belgium (Vekeman, 2003) uses administrative data to compensate for non-response in the Belgian Structural Business Statistics. Information from Profit and Loss accounts is used to recover missing information on accounting totals, then a breakdown of these totals are imputed using methods that exploit as much as possible the observed correlations between accounting totals and the missing total details. Two methods for imputing missing information on accounting totals are being compared in a trial: temporal extrapolation (ratio estimation on data of the same responding unit from a previous survey) and the use of additional collective data (ratio estimation on grossed up data of similar respondents with respect to known auxiliary information). The results of a comparative evaluation study showed that if previous data are available, the temporal extrapolation gives better results because it exploits temporal correlations in the breakdown of accounting totals for each given company. The second technique imputes the mean ratio within each homogeneous group, consequently its performance depends on the amount of available auxiliary information that can be used to define groups.

The focus of editing strategies when external and administrative data are used is on finding the trade off between the gain in productivity and ensuring quality. How to find this balance depends on the type of data suppliers, the type of information they collect, the type of quality controls performed, the adopted statistical definitions and classifications, the coherence and quality criteria, and the quality of record linkage between different sources of data. External and administrative data need to be adapted to the statistical process and integrated with other sources of information, especially when the goals are to investigate coverage errors in frames and registers, and to harmonize and standardize of statistical classifications for producing statistical target indicators. The challenge is to be able to link the information coming from different sources, to identify the missing information, and to assess the quality and adapt appropriate E&I methods to make external and administrative data usable for statistical purposes. Obtaining as much knowledge as possible on the sources of data directly from the

data suppliers, the checks and edits carried out by data suppliers as well as their definitions and classifications, form the basis for the successful integration of external and administrative data in the statistical processes at the statistical agency. Data with low quality can be utilized efficiently when combined with other sources of information through the use of statistical modeling and imputation (Erikson, 2003).

Increasing cooperation with data suppliers for changing/updating the type and amount of data checks is an important factor for integrating external data sources. Data suppliers are not necessarily responsible for data quality from its statistical point of view. They usually have a different conception of data with respect to accuracy and content, and are not obliged to modify their data processing procedures. Statistical Agencies generally have more demanding targets for data quality than those of the data suppliers, and this fact influences the type and amount of editing activities that is performed on external and administrative data at the agency. The quality requirements depend on the target variables, type of edits applied, and the detail of the editing. The complexity of the editing activities increases as the differences among purposes, definitions of units and variables, concepts, and classifications increase. Experience shows that external data suppliers generally provide the statistical agency with all information needed for their editing and analysis activities, and sometimes provide more variables than is minimally needed to allow the statistical agency to exploit as much information as possible. In general, data suppliers are available for reviewing their own data if the statistical agency is not satisfied with the quality of some subsets of data. The cooperation and the interaction with the data supplier with regard to making the data supplier part of the data verification process is one of the most important factors for obtaining high quality external and administrative data.

The E&I procedures on external and administrative data have similar characteristics and pose similar problems as those developed for traditional survey data. An efficient editing system should guarantee higher data accuracy and lower costs. Internal inconsistencies, missing, invalid and extreme values potentially influent on target indicators are looked for among the data. The use of electronic data capturing of external and administrative data allows incorporating rigorous checks at the point of data capture, and data suppliers can be re-contacted within a limited time following the data collection. In addition, appropriate edits need to be defined for incorporating different sources of external and administrative data with

survey data. The goal is to select the values of variables that ensure that no inconsistencies occur in the data and that guarantee high accuracy and data quality. Manual review may be performed on critical units while in some experiences smaller units can be imputed automatically. A balance must be found between automatic and manual editing with respect to costs, quality and timeliness. A simple procedure for imputation on external and administrative data described in papers may be based on the average values of the variables in homogeneous groupings (for example, groupings defined by activity code and size when using administrative tax data to impute data for businesses). A validation of target indicators after the E&I process is necessary.

The crucial points for a successful E&I strategy on external and administrative data are:

- defining the amplitude of acceptance bounds for both ratio and query edits in order to find the balance between how much editing to perform and the required level of data accuracy;
- balancing between the amount of manual editing and automatic imputation through the rationalisation of resources, reduction of time, costs and respondent burden;
- identifying the appropriate type and amount of edits to be used taking into account the statistical quality requirements and the available resources;
- balancing between the desired level of accuracy of final data and accuracy of manual data review;
- identifying the most appropriate imputation model for the different missing patterns, exploiting as much as possible all available information.

Methodologies for statistical modeling to integrate all available information required to derive statistical target indicators need to be developed. This implies initial high survey costs for the extensive editing and quality checks on the external and administrative data and moving resources to research. However, the costs are balanced by the increase in data quality and timeliness and the decrease of respondent burden and other costs for carrying out surveys. This is especially true in recent years when survey data suffers from a high level of non-response thus lowering the quality of the survey data. New types of biases that may occur in the statistical data when incorporating external and administrative data into the survey process need to be assessed. These are, for example, errors in the record linkage process between different sources of external data, inconsistencies in the sources of data and compensating for missing values for specific indicators or sub-populations. Being dependent on external and administrative data, the statistical agency needs to continuously adapt its practices to external data changes, to classifications and definitions used by data suppliers, and to increase the interaction and cooperation with data suppliers for setting up better editing practices and detecting erroneous data.

4.   Conclusions and Future Research

The main sub-topics that evolved from the session *Editing by respondents and data suppliers* at the 2003 UN/ECE Work Session on SDE were the following: managing, improving and

evaluating the editing effectiveness when editing activities are spread over the different survey phases; managing survey processes when more than one source of information (either statistical or administrative) is used for statistical purposes; rationalizing and improving the effectiveness of survey processes when different modes of data collection are combined together; cooperating with data providers who have an important role in the editing and data verification processes.

Conclusions and future areas for research on *editing strategies when editing is anticipated at the data collection stage* are summarized in the following points.

- Using IT modes of data collection implies the need to take into account in the data collection strategy the information and quality needs, the survey constraints and the characteristics of the data suppliers (households, businesses, administrative registers). Future research should be devoted to finding criteria and strategies for balancing between the cooperation level of respondents and the data accuracy (i.e. the types and complexity of edit rules used at the data capturing stage). Effectiveness should be measured in terms of both response rates (response burden), gain in data quality and gain in timeliness. Critical open problems are determining what type and how many edits are to be anticipated at the data collection stage, the optimal timing of when to perform the edits, and how to present the edit failures to the respondents without lowering the overall response rates. Edit checks could in the future become more sophisticated by including previous or complementary external information while preserving confidentiality and developing tailored and personalized data collection modes to meet the respondent's characteristics and technological capabilities. Questionnaire developers and editing methodologists need to work closely together when developing and testing survey questionnaires, in particular for mixed modes of data collection. Gathering information on survey processes through metadata is crucial for improving questionnaires and editing strategies in order to prevent future errors.

- The impact on data quality when moving parts of edits to electronic data collection compared to the traditional approach to data collection and post-data editing has to be effectively tested, measured and evaluated. Methodology needs to be developed and tested for integrating data with varying levels of quality from different data collection modes, and for an optimal mixed editing strategy for harmonizing editing activities performed at the various stages of the survey process. In general, there is a need for more evaluation studies in the area of measuring data quality improvements resulting from partially editing data through electronic data collection versus editing entirely performed after the data collection stage.

- Possible new biases and non-sampling errors, which may arise from mixed modes of data collection and editing, have to be properly measured. Statistical Agencies are moving from traditional paper-and-pencil mode of data capture to mixed data processing strategies, where different electronic-based data capturing technologies and methodologies (Web files, CD, diskettes, personal or telephone surveys using CAI) are combined with paper-and-pencil data collection, and different editing approaches are used over all the survey processes. In this way, respondents not only participate in the editing activities, but they perform these activities in different ways, depending on the specific adopted mode of data

collection. The use of multiple questionnaires and different tools for data capturing in the survey process for sub-groups of respondents result in different response rates on each data collection mode. Mixed approaches to data collection and editing produce an increasing complexity for the integration and management of the overall information flow, and imply additional efforts for integrating, rationalizing and optimising editing activities performed over the different parts of the survey process.

- There is a need to raise awareness and increase response rates for Web-based and self-administered questionnaires and especially to deal with issues of confidentiality when data are collected over the Internet. Since user concerns about confidentiality, privacy, and data security could have an impact on response rates, efforts are to be made to identify technological and methodological tools for improving the preservation of data confidentiality, as well as designing strategies for managing the security issues for the transfer of data, in particular over the Internet.

Summary points and future areas for research for *editing strategies when external and administrative data are used in the statistical survey process* are:

- The balance between maintaining a complex survey processing system integrating data from multiple sources and the development and implementation of efficient editing strategies must be assessed and evaluated. In particular, determining the appropriate edits on external and administrative data, balancing between automatic and manual editing, and utilizing external and administrative data with low quality are open areas of research that need to be explored and tested.

- New methodologies need to be developed for incorporating and utilizing external and administrative data in the statistical processes, such as for quantifying frame coverage errors, for editing and imputing missing or erroneous survey data, and for statistical modeling to compensate for non-response. To make the use of external and administrative data as efficient as possible and to ensure that new biases will not be introduced into the statistical data, more research and development must go into integrating databases, record linkage processes and measuring inconsistencies and errors between sources of data.

- Statistical Agencies need to increase cooperation and determine appropriate incentives that will improve the overall communication and interaction with data suppliers, in order to get them to set up better editing practices and conform to statistical classifications and definitions, and to provide feedback to the agency in the data verification process.

The continuous IT developments and the growing availability of electronic external data on households, persons and businesses is deeply changing the way Statistical Agencies perform their own statistical survey processes. Electronic data capturing and transmission are more and more exploited, with an increasing need to develop methodologies and strategies for adapting traditional processes (including E&I) to the new context. This new overall approach implies both advantages and drawbacks. One advantage relates to the general increase of response rates and data accuracy due to using the most suitable mode of data collection for the type of respondents and the information required. In addition, respondent burden and costs can be reduced, particularly when external and administrative data are incorporated into the survey

processes. These situations, however, are characterized by a high complexity from both an operational and methodological point of view. In the specific area of E&I, critical problems are the integration and harmonization of the editing activities performed at the different data collection stages and at the post-data collection editing stage for both survey and external and administrative data, as well as the rationalization of the available resources among these phases of the survey process. Further experiments and applications are needed to identify, for each specific situation, the best and most suitable editing strategy depending on the source of the data and the resources and costs required for the design and test phases.

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