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CATI in an Agricultural Statistical Agency

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Abstract: Computer assisted telephone interviewing (CATI) is a new data collection procedure that is under development, evaluation and use in several survey research organizations. Many private survey organizations (Shanks (1983)) have developed CATI systems. In the U.S. some of the major federal statistical agencies are developing, testing and implementing CATI. This paper describes the Statistical Reporting Service's CATI system, summarizes a comparison of CATI and conventional telephone data collection, discusses the impact of CATI on interviewers and outlines the implementation plan for CATI in the Statistical Reporting Service.

Key words: CATI; computer assisted telephone interviewing; data collection mode; telephone interviewing.

1. Introduction

The Statistical Reporting Service (SRS) of the United States Department of Agriculture is responsible for producing U.S., State and County crop and livestock estimates and related statistical data. SRS prepares a picture of the current and near future supplies of agriculture. For crops, the annual cycle of reports begins with farmers' intentions to plant followed by estimates of planted acreage, harvested acres, yield, production and storage. These estimates are made throughout the agricultural season. Various livestock inventory numbers are published monthly, quarterly, semi-annually and annually. This includes information on hog production, cattle, cattle on feed, and production of milk, eggs and meat. Reports on breeding intentions, farrowing, hatchings, chick placement and calf and lamb crops are also made, as well as estimates of manufactured dairy products and cold storage holdings of agriculture commodities. Various statistical series are also produced to indicate the economic well-being of farmers in the U.S., the number and size of farms, estimates of farm labor and wages, prices received and paid by farmers, fertilizer usage, on-farm and off-farm grain storage. Finally, estimates are made for various speciality crops such as honey, mink, mushrooms, naval stores, etc. In total, over 300 statistical reports are published each year.

SRS is a decentralized statistical agency. There are 44 field offices, primarily data collection offices, throughout the U.S. The headquarters staff located in Washington, D.C. is responsible for planning, designing, coordinating and training for national surveys. This staff also supports a nationwide telecommunications network to transfer data to a mainframe computer for editing, summarizing and dissemination of published data.

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Approximately one-third of the SRS staff is in Washington. All of the enumeration staff is in the field offices. Field office statisticians are responsible for training their enumeration staff and preparing state and county estimates.

SRS uses area and list frame sampling to collect agricultural data. Each of the 48 conterminous states has an area frame stratified by land use. The list frame is composed of names, addresses, telephone numbers and control data, for stratification of farmers and ranchers and various types of agribusiness firms such as mills, elevators, terminals, implement dealers, etc. SRS collects data through mailed questionnaires, telephone and face-to-face interviewing. Many of the surveys SRS conducts are dual frame surveys. Face-to-face interviewers collect area frame data. Traditionally, SRS collects list frame data using all three modes of data collection. After an initial mailing, telephone and face-to-face interviewers follow up on nonrespondents. However, the combination of increasing postage costs and decreasing mail returns has increased the amount of data collected by telephone. The increased use of telephone interviewing has led SRS to investigate computer assisted telephone interviewing (CATI) as a technique to improve the quality of telephone data. Several other U.S. federal statistical agencies are also investigating CATI. The U.S. Bureau of the Census (Nicholls (1983a)) has a major CATI development project. The National Center for Health Statistics has sponsored methodological research on CATI (U. S. Office of Management and Budget (1984)). The U.S. Bureau of Labor Statistics has recently started research in this area. Many private survey organizations have also developed CATI systems. Companies such as Audits and Surveys Inc and Chilton have many years' experience in the use of their own CATI systems. Other, not-for-profit organizations, such as the Research Triangle Institute, The Survey Research Center at the University of Michigan and the Wisconsin Survey Research Laboratory at the University of Wisconsin have developed a broad base of expertise in CATI systems. In addition, CATI development is going on in other countries (see for example Collins (1983)). A special issue of Sociological Methods and Research (Vol. 12, No. 2, 1983), containing the proceedings of a 1980 CATI conference, reviews the impact of CATI as a data collection activity. The present paper describes the SRS CATI project. After a brief discussion of the advantages and disadvantages of CATI, this paper describes the software and hardware SRS uses, compares costs for hardware acquisition, reviews some data quality comparisons of CATI and non-CATI interviewing, discusses the impact on telephone enumerators, describes other uses of the CATI software and hardware, and outlines the future of CATI in SRS.

2. Advantages and Disadvantages of CATI

Computer assisted telephone interviewing requires an interactive computer facility to control the content and the sequence of questions to be asked by the interviewer. Questions are read from individual video display terminals and respondents' answers are keyed directly into the system at the interviewer's keyboard. With conventional telephone interviewing the interviewer records the respondent's answer on a paper questionnaire. The advantages of CATI stretch beyond the convenience of using the computer to collect data by telephone. CATI's influence reaches all stages of a survey.

The advantages that result from CATI include:

1. Question branching is controlled
2. Edit and consistency checks are made in real time
3. Field practices are standardized
4. Survey management is improved

5. Data availability is improved
6. Data in panel surveys is used in subsequent interviews
7. Question order effect is reduced.

2.1. *Question Branching*

The automated branching to appropriate questions in the survey instrument (questionnaire) insures that the enumerator follows proper skip patterns, obtaining data on relevant or designated items and omitting items when they do not pertain to the respondent. The interviewer staff avoids time-consuming call-backs to obtain missed items, e.g., expected three- and six-month births from a hog farrowing operation. The data collection agency reduces the burden it places on respondents by not asking inappropriate questions, e.g., the number of pounds of milk produced from a cattle feeding operation. Instrument designers can develop more complicated instruments, e.g. using previously reported data to generate individual instruments geared to a specific type of farming operation, with the knowledge that CATI will display questions in the proper order.

2.2. *Edit and Consistency Checks*

On-line edit and consistency checks improve the accuracy of the data. Both the software checks and the interviewer can question during the interview an unusual ratio of the number of pounds of milk produced to the size of the dairy herd. The respondent and the interviewer can review and correct either or both items, or the interviewer can enter notes into the system to explain an unusual relationship.

Large observations can also be flagged. When apparent inconsistencies occur, CATI can display alternative questions or probes to the interviewer.

2.3. *Standardization*

Field practices are standardized in several ways. One of the ways standardization occurs is through the close monitoring of interviewers. Supervisors can listen to interviews and observe the questions and answers on the screen. Through the controlled branching process interviewers follow the same paths through the instrument. By including alternative questions, interviewer probing is standardized. A particular sequence of probes can be programmed or two or three probes can be displayed so the interviewer can choose the most appropriate. If automatic scheduling is part of the CATI system, calling and call-back procedures between different data collection sites can be standardized. A minimum number of calls at appropriate time periods can be made before the sample unit is given to a face-to-face interviewer for follow-up.

2.4. *Survey Management*

When a survey organization collects a large volume of data in a short time, survey management becomes critical. Keeping track of survey progress and scheduling interviewer assignments, providing questionnaires to the interviewers, and evaluating the data collection process in the traditional manual way is a great deal of work. CATI systems can aid the director by providing detailed progress reports at any time during the survey, automatically scheduling interviewer assignments and call-backs. The integration of a (semi-)[2] automated scheduling algorithm into a CATI system can usually reduce the number of no-answers or inaccessibles that can occur over the telephone. For example, the algorithm can keep track of unsuccessful calls by time of day and day of week. Calls can be rescheduled for different times of day. It can also automatically deliver cases to each interview station, either at random, by replicate for interviewer

[2] Any scheduler should contain the option of being overridden so the survey manager can directly intervene in the scheduling process.

variances studies, or for scheduled call-backs. Finally, the instrument designer can identify problems with the survey instrument, wording or order problems, because CATI produces an audit trail for each interview.

2.5. *Data Availability*

CATI data are more readily available to survey statisticians. CATI eliminates the need to key in data after it has been collected and hand-edited. The system can produce intermediate tabulations of the data any time during the survey. Using CATI for an entire survey allows a survey organization to produce tabulations almost immediately after the interviewing is completed.

2.6. *Panel Surveys*

In panel surveys, it is often appropriate to provide the interviewer with the panel's earlier responses. CATI provides a larger degree of flexibility in using this data on second and later interviews when compared to paper and pencil interviewing. Once data is captured in a storage media, from mail, telephone or face-to-face modes of data collection, it can be used to familiarize the CATI interviewer with the respondent, for editing during the interview, or to automatically develop customized CATI questions for the respondent.

2.7. *Question Order*

When question order bias is detected in surveys using paper questionnaires, the instrument designer often develops several versions of the questionnaire, with different question orderings, that are administered to randomly selected subgroups of the sample. The administration and management of even a few questionnaire versions can complicate the survey process. CATI, besides easily allowing for more than one version, simplifies the administration of each version. Question order effects can be averaged over all the versions of the instrument.

These measures improve the quality of survey data; inconsistencies are resolved, scheduling is improved, more contacts are made, and relevant questions are asked at the appropriate time. CATI's standardized data collection practices lead to a better understanding of the data. However, these improvements do not come without disadvantages.

Some of the disadvantages associated with CATI are new to survey practice. Others are restatements of problems already encountered by the survey practitioner, for instance, skip patterns are one such problem. But now these problems involve the use of computer software and hardware. The new CATI disadvantages include:

1. Operation and management of a computer facility
2. Increased overhead costs
3. Increased interview length
4. Additional interview skills
5. Additional instrument designer skills
6. Retention of back-up paper questionnaire interviewing capability.

2.8. *Computer Facility*

A potentially difficult problem the survey organization has to overcome is the operation and management of the CATI computer. Most CATI systems run on a relatively complex computer which requires a computer specialist to operate and maintain. The instrument designer, survey manager and computer specialist must work together to see that the system is ready to begin data collection on time and to run at the pace the survey manager requires to complete the survey on time. The addition of the computer specialist to survey planning and operation complicates the communication process for all areas of the survey.

2.9. *Overhead Costs*

Because most federal organizations have not been able to use existing hardware for CATI,

they must absorb an increase in overhead costs for computer acquisition. Staff costs may increase if a computer specialist must be hired. One way of reducing these overhead costs is to use the hardware for other tasks besides CATI. These might include data entry for non-CATI surveys, providing additional analysis capabilities using spreadsheets and statistical software packages, database applications and word processing. While these activities can defray overhead costs, they also complicate management of the system. The organization must designate a system manager with the responsibility for prioritizing system activities and removing users, if necessary, that interfer with CATI production. Finally, training costs for new interviewers increase. Besides the usual questionnaire training, they must be trained to enter answers and notes, and learn the CATI commands. This cost will always be incurred with new interviewers, but should be minimal for experienced CATI interviewers.

2.10. *Time Spent Interviewing*

Because CATI provides on-line edit and consistency checking, an interviewer may spend, on the average, more time with a respondent. The possible increase in interview time is probably related to the complexity of the relationships for each case. The more internal consistency checks a CATI system runs, the greater an interviewer's chance of spotting errors; the time devoted to correcting these errors lengthens the interview. Non-CATI interviewers may not be aware of such inconsistency and may thus complete interviews faster. The difficulty with documenting interview time, especially for non-CATI calling, will make it hard to quantify CATI versus non-CATI time differences. However, any increase in interview time may be offset by a decrease in the time needed to edit data after interviewing, resulting in an overall decrease in survey processing time. However, this author is not aware of any studies documenting this possible time trade-off.

2.11. *Interview Skills*

Depending on the type of data collected (open-ended questions versus numerical data) a survey organization might have to consider typing skills when hiring interviewers. Even in organizations like SRS, that collect primarily numerical data, typing skills must be taken into consideration. In the SRS CATI system, interviewers can enter notes at any time and of any length to explain unusual circumstances. Ideally these notes should be entered at the place in the interview where the problem or interruption occurs. SRS has found that for those interviewers with inadequate typing skills the quality of the notes are reduced or they are placed at the end of the interview. This situation can reduce the quality of a statistician's edit. Morton and House (1983) give a more thorough discussion of developing CATI interviewer skills.

2.12. *Instrument Designer Skills*

A questionnaire designer's standard skills should be extended to include a good knowledge of instrument design. An instrument design is most efficient when the questionnaire designer programs the instrument himself. He is aided in this task by an easy CATI instrument design language, given that the available language is a CATI design language and not just an ordinary programming language. House (1985) has a more detailed discussion in this area.

2.13. *Back-up Capability*

When CATI is executed from a single computer system, potential failures – hardware and software – require back-up paper and pencil interviewing capability. Hardware failures occur and during short, intensive data collection periods there may not be enough time to

repair the system. Software failures or program bugs also occur. Programming errors may not be CATI errors. Examples of these programming errors are operating system errors that occur in a particular situation or the "garbling" of data on name, address and telephone number during computer-to-computer communications. With any of these errors, paper and pencil interviewing capability will allow the collection of data in the appropriate schedule.

Finally, a warning about CATI surveys is appropriate. CATI does not eliminate any of the usual presurvey activities. An organization must still pretest. Part of the pretesting will be debugging the program, the survey instrument. It is important to insure that the instrument will follow proper question order and skip patterns.

3. CATI in SRS

After deciding to use CATI, SRS had the option of developing its own software or acquiring CATI software. SRS chose the latter option for several reasons. First, we would minimize our chances of failure on the initial system development. Many U.S. survey organizations did not succeed with their first CATI system and either had to rewrite the system or acquire a system. Second, a staff would have to be organized and trained in CATI software development techniques. SRS did not have staff available to begin this system activity. Third, SRS wanted to evaluate the potential of CATI in as short a time as possible and with a minimum investment in development resources. SRS did not want to spend one or two years on system development before beginning to evaluate CATI. Finally, many of the 44 SRS field offices recognized the potential of CATI and were anxious to start using the technique. By acquiring a CATI system and beginning tests and evaluations, SRS would minimize the chances of individual field offices developing their own CATI systems with different capabilities.

So, SRS and the Computer Assisted Survey Methods (CSM) group of the University of California at Berkeley started a cooperative research agreement. This joint research project was developed to evaluate and extend the CSM CATI software to SRS surveys using multiuser, multitasking supermicrocomputers. Under this joint agreement, SRS and CSM agreed to: 1) extend the CATI software to more easily handle the hard data – as opposed to primarily opinion data – SRS collects, 2) develop several CATI instruments for SRS surveys, 3) train new CATI interviewers in two field offices, 4) compare CATI and non-CATI telephone interviewing, 5) évaluate various supermicrocomputers, 6) develop an automatic scheduler, and 7) document and provide to SRS CATI source code.

The SRS/CSM CATI system consists of six closely related computer programs (Shanks et al. (1983) and Shanks (1983)). The two most important are the CATI executor and translator. The executor is used by interviewers, supervisors, coders and data entry personnel to display questions on the video terminal and accept responses in textual form. The program "executes" the survey instrument to "produce" questionnaire data. The translator or language processor reads machine-readable survey instruments, including the interviewer schedule and all other computer-related specifications for each survey.

A high-level language called Q is used for instrument implementation. This language can be used to develop telephone instruments, heads-up data entry instruments and self-administered instruments.

This language-based instrument design places the responsibility of defining the logic of the data collection process on the instrument designer, rather than on a computer specialist.

All of the programs in the SRS/CSM CATI system are written in the C programming language and operate on hardware using a UNIX[3] or UNIX-like operating system. SRS chose to use supermicrocomputers[4] because of SRS's decentralized data collection from 44 field offices. These computers represent a cost-efficient approach to equipping all of the field offices with their own CATI hardware.

The minimal hardware configuration requires at least one megabyte of memory and an 80 megabyte hard disk. Each machine must have at least 16 ports, of which 13 are available for CATI interviewing. The remaining three ports are used for hardcopy output and communications with the mainframe computer. The machine should be fast enough to allow for no more than 1.5 seconds between an interviewer entered answer and a new question appearing on the screen.

SRS has acquired four separate Zilog hardware systems. One system is in headquarters and is used only for system enhancements and instrument design. The first test site for CATI was the California field office. Because we were concerned with possible hardware failure during CATI testing, a back-up system was also installed. The second test site, in the Nebraska field office, has been equipped with only one Zilog computer because the California and headquarters hardware has proved reliable. All 13 CATI ports are used for large SRS data collection efforts without degrading the system.

The cost of all computer hardware has been decreasing and the power of these computers increasing. Table 1 gives the costs for the primary CATI system in California purchased in November, 1982.

Table 1. Costs for the primary California CATI hardware system

Item	Quantity	Cost (U.S. $)
Multiuser computer 1 megabyte memory 80 megabyte hard disk 5.0 megahertz clock 16 operating ports 24 maximum ports	1	29 200
Cathode ray tube	13	18 200
Dot matrix printer	1	1 200
Communications Protocol converter 4800-baud modem	1	4 500
Total cost (including system installation)		53 100

With this system, California conducts operational CATI data collection. The cathode ray tubes (CRTs) represent over one-third of the total system cost. This high percent of total cost was intentionally incurred because SRS decided to equip the California office with the capability for office automation on the CATI hardware. With these CRTs such office functions as word processing, spreadsheet capability, graphics and database activities could be tested. This required CRTs with more capability than would have been required for CATI. CRTs used only for CATI cost $500–$800. This reduces the system cost to $45 300, an 8.5 percent reduction in total cost.

The cost of the Nebraska hardware, acquired in September, 1984, is given in Table 2 on the next page.

The cost of this system dropped by over $6 500. Most of this savings is caused by the reduced cost of the CRTs. The computer price was over $2 000 more. But this new computer is more than twice as fast, having an 11.0 megahertz clock for the Nebraska computer versus a 5.0 megahertz clock for the California computer. It also has double the hard disk storage and can be upgraded to 40 ports, 16 more than the California computer.

[3] UNIX is a trademark of AT&T Bell Laboratories.

[4] Currently these computers are Zilog Model 31 and 32 computers.

Table 2. Costs for the Nebraska CATI hardware system

Item	Quality	Cost (U.S. $)
Multiuser computer 1 megabyte memory 160 megabyte hard disk 11.0 megahertz clock 16 operating ports 40 maximum ports	1	31 500
Cathode ray tube	13	10 200
Dot matrix printer	1	1 000
Communications Protocol converter 4800-baud modem	1	3 800
Total cost (including system installation)		46 500

These cost comparisons are for Zilog supermicrocomputers only. The SRS/CSM CATI system runs on several other computers that use a UNIX or UNIX-like operating system, including several Digital Equipment Corporation minicomputers and, most recently, the IBM–PC AT with a UNIX-like operating system and a 10 megabyte hard disk. For other organizations with a different organizational structure or different needs, one of these other types of hardware systems might be more appropriate.

Examples of other hardware configurations that run CATI software include mainframes, minis (Nicholls (1983b), Smith and Smith (1980)), and micros networked to a mini computer (Palit (1980)). Shortly CATI systems will be running on full-screen portable computers. SRS is planning to start a feasibility study late in 1985 to use its CATI system on these types of computers for face-to-face interviewing.

4. Data Quality Comparisons

SRS began experimentation with CATI after initiating the joint research agreement with CSM. It was CATI's potential to improve data quality that aroused SRS's interest in the technique. This section summarizes those improvements found in the 1983 split-sample test of the Cattle Dual Frame Survey in California (House and Morton (1983) and House (1984)). Wording differences between the CATI instrument and the original paper questionnaire were minimized to eliminate the effect such changes might have on the data analysis. The operational list frame sample was randomly split in two half-samples. After eliminating sample units without telephone numbers, the effective sample size was 614 on the CATI half-sample and 600 on the non-CATI half-sample. The interviewers were subjectively split into two teams of nearly equal experience and ability.

The analysis compares estimates of California cattle at two different stages of the processing. One comparison is of the data as they come from the completed interview, before any editing. A second comparison of the data is made after the data has been through the entire editing process and is ready for summary.

Seven representative inventory variables and response rates were chosen for comparison. Stratum totals for each variable were multiplied by the appropriate stratum expansion factors to produce overall totals and are presented in Table 3. The response rate was computed by dividing the expanded number of responses by the population total.

Table 3 also presents the results from multivariate and univariate tests. All test statistics are computed using replicate totals instead of individual data to avoid the complications of a stratified sample design in test procedures that assume a simple random sample. There are ten replicates across strata in each half-sample of data.

Results from two multivariate tests – Hotelling-Lawley Trace and Walks' Criterion – provided identical results and are presented in the table as a single statistic.

Table 3. Direct expansion estimates, multivariate and univariate tests

Variable	CATI	Non-CATI	% Relative Difference[1]	Significant Level for Difference (Prob F)
Sample Size	614	600		
Multivariate Tests				
Unedited	–	–	–	.06
Edited	–	–	–	.05
Response Rate	80.1	65.4	22.5	.00
Total Cattle				
Unedited	2 570 089	2 475 652	4.6	.36
Edited	2 505 691	2 541 160	2.1	.63
% EdDiff[2]	1.0	3.3	–	–
Total Beef Cows				
Unedited	514 833	581 498	–11.5	.26
Edited	518 025	581 907	–11.5	.28
% EdDiff[2]	.6	.1	–	–
Total Milk Cows				
Unedited	773 403	708 353	9.2	.11
Edited	782 698	731 942	6.9	.10
% EdDiff[2]	1.2	3.2	–	–
Total Other Heifers				
Unedited	70 806	59 455	19.1	.61
Edited	70 860	61 680	14.9	.68
% EdDiff[2]	.1	3.6	–	–
Total Steers				
Unedited	136 771	149 360	–8.4	.67
Edited	137 531	164 337	–16.3	.41
% EdDiff[2]	.6	9.1	–	–
Total Calves Born				
Unedited	1 038 447	1 020 273	1.8	.65
Edited	1 113 247	1 122 601	–.8	.92
% EdDiff[2]	6.7	9.1	–	–
Total Cattle Deaths				
Unedited	39 235	32 885	19.3	.04
Edited	40 283	33 918	18.8	.03
% EdDiff[2]	2.6	3.0	–	–

[1] % Relative Diff = ((CATI – Non-CATI) / Non-CATI) x 100 %.
[2] % EdDiff = ((Edited – Unedited) / Edited) x 100 %.

The multivariate tests for unedited and edited data were significant at $\alpha = .06$ and $\alpha = .05$, respectively. The alpha levels for three variables, response rate, total milk cows and total cattle deaths, were very low. Other inventory variables showed fairly large differences (the column titled % DIFF) including a relative 11 percent lower estimate of total beef cows for the CATI half-sample, a relative 15 percent higher estimate for the edited CATI half-sample of total other heifers, and a relative 16 percent lower estimate of edited total steers in the CATI half-sample.

The difference in response rates between the CATI and non-CATI half-samples is caused by the number of inaccessibles rather than the number of refusals – which is about 8 percent in each half-sample. The decrease in

the CATI inaccessible rate is attributed to better sample management. In attempting to develop the CATI automatic scheduler system (which has just been completed), the telephone supervisor constantly sorted through no answers, busy signals and callbacks and redistributed them to the interviewers to make maximum use of the interviewing stations. This resulted in a higher response rate.

Finally, from Table 3 the following relationships between CATI and non-CATI are observed. There are relatively large differences between CATI and non-CATI for individual variables but the direction of these changes differ and they tend to cancel each other out when combined. For example, two variables – total cattle, total calves born – are both sums of other variables actually reported by respondents. The average absolute difference between CATI and non-CATI for these two variables (including edited and unedited estimates) is 2.3%. In contrast, the average absolute difference for individually reported variables (beef cows, milk cows, other heifers, steers, cattle deaths) is 13.5%.

The effect of CATI on-line editing is not always consistent with the effects of SRS batch editing. Without exception, the SRS operational editing procedures have the effect of increasing the level of the estimates. These increases ranged from .1% to 9.1%. The effect of having CATI on-line editing versus non-CATI with no on-line editing increases the estimates of some variables and decreases the estimates of others.

The effect of editing was consistently greater on the non-CATI sample than on the CATI sample. The average increases were 4.5% and 1.8% respectively.

Table 4 displays counts of critical[5] and non-critical[6] errors from the SRS generalized edit programs that are generated for each data set. The CATI sample has 77 percent fewer critical errors than the non-CATI sample. Seven of the twelve critical errors from the CATI sample result from a consistency check inadvertently left out of the programming of the on-line CATI checks. This check has since been added. The remaining five indicate that the amount of feed fed to cattle-on-feed, although verified with the respondent, is too low to be classified as "on-feed" by SRS.

Table 4. Summary of edit errors

	Type of Error		
	Total	Critical	Non-critical
Total Error Messages			
Non-CATI	245	53	192
CATI	190	12	187
% Rel Difference[1]	22	77	3
Errors Corrected for Summary			
Non-CATI	84	53	31
CATI	20	12	8
% Rel Difference[1]	76	77	74

[1] % Rel Difference = ((Non-CATI – CATI) / Non-CATI) x 100.

There was a three percent difference in non-critical errors between the two data sets. However, because all inconsistencies were verified by the respondents during the interview for the CATI sample, there were 74 percent relatively fewer changes made to the CATI data than to the non-CATI data as a result of these error flags. Overall, there were 76 percent fewer corrections needed before summary on the CATI sample than on the non-CATI sample.

A similar split-sample test on the Hog and Pig Dual Frame Survey was conducted in Nebraska in June 1984. The results of that test are not yet available but will be published shortly by SRS in a technical report.

[5] SRS defines a critical error as an error that *must be* corrected before the data can go to summary, i.e., a change must be made.

[6] A non-critical error must be reviewed, but the data can go to summary without change.

5. Impact on Enumerators

Two new requirements must be met by potential SRS CATI interviewers. They are:

1. No fear, or willingness to overcome any fear, of the video display terminal and keyboard.
2. Some typing skill.

In the two test states about 30 telephone interviewers have been trained on CATI. Those not familiar with computers or with video display terminals exhibit some fear of the CATI system. The trainer must take the time and make the effort to help interviewers overcome this fear. Learning to use the CRT's and the CATI commands is a stumbling block for some interviewers. By dividing the training into three phases (introduction to the CRT, introduction to CATI, and practice interviewing) most interviewers overcome these fears. SRS has had only one interviewer refuse to do CATI calling.

As mentioned earlier, notes can be an essential part of a CATI interview. They can explain inconsistencies in data, give information about a respondent for callbacks or future interviews, or even explain new probes used during an interview. The length, location and clarity of these notes can all be affected by the interviewer's typing skills. The closer the note is to the item it refers to, the more useful the note.

In the California Test SRS did not observe any typing problems with its enumerators, but in Nebraska, for a small 200 interview pretest of the Hog and Pig instrument the quality of the notes was poor. They did not compare with the notes found on the paper version of the questionnaire. This difference was attributed to the lack of typing skills for some of the Nebraska interviewers.

Once these two new requirements are overcome, there is only one interviewing problem that must be accounted for by intensive training. This problem concerns edit and consistency checks. In paper questionnaire interviewing, edit checks are made when the interviewer recognizes a potential inconsistency or error. This mental recognition of the problem helps the interviewer in preparing probes to clearup the inconsistency. With CATI a potential error can appear on the video display without any advance recognition on the part of the interviewer. Even though a suggested probe(s) is displayed, the interviewer must take the time to react to and understand the problem. This may be long enough to disturb the flow of the interview. Having the respondent hanging, waiting for the interviewer to ask a question, disrupts the interview. This situation can be overcome by an intense and thorough training session. The interviewers must be put into situations where these "rare" edit checks and suggested probes appear.

6. Other Uses of CATI Software

SRS has developed CATI instruments for ten different surveys. While the development of these instruments represents the main use of the CATI software, SRS is investigating other applications. These applications include:

1. Call-in of face-to-face interviews
2. Direct data entry
3. Self-administered questionnaires.

In the first application of CATI software, call-in of face-to-face interviews, a CATI instrument is used by field office staff to obtain completed face-to-face interviews from the personal enumeration staff. This allows the interviewers to spend two or three more days in the field collecting data since the time that was required to mail the completed questionnaires to the field office is eliminated. Typically, these questionnaires are for respondents that did not respond to a mailed questionnaire or were not available for a telephone interview.

The primary advantage of this procedure is to reduce the inaccessible, (i.e., not available) rate in SRS surveys. Two other advantages are

the on-line edit and consistency checks that CATI performs for the field staff and the elimination of the need to enter the data into storage media by the data entry staff. The former advantage improves the quality of the data. Questions can be asked and usually resolved with the face-to-face interviewer. This is important in the last few days of data collection when recontacting the interviewer or the respondent may be difficult. This also saves time. The completed questionnaire is put into storage media as it comes into the office. Handling time, for check-in and hand edit, is eliminated. This procedure can be used on a relatively large percentage of the sample, for instance when mail and telephone completion rates reach 75 percent.

The second application of the CATI software being investigated by SRS is "heads-up" data entry. "Heads-up" means data entry with edit. The emphasis is on quality. This is different from high speed "heads-down" data entry where the emphasis is on quantity. This new heads-up data entry represents a reversal in the SRS philosophy of data edit. Prior to the availability of computers SRS used a large clerical staff to edit each questionnaire carefully when it came into the office. Although the concept of a limited initial hand edit has always been retained, the emphasis has changed to getting data into machine media. CATI software brings these concepts full circle with the emphasis on editing data as it is put into the computer.

The third application of CATI software, self-administered questionnaires, is used by SRS in the maintenance of list sampling frame units. Names, addresses, telephone numbers, and control data are regularly updated in this process. Prior to the availability of CATI software, updates and changes to list sampling frame units were made in two steps: the first required entering a change on a coding sheet and the second entailed keying in the change from the coding sheet. These steps were completed without machine edit. CATI combines these steps and insures accurate entries by simultaneous entry and editing. Regarding self-administered questionnaires, the following has also been demonstrated by SRS. State estimates and comments are supplied to headquarters by statisticians in each field office. Currently, this process involves coding fixed-field, 80-character records with these estimates and comments, key entering these records and finally, the execution of a batch process to transmit the data to headquarters. The CATI software can modify this process in several ways. First, the statistician is prompted to enter the data with a user friendly menu. This removes many potential errors in entering estimates and comments. Second, the separate step of key entry is eliminated. Finally, the process can be completed with the usual CATI on-line edits. This application of CATI has been demonstrated for the SRS quarterly grain storage survey. Shanks and Tortora (1985) describe several extensions and generalizations of CATI software to the survey process.

Because of the potential for improved data quality and the flexibility of CATI software, SRS has planned the implementation of CATI into its operational program.

7. Future of CATI in SRS

As a result of the two-state CATI evaluation program, SRS has decided to implement CATI in its 44 field offices. The first phase of this implementation plan will result in 20 CATI offices. The second phase covers the remaining offices.

The first step in this plan is the development of manuals on training procedures, system operation and instrument development. This should result in a standard operating procedure for CATI in SRS. The second step is the training of field office staff to conduct CATI surveys at regional training schools. Each field

office will conduct several monthly CATI surveys to increase its proficiency with CATI. To minimize overhead costs the hardware will be used for CATI and high speed data entry. The hardware will arrive in nine field offices no later than September 1985. Nine other field offices will receive CATI hardware one year later. By January 1987, these 18 field offices, plus the original two test sites, will be operational CATI sites. The remaining 24 field offices will be operational CATI sites by January 1989.

At least two new issues arise in survey practice as a result of CATI. The first issue has already been mentioned. It involves the office management of the hardware when it is used for more than just CATI. SRS will use this hardware for data entry and survey management functions like list frame update and maintenance. Authority will be given to one individual in each field office to manage the system so that conflicts are avoided.

The second new issue coming out of CATI goes beyond SRS. This issue involves questionnaire clearance. This responsibility is assigned to the Office of Management and Budget (OMB) for all U.S. surveys. Currently, each U.S. federal agency provides OMB with a copy of the paper questionnaire, survey objectives, survey design, etc. for each survey. OMB then clears, i.e. gives authorization for the survey, after a review that approves questionnaire design and wording, sample design, etc. But how will OMB deal with CATI instruments? A four page paper questionnaire easily becomes a 40-page CATI instrument when edit checks and probes are included in the instrument. Will OMB be able to review this instrument without a flow-diagram or without hardware to test the instrument? When CATI and non-CATI interviews are conducted for the same survey, how closely must the two questionnaires match? How will OMB understand different U.S. CATI systems? How will it be able to understand the different instruments for any given agency? For example, to understand SRS instruments, OMB must know the Q language. To understand Census Bureau instruments OMB must know the QUIS C language. Will OMB have employees trained by each agency to know these CATI systems? These questions have not been addressed by the U.S. statistical community, but because SRS, the Census Bureau, and the Bureau of Labor Statistics are all developing CATI capability, OMB must develop a policy.

8. Summary

This paper describes the evaluation, testing and implementation of CATI in the Statistical Reporting Service, U.S. Department of Agriculture. Advantages and disadvantages of CATI for agriculture surveys are discussed. The success of CATI, particularly with respect to data quality, demonstrates the potential for the use of this technology for ongoing agricultural surveys.

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