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Comparing and combining survey modes and data

Maintaining best practice: an investigation into the suitability of Computer Assisted Personal Interviewing (CAPI) for the Sydney Household Travel Survey

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1. INTRODUCTION

The Survey

This paper presents an investigation into the suitability of Computer Assisted Personal Interviewing (CAPI) for the Sydney Household Travel Survey (HTS).

The HTS is a continuous survey conducted by the Bureau of Transport Statistics (BTS). The survey collects data on travel made by members of randomly selected households. The study area is the Sydney Greater Metropolitan Area (GMA). This area is approximately 25,000 square kilometres and a population of 5.7 million persons. Since 1997 the survey has been continuous, running every year, where the last day of the previous survey is followed by the first day of the next survey. Prior to this surveys had been conducted every ten years since 1971. The annual gross sample size of the HTS is approximately 5,100 households, the target population is all residents of occupied private dwellings within the study area.

The survey provides an evidence base for informed decision making towards core state government projects and programs. It is used to examine general transport trends in the GMA and undertake detailed analysis of particular geographic areas or transport corridors. The data is a primary input to the BTS' Strategic Travel Model which produces forecasts of personal travel demand.

The data collection method is face-to-face paper and pen interviewing (PAPI), a method that has been employed since survey inception. Through the use of a travel diary, all persons within a selected household record their travel behaviour for a 24 hour period and are subsequently interviewed to record their detailed travel information.

A changing environment

Primary reasons for shifting the HTS to a continuous survey in 1997 related to timeliness, quality of data, and administrative and institutional reasons which impacted on the political climate for the operation of the survey (Battellino and Peachman, 2001). The primary goal for the then Transport Data Centre was to provide current, high quality data in a cost effective manner to inform transport planning and the policy making process.

Whilst the HTS has continued to deliver high quality estimates, the institutional environment in which the survey operates has changed markedly. In 2011 transport departments within NSW underwent significant reform and were streamlined into a cluster, with Transport for NSW as the lead agency. Transport planners and policy makers from service operating agencies were brought together to encourage collaboration and facilitate an integrated approach to planning and programs.

The BTS is placed within the Planning and Program division of Transport for NSW. A key goal of this division is to use a strong evidence base to establish links between planning, land use and the development of the transport system. This corporate requirement and the availability of 17 years of historical data has driven continued demand for high quality travel data, to improve survey delivery timeframes, the need for a more responsive and flexible questionnaire to reflect the changing transport environment, and the potential to integrate with new travel data sources such as electronic ticketing.

Acknowledgement
This paper acknowledges the contribution of the Hunter Research Foundation (HRF). HRF has undertaken the HTS fieldwork since 1997, and continue to perform the survey fieldwork for the current 18th wave (2014/15) of the survey. They also performed the HTS CAPI pilot fieldwork detailed within this paper. Their diligent approach to performing the required services and provision of fieldwork has greatly assisted the delivery of this paper.

2. Computer Assisted Personal Interviewing

Summary of benefits and challenges
The benefits of CAPI have been well documented and can be considered to provide advantages for key survey components. Crocker et al. (1999) and Laurie (2003) both identified reasons for moving to CAPI include the potential to improve data quality, survey data delivery timeframes and significant savings in fieldwork cost, especially for longer term surveys where the initial development cost can be recovered over time. Stopher (2012) is more detailed in identifying the removal of manual data entry, the simplified progression through a survey for the interviewer, the capability to build-in answer checks into the instrument and to reduce item non response.

Whilst the benefits can be significant, CAPI can also provide many challenges that need to be addressed. These challenges can be largely dependent on the design requirements of the survey and the information required. Caeyers et al. (2010) state the success of CAPI is dependent upon the effort spent programming, piloting and testing the application. This technical challenge is acknowledged by Watson (2010) who recognises that questionnaire development and the testing of scripts can be time consuming in a CAPI environment. There was also recognition of a major effort required to harmonize data collected from previous waves using a different collection instrument. Crocker et al. (1999) provide further insight to the whole of survey process, recognising changes required to interviewer training, potential occupational, health and safety concerns for interviewers, the impact on the roles of internal staff, the need to address data security and the provision of an appropriate interviewer support structure.

CAPI and the HTS
The PAPI collection method has served the HTS well, allowing for fieldwork and interviewer continuity, and identified learning's are able to be readily applied each wave. This has fostered resource stability within the BTS and the fieldwork agency. However, a PAPI method also continues to present a number of risks to the delivery of high quality data, including:

- Data recording error at point of collection where there are minimal safety nets for interviewers and errors can be repeated throughout collection and processing.
- An inefficient paper questionnaire that interviewers manually navigate and duplicate information is recorded within a household.
- Untimely data release due to a separate data entry phase and exhaustive data processing
- Inability to utilise and incorporate technological advances, particularly in regards to the capture of street address information.
- Respondent perception that the survey is not moving with the times. The population is increasingly technologically savvy and aware that there are many forms of electronic data collection available to use.

While the survey continues to deliver high quality data, the BTS continues to monitor industry best practice for travel surveys. This includes methods for conducting a survey and the design of survey instruments. BTS has found that best practice cannot always be standardised, with the HTS it is accommodating a balance of the survey's objectives, user needs and the information required, resource and budget availability, and acceptable data quality.

To better understand the credentials of a CAPI methodology, a pilot survey was commissioned to test the suitability and viability of conducting the HTS fieldwork using a CAPI survey instrument.

3. HTS CAPI Pilot

Background

The purpose of the pilot was to provide evidence to assist BTS to evaluate the suitability of CAPI as a data collection instrument. Primarily this was to be achieved through understanding the impact the CAPI instrument had on data quality, survey efficiency and cost for the HTS program.

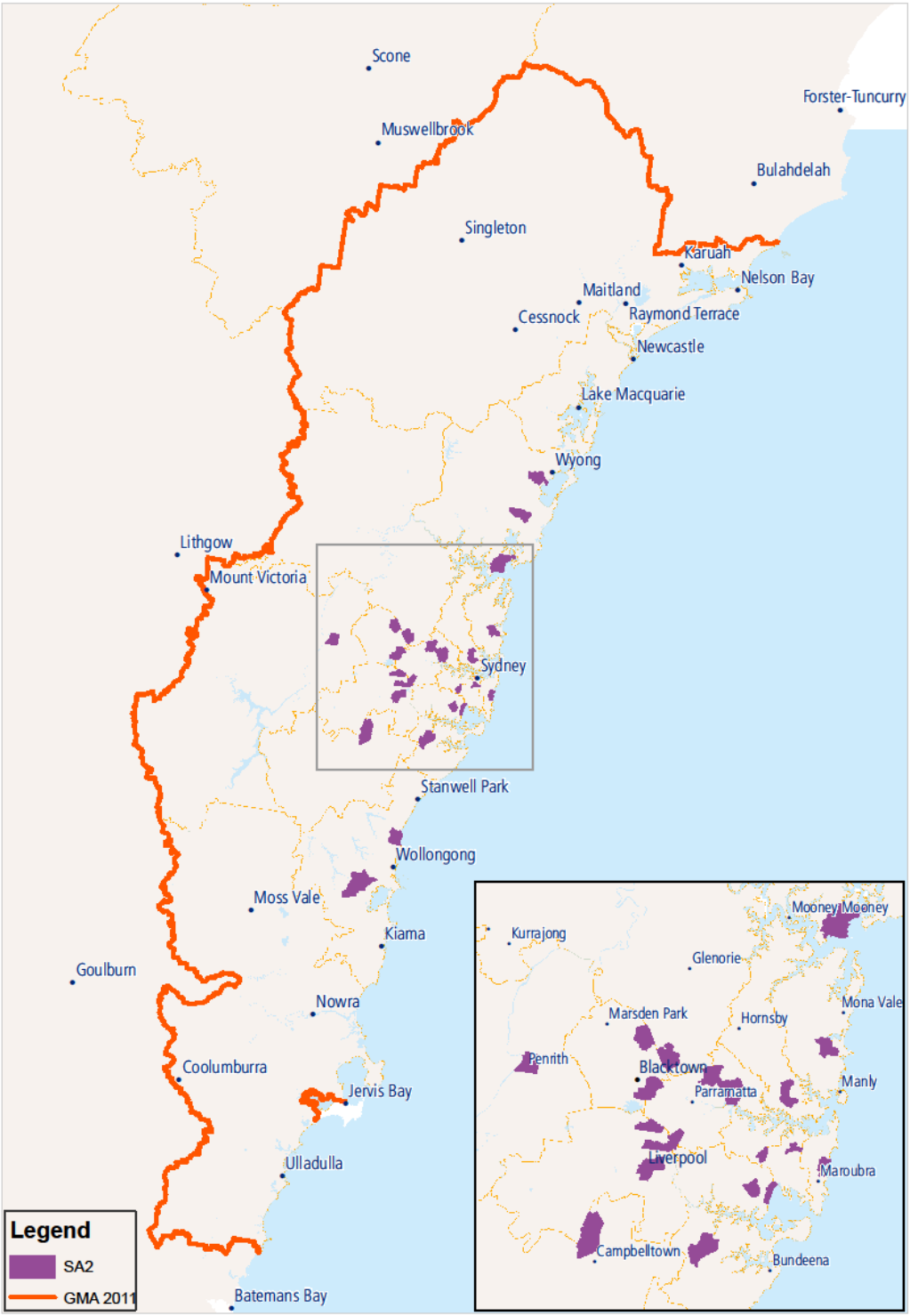
HRF performed the pilot fieldwork, including the primary development of the instrument hardware and software. As HRF was the agency responsible for the regular HTS fieldwork, this provided the opportunity to maintain a number of consistencies between the pilot and the regular wave, including established survey procedures, protocols and project staff (management team and interviewers).

Design

The CAPI pilot ran in parallel with the regular PAPI wave of the HTS. To maximise the transfer of survey knowledge the regular wave project structure was maintained, including staff management, field interviewers and survey procedures. This assisted to minimise the impact on measurable outcomes and permitted the regular wave to act as a control sample and facilitate identification of CAPI effects on the survey.

A gross sample size of 182 households was specified, this represented 3.6% of the regular wave gross sample. The sample selection was driven by the existing regular wave sample, with the CAPI sample effectively shadowing the PAPI sample. Figure 1 demonstrates the survey study area and the geographic location of the sample. Whilst the sample locations tend to be clustered, this is reflective of the population base and topography of the study area. The household population is predominant in the Sydney Metropolitan Area and eastern coastal fringes.

Figure 1 – HTS study area and CAPI pilot locations



Instrument Design – hardware and software

A Motion Computing F5V ruggedized tablet was selected for the pilot. Whilst there were many factors affecting choice (durability, size, screen quality), primarily the decision was based on the tablet's processing capability and physical durability in the field. To assist fieldworkers a carry strap, spare battery, spare stylus and laptop carry bag was provided.

VOXCO software was used to program the questionnaire, a specialist survey software that could accommodate the design demands of the HTS questionnaire and be utilised in a mobile environment. HRF also possessed previous experience in utilising VOXCO through their computer assisted telephone interviewing survey program.

To accommodate existing survey conventions and questionnaire sequencing the program was designed closely on the existing PAPI form. This also assisted interview staff who were familiar and skilled with the survey in the PAPI form. To assist data validation at point of interview a number of logic and range checks were incorporated into the program, these checks were based on data variable importance and the existing survey editing specifications[1].

As part of the design process, a number of design parameters were agreed. This was due to software limitations in meeting the complexity of the survey and project timeframe constraints:

- Maximum of six adults and five children per household
- Maximum of 25 trips recorded per person
- Completed interviews could not be amended
- Minimum capability to amend data during an interview
- No provision of look-up tables for trip destinations (e.g. street addresses)

Field Planning

Of the 26 interviewers working on the regular wave HTS, nine interviewers were selected and agreed to participate in the pilot. In conjunction with their regular PAPI duties, the interview team also performed interviews for the CAPI pilot.

A comprehensive training day was undertaken for all interviewers. As interviewers were already experienced in the PAPI survey form, the training concentrated on learning the CAPI hardware and software, navigating the instrument, trouble shooting and support networks, and the importance of recording feedback and evaluation. Based on survey experience, thorough scenario testing was undertaken to familiarise interviewers with likely interview scenarios and how to record information into the CAPI instrument.

Sample achieved

Fieldwork occurred over a two month period, household travel dates were between 24 June 2012 and 8 September 2012 inclusive. Table 1 demonstrates the gross and net sample achieved. For the CAPI pilot there was a net sample of 174 households and a total of 321 person interviews completed. For the PAPI control sample the net sample was 176 households and 335 person interviews completed.

[1] The HTS questionnaire exists as three different forms (household, adult, child) and in its entirety is considered a lengthy survey, this coupled with the project timeframe did not permit the development of a conclusive program of range and logic checks.

Table 1 – CAPI and PAPI samples

	CAPI pilot	PAPI control
Household gross sample	182	182
Household sample loss	8	6
Household net sample	174	176
Adult forms completed	254	275
Child forms completed	67	60
Total person forms completed	321	335

Response rates

For the survey, two response rates are commonly used, a response rate based on fully responding households and a response rate based on full and part responding households. A full response is where all members of the household answer all questions, including demographic and trip data[2]. A part response is where at least one adult member in the household has provided all core data.

Table 2, demonstrates the full and part response for recent waves of the survey, the CAPI pilot sample and PAPI control sample[3].

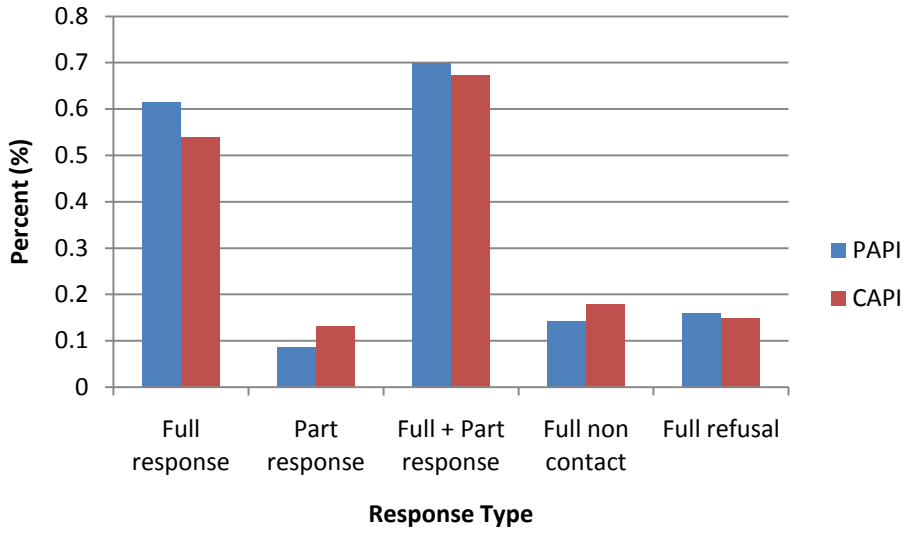
Table 2 – CAPI and PAPI, full and part response rates

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	CAPI pilot	PAPI control
Full Response	59.3%	61.3%	58.8%	58.1%	58.4%	59.5%	54.0%	61.4%
Part Response	6.9%	6.1%	7.1%	7.9%	8.8%	9.6%	13.2%	8.5%
Full + Part Response	66.2%	67.4%	65.9%	66.0%	67.2%	69.1%	67.2%	69.9%

The CAPI pilot recorded a 54.0% full response rate, lower than the PAPI control (61.4%) and previous PAPI waves of the survey. The primary difference was a higher part response and full non-contact for the CAPI pilot sample. Figure 2 presents a more detailed response rate comparison between CAPI pilot and PAPI control samples.

[2] Refusal to a select number of sensitive questions such as income is permitted and only the last non-responding person in an otherwise fully-responding household may be interviewed by telephone.
[3] The PAPI control sample is a subset of the 2012-13 wave.

Figure 2 – CAPI and PAPI, detailed response rates



Whilst it is preferable to achieve a higher full response rate, depending on the quality of data collected, part response data can be included in a final wave dataset. Historically this has occurred as it provides a stronger representation of those persons residing in larger households and to exclude valid records conflicts with the time and cost expended to collect the data. In comparing the full and part response rate for the CAPI (67.2%) and PAPI (69.9%) samples, the difference is much reduced. It is also noted that there was a methodological difference between the samples where the CAPI pilot did not allow for phone interviews, in the PAPI sample there were three fully responding households that were completed by phone.

Within the part response CAPI sample, fieldworkers reported a small number of households (five) where interviews with all household members could not be obtained due to the constraints of the CAPI instrument. Reasons for this included an interview being terminated as the respondent became frustrated in not being able to copy duplicate trip information, a respondent provided incorrect travel information and the instrument was not able to amend the reported data, and difficulty in including additional household members.

In regards to full non-contact, the difference was six households and the fieldworkers reported no evidence that suggested an association between the CAPI instrument and the result. The CAPI sample did include a higher number of security dwellings[4]. Historical survey evidence suggests these dwellings will tend to report lower response rates due to difficulty in directly accessing the household.

While the PAPI response rate is slightly stronger than the CAPI pilot, in consideration of the full and part response and minor methodological difference, it is concluded that there is no evidence to suggest the change in instrument has impacted the response rate. This conclusion is in line with previously reported findings where a change in mode had minimal impact on a survey's response rate (De Leeuw et al., 1995; Schräpler et al., 2010; and Watson and Wilkins, 2011). In the 1993 CAPI trial of the British Social Attitudes survey there were slightly more refusals in the CAPI sample, though when taking into account the clustered nature of the sample, the difference did not achieve significance

[4] Security dwellings are recorded to identify those households where house door access cannot be attained by the fieldworker, this can include units and apartments with a secure main front door and semi-rural properties with secure front gates.

(Lynn, 1998). Schräpler et al. (2010) analysis of the probability of respondents participating in the next wave of the German Socio-Economic Panel (SOEP) following a CAPI interview did not produce significant negative effects on the participation rate.

Quality Assurance

As per regular PAPI processes, a number of quality assurance measures were implemented to monitor interviewer performance. This included in-field monitoring where the field manager accompanied interviewers to ensure correct survey procedures were being maintained and the validation of workloads where a minimum of one responding household was contacted for each interviewer's workload. A total of 19 supervised household visits were completed (10.9% of net household sample) and a total of 31 phone household validations were completed (17.8% of net household sample).

Demographic data

The demographic characteristics of the PAPI and CAPI samples have been compared to review differences between each sample collected[5]. Table 3 demonstrates a comparison between gender, marital status, dwelling structure, household type and number of household residents. To test the statistical significance for each variable between the samples, the p-value test at 5% (p<=0.05) level of significance was used. As there is no p-value less than or equal to 0.05, it is concluded there is no statistically significant difference for the shown demographic variables between the two samples.

Table 3 – Comparison of demographic characteristic distribution between CAPI and PAPI

	CAPI	PAPI	Diff	p-value
Gender				
Female	53.2%	49.1%	4.1	0.147
Marital Status				
Married	46.5%	46.2%	0.3	0.464
De facto	3.9%	4.7%	-0.8	0.309
Separated	0.3%	0.9%	-0.6	0.164
Divorced	4.8%	3.8%	1.0	0.261
Widowed	3.9%	3.8%	0.1	0.472
Never married	40.5%	40.6%	-0.1	0.488
Dwelling structure				
Separate house	79.1%	79.7%	-0.5	0.460
Semi detached	12.2%	13.8%	-1.6	0.352
Flat/unit	7.8%	6.5%	1.3	0.345
Household type				
Persons living alone	14.8%	17.9%	-3.1	0.258
Couple only	24.3%	25.2%	-0.9	0.440
Couple with unmarried children 15+	13.9%	9.8%	4.2	0.161
Couple with children 0-14	21.7%	22.0%	-0.2	0.484
Couple with children o-14 and unmarried 15+	6.1%	6.5%	-0.4	0.448
One person with unmarried children 15+	5.2%	8.1%	-2.9	0.184
One person with children 0-14	0.9%	0.0%	0.9	0.149
One person with children 0-14 and unmarried 15+	0.9%	1.6%	-0.8	0.302
Other households	12.2%	8.9%	3.2	0.209
Usual number of household residents	2.88	2.76	0.12	0.527

[5] Comparison is the characteristics of respondents only, Table 2 and Figure 2 present each sample's response rates.

Trip data

The difference between PAPI and CAPI samples was further reviewed through investigation of the trip data collected. The p-value test at 5% (p<=0.05) level of significance has again been used to test the statistical significance between the collected data. Table 4 demonstrates the difference between trip purpose, trip mode, trips per person and per household, proportion of non mobility trips performed (zero trippers), trip distance and number of household vehicles.

Table 4 – Comparison of trip characteristic distribution between CAPI and PAPI

	CAPI	PAPI	Diff	p-value
Trip purpose				
Change mode	15.7%	16.4%	-0.7	0.181
Home	30.2%	30.4%	-0.2	0.409
Go to work	5.4%	5.8%	-0.4	0.181
Return to work	1.5%	1.3%	0.3	0.113
Work related business	3.4%	3.3%	0.1	0.421
Education	2.0%	2.2%	-0.2	0.203
Shopping	11.4%	10.5%	0.9	0.068
Personal business/services	2.9%	3.2%	-0.4	0.152
Social/recreation	15.6%	15.3%	0.2	0.363
Serve passenger	11.2%	11.1%	0.1	0.440
Trip mode (priority)				
Vehicle driver	43.8%	43.7%	0.1	0.480
Vehicle passenger	25.6%	21.5%	4.2	0.007*
Train	5.4%	4.3%	1.1	0.106
Bus	2.7%	2.4%	0.3	0.291
Ferry	0.2%	0.1%	0.2	0.142
Taxi	0.2%	0.3%	-0.1	0.390
Walking	21.6%	26.2%	-4.7	0.003*
Bicycle	0.2%	1.3%	-1.1	0.001*
Number of trips per person	3.9	4.0	-0.1	0.740
Number of trips per household	10.5	10.5	0.0	0.965
Zero trippers	16.6%	19.4%	-2.9	0.174
Trip distance (total)	35.6	35.3	0.3	0.930
Number of vehicles per household	1.65	1.80	-0.15	0.268

The person and household trip rates and road distance are key survey estimates, all three have shown a distinct similarity with no statistically significant difference between the samples. Another key estimate, the mode counts (number of trips), revealed statistically significant differences for vehicle passenger, walking and bicycle. This finding may be attributable to the size of the sample achieved and that the sample design is household based.

The proportion of zero trippers in the CAPI sample is lower than PAPI but the difference was not found to be statistically significant. This measure of non-mobile persons in the sample is regularly used to monitor data quality. Apart from identifying those persons who have not performed any activity on their travel day, it also acts as a verification tool to ensure persons are not deliberately specifying nil travel to reduce their commitment to completing the survey. This use as a measure of data quality is supported by Stopher et al. (2006) who conclude that non-mobility may be used by respondents as a benign form of non response. Table 5 demonstrates the proportion of zero trippers in

the CAPI and PAPI samples, whilst the PAPI control is slightly higher, it is still historically in line with what has been reported for previous waves.

Table 5 – Proportion of zero trippers between CAPI and PAPI

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	CAPI pilot	PAPI control
Zero trippers (proportion of)	16.5%	16.4%	16.1%	15.6%	17.5%	16.3%	16.6%	19.4%

During the fieldwork no evidence was found to suggest there were any respondent issues affecting their ability to report trip data. There were instances where all trip data was not recorded into the CAPI instrument at time of interview, as the instrument did not permit re-access this information was separately recorded and reported. This occurred for four respondents and a total of nine trips. All of these trips were subsequently added and included in the final dataset.

Item non-response

Two types of item non response were investigated between the samples, sensitive information and responses to street address information.

Age is a key variable within the survey as it is integral to the weighting and expansion process. The question is located within Form 1 Household and is requested of all household members at the time of initial recruitment. A missing value for age can occur through respondent refusal or if the interviewer forgets to ask this question. No missing age value occurred in the PAPI sample, whilst two missing values were observed in the CAPI sample. It is likely the interviewer was unable to attain the information at the time of the initial household interview and subsequently forgot to request this information during the personal interviews.

Another form of sensitive information is income, this is one of the few questions where a refusal is accepted and the household can still be considered fully responding. The PAPI sample reported seven refusals and the CAPI sample eleven refusals. Given the small number of refusals for similar net sample size, it is concluded the CAPI instrument is unlikely to result in a higher rate of refusal for this variable.

Previous studies have indicated mixed results for respondents providing sensitive information in a CAPI environment. Randomised experiments comparing PAPI and CAPI for the US National Longitudinal Survey of Labour Market Experience/Youth Cohort (NLS/Y) found evidence to suggest that respondents view CAPI as providing more assurance of confidentiality than PAPI and thus were more forthright in responding to sensitive questions (Baker et al., 1995). However a CAPI experimental design for the German SOEP found CAPI interviews have a slightly higher probability of refusals for income than PAPI interviews (Schräpler et al., 2010). This was similar to the experience of the British Household Panel Survey following a conversion to CAPI where particular groups demonstrated reluctance to answer income questions (Laurie 2003).

A select number of variables were tested for the ‘don’t know’ response. For one variable, street number for job street address, it was found that the CAPI sample was much higher than the PAPI sample with fifty-six occurrences compared with five. It was concluded that the difference in data quality was not related to respondents adversely reacting to the CAPI instrument, rather a result of the

clerical intervention that occurs in the PAPI environment where interviewers and office staff routinely investigate street addresses using secondary information. The high number of ‘don’t know’ responses reported for CAPI does suggest that the survey program would benefit from spatial support, such as an established street address database or interactive mapping tool.

Literature suggests the impact on data item response due to the introduction of a CAPI instrument is predominantly positive. De Leeuw et al. (1995) found much of the improvement in data quality was the result of a well designed computerised questionnaire that facilitated fewer interviewer and respondent errors. Laurie (2003) also concluded CAPI reduced the level of missing data and also significantly reduced the extent of post field editing required to correct interviewer errors. Through a CAPI test, Watson and Wilkins (2011) identified a higher rate of ‘don’t know’ responses for items such as benefit income, and the effects on the distribution of key variables were also evident but were usually considered in a desirable direction.

There is also the consideration a questionnaire within a CAPI instrument requires change to enable respondent completion. For example, Watson (2010) comments that in the CAPI script each question now offers ‘don’t know’ and ‘refused’ options to enable the interviewer to continue to the next question if the respondent cannot or does not wish to respond to certain questions.

Street address quality

Street address quality is an important component of the survey, providing location information to understand personal travel behaviour at multiple geographic levels and the capability to estimate trip distance. Through the use of secondary location information all regular wave HTS street address data is cleaned and edited before being geocoded, a process of assigning a spatial (latitude and longitude) co-ordinate. During the pilot, both PAPI and CAPI samples underwent the same geocoding process. The quality of point geocoding can be impacted in many ways, including the design of the survey instrument, quality of respondent information, capability of the interviewer to illicit and report the required information and the internal capability to convert the collected information into a geocoded point.

As part of the sampling procedure all household street addresses are validated and confirmed prior to respondent recruitment. All other street addresses (non-household) are collected through interview following a respondent’s travel day. Both of these processes were maintained for the pilot.

Non-household addresses were recorded into a text field within the tablet, using the provided stylus or the embedded floating keyboard. There was no address file or supporting street verification information loaded to the software installed on the tablet. In transferring skills from a PAPI to CAPI environment the collection of street addresses was one of the more challenging tasks for the field team. In a PAPI environment they were comfortable with a paper form that had minimal change over the past decade and interviewers would record the street address using short hand, especially where the same address was reported for multiple trips and for multiple household members. The address would then be completed in full subsequent to the interview. Within a CAPI environment, the program required each field to be completed in full for each trip and did not permit the interviewer to revisit trips that had already been recorded.

In reviewing the quality of address information, it is noted that prior to data delivery the field agency cleaned the data, ensuring consistency of street types and amending apparent spelling errors.

As mentioned, during the regular PAPI wave, street address data is provided to the BTS Spatial Team to undergo further validation and to assign a spatial coordinate, usually xy coordinates. This process

ensures respondent information is converted to accurate location information and that the same address is coded consistently. To determine the level of street address accuracy the Spatial Team utilises a geocoder to rank the quality of address information. Table 6 details the geocoding hierarchy, based on the Geocoded National Address File.

Table 6 – Geocoding hierarchy of HTS geocoder

Address Type	Geocoding Type	Hierarchy Order
Transit Stop Number	Match to transit stop	1
Train Station	Match to train station	2
Ferry Wharf	Match to ferry wharf	3
Light Rail Station	Match to light rail station	4
Address	Match to Geocoded National Address File with suburb	5
Address	Match to Geocoded National Address File with adjacent suburb	6
Building	Match to building with suburb	7
Organisation	Match to organisation with suburb	8
Building	Match to building with adjoining suburb	9
Organisation	Match to organisation with adjoining suburb	10
Address	Match to StreetPro file with suburb	11
Address	Match to StreetPro file with adjoining suburb	12
Street Intersection	Match to intersection with suburb	15
Address – street centroid	Match to street centroid with suburb	16
Address – street centroid	Match to street centroid with adjacent suburb	18
Suburb	Match to suburb	20

The accuracy of street address is considered as follows:

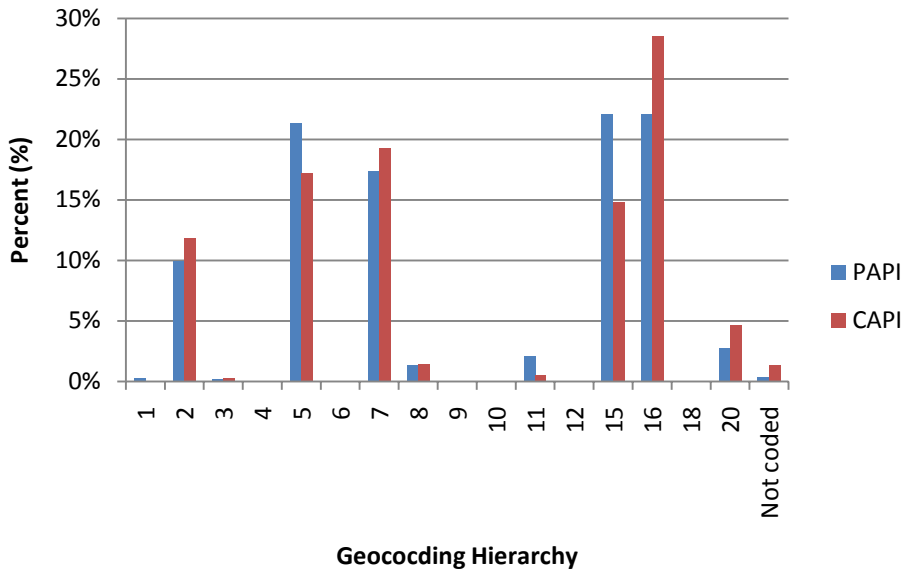
- High accuracy – Hierarchy 1-10 and 15
- Acceptable accuracy – Hierarchy 11-14 and 16
- Poor accuracy – Hierarchy 17-20

Pre Validation

Figure 3 demonstrates the quality of street address data prior to validation for both PAPI and CAPI samples. For example, for Hierarchy Order 2 the proportion of street addresses was 9.9% (PAPI) and 11.9% (CAPI). Overall, the quality of PAPI was higher than that of the CAPI sample with 72.6% of PAPI addresses collected considered to be of high accuracy, whilst the corresponding figure for CAPI addresses was 64.9%. For both samples there were a small number of addresses that were unable to be geocoded.

It is noted that this result is in contrast to the address quality achieved by other BTS commissioned CAPI surveys and may be attributable to the lack of reference to an address file at the time of interviewing during the pilot.

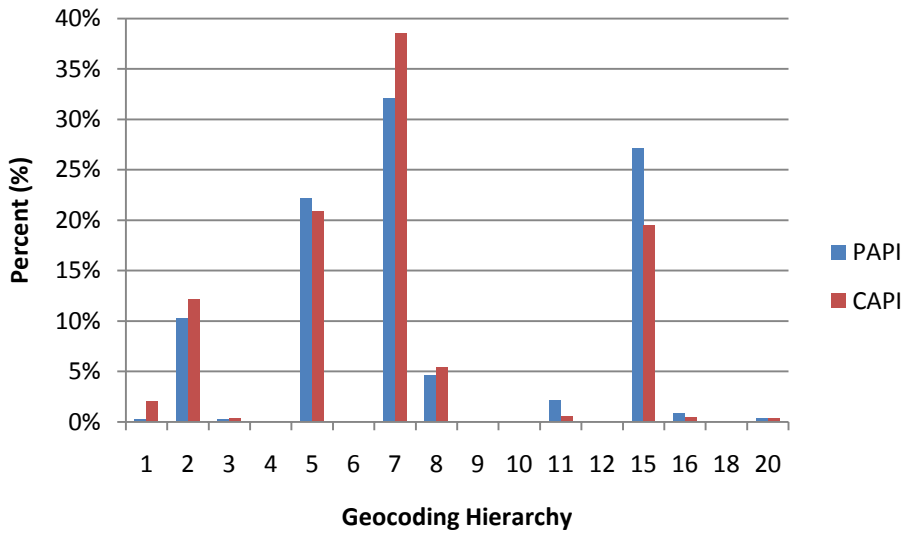
Figure 3 – Quality of street address data between CAPI and PAPI (pre validation)



Post Validation

Figure 4 demonstrates the quality of street address following spatial validation where all addresses were able to be assigned a spatial coordinate. The quality of both samples has been improved with 96.7% of the PAPI sample considered to have a high level of accuracy whilst the corresponding figure for CAPI is 98.8%.

Figure 4 – Quality of street address data between CAPI and PAPI (post validation)



Whilst there is minimal difference in the quality of the finalised (post validation) street addresses, it is evident there was a large discrepancy between PAPI and CAPI samples for the received (pre validation) data. For the interviewers this was an area of significant change in collection technique. In a PAPI environment, interviewers regularly employ a shorthand method, especially for duplicate addresses within a household, with the address being completed following the interview. This provides the interviewer the opportunity to ensure consistency and accuracy in the reporting of street

addresses. Within the CAPI environment, the data entry was more rigid, requiring complete entry for each trip at the point of interview and there was not the opportunity to revisit records to amend the submitted address or to ensure the consistency of duplicate addresses. There was also the occurrence of misspelt addresses and variations in street type formatting, for example interviewers submitting variations of street or road. In a PAPI environment this is reviewed following form submission and corrected at data entry.

Interview length

The CAPI instrument recorded the interview time for Form 2 and Form 3, Form 1 (household) was not implemented in the CAPI software[6]. As per regular procedure in a PAPI environment, start and finish times are recorded by the interviewer for each form. Table 7 demonstrates the average interview time in minutes recorded for recent waves of the survey, the CAPI pilot sample and PAPI control sample.

Table 7 – Average form interview time between CAPI and PAPI

	2007-08	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**CAPI pilot**	**PAPI control**
Form 2	15.0	15.2	13.9	13.8	13.8	13.7	15.1	12.1
Form 3	7.0	6.9	6.3	5.8	6.0	6.0	7.4	5.1
Average both forms	13.4	13.4	12.4	12.1	12.2	12.1	13.5	10.7

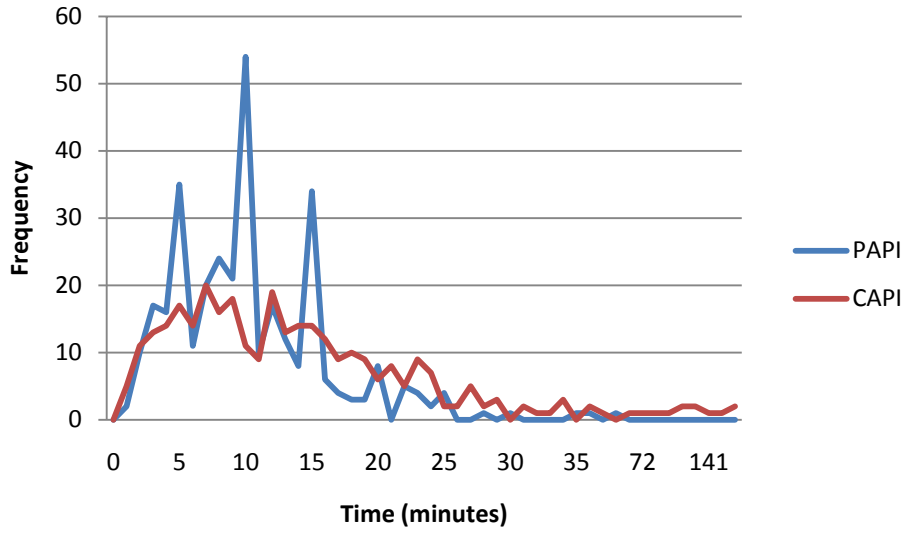
The pilot demonstrated that CAPI interviews were longer than the PAPI sample, for Form 2 24.8% longer and Form 3 45.1% longer. There are three primary conclusions for this difference:

1. The requirement for interviewers to record in full all street addresses for each household member into the CAPI instrument at time of interview, in a PAPI environment it is common practice for interviewers to use short hand and complete the address later,
2. Adjustment to the CAPI instrument for data entry, e.g. using virtual keyboard and stylus took time, particularly for interviewers with years of PAPI experience, and
3. The CAPI instrument records precise interview times whereas the PAPI records tend to be rounded by the interviewer.

Figure 5 demonstrates interview lengths reported for Forms 2 and 3 for both PAPI and CAPI samples. The PAPI interview length demonstrates clustered reporting at 5 minutes, 10 minutes and 15 minutes, indicating a rounding effect to the nearest 5 minutes. The reported CAPI interview length is much less volatile with no obvious time clusters. With the removal of this bias, the CAPI instrument demonstrates no obvious time rounding.

[6] Under PAPI the HTS consists of three forms – Form 1 Household, Form 2 Person Adult and Form 3 Person Child. Form 1 records information of the household and is completed prior to travel day, Forms 2 and 3 are completed subsequent to travel day.

Figure 5 – Distribution of reported interview length between CAPI and PAPI



Due to the rounded PAPI reporting it is difficult to deduce the real effect of the CAPI instrument on interview length. Considering the interviewer's inability to use shorthand to record street addresses, it is likely that the CAPI instrument interview length was longer than the PAPI equivalent.

Literature on the change in instrument impacting on interview length is varied. In an analysis of NLS/Y CAPI trial data, CAPI interviews were found to be shorter when compared to PAPI, 47 minutes compare to 57 minutes (Baker et al. 1995). Similarly the 1993 CAPI trial of the British Social Attitudes Survey (BSA) found that the mean length of interview times for CAPI was 45.5 minutes and 54.0 minutes for PAPI (Lynn, 1998). Caeyers et al. (2010) also found interview time was reduced by 10%, primarily due to the benefits of an automatic routing system and the use of drop down menus to select a response.

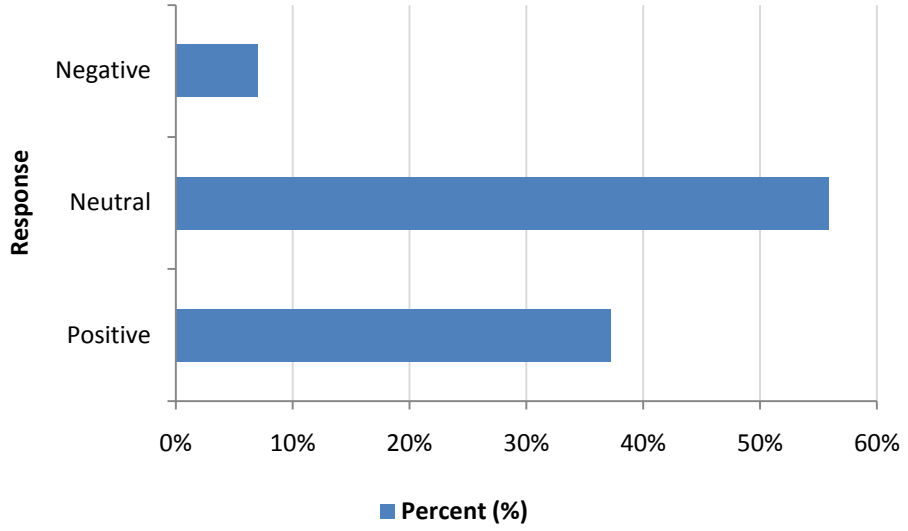
The HTS CAPI pilot findings are consistent with a comparison study by the US Census Bureau's National Health Interview Survey (NHIS) and a CAPI test for the Household, Income and Labour Dynamics in Australia (HILDA) survey that found on average the CAPI instrument took more time to collect the same information, 16.5% and 24%-35% respectively (Fuchs et al., 2000 and Watson and Wilkins, 2011). The BTS experience is similar to that of the HILDA CAPI test, deducing that much of the increase was likely due to the nature of the software used, including the interviewer's minimal experience, and their proficiency in minimising the time taken to administer the PAPI instrument (Watson and Wilkins, 2011).

It is interesting to note that upon mainstream survey implementation of CAPI into the HILDA survey the estimated net reduction in overall interview length was 3% (Watson and Wilkins, 2012). It was estimated that interviewers required approximately 50 respondents in order to achieve stable interview lengths.

Respondent reaction

Following the completion of interviews at each household, an interviewer had the opportunity to evaluate the household's reaction to the CAPI instrument. There were a total of 129 reactions reported with the majority of observations reported as positive or neutral. Figure 6 demonstrates the reported evaluation.

Figure 6 – Respondent reaction to use of CAPI instrument



Minimal information was reported of positive and neutral reactions. Detailed responses were primarily recorded of negative reactions, including:

- Concern of data collected and its use
- Concern with the associated expense
- Irritation with repetitiveness of the interview
- Interview length

It is noted the above responses relate to participating respondents and that the field agency also reported similar concerns within the PAPI sample. Overall, the field agency reported no evidence to suggest the CAPI instrument influenced a respondent's decision to participate.

Previous studies such as pre-testing and piloting of CAPI for the British Household Panel Survey found the reaction from respondents was positive with Laurie (2003) and Caeyers et al. (2010) reporting no difference in respondents' perceptions (such as degree of intimidation, perception of confidentiality). Following a change of mode to CAPI for the HILDA survey, indicators recorded by the interviewers demonstrated consistency with prior waves, with little or no impact on the interview situation (Watson, 2010).

Interviewer reaction

As with all face-to-face surveys, interviewers are integral to the field operation and overall outcome of the survey. During the pilot, interviewers recorded their experience, perceptions and recommendations through two forms – a diary and participation in a post pilot focus group session. The overall experience for the interviewers was that the CAPI instrument was initially not easy to use. However, by the conclusion of the pilot most had been able to adapt and there was a growing level of comfort in using the instrument.

Positive feedback included:

- Improved data completion
- Efficient submission of data
- Improved data security

- More professional appearance
- Better for the environment

Negative feedback included:

- Decline in quality of street address information recorded
- Decline in trip consistency between household members
- Restriction of the instrument
- Work, health and safety (WHS) concerns
- Reduced personal (eye) contact

Much of the interviewer concerns related to comfort factors that currently exist in the PAPI environment that were not replicated in the CAPI instrument. This includes the ability to record street addresses in short hand and complete later, the ability to readily move through multiple household forms to ensure trip consistency, and the ability to amend recorded data.

The health of interviewers was related to the weight of the instrument and subsequent discomfort of the neck, back, arms, hands and eyes was reported. Interviewers had to become proactive to ensure they were not standing for long periods, and where possible requested a seat or a more comfortable area to complete interviews. In regards to safety, some interviewers reported they felt more conspicuous and vulnerable carrying an electronic tablet. This was especially a concern at night where the brightness of the tablet drew public attention.

Interviewers also reported a general disengagement with respondents as they focused on the CAPI instrument, creating a reduction in eye contact and general respondent engagement. As interviewers became more comfortable and confident with the instrument this concern tended to dissipate throughout the pilot.

Much of the interviewer feedback is consistent with a review of the effect of computer assisted interviewing undertaken by De Leeuw et al. (1995). This review revealed that inexperienced interviewers can direct their attention to keeping the computer running and correctly typing answers, that the weight of the computer can sometimes be a problem, but in general interviewers and respondents are positive of the CAPI experience.

Evaluation of hardware and software

The ruggedized tablets provided a number of physical benefits that enabled the protection and security of data, including water resistance, a shock mounted hard drive and anti-reflective screens. The tablet provided a powerful processing capability to utilise the VOXCO software and to accommodate a large questionnaire. Despite these benefits, a drawback was the size and weight of the tablet. At approximately 2kgs, interviewers struggled to stand for any substantial time and regularly sought a comfortable environment to conduct the interview. Interviewers did report physical discomfort and WHS strategies had to be deployed during the pilot to minimise this impact on interviewers.

In designing the questionnaire a strategy was to replicate the PAPI form into the CAPI instrument, where much of the questionnaire layout and order remained the same. However, interviewer experience during the pilot revealed this design strategy was not always suitable in a CAPI environment. The pilot revealed the type of instrument used leads to a much different experience for both the interviewer and respondent. It became apparent that in adapting this survey for a CAPI instrument questionnaire design, screen layout and interviewer guidance are critical to a successful transition to a CAPI environment.

In transitioning to CAPI, the NHIS discovered that technology influences the interview flow, the question logic, the screen design and the interviewer's interaction with the instrument (Fuchs et al., 2000). Furthermore, it was concluded that a careful assessment of useability is required, including screen design trade-offs, interview coverage versus speed of interview, and ease of navigation versus logical consistency.

The instrument design did not allow for the review or correction of data entry, this was an agreed limitation with the service provider. However, it became evident throughout the pilot that for information such as travel behaviour, a respondent's recall can be prompted at other points throughout the questionnaire or by other responding household members. Not being able to correct or add a respondent's information throughout the survey became a hindrance to enable high quality and consistent household data collection.

Cost

It is challenging to provide a detailed cost comparison between the CAPI pilot and regular PAPI wave, much of the costing is relative to an agreed project delivery schedule with the fieldwork agency rather than explicit survey design requirements. However, it is evident that the allocation of budget for the 'whole of survey' is different for CAPI. Whilst there are gains with CAPI (no paper form printing, partially automated data entry) there are other areas which require greater budget, such as software development and ongoing technical maintenance. The initial set up cost for CAPI was much greater, requiring significant investment in hardware purchase and software development and testing.

The experience from the HTS CAPI pilot indicates that if a switch to CAPI was to occur, the project cost will be more substantial in the initial year to design and develop the hardware and software and to undertake associated testing. As this survey is continuous and contains a large questionnaire, it is anticipated that the initial investment would be recovered after approximately two years as the instrument becomes established and the benefits of CAPI realised. Such benefits include a more integrated whole of survey approach; facilitating integrated project management, a reduction in data editing and cleaning, the pre coding of responses, and other opportunities such as recording improved street address information.

Caeyers et al. (2010) confirm a similar experience, indicating CAPI has a larger fixed cost component for the upfront outlays of hardware purchase and software development. It is acknowledged that many of the variable costs incurred with PAPI, such as printing and data entry, are eliminated in CAPI. Baker et al. (1995) state that CAPI may be initially more expensive than comparable PAPI surveys but the cost difference is likely to decline as interviewers gain experience using CAPI. This is especially so for surveys with large questionnaires that can take advantage of the technical capabilities of CAPI.

During the pilot, the need for alternate skills and capabilities became evident. Under PAPI, the backend data entry phase is a significant part of processing and doubles as a point of data validation, reviewing travel behaviour within a household. Whilst this was not able to be thoroughly tested within the CAPI pilot, it is evident that with a fully functioning instrument the need for manual capabilities will be significantly reduced. This does not denote a reduction in personnel, rather a need for different capabilities, such as technical skills, to develop the questionnaire script and to provide ongoing maintenance. Within the BTS team, the skill set would predominantly remain, however it is likely that skills would be transferred into more value added areas. It is anticipated there would be increased time available to further analyse data, review survey performance and to ensure the timely delivery of data. It is also foreseen that if a geospatial function could be integrated into the instrument to capture street

address information, the BTS Spatial Team would then become data validators rather than data processors.

Cost savings should not be solely viewed in field operational and resource terms. Whilst it is difficult to quantify the impact of changing to a different form of collection, cost should also be viewed from a broader project perspective and how it aligns with the long term goals for the survey. There are many benefits that cannot always be quantified but add significant value, including a flexible survey instrument that can readily adapt to the changing transport environment, the capability to improve data delivery timeframes, and the capability to incorporate emerging technological functions such as geographic mapping tools.

4. Conclusion

The conduct of a CAPI pilot for the Sydney Household Travel Survey has largely confirmed the consensus of previous studies, that the CAPI instrument has had no effect on the survey's response rates. While there were differences between the samples for household full response, when considering both full and part response the difference was not statistically significant.

In regards to data quality, a main finding was the difference between PAPI and CAPI street address quality. According to the specified geocoding hierarchy, prior to internal spatial validation the PAPI street addresses were of a higher standard than addresses collected through the CAPI instrument (72.6% compared to 65.4% were considered as high accuracy). For all interviewers, it was recognised this was an area of significant change between PAPI and CAPI collection. Interviewers found it difficult to adapt to CAPI's rigid data entry structure where every field requires completion. There was also not the opportunity to amend submitted addresses or to copy addresses to ensure duplicate address consistency.

Interview length was another area of distinct disparity between PAPI and CAPI samples. A significant contributor to this was the number of data entry challenges for interviewers and the highlighted difference in quality of interview time reporting between PAPI and CAPI. Despite accounting for these differences, it is still likely that the CAPI interview was longer than the PAPI equivalent.

Through the use of diaries and a focus group debrief interviewers have provided an in depth response to their CAPI pilot experience. Their experience has been mixed and it is evident that many initially struggled with the change to a CAPI instrument. Much of this pertains to the comfort and knowledge of the PAPI survey form and embedded habits developed over time, such as using short hand. It is evident how the change in instrument has impacted on the interaction between interviewer and respondent, their satisfaction in performing their work and WHS concerns. Difficulties with data entry and reporting of trip street addresses have been well documented. It is believed these issues could be overcome through incorporating a wider scope of CAPI functionalities (such as use of supporting address databases or interactive mapping tools), through improved programming and testing, and more extensive interviewer training.

A significant outcome from the pilot is the direct impact a change in instrument can have on the field team for a face-to-face survey. Whilst much focus is placed on programming, questionnaire design, and data entry, there is also a direct impact on the field operation. This includes interviewer job satisfaction in performing their role and enjoying the interaction with households, their personal confidence to perform their duties to a high level, and their personal safety and workplace health concerns in carrying an electronic tablet.

This paper endeavoured to investigate the suitability of CAPI for the Sydney Household Travel Survey. Conducting the pilot survey has demonstrated CAPI can be considered a viable method to improve and add further value to the HTS. While the pilot survey has provided valuable insight, it is evident that not all possible CAPI features were utilised and that there were missed opportunities. Such opportunities and areas of improvement that would require further development if a transition to a CAPI instrument was to occur include:

- A choice of hardware that reduces physical stress for interviewers
- A choice of hardware that does not rely on virtual keyboard or stylus
- Investigating other potential software solutions that are more flexible in design and application
- Improved questionnaire design and screen layout
- Improved data capture, especially street address capture
- Improved capability to efficiently record duplicate trip and street address information

Literature suggests the application of the above opportunities is likely to improve the quality of data collected via a CAPI instrument. It is also evident from successful CAPI transitions that the time, expense and expertise invested will be rewarded by improved survey operations, including time saving efficiencies, real time monitoring of data collection and the flexibility to add in features or amend survey questions.

5. Glossary

BHPS	British Household Panel Survey
BSA	British Social Attitudes Survey
BTS	Bureau of Transport Statistics
CAPI	Computer Assisted Personal Interviewing
GMA	Greater Metropolitan Area
HILDA	Household, Income and Labour Dynamics in Australia survey
HRF	Hunter Research Foundation
HTS	Household Travel Survey
NHIS	National Health Interview Survey
NLS/Y	National Longitudinal Survey of Labour Market Experience/Youth Cohort
PAPI	Paper and pen interviewing
SA	Statistical Area
SOEP	German Socio-Economic Panel
WHS	Work health and safety

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