# Design and administration of activity-travel diaries: a case study from Bengaluru city in India

**M. Manoj[1] and Ashish Verma[1,2,*]**

[1]Department of Civil Engineering, Indian Institute of Science and
[2]Centre for Infrastructure, Sustainable Transportation and Urban Planning (CiSTUP), Indian Institute of Science, Bengaluru 560 012, India

**Studies on travel survey instrument design and administration in the context of Indian cities are limited despite the fact that these aspects of travel survey face unique challenges here when compared to the cities in the developed world. Here we report results of a pilot survey conducted for evaluating the performances, alternative diary formats and survey administration techniques in Bengaluru city, India. The study proposes two diary formats. 'Diary-1' is in day-planner format and is a variant of the one reported earlier in the literature. 'Diary-2' is derived as a combination of 'Diary-1' and the trip-based dairies widely applied in Indian cities. 'Face-to-face', and 'drop-off and pick-up' methods of survey administration are considered for retrieving the activity-travel information of individuals. Evidence appears to be strong that diary-2 is preferable to diary-1 for collecting the travel details of individuals. The comparison of the retrieval methods suggests that the face-to-face method of instrument administration is superior to the drop-off and pick-up method in terms of higher response rates and minimum recording errors.**

**Keywords:** Activity-travel survey, combined diary format, design and administration, transportation systems.

TRANSPORTATION planning has been gradually shifting its focus from capacity expansion to managing transportation systems with demand management strategies. Consequently, transportation planners demand minute details on activity-travel behaviour of individuals and comprehensive data collection approaches such as time-use surveys have become the need of the hour. Time-use survey data are necessary for calibrating activity-based travel demand models[1], which are being proposed worldwide for analysing the impacts of travel demand management measures. Time-use survey captures the information of in-home and out-of-home activities and travel details (if activity participation entails travel). Individual/household socio-demographic information is usually supplemented with time-use data. Extreme care should be given to the design and administration of survey instruments as the quality and quantity of data depend at large on these aspects of a travel survey[2,3].

Over the past years, the literature has seen substantial progress in the research related to survey instrument design and administration. Numerous studies have focused on introducing and/or comparing alternative travel diary formats for capturing the activity-travel information of individuals[2,4–9]. It can be concluded from these studies that a comparison between different diary formats is essential before selecting a particular instrument format for a study area. It is evident from the literature that instrument layout and question format also have a substantial role in ensuring the quality of the data[10–13]. Response rate of surveys is observed to vary with respect to survey administration methods[4,5,11,12,14–19]. It can also be inferred from the previous case studies that the performances of survey administration techniques can vary across different study areas or at different points in time in a study area[15–19]. Nowadays developed nations incorporate advanced technologies such as internet, GIS and GPS for survey administration[15,20–25]. However, the use technologies such as GPS often adds to issues[26] such as breaching privacy, respondent burden due to survey recalls, and additional survey costs; most of them remain unsolved. The literature from developed nations also shows that a combination of different survey administration techniques can be implemented for addressing the shortcomings of (a) particular administration procedure(s)[15,27–29].

Case studies highlighted in the literature[3–29], all of them from developed nations, show that dissemination of survey design experiences is relevant for developing standards for conducting travel surveys. The National Highway Cooperative Research Program (NCHRP) Report 571 is one such guideline for conducting travel surveys, which has been developed from the findings of the case studies on survey design in the US and other parts of the world[14,30–33]. Overall, the experiences available from research studies and the guidelines provided in the standards can be considered for conducting travel surveys in a particular area, but the regional adoptability of this approach is often questionable. For example, Behrens[34] found that a diary design reported earlier in the literature from a developed nation[35] was not performing well in

*For correspondence. (e-mail: ashishv@civil.iisc.ernet.in)

South African context, and had to be modified substantially before applying to their study area. Finding equivalent terms, for the standard survey questions, suitable to a particular region is also an issue[36]. Nowadays, researchers bring study area into the picture before deciding upon a particular survey instrument design and an administration technique[26].

In India, household travel surveys are conducted as part of the comprehensive transportation planning studies. Most of the studies, to which the writers have access, have limited the data collection to peak period trips, and none of them has disseminated the details of surveys (instrument design, pilot survey, administration technique, non-response issues, etc.). Thus, a comparison of survey experiences (including those related to question wordings, layout) across Indian cities is difficult. Further, activity-based (time-use) surveys are rarely conducted in Indian cities – only a few case studies have been reported[6,37], and all of them are from the same case study area. Only one of these studies compares the performances of alternative diary formats and survey administration techniques[6]. However, the use of traditional trip-based data for comparison of the performance of diaries, as done in this study[6], may lead to erroneous conclusions. At the outset, the readers can understand the status of diary design and data collection practices in Indian cities. It should be highlighted that other developing nations (with similar socio-demographic settings as in Indian cities) have made a leap forward in collecting the activity-based survey data using instruments and procedures applicable to their context[7,13,34,36,38,39].

The present article attempts to bridge the knowledge gap about travel survey data collection in Indian cities while adding to a growing body of research on survey design and data collection. Specifically, it reports the experiences of a pilot survey conducted for comparing the performances of alternative instrument formats and administration techniques for an activity-travel survey planned (for academic research) in Bengaluru city, India. Studies on survey instrument design[2,4–9] indicate that the day-planner format of time-use diaries shows satisfactory performance in the developed countries (Louisiana in the US and in the Netherlands)[2,5]. These case studies show that the day-planner format is easier to manoeuvre and relatively quicker to complete, flexible in terms of data insertion, manageable by individuals with relatively little education[5], and has comparable performances with other diary formats in terms of recording activities and trips. It would then be interesting to study its performance in a developing country like India. So far, no studies have contributed in this direction, except the application of time-use diaries in sociological research[40]. Most of the studies related to survey instrument design investigate the performances of diaries under an administration method. Thus, a comparison of performances of diaries with different administration methods is worth probing. This can help identify the best combination of instrument format and administration method suitable to the study area. Rest of the article deals with discussion of the pilot survey and survey findings.

## Study setting

This section enlists the contextual factors that have influenced the survey instrument design and administration. (i) Considering the financial constraints and the large families in Indian cities, instruments are developed here as a single sheet per person as against the booklet design applied in many developed nations. (ii) Computer-assisted surveys and GPS-based surveys are excluded due to monetary resource constraints. Telephone-based and internet-based retrieval methods are omitted due to the lower penetration of the technology into society and due to the inaccessibility to subscribers list. (iii) The study emphasizes on capturing stage-level details accurately due to the multi-modal travel practices in Indian cities, i.e. use of multiple modes and transfer between modes. (iv) Due to the absence of level-of-service information about various modes, the survey demands generalized cost-related parameters (travel cost, travel time, distance, etc.) directly from the respondents. (v) Unavailability of public transit/para-transit service frequency information prompts the diaries to capture the waiting/transfer time directly from the respondents.

## Study area

The study area is selected from the Bangalore Metropolitan Region (BMR). Urban area of BMR is considered for the present study. This region has a population of 4.5 million and has nearly 1.01 million households[41]. The area is also characterized by the presence of all major activities (residential, institutional, industries and commercial/shopping activities), the availability of all modes of surface transport (including metro rail), and sufficient segregation in the socio-economic status of individuals.

## Instrument design

The instrument is divided into three parts: activity-travel diary, household form and person form. The activity-travel diary collects the activity-travel information of individuals over a prescribed period, whereas household and person forms collect the household and person socio-demographic information of individuals respectively. The following subsections briefly summarize the components of the instrument.

### *Household and person forms*

The concepts of key terms (household, worker, no-worker, etc.) are according to the Census of India definitions[42].

The questions in the household form (related to home ownership status, housing type, household size, etc.) are finalized based on the recommendations in the guidelines for household travel surveys[31]. The question layout and wording are drawn from the Census of India format[43]. However, a pre-pilot survey (using a sample of 50 individuals) suggested that 'close-ended right-aligned format' (Figure 1) is superior to census format in terms of response rate, minimum errors and lower recording time.

Person form collects details of the individual (age, gender, educational qualification) in a sampled household. The 'close-ended right-aligned' format (Figure 2) is finalized after a prepilot survey (using a sample of 50 individuals).

### *Activity-travel diary formats*

The activity-travel diaries developed in this study are from time-use perspective. Time-use diaries (and their variants) have been applied for travel surveys[2,5,9,44], but so far, no attempt has been made to implement it in the Indian cities.

As discussed in the introductory section, one of the diaries is a day-planner format of the time-use diary, and is a variant of the one proposed earlier in the literature[2]. The modifications made here include the addition of a field for recording the travel cost information of public/para transit modes and the insertion of a field for capturing the parking cost information. Figure 3 shows the day-planner format of the time-use diary (diary-1) proposed here. There is no explicit differentiation between activities and trips (travel and waiting) in this format. The respondent starts filling the left side of the diary, and when a trip is undertaken, he/she reports it as an activity and moves to the right side of the diary for inserting the attributes associated with the trip.

Figure 4 shows the alternative format of the diary, diary-2, considered in this study. It is a combination of diary-1 and the traditional trip-based diaries employed for travel survey data collection in Indian cities. Stage-wise movements are recorded in the trip-based diaries. Details such as stage number, stage purpose, stage mode, etc. are usually recorded in these diaries[45–47].

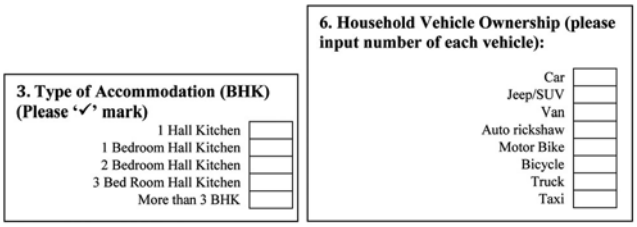


**Figure 1.** Close-ended right-aligned format of household form (sample questions).

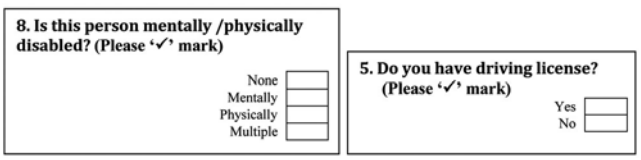


**Figure 2.** Close-ended right-aligned format of person form (sample questions).

It is evident from Figure 4 that the layout of diary-2 is comparable with that of diary-1, but they differ in terms of how travel details are recorded. In the case of diary-2, trip is not considered as an activity; instead when a trip is undertaken, the respondent directly moves to the right side of the diary without mentioning it as an activity on the left side, and starts recording the details of each stage in a trip. The respondent records mode transfer location and waiting time for the next mode, if a trip involves more than one stage.

As can be inferred from the Figures 3 and 4, the layouts of diaries are much simple, and are comparable in terms of information requisites and question words (e.g., what did you do). The main difference between the diaries proposed in this study and those available from the literature is that only one sheet (of size 8.27″ × 11.69″) is allocated for a person as against a booklet applied in many such studies[35,48].

## Pilot survey

The objective of the pilot survey is to compare the performances of alternative diary formats and retrieval methods in the context of the study area. A sample of 125 households was selected for the survey following the thumb rule given in Richardson *et al.*[12] and according to the guidelines given in the NCHRP report[13]. The sampling frame used for this study is an address database developed from the comprehensive traffic and transportation study (CTTS) conducted in 2010 for BMR[45]. No incentive (monetary/material) was provided in this study. The pilot survey collected the activity-travel information of all individuals (age above 5 years) in a sampled household for a day (24 h). 'Face-to-face' (FTF) person interviews and 'drop-off and pick-up' (DAP) method were considered for retrieving the activity-travel information. The surveys were administered with the help of educated interviewers (above high-school qualification), who were properly instructed about the conduct of the survey (through one week of training). The FTF method was administered on 104 households and 67 households responded to the survey (64% response rate). For the DAP method, additional documents such as a sample-filled diary, instruction for filling the diary, and a questionnaire for recording the respondent's experience were also prepared. Instruments (and additional documents) were developed in English, Kannada (regional language), and Hindi (an official language) for the DAP method. In this method, only 58 out of the 283 contacted households responded (20% response rate). The sample size available for each of the

| Activities | | | | If you were travelling | | | | If you were at a transfer station | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start time hh:mm | What did you do? | With whom did you do? | Where did you do? (Except travel; 'home' or address of location) | How did you travel? | With whom did you travel? | How much distance did you travel? (km) | How much fare did you pay (Rs; Bus/Taxi) | When do you arrive here? | Address of mode change location | Parking cost (**Rs**) (in case of private modes) |
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**Figure 3.** Day-planner format of the diary (diary-1).

| Activities (other than travel) | | | | If you were travelling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start time hh:mm | What did you do? | With whom did you do? | Where did you do? ('Home' or address of out-of home location) | Stage no. | Stage start time | How did you travel? | With whom did you travel? | How much distance did you travel? (km) | How much fare did you pay? (Rs; bus/taxi) | Parking cost (Rs) (in case of private modes) | Stage travel time (min) | Address of mode transfer location | Mode transfer time (min) |
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**Figure 4.** Combined diary format (diary-2).

administration techniques is comparable with the previous case studies on diary design and administration[4,5].

### *Sample characteristics*

Average household size and male-to-female ratio of the sample were 4.04 and 1.08 respectively. About 38.4% of the total individuals were workers, 50.9% are non-workers, and 10.7% are school-going children. Nearly 7.9% of households fell in the monthly income range 0–7500 Indian rupees (1 US$ = 62.32 rupees). Also, 50% of households fell in the income range 7500–20,000 rupees and the rest fell above 20,000 rupees. The income distribution observed here is comparable with that observed for Bengaluru in an earlier transportation planning study[45]. At the individual level, 67% individuals belonged to the age group 20–50 years, 20% to 5–20 years, and the rest were above 50 years. Fifty two percent of the individuals hold a bachelor's degree. About 25.6% of individuals were educated up to the higher secondary level, 11.2% were educated above graduation level (Bachelor's degree), and the rest were illiterate. Among employed individuals, 17.2% were self-employed, and rest employed in private (53.8%) and public (30%) sectors.

The sample was observed to be a representative of the socio-demographic trends in the study area (on comparing with the census information[49]) with respect to household size ($t = 0.44$) and gender ratio ($t = 0.82$; following $t$-test at 5% significance level).

## Performance evaluation with FTF survey administration

Out of the 67 households that responded to the FTF survey, 32 households (143 individuals) were interviewed with diary-1, and the rest were interviewed (163 individuals) with diary-2. Activity-travel information of those who travelled on the previous day was segregated from these samples, and were adjusted with respect to male to female ratio; shares of workers, students and non-workers; age group distribution, and shares of employment type (for workers) observed in the actual collected sample. Thus, for the comparative analysis, 79 individual observations were available for diary-1 and 83 for diary-2. The sample size available (at individual level) was also comparable across the studies on diary design[2,7].

The objective of the analysis phase is to evaluate the impacts of the diary formats on respondent (interviewer) burden (interview duration), information recording potential (average number of (missing) trips and stages), incompleteness in the registration (mismatching activity timings), and recording errors (mistakes). Tables 1 and 2 show the results of the comparison between diary types with respect to the above-mentioned parameters. The parameters are reported as average values across persons (and diary in Table 2), and are compared using the two-sample $t$-test for unequal samples with unequal standard deviation (at 5% significance level).

Average interview duration was considered as an indicator of burden on the respondent (and indirectly on the interviewer). Statistical evidence suggests that (at 5% level) the average interview durations of both diaries are comparable. Similar is the case with respect to the average number of activities recorded by both diaries. Performances of diaries when capturing travel details show another picture. The probability of observing average trip rates as summarized in the Table 1 is low under the stated hypothesis that both diaries perform equally. Diary-2 yielded a higher number of trips compared to diary-1. The same hypothesis (that diaries perform equally) is also

**Table 1.** Selected parameters (per person) for comparison of diaries (FTF method)

| Parameter description | Diary-1 | Diary-2 | *P*-value |
|---|---|---|---|
| Average interview duration (min) | 14.58 | 15.36 | >0.05 |
| Average number of activities | 17.21 | 16.97 | >0.05 |
| Average number of trips | 3.18 | 4.07 | <0.05 |
| Average number of stages | 4.41 | 5.71 | <0.05 |
| Average number of missing trips | 0.29 | 0.14 | <0.05 |
| Average number of missing stages | 0.52 | 0.10 | <0.05 |
| Average number of short NMT trips | 1.19 | 1.45 | <0.05 |
| Average number of NMT access/egress trips | 0.75 | 1.04 | <0.05 |
| Mismatching out-of-home activity timings | 0.87 | 0.24 | <0.05 |

NMT, Non-motorized transport.

**Table 2.** Item recording error (per diary) in diaries (FTF method)

| Item description | Diary-1 | Diary-2 | *P*-value |
|---|---|---|---|
| Activity (transfer) location | 0.41 | 0.36 | >0.05 |
| Trip start time | 0.10 | 0.06 | >0.05 |
| Trip end time | 0.44 | 0.14 | <0.05 |

not tenable in the case of trip-stages. Statistical evidence suggests that missing trips per person is much less in diary-2 compared to diary-1. Average number of missing stages is higher in diary-1 compared to diary-2. The differences are significant at 5% level. Comparing with the travel attributes recorded by both diaries, the results show that diary-2 is superior to diary-1 in recording stage-wise movements. Further, the analysis indicates that diary-2 is preferable to diary-1 when capturing short non-motorized transport (NMT) (distance $\leq 200$ m) trips and NMT access/egress trips. Furthermore, the point biserial correlation values[50] for diaries (diary-1 coded as 0, and diary-2 as 1) with number of trips number of stages, number of NMT trips and number of NMT access/egress trips are 0.841, 0.872, 0.900 and 0.895 respectively. This shows that diary format has a significant role in measuring the trip attributes, and can explain a significant share of the variability observed in the data (the correlation is significant at 5% level as evident from the *t*-test[51]). Finally, with respect to the mismatching out-of-home activity-timings, diary-1 is observed to have a higher number of mismatching entries. An investigation into the diaries indicates that the problems associated with the recording of the travel parameters in diary-1, as mentioned above, have compounded this issue.

Table 2 is a comparison of the diaries with respect to recording errors (or mistakes). The table suggests that both diaries are comparable with respect to the average values of erroneous records of activity (transfer) locations and trip start time. However, the probability of observing data on mistakes in recording trip end time as extreme, as shown in Table 2, is low under the null hypothesis that both diaries have equal errors. Diary-1 is observed to have a large number of mistakes, and this may have resulted due to the missing of some stages in multi-stage trips. Overall, the average number of mistakes observed in diary-1 is higher than that in diary-2.

To have a better understanding of the issues with the diaries (e.g. missing trips), 'clarification Interviews'[52] were concluded with the respondents over phone (and personally when numbers were not given) a few hours after the survey (without informing the interviewers). The results of the 'reinterview' were consistent with the diary (and household and person form) records (no evidence of trip under reporting), and showed no evidence of proxy reporting. The issues with missing trips, stages and other mistakes (now could be reasonably deduced [e.g. egress trip (a stage) to home from a bus stop is missing in return journey, or short (one-way) NMT trip to a nearby store is missing]) can be traced to the format of diaries. In general, it can be concluded that diary-2, with its structured nature of recording trips, shows satisfactory performance when applied to an area that has multimodal travel practices.

## Performance evaluation with DAP survey administration

Among the 58 households that responded to the DAP survey administration, 30 households (146 individuals) were administered with diary-1 and rest of the samples with diary-2 (158 individuals). The samples were then adjusted with respect to a socio-demographic factors in the same way as in the case of the FTF method. Accordingly, 86 individuals were selected for diary-1 and 90 for diary-2.

Table 3 shows results of the comparison of diaries with respect to the selected indicators. The table indicates that the average number of activities captured by both diaries is equal (at 5% significance level). However, the hypothesis that both diaries perform equally when measuring travel attributes is not tenable. Statistical evidence suggests that (at 5% level) diary-2 is preferable when capturing trips and stages, and with respect to missing attributes. Diary-2 also shows satisfactory performance when measuring short NMT trips and NMT access/egress trips. Furthermore, the point Biserial correlation coefficients for diaries (diary-1 coded as 0, and diary-2 as 1) with number of trips, number of stages, number of NMT trips and number of NMT access/egress trips are 0.880, 0.772, 0.812, and 0.825 respectively. The correlation

**Table 3.** Selected parameters (per person) for comparison of diaries (DAP method)

| Parameter description | Diary-1 | Diary-2 | *P*-value |
|---|---|---|---|
| Average number of activities | 13.77 | 14.31 | >0.05 |
| Average number of trips | 2.26 | 3.07 | <0.05 |
| Average number of stages | 4.01 | 4.99 | <0.05 |
| Average number of missing trips | 0.44 | 0.22 | <0.05 |
| Average number of missing stages | 0.88 | 0.13 | <0.05 |
| Average number of short NMT trips | 0.73 | 1.02 | <0.05 |
| Average number of NMT access/egress trips | 0.51 | 0.85 | <0.05 |
| Mismatching out-of-home activity timings | 0.97 | 0.14 | <0.05 |

**Table 4.** Item recording error (per diary) in diaries (DAP method)

| Item description | Diary-1 | Diary-2 | *P*-value |
|---|---|---|---|
| Activity (transfer) location | 0.67 | 0.36 | <0.05 |
| Trip start time | 0.38 | 0.31 | <0.05 |
| Trip end time | 0.90 | 0.59 | <0.05 |

coefficients are significant here too, indicating the influence of the diary formats on the observed data.

Table 4 is a comparison of item recording errors (mistakes) between the diaries. Comparing with Table 2, the magnitude of the observed mistakes is higher in Table 4. This shows that the FTF method (and trained interviewers) offers satisfactory recording of attributes compared to the DAP method. In the case of recording location attributes, individuals recorded 'same as previous' in many instances, but this approach has contributed to mistakes, especially in multi-stage trips. Further, a comparison of the performance of the diaries across the income groups (low, medium and high) based on the indicators in Tables 3 and 4 suggests that the diary performances are independent of income groups.

Table 5 summarizes the findings of the questionnaire survey. The questionnaire collected the respondents' experience with diary formats. The first parameter is the time required for filling the questionnaire (continuous variable). Other parameters were recorded on a five-point interval-scale (1 – poor to 5 – excellent). All parameters, except duration, were compared using the Mann–Whitney statistic. Table 5 suggests that (at 5% significance level) performances of both diaries are comparable in terms of interview duration, design and layout, and overall ease of recording. However, the comparison suggests that (at 5% significance level) diary-2 is superior to diary-1 in recording travel details.

Overall, the analysis indicates that diary-2 has satisfactory performance than diary-1 in this method as well. Once again, the 'clarification interview' results were the same as in the case of the FTF method (no evidence of under reporting of trips), indicating the households (that participated in the study) generally followed the survey guidelines.

## Comparison of survey administration methods

This section compares the survey administration procedures (FTF and DAP) with respect to the nonresponse to different parts of the survey instruments. Table 6 is a summary of the reasons for nonresponses to the survey request. About 64% of the households contacted in the FTF method responded to the survey, whereas only 20% of the households responded to the survey request in the DAP method. In both administration methods, unwillingness of individuals to participate was one of the major reasons. It was higher in the DAP method (38%), and may reflect the bulkiness of the instruments applied in the method (sample diary, actual diary, instructions and questionnaire). A description about the information requisite lead to the refusals of households citing reasons such as: 'my husband/kid does not have time for doing this exercise/I may forget in the course of household chores/I do not have the habit of writing diaries/it is a time-consuming business' in the DAP method. We received the message that the 'ideal person is not present' from many households. This was most common in households where at the time of contact only aged people, only kids or only women (and kids) were present, or when the head of household was absent. Many households showed their unwillingness to participate at the time of contact, and recommended for a later visit. The percentage of this non-response was higher for the DAP method (19). In the FTF method, it was observed that educated individuals (having high-school qualification and above) responded easily to the questions. They could understand the logic behind the information retrieval (in case of diaries), and easily recounted the events that happened during the previous day. We did not find any such trend in the DAP method, as educated and uneducated individuals were equally nonresponding.

Table 7 presents a summary of non-responses to different parts of the survey instrument. The table reveals that non-response rate is quite low in the FTF method compared to the DAP method. Among the household characteristics, the highest non-response was observed for household income followed by number of vehicles in the household and type of dwelling unit. In case of person form, the highest non-response was observed for income followed by monthly maintenance cost of vehicle. Non-responses were also observed for parameters like work/school schedule flexibility, type of occupation, education level, age, driving license status and disability status (higher in the DAP method). With respect to diary

**Table 5.** Results of questionnaire survey for comparison of diaries (DAP method)

| Item description | Diary-1 | Diary-2 | *P*-value |
|---|---|---|---|
| Mean recording duration (min) | 9.67 | 10.46 | >0.05 |
| *Rating parameters* | Mean rank order | Mean rank order | |
| Design and layout | 18.31 | 20.38 | >0.05 |
| Overall ease of recording | 19.90 | 24.19 | >0.05 |
| Ease of filling travel details (trip and stage details) | 14.23 | 21.36 | <0.05 |

**Table 6.** Non-responses (%) in FTF and DAP methods

| | Non-response as % of total contacted | |
|---|---|---|
| Reason for non-response | FTF | DAP |
| Uninterested | 11 | 38 |
| Ideal Person not present | 14 | 12 |
| Contact again | 11 | 19 |
| Returned incomplete forms | 0 | 11 |
| Total | 36 | 80 |

parameters, highest non-response was observed for travel distance followed by cost and location details. It can be seen that non-responses to activities, modes, travel party (with whom), and timings are higher in the DAP method.

Comparison of Tables 1 and 3 shows that irrespective of the diaries, the FTF method of survey administration is better at recording (in terms of magnitude) short NMT trips as well as NMT use for access/egress modes. This trend is comparable with the findings of previous case studies[53–55].

## Overall survey experience

(i) Unavailability of qualified enumerators, and time constraints on the part of the available enumerators was one issue in the survey. Further, female interviewers left the survey citing various, reasons, including safety concerns. These issues were addressed by conducting survey in shifts, especially including a first visit by (female) interviewers in earlier periods of a day for collecting details of available individuals and a later visit by (male) interviewers during other periods of the day.

(ii) Unavailability of address list from utility bodies was an issue in developing sampling frame for the survey. This issue can be tackled by developing a sampling frame from the available household travel survey dataset.

(iii) Unawareness about the nature of survey led to higher refusal to the survey request, and many respondents found the survey breaching their privacy. However, those who were familiar with the institution conducting the survey cooperated with the designers. Under such a situation, reference of an urban local body and the presence of a person in the survey group who is familiar to study area can improve the response rate.

**Table 7.** Non-response to instrument sections under FTF and DAP methods

| | % Non-response under | |
|---|---|---|
| Item description | FTF | DAP |
| Household form | | |
| Ownership status | 0.00 | 0.00 |
| Type of accommodation | 0.00 | 0.33 |
| Type of dwelling unit | 0.20 | 0.54 |
| No. of persons in the household | 0.00 | 0.00 |
| No. of vehicles in the household | 0.29 | 0.37 |
| Availability of ICT facilities | 0.00 | 0.07 |
| Household income | 2.11 | 3.40 |
| Person form | | |
| Age | 0.00 | 1.02 |
| Gender | 0.00 | 0.00 |
| Marital status | 0.17 | 0.27 |
| Education level | 0.06 | 0.56 |
| Driving license | 0.00 | 0.41 |
| Mobile phone ownership | 0.01 | 0.19 |
| Employment status | 0.01 | 0.23 |
| Occupation | 0.35 | 0.69 |
| Pass ownership | 0.00 | 0.06 |
| Cost of pass | 0.00 | 0.06 |
| Disability status | 0.00 | 0.11 |
| Work (school) schedule flexibility | 0.23 | 0.45 |
| Monthly income of the person | 3.02 | 4.78 |
| Monthly maintenance cost of vehicle | 1.02 | 1.63 |
| Activity-travel diary | | |
| Activities | 0.00 | 0.21 |
| Mode | 0.00 | 0.36 |
| Travel party | 0.09 | 0.31 |
| Activity-travel timings | 0.06 | 0.29 |
| Location | 0.11 | 0.45 |
| Travel distance | 1.73 | 2.98 |
| Travel cost | 0.67 | 1.01 |

ICT, Information and Communication Technologies.

(iv) The study did not face any issues from political and communal sides. This may be due to dispensing of a message about the survey through a person familiar to the survey participants. This has also allowed access to low-income (and high-income) households easily.

(v) There were no issues related to the religion/race of interviewers and that of respondents.

(vi) Linguistic equivalence is still an issue; however not as much as in case of African cities[39]. However, language proficiency (especially in regional languages) of interviewers mattered in the response of households.

(vii) Higher refusal rates were encountered from women. This can be tackled in the FTF method by conducting interviews using female interviewers.

(viii) Respondents had a clear apprehension of travel time, but not of travel distance. The non-response to travel distance can be tackled by stressing upon the location (address) details (and if possible exact route), and then use a GIS tool to calculate the distance.

(ix) The performances of the diaries were observed to be independent of the language used in them.

## Summary and conclusion

The objective of this study is to identify a diary format and an administration technique that can help researchers in gathering quality data for their research on travel behaviour analysis from the BMR. Monetary and time constraints shaped the research design, and it did not meet the rigorous methodological criteria required for comparing instrument formats and administration procedures (and aligned with case studies of the same study set-up reported earlier in the literature[2,53]). The study proposed two diary formats. Diary-1 is a day-planner format of the time-use diary that is observed to have satisfactory performance across the cities of developed nations. Diary-2 is derived as a combination of diary-1 and the traditional trip-based diaries employed in the travel surveys for Indian cities. FTF and DAP methods of survey administration were considered for retrieving the diaries. The performances of the diaries were compared using various indicators and employing statistical tests such as two-sample *t*-test and Mann–Whitney test. Important findings from the analysis are as follows:

(i) The diaries are comparable with respect to the time requirement for completion and the recording of activities; however, the combined diary is superior to the day-planner format in terms of less number of missing stages and trips, and fewer recording errors.

(ii) The combined diary is preferable to the day-planner format when recording short NMT trips and NMT access/egress trips, and its performance is consistent in both administration methods.

(iii) The qualitative analysis suggests that both dairies are comparable in terms of design, layout and overall ease of recording; however, the combined diary received higher ranks on the easiness associated with filling of travel details.

(iv) The FTF method of survey administration is observed to have higher response rate and lower recording errors (mistakes).

Overall, the study contributes to the literature on survey design by showing that the diary formats applicable to the developed nations may not be suitable for Indian cities. The present study can be improved in many ways. Comparison of the performances of diaries across different Indian cities can be one front of research. Investigation into the influence of incentives on survey response and survey retrieval methods can be another scope of future research. Studies with experimental designs can help identify the diary format and administration method suitable to a particular income group.


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