Note on sample design and estimation procedure of Time Use Survey

1. Introduction

1.1 The National Sample Surveys (NSS) are being conducted by the Government of India since 1950 to collect socio-economic data employing scientific sampling methods. Time Use Survey (TUS), collects data on time dispositions of household members, is an area of survey introduced in response to demands from various stakeholders. Time Use Survey started from 1st January 2019

2. Outline of Survey Programme

2.1 **Geographical coverage**: The survey covers whole of the Indian Union *except the* villages in Andaman and Nicobar Islands which are difficult to access.

2.2 **Survey Period:** The duration of survey period is one year.

2.3 **Schedules of enquiry:** During this round, the following schedules of enquiry are canvassed:

Schedule 0.0T : List of Households
Schedule 10.6 : Time Use

2.4 **Sub-rounds:** The survey period is divided into four sub-rounds of three months' duration each as follows:

sub-round 1 : January – March 2019
sub-round 2 : April – June 2019
sub-round 3 : July – September 2019
sub-round 4 : October – December 2019

In each of these four sub-rounds equal number of sample FSUs are allotted for survey with a view to ensuring uniform spread of sample FSUs over the entire survey period. Attempt will be made to survey each of the FSUs during the sub-round to which it is allotted. Because of the arduous field conditions, this restriction is not strictly enforced in *Andaman and Nicobar Islands, Lakshadweep, Ladakh region (Leh and Kargil districts) of Jammu & Kashmir and rural areas of Arunachal Pradesh and Nagaland.*

3. Sample Design

3.1 **Formation of sub-units (SUs)**:

3.1.1 **Rural areas**: A rural village is notionally divided into a number of sub-units (SU) of more or less equal population during the preparation of frame. Census 2011 population of

villages was projected by applying suitable growth rates and the number of SUs formed in a village was determined apriori.

3.1.2 The above procedure of SU formation was implemented in the villages with population *more than or equal to 1000 as per Census 2011*. In the remaining villages, no SU was formed.

3.1.3 The number of SUs formed in the villages (with Census 2011 population 1000 or more) of the frame was decided before selection of the samples following the criteria given below:

projected population of the village	no. of SUs formed
less than 1200	1
1200 to 2399	2
2400 to 3599	3
3600 to 4799	4
4800 to 5999	5
.......and so on	....

3.1.4 **Special case**:

3.1.4.1 For rural areas of (i) Himachal Pradesh, (ii) Sikkim, (iii) Andaman & Nicobar Islands, (iv) Uttarakhand (except four districts Dehradun, Nainital, Hardwar and Udham Singh Nagar), (v) Punch, Rajouri, Udhampur, Reasi, Doda, Kishtwar, Ramban, Ladakh region (Leh and Kargil districts) of Jammu and Kashmir and (vi) Idukki district of Kerala, numbers of SUs formed in a village were determined in such a way that each SU contains 600 or less projected population. Further, SUs were not formed in the villages in the above mentioned districts/States with population less than 500 as per Census 2011. In the remaining villages, the number of SUs formed for these States/districts is as follows:

projected population of the village	no. of SUs formed
less than 600	1
600 to 1199	2
1200 to 1799	3
1800 to 2399	4
2400 to 2999	5
.......and so on	....

3.1.4.2 For rural parts of Kerala, similar procedure as mentioned in para 3.1.3 above was adopted with the modification that the SUs were formed within Panchayat Wards instead of villages.

3.1.5 **Urban areas**: SUs were formed in urban sector also. The procedure was similar to that adopted in rural areas except that SUs were formed on the basis of households in the UFS frame instead of population, since UFS frame does not have population. Each UFS block with number of households more than or equal to 250 was divided into a number of SUs. In the remaining UFS blocks, no SU was formed.

3.2 **Outline of sample design:** A stratified two stage design has been adopted for the TUS. *The first stage units (FSU) are villages/UFS blocks/sub-units (SUs) as per the situation.* The ultimate stage units (USU) are households in both the sectors.

3.3 **Sampling Frame for First Stage Units:**

3.3.1 There was no SU formation in uninhabited villages and villages (Panchayat wards for Kerala) with population less than 1000 as per Census 2011 (less than 500 as per Census 2011 for the areas mentioned in para 3.1.4.1) and entire village was considered as one FSU. All such villages (Panchayat wards for Kerala) were the First Stage Units (FSUs).

3.3.2 In the remaining villages, notional sub-units (SUs) following the procedure as described in para 3.1.1 were formed. Such SUs were considered as First Stage Units (FSUs).

3.3.3 For the UFS blocks with less than 250 households, the entire UFS block was considered as one FSU. In the remaining UFS blocks, the SUs were considered as First Stage Units (FSUs).

3.3.4 List of FSUs as described above was the sampling frame for respective cases.

3.4 **Stratification of FSUs**:

3.4.1 **Rural sector**:

(a) All inhabited villages within each NSS State region constituted a rural stratum.

(b) A special stratum, in the *rural areas* only, was formed at all-India level before the strata are formed in each State/UT. This stratum comprised all the uninhabited villages as per Census 2011 belonging to all States/UTs.

3.4.2 **Urban sector:** In urban areas strata have been formed within each NSS State region on the basis of size class of towns as per Census 2011. The tentative stratum numbers and their composition (within each NSS State region) are as follows:

stratum 1 :	all towns with population less than 50,000
stratum 2 :	all towns with population 50,000 or more but less than 3 lakhs
stratum 3 :	all towns with population 3 lakhs or more but less than 15 lakhs
stratum 4, 5, 6,... :	each city with population 15 lakhs or more

3.5 **Sub-stratification:**

3.5.1 **Rural sector:** Three groups of villages were formed within each stratum (except special rural stratum):

Group 1: all villages (Panchayat wards for Kerala) with Census 2011 population less than 250

Group 2: all villages (Panchayat wards for Kerala) with Census 2011 population more than or equal to 250 but less than 500

Group 3: remaining villages

The sample size for a rural stratum was allocated among 3 groups in proportion to population. Let r_1, r_2 and r_3 be the allocations to Group 1, Group 2 and Group 3 respectively. The villages within each group were first arranged in ascending order of population. For all the three groups within each strata, '$r_1/4$'>1, '$r_2/4$'>1 and '$r_3/4$'>1, implying formation of 2 or more sub-strata in each group. Sub-strata was demarcated in Group 1, Group 2 and Group 3 respectively in such a way that each sub-stratum comprises a group of villages (all SUs of a village considered together) of the arranged frame and have more or less equal number of population within the respective group.

The sub-strata in Group 1 numbered as 11, 12, 13,........ The numbering of sub-strata in Group 2 were 21, 22, 23,....... Finally, for Group 3, sub-strata numbers started from 31.

If number of FSUs in a particular Group is very small, no sub-stratum was formed in that Group. Further, in those strata where allocations are very small, minimum allocation for Group 1 and Group 2 was 1 each.

3.5.2 **Urban sector**: Let 'u' be the sample size allocated for an urban stratum. For all strata, if 'u/4' >1, implying formation of 2 or more sub-strata, all the UFS blocks within the stratum were first arranged in ascending order of total number of households in the UFS blocks as per urban frame. Then sub-strata were demarcated in such a way that each sub-stratum comprised a group of UFS blocks (all SUs within the block taken together) having more or less equal number of households.

3.6 **Total sample size (FSUs):** 10004 FSUs are being covered at all-India level.

3.7 **Allocation of total sample to States and UTs:** The total number of sample FSUs has been allocated to the States and UTs in proportion to population as per Census 2011 subject to a minimum sample allocation of 16 FSUs to each State/UT.

3.8 **Allocation of State/ UT level sample to rural and urban sectors:** State/UT level sample size has been allocated between two sectors in proportion to population as per Census 2011 with 1.5 weightage to urban sector. A minimum of 4 FSUs, each for rural and urban sector separately, have been allocated to each State/UT. For more urbanised big States like Maharashtra, Tamil Nadu etc., the urban allocation was limited to rural sample size to avoid undue weightage to urban sector.

3.9 **Allocation to strata:** Within each sector of a State/ UT, the respective sample size has been allocated to the different strata in proportion to the population as per Census 2011. Stratum level allocation was adjusted to multiples of 4 with a minimum sample size of 4.

For special stratum formed at state level as mentioned in para 3.4(b), 4 FSUs were allocated.

3.10 Allocation to sub-strata:

3.10.1 Rural: Allocation was 4 for each sub-stratum in the rural sector and urban sector.

3.11 Selection of FSUs within a stratum/sub-stratum:

3.11.1 From all the sub-strata in both rural and urban sector within each stratum, required number of FSUs was selected by Simple Random Sampling Without Replacement (SRSWOR) scheme.

3.12 Formation of sub-units and listing of households

3.12.1 Procedure of formation of SUs: After identification of the boundaries of the village/ UFS block which contains the sample FSU, the village/ UFS block is to be divided into the number of SUs (say, D) as given in the sample list by more or less equalising the present population of the village/UFS block in which the sample FSUs are located. It is to be ensured that SUs formed are clearly identifiable in terms of physical landmarks. For villages/blocks where the number of SUs to be formed is 1 as per the sample list, no SU formation is required.

3.12.2 Listing of households: All the households of the sample FSU are listed. Temporarily locked households are also listed after ascertaining the temporariness of locking of households through local enquiry.

3.12.3 Selection of households: A total number of 14 households are selected from each FSU and canvassed during 7 days. 2 households are canvassed on each day of the week. The sample households are selected by SRSWOR.

4. Estimation Procedure

4.1 Notations:

s = subscript for s-th stratum

t = subscript for t-th sub-stratum

i = subscript for i-th FSU [SU/ village (panchayat ward)/ block]

j = subscript for j-th sample household within an FSU

N = total number of FSUs in any rural/urban sub-stratum

n = number of sample FSUs surveyed including 'uninhabited' and 'zero cases' but excluding casualty for a particular sub-stratum

H = total number of households listed in a FSU

h = number of households surveyed in a FSU

x, y = observed value of characteristics x, y under estimation

$\hat{X}$, $\hat{Y}$ = estimate of population total X, Y for the characteristics x, y

Under the above symbols,

y_{stij} = observed value of the characteristic y for the j-th household of the i-th FSU for the t-th sub-stratum of s-th stratum.

However, for ease of understanding, a few symbols have been suppressed in following paragraphs where they are obvious.

4.2 Formulae for Estimation of Aggregates for a stratum × sub-stratum:

4.2.1 Schedule 0.0T:

(i) For estimating the number of households in a stratum × sub-stratum possessing a characteristic:

$$\hat{Y} = \frac{N}{n} \sum_{i=1}^{n} y_i$$

where y_i is the total number of households possessing the characteristic y in i-th FSU respectively.

4.2.2 Schedules 10.6:

4.2.2.1 For a stratum × sub-stratum:

$$\hat{Y} = \frac{N}{n} \sum_{i=1} \left[\frac{H_i}{h_i} \sum_{j=1}^{h_i} y_{ij} \right]$$

4.3 Overall Estimate for Aggregates for a stratum:

Overall estimate for a stratum ($\hat{Y}_s$) will be obtained as

$$\hat{Y}_S = \sum_t \hat{Y}_{st}$$

4.4 Overall Estimate of Aggregates at State/UT/all-India level:

The overall estimate $\hat{Y}$ at the State/ UT/ all-India level is obtained by summing the stratum estimates $\hat{Y}_s$ over all strata belonging to the State/ UT/ all-India.

4.5 Estimates of Ratios:

Let $\hat{Y}$ and $\hat{X}$ be the overall estimates of the aggregates Y and X for two characteristics y and x respectively at the State/ UT/ all-India level.

Then the combined ratio estimate ($\hat{R}$) of the ratio ($R = \dfrac{Y}{X}$) will be obtained as

$$\hat{R} = \frac{\hat{Y}}{\hat{X}}.$$

4.6 Estimation of Errors:

4.6.1 Formula for estimated variance (for Rural/Urban):

4.6.1.1 The sampling sheme in the current round is SRSWOR. However, if the sampling fraction is small, then the difference between variance estimates using the SRSWR and SRSWOR becomes neglible. In such case, samples can be treated as drawn with SRSWR and variance estimates becomes simpler in form and easy to calculate. It has been observed that overall sampling fraction is quite low in the current situation and hence there is not much loss in accuracy of variance estimates if SRSWR is assumed.

With this view, formulae for estimates of variances are given below based on SRSWR scheme.

(a) **Formula for aggregate** $\hat{Y}$ **(for Rural/Urban)**:

$$Vâr(\hat{Y}) = \sum_s Vâr(\hat{Y}_s) = \sum_s \sum_t Vâr(\hat{Y}_{st})$$

$$Vâr(\hat{Y}_{st}) = \frac{1}{n_{st}(n_{st}-1)} \sum_{i=1}^{n_{st}} (N_{st}\hat{Y}_{sti} - \hat{Y}_{st})^2$$

(b) Formula for ratio $\hat{R}$ (for Rural/Urban):

$$M\hat{S}E(\hat{R}) = \frac{1}{\hat{X}^2} \sum_s \sum_t M\hat{S}Est(\hat{R})$$

$$M\hat{S}E_{st}(\hat{R}) = \frac{1}{n_{st}(n_{st}-1)} \sum_{i=1}^{n_{st}} \left[N_{st}(\hat{Y}_{sti} - \hat{R}\hat{X}_{sti}) - (\hat{Y}_{st} - \hat{R}\hat{X}_{st}) \right]^2 \, ,$$

where $\quad N_{st}\hat{Y}_{sti} = \sum_j \sum_k y_{stij} \times n_{st} \times multiplier \quad ,$

$$N_{st}\hat{X}_{sti} = \sum_j \sum_k x_{stij} \times n_{st} \times multiplier$$

in the formula in (a) and (b) above.

Multiplier is as given in the table in para 5 of Page A – 8

4.7.2 Estimates of Relative Standard Error (RSE):

$$R\hat{S}E(\hat{Y}) = \frac{\sqrt{V\hat{a}r(\hat{Y})}}{\hat{Y}} \times 100$$

$$R\hat{S}E(\hat{R}) = \frac{\sqrt{M\hat{S}E(\hat{R})}}{\hat{R}} \times 100$$

5. Multipliers:

The formulae for multipliers at stratum/sub-stratum for a schedule type are given below.

sch type	sector	formula for multipliers
0.0T	Rural/urban	$\dfrac{N_{st}}{n_{st}}$
10.6	Rural/urban	$\dfrac{N_{st}}{n_{st}} \times \dfrac{H_{sti}}{h_{sti}}$

Note:
(i) For estimating any characteristic for any domain not specifically considered in sample design, indicator variable may be used.

(ii) Multipliers have to be computed on the basis of information available in the listing schedule irrespective of any misclassification observed between the listing schedule and detailed enquiry schedule.

6. Treatment for zero cases, casualty cases etc.:

6.1 While counting the number of FSUs surveyed (n_{st}) in a stratum/sub-stratum, all the FSUs with survey codes 1 to 6 in schedule 0.0T will be considered.

6.2 However, household of a particular schedule type are available in the frame of the FSU but none of these could be surveyed then that FSU has to be treated as casualty and it will not be treated as surveyed in respect of that schedule.

6.3 *Casualty cases*: FSUs with survey code 7 as per schedule 0.0T are treated as casualties.

6.4 *All the FSUs with survey codes 1 to 6 as per schedule 0.0T minus the number of casualties as identified in 6.2 will be taken as the number of surveyed FSUs (n_{stj}) for that (stratum/sub-stratum).*

7. Treatment in cases of void sub-strata/strata

7.1 A stratum/sub-stratum may be void because of the casualty of all the FSUs belonging to the stratum/sub-stratum.

7.2 When a stratum/sub-stratum is void, the following procedure is recommended:

(i) If a rural sub-stratum is void then it may be merged with the other sub-stratum of the same Group of the stratum or a suitable sub-stratum of the nearest Group.
(ii) If an urban sub-stratum is void, it may be merged with other suitable sub-stratum of the same stratum or suitable sub-stratum of the nearest stratum.
(iii) If a complete rural/urban NSS Region is void due to all FSUs being casualty, it may be excluded from the coverage of the survey. The state level estimates will be based on the estimates of regions for which estimates are available and remarks to that effect may be added in appropriate places.

Table 1: allocation of sample FSUs in Time Use Survey			
State/UT	number of sample FSUs		
	total	rural	urban
(1)	(2)	(3)	(4)
ANDHRA PRADESH	404	248	156
ARUNACHAL PRADESH	104	72	32
ASSAM	304	232	72
BIHAR	661	529	132
CHHATTISGARH	197	125	72
GOA	24	12	12
GUJARAT	440	220	220
HARYANA	196	108	88
HIMACHAL PRADESH	92	68	24
JAMMU & KASHMIR	104	64	40
JHARKHAND	249	157	92
KARNATAKA	493	257	236
KERALA	304	152	152
MADHYA PRADESH	540	340	200
MAHARASHTRA	896	448	448
MANIPUR	192	112	80
MEGHALAYA	116	76	40
MIZORAM	104	52	52
NAGALAND	80	48	32
ODISHA	348	260	88
PUNJAB	228	120	108
RAJASTHAN	524	348	176
SIKKIM	72	48	24
TAMIL NADU	600	300	300
TELANGANA	256	132	124
TRIPURA	192	116	76
UTTAR PRADESH	1196	800	396
UTTARAKHAND	96	60	36
WEST BENGAL	728	428	300
A & N ISLANDS	24	12	12
CHANDIGARH	16	4	12
D & N HAVELI	16	8	8
DAMAN & DIU	16	8	8
DELHI	144	8	136
LAKSHADWEEP	16	8	8
PUDUCHERRY	32	12	20
ALL- INDIA	**10004**	**5992**	**4012**

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