Survey methodology and Estimation procedure

1. Introduction

The National Sample Survey (NSS) undertook Comprehensive Modular Survey - Telecom (CMS-T) as a part of its 80th round during the period January, 2025 to March, 2025.

1.1 Geographical coverage: The survey will cover the whole of the Indian Union except the villages in Andaman and Nicobar Islands which remain extremely difficult to access throughout the year.

1.2 Schedule of enquiry: The following Schedules of enquiry were canvassed for the survey on CMS-T.

Schedule 0.0	List of Households
Schedule CMS-T	Comprehensive Modular Survey-Telecom

1.3 Participation of States: The is no State participation in the CMS-T.

2. Sample Design, Sampling Frame, Stratification Criteria

2.1 Formation of sub-units (SUs):

2.1.1.1 Rural areas: The projected population of a village with Census 2011 population 1000 or more was determined by applying suitable growth rates to the census 2011 population. Thereafter, it was notionally divided into a number of sub-units (SU) of more or less equal population. The number of SUs to be formed in a village was determined *apriori*. The following criteria were adopted for deciding the number of SUs to be formed:

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

2.1.1.2 Special case:

For rural areas of (i) Himachal Pradesh, (ii) Sikkim, (iii) Andaman & Nicobar Islands, (iv) Uttarakhand (except the districts Dehradun, Nainital, Hardwar and Udham Singh Nagar), (v) Punch, Rajouri, Udhampur, Reasi, Doda, Kishtwar, Ramban of Jammu and Kashmir (vi) Leh

and Kargil districts of Ladakh region and (vii) Idukki district of Kerala, numbers of SUs to be formed in a village were determined in such a way that each SU contains 600 or less projected population. Further, SUs was 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 criteria for deciding the number of SUs to be formed were as below:

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

For rural parts of Kerala, similar procedure as mentioned in para 2.1.1.1 above was adopted with the modification that the SUs were formed within Panchayat Wards instead of villages.

2.1.1.3 Urban areas: SUs were formed in urban sector also. The procedure is similar to that adopted in rural areas except that the criteria for determining number of SUs to be formed is on the basis of number of households in the UFS frame as 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. The following criteria was adopted for deciding the number of SUs to be formed in the UFS blocks of the frame and the number of SUs to be formed was decided before selection of the samples:

number of households of the UFS block	no. of SUs to be formed
less than 250	1
250 to 499	2
500 to 749	3
750 to 999	4
1000 to 1249	5
.......and so on	....

2.2 Sample design: A stratified multi-stage design was adopted for the 80th round survey. *The first stage units (FSU) were villages/UFS blocks/sub-units (SUs) as per the situation.* The ultimate stage units (USU) were households in both sectors.

2.3 Sampling Frame for First Stage Units (FSUs):

2.3.1 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 2.1.1.2) and entire village was considered as one FSU. All such villages (Panchayat wards for Kerala) were regarded as the First Stage Units (FSUs).

2.3.2 In the remaining villages, notional sub-units (SUs) were formed using the procedure as described above in para 2.1. Such SUs were considered as the First Stage Units (FSUs).

2.3.3 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 the First Stage Units (FSUs).

2.3.4 The list of FSUs as described above constitutes the sampling frame for respective sectors, i.e., rural and urban areas.

2.4   Stratification of FSUs:

2.4.1 Rural areas:

A Special Rural stratum, at all-India level, was formed comprising all the uninhabited villages as per census 2011 belonging to all States/UT.

For the remaining villages which are inhabited as per census 2011, districts were the basic geographical unit for stratum formation. Within each district, two Stratum were formed:

(a)   The villages (i) within a distance of 5 Kms from the district headquarter or (ii) within a distance of 5 Kms from a city/town with more than 5 lakh population, form a stratum (stratum 1).

(b)   Rest of the villages constitute another stratum (stratum 2) of the particular district.

2.4.2 Urban Sector:

Two or more strata were formed in urban areas of each district:

(i)   Each million plus city as per census 2011 constitutes separate stratum.

(ii)   Rest of the urban areas of the district form another stratum.

2.5 Sub-stratification of FSUs:

2.5.1 Rural sector: Three groups of villages were formed within each stratum, except special rural stratum at all-India level as mentioned in para 2.1.1.2.

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 is 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 are first arranged in ascending order of number of populations. For all the three groups within each stratum, '$r_1/8$'>1, '$r_2/8$'>1 and '$r_3/8$'>1, will imply formation of 2 or more sub-strata in each group. Sub-strata will be demarcated in Group 1, Group 2 and Group 3 respectively in such a way that each sub-stratum will comprise a group of villages (all SUs of a village considered together) of the arranged frame and have more or less equal population.

If number of FSUs in a particular Group is very small or sufficient number of samples is not allocated, no sub-stratum was formed in that Group.

2.5.2 Urban sector: Let 'u' be the sample size allocated for an urban stratum. For all strata, if 'u/8' >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 was comprised a group of UFS blocks (all SUs of a block considered together) having more or less equal number of households. If number of blocks in a particular stratum was very small, no sub-stratum was formed in that stratum.

2.3.6 Total sample size (FSUs): 4409 FSUs were allotted at the all-India level for CMS-T survey. State/UT-wise allocation of sample FSUs are given in Table 1.

2.3.6.1 Allocation of total sample to States and UTs

The total number of sample FSUs allocated to the States and UTs in proportion to the projected population figures as on 1st October 2024 as available from the report, 'Population Projections for India and States 2011-2036' of the Technical Group on Population Projections, Ministry of Health and Family Welfare, Government of India, subject to a minimum sample allocation to each State/UT. A minimum of 4 FSUs (2 each for the rural and urban sector) are allocated to each State/ UT on quarterly basis.

2.3.6.2 Allocation of State / UT level sample to rural and urban sector

The State/ UT level samples are allocated between two sectors in proportion to the projected population figures as on 1st October 2024 as available from the report mentioned earlier.

Within each sector of a State/ UT, the respective sample size was allocated to the different strata in proportion to the population as per Census 2011. The stratum level allocation was adjusted to multiples of 2 for the quarter with minimum allocation of 2 FSUs. For special stratum (stratum code '999') formed in rural areas, 6 FSUs were allocated.

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

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.

2.3.8 Formation of Sub-divisions in the selected SU: It has been experienced in the previous NSS surveys that there happen to be some extreme cases where the approximate ascertained present population in the selected SU was very high and listing becomes very difficult. To take care of such extreme situations, the SU was sub-divided into a number of smaller units (Sub-divisions) each having more or less equal population content and one of them is randomly selected. Listing and selection of households was done in the selected Sub-division unit only. The procedure for formation of Sub-divisions is same as that of formation of SUs within village/blocks.

The criteria for determining the number of Sub-divisions (D_1) to be formed in the selected rural/urban SUs is as follows:

Approx. population of the SU	no. of Sub-divisions (D_1) to
less than 1500	1
1500 to 2399	2
2400 to 3599	3
3600 to 4799	4
.......and so on	....

2.3.9 Special case:

2.3.9.1 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 of Jammu (vi) Leh and Kargil

districts of Ladakh region and (vii) Idukki district of Kerala, the criterion for determining the number of sub-divisions (D_1) to be formed in rural SUs is as follows:

Approx. population of the SU	no. of Sub-divisions to be
less than 750	1
750 to 1199	2
1200 to 1799	3
1800 to 2399	4
2400 to 2999	5
.......and so on	....

2.3.10 Listing of households: All the households of the sample FSU were included in the list of households. Temporarily locked households are also included after ascertaining the temporariness of absence of the households through local enquiry.

2.3.11 Selection of households: 8 sample households were selected by simple random sampling without replacement (SRSWOR).

3. Estimation Procedure

3.1. Notations:

s	subscript for s^{th} stratum
t	subscript for t^{th} sub-stratum
i	subscript for i^{th} FSU [SU/ Village / panchayat ward/ UFS block]
k	subscript for k^{th} sample household within an FSU
D_1	total number of sub-divisions formed in the sample FSU. $D_1=1$, if no Sub-division is formed in the SU)
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 an FSU
h	number of households surveyed in an 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

Let y_{stik} be the observed value of the characteristic y for the k-th household of the i-th FSU for the t-th sub-stratum of s-th stratum.

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

3.2.Formulae for Estimation of Aggregates for a stratum × sub-stratum:

3.2.1. Schedule 0.0 (Rural/Urban):

3.2.1.1. For estimating the number of households in a stratum × sub-stratum possessing a characteristic:

$$\hat{Y} = \frac{N}{n} \sum_{i=1}^{n} D_1 \times y_i$$

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

3.2.2. Schedule CMS-T:

3.2.2.1. For a stratum × sub-stratum:

$$\hat{Y}_{st} = \frac{N}{n_{st}} \sum_{i=1}^{n} \left[D_1 * \frac{H_i}{h_i} * \sum_{k=1}^{h_i} y_{ik} \right]$$

where n_{st} is the number of sample FSUs surveyed including zero cases and uninhabited in a particular stratum × sub stratum.

3.3.Overall Estimate of Aggregates for a stratum:

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

$$\hat{Y}_s = \sum_{t} \hat{Y}_{st}$$

3.4.Overall Estimate of Aggregates at 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.

3.5.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 All-India level.

Then, the combined ratio estimates $(\hat{R})$ of the ratio $\left(R = \frac{Y}{X} \right)$ will be obtained as $\hat{R} = \frac{\hat{Y}}{\hat{X}}$.

3.6.Estimation of Errors:

3.6.1. Formula for estimated variance (for Rural / Urban):

3.6.1.1. Here, the FSUs are selected by SRSWOR independently for each quarter. Subsequently, USUs will be selected by SRSWOR. If the ith FSU has been selected, h_i unit is selected from this particular FSU by SRSWOR method.

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

$$\hat{Y}_i = H_i * \bar{y}_i * D_{1si} \qquad \text{and} \qquad \bar{y}_i = \left.\sum_1^{h_i} y_{ik}\right/ h_i$$

$$V\hat{a}r\left(\hat{Y}\right) = \sum_S V\hat{a}r\left(\hat{Y}_s\right) = \sum_S \sum_t V\hat{a}r\left(\hat{Y}_{st}\right)$$

$$V\hat{a}r\left(\widehat{Y_{st}}\right) = N_{st}^2 \left(\frac{1}{n_{st}}\right.$$

$$- \frac{1}{N_{st}}\right)\left(\frac{1}{n_{st}-1}\right)\sum_1^{n_{st}}(H_{sti} * D_{1sti} * \overline{y_{sti}} - \frac{1}{n_{st}}\sum_1^{n_{st}} H_{sti} * D_{1sti} * \overline{y_{sti}})^2$$

$$+ \frac{N_{st}}{n_{st}}\sum_1^{n_{st}} H_{sti}^2 * D_{1sti}^2 * \left(\frac{1}{h_{sti}} - \frac{1}{H_{sti} * D_{1si}}\right)s^2{}_{wi}$$

where $s^2{}_{wi} = \frac{1}{(h_{sti}-1)}\sum_{k=1}^{h_{sti}}(y_{stik} - \bar{y}_{sti})^2$

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

Note that $MSE\left(\hat{R}\right)$ is unbiasedly estimated by $V\left(\hat{Y} - R\hat{X}\right) * \frac{1}{\hat{X}^2}$

$V\left(\hat{Y} - R\hat{X}\right) = v(\hat{u})$ where $u_{ik} = (y_{ik} - Rx_{ik})$,

$U_i = (Y_i - RX_i)$ and $U = (Y - RX) = 0$ at domain level (All-India).

$\hat{X}^2 M\hat{S}E\left(\hat{R}\right) = \hat{V}\left(\hat{U}\right)$ at $R = \hat{R}$

$$\hat{Y}_{sti} = \frac{1}{N_{st}} * \sum_k y_{stik} * n_{st} * \text{multiplier}$$

$$\hat{X}_{sti} = \frac{1}{N_{st}} * \sum_k x_{stik} * n_{st} * \text{multiplier}$$

$M\hat{S}E\left(\hat{R}\right) = \frac{1}{\hat{X}^2}\sum_s \sum_t M\hat{S}E_{st}\left(\hat{R}\right)$

Finally;

$$M\hat{S}E_{st}(\hat{R}) = N_{st}^2 \left(\frac{1}{n_{st}} - \frac{1}{N_{st}}\right) \frac{1}{(n_{st}-1)} \sum_{1}^{n_{st}} (H_i D_{1si}\bar{u}_i - \frac{1}{n_{st}} \sum_{1}^{n_{st}} H_i D_{1si}\bar{u}_i)^2 + \frac{N_{st}}{n_{st}} \sum_{1}^{n_{st}} H^2_i$$

$$* D_{1si}^2 (\frac{1}{h_i} - \frac{1}{H_i * D_{1si}}) s_{ui}^2$$

where $s_{ui}^2 = \frac{1}{(h_i-1)} \sum_{k=1}^{h_i} (u_{ik} - \bar{u}_i)^2$

$\bar{u}_i = \bar{y}_i - \hat{R}\bar{x}_i$

The formulae for multipliers are as given in Section 4.

3.6.2. Estimates of Relative Standard Error (RSE):

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

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

4. Multipliers:

4.1. The formulae for multipliers at stratum/sub-stratum level for different types of schedules are given below.

Schedule	Sector	Formula for multipliers
0.0	Rural / Urban	$\dfrac{N_{st}}{n_{st}}$
CMS-T	Rural / Urban	$\dfrac{N_{st}}{n_{st}} * D_1 * \dfrac{H_{sti}}{h_{sti}}$

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 0.0, irrespective of any misclassification observed between the listing Schedule and detailed enquiry Schedule.

4.2. The sample is drawn independently for each of the quarters. Therefore, multiplier will be computed using the sample allocated for the period January – March 2025 only.