2.2 Method of Estimation

The results of the Household Socio-Economic Survey were presented separately for the Greater Bangkok Metropolitan Area (Bangkok Metropolis, Nonthaburi province, Pathum Thani province and Samut Prakan province) and the remaining provinces were classified by region, municipal areas, sanitary districts and non-municipal areas-outside sanitary districts and province.

For estimation at regional level including Greater Bangkok Metropolitan Area and at the provincial level, the following estimation formula were used.

Let

j = the serial number of block/village $j = 1, 2, 3, \ldots m_{hki}$

i = Type of local administration

$$i = \begin{cases} 1 & \text{for municipal areas} \\ 2 & \text{for sanitary districts} \\ 3 & \text{for non-municipal areas-outside sanitary districts} \end{cases}$$

k = province $k = 1, 2, 3, \ldots A_h$

$$h = \begin{cases} 1 & \text{for Greater Bangkok Metropolitan Area} \\ & \text{(Bangkok includes code 6 - Nonthaburi, Pathumthani, Samutprakan)} \\ 2 & \text{for Central region (excluding Greater Bangkok Metropolitan Area)} \\ 3 & \text{for Northern region} \\ 4 & \text{for Northeastern region} \\ 5 & \text{for Southern region} \end{cases}$$

1) Estimation of Total

(1) Estimate of the total number of characteristic Y of household

(1.1) Adjusted estimate of the total number of characteristic Y of household for the i^{th} area, k^{th} province and h^{th} region is based on the formula

$$Y''_{hki} = \frac{Y'_{hki}}{H'_{hki}} \cdot H''_{hki} = r_{hki} \cdot H''_{hki} \qquad \text{..............................} (1)$$

where Y'_{hki} is the ordinary estimate of the total number of characteristic Y of household in the i^{th} area, k^{th} province and h^{th} region

H'_{hki} is the ordinary estimate of the total number of households in the i^{th} area, k^{th} province and h^{th} region

H''_{hki} is the known total number of households, based on the household projection, for the i^{th} area, k^{th} province and h^{th} region

The formula for the estimate from a stratified two-stage sampling :

i) $$Y'_{hki} = \frac{1}{m_{hki}} \sum_{j=1}^{m_{hki}} \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot Y_{hkij} \quad \text{.............................. (2)}$$

where Y_{hkij} is the characteristic Y of every sample household in j^{th} sample block/village, i^{th} area, k^{th} province and h^{th} region

N_{hkij} is the total number of listing household in j^{th} sample block/village, i^{th} area, k^{th} province and h^{th} region

n_{hkij} is the total number of sample households in j^{th} sample block/village, i^{th} area, k^{th} province and h^{th} region

P_{hkij} is the probability of selection of j^{th} sample block/ village, i^{th} area, k^{th} province and h^{th} region

m_{hki} is the total number of sample blocks/villages in i^{th} area, k^{th} province and h^{th} region

ii) $$H'_{hki} = \frac{1}{m_{hki}} \sum_{j=1}^{m_{hki}} \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot n'_{hkij} \quad \text{.............................. (3)}$$

where n'_{hkij} is the total number of interviewed households in j^{th} sample block/village, i^{th} area, k^{th} province and h^{th} region

(1.2) Adjusted estimate of the total number of characteristic Y of household for the k^{th} province and h^{th} region is based on the formula

$$Y''_{hk} = \sum_{i=1}^{3} Y''_{hki} \quad \text{.............................. (4)}$$

(1.3) Adjusted estimate of the total number of characteristic Y of household for the i^{th} area and h^{th} region is based on the formula

$$Y''_{hi} = \sum_{k=1}^{A_h} Y''_{hki} \quad \text{.............................. (5)}$$

where A_h = Number of provinces in each region and $\sum_{k=1}^{5} A_h = 76$

(1.4) Adjusted estimate of the total number of characteristic Y of household for the h^{th} region is based on the formula

$$Y''_h = \sum_{i=1}^{3} Y''_{hi} \qquad \text{.............................. (6)}$$

(1.5) Adjusted estimate of the total number of characteristic Y of household for i^{th} area of the whole kingdom is based on the formula

$$Y''_i = \sum_{h=2}^{5} Y''_{hi} \qquad \text{.............................. (7)}$$

(1.6) Adjusted estimate of the total number of characteristic Y of household for the whole kingdom is based on the formula

$$Y'' = \sum_{h=1}^{5} Y''_h \qquad \text{.............................. (8)}$$

(2) Estimate of variance of the total number of characteristic Y of household

(2.1) The estimate variance of Y''_{hki} is

$$\hat{V}(Y''_{hki}) = \left[\frac{H''_{hki}}{H'_{hki}}\right]^2 \frac{1}{m_{hki}(m_{hki}-1)} \sum_{j=1}^{m_{hki}} Z^2_{hkij} \qquad \text{.............................. (9)}$$

where

$$Z_{hkij} = Y'_{hkij} - r_{hki} \cdot H'_{hkij}$$

$$Y'_{hkij} = \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot Y_{hkij}$$

$$H'_{hkij} = \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot n'_{hkij}$$

(2.2) The estimate variance of Y''_{hk} is

$$\hat{V}(Y''_{hk}) = \sum_{i=1}^{3} \hat{V}(Y''_{hki}) \qquad \text{.............................. (10)}$$

(2.3) The estimate variance of Y''_{hi} is

$$\hat{V}(Y''_{hi}) = \sum_{k=1}^{A_h} \hat{V}(Y''_{hki}) \qquad \text{.............................} (11)$$

(2.4) The estimate variance of Y''_{h} is

$$\hat{V}(Y''_{h}) = \sum_{i=1}^{3} \hat{V}(Y''_{hi}) \qquad \text{.............................} (12)$$

(2.5) The estimate variance of Y''_{i} is

$$\hat{V}(Y''_{i}) = \sum_{h=2}^{5} \hat{V}(Y''_{hi}) \qquad \text{.............................} (13)$$

(2.6) The estimate variance of Y'' is

$$\hat{V}(Y'') = \sum_{h=1}^{5} \hat{V}(Y''_{h}) \qquad \text{.............................} (14)$$

(3) Coefficient of variation (CV) of the total number of characteristic Y of household

(3.1) The formula of CV of Y''_{hki} is

$$CV(Y''_{hki}) = \frac{\sqrt{\hat{V}(Y''_{hki})}}{Y''_{hki}} \text{ X } 100\ \% \qquad \text{.............................} (15)$$

(3.2) The formula of CV of Y''_{hk} is

$$CV(Y''_{hk}) = \frac{\sqrt{\hat{V}(Y''_{hk})}}{Y''_{hk}} \text{ X } 100\ \% \qquad \text{.............................} (16)$$

(3.3) The formula of CV of Y''_{hi} is

$$CV(Y''_{hi}) = \frac{\sqrt{\hat{V}(Y''_{hi})}}{Y''_{hi}} \text{ X } 100\ \% \qquad \text{.............................} (17)$$

(3.4) The formula of CV of Y''_h is

$$CV(Y''_h) = \frac{\sqrt{\hat{V}(Y''_h)}}{Y''_h} \times 100 \% \quad \text{.............................. (18)}$$

(3.5) The formula of CV of Y''_i is

$$CV(Y''_i) = \frac{\sqrt{\hat{V}(Y''_i)}}{Y''_i} \times 100 \% \quad \text{.............................. (19)}$$

(3.6) The formula of CV of Y'' is

$$CV(Y'') = \frac{\sqrt{\hat{V}(Y'')}}{Y''} \times 100 \% \quad \text{.............................. (20)}$$

2) Estimation of Average

(1) Estimate of the average of characteristic Y per household

(1.1) The estimate of the average of characteristic Y per household for the k^{th} province and h^{th} region is based on the formula

$$\overline{Y}_{hk} = \frac{Y''_{hk}}{H''_{hk}} = r_{hk} \quad \text{.............................. (21)}$$

where $H''_{hk} = \sum_{i=1}^{3} H''_{hki}$

(1.2) The estimate of the average of characteristic Y per household for the i^{th} area and h^{th} region is based on the formula

$$\overline{Y}_{hi} = \frac{Y''_{hi}}{H''_{hi}} = r_{hi} \quad \text{.............................. (22)}$$

where $H''_{hi} = \sum_{k=1}^{A_h} H''_{hki}$

(1.3) The estimate of the average of characteristic Y per household for the h^{th} region is based on the formula

$$\overline{Y}_h = \frac{Y''_h}{H''_h} = r_h \qquad \text{.............................. (23)}$$

where $$H''_h = \sum_{i=1}^{3} H''_{hi} = \sum_{k=1}^{A_h} H''_{hk}$$

(1.4) The estimate of the average of characteristic Y per household for i^{th} area of the whole kingdom is based on the formula

$$\overline{Y}_i = \frac{Y''_i}{H''_i} = r_i \qquad \text{.............................. (24)}$$

where $$H''_i = \sum_{h=2}^{5} H''_{hi}$$

(1.5) The estimate of the average of characteristic Y per household for the whole kingdom is based on the formula

$$\overline{Y} = \frac{Y''}{H''} = r \qquad \text{.............................. (25)}$$

where $$H'' = \sum_{h=1}^{5} H''_h$$

(2) Estimate of variance of the average of characteristic Y per household

(2.1) The estimate variance of average $\overline{Y}_{hk}$ is

$$\hat{V}(\overline{Y}_{hk}) = \left[\frac{1}{H'_{hk}}\right]^2 \sum_{i=1}^{3} \frac{1}{m_{hki}(m_{hki}-1)} \left[\sum_{j=1}^{m_{hki}} (Z'_{hkij})^2 - m_{hki} \cdot Z^2_{hki}\right] \qquad \text{.......................... (26)}$$

where $$Z'_{hkij} = Y'_{hkij} - r_{hk} \cdot H'_{hkij}$$

$$Y'_{hkij} = \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot Y_{hkij}$$

$$H'_{hkij} = \frac{1}{P_{hkij}} \cdot \frac{N_{hkij}}{n_{hkij}} \cdot n'_{hkij}$$

$$Z_{hki} = Y'_{hki} - r_{hk} \cdot H'_{hki}$$

(2.2) The estimate variance of average $\overline{Y}_{hi}$ is

$$\hat{V}(\overline{Y}_{hi}) = \left[\frac{1}{H'_{hi}}\right]^2 \sum_{k=1}^{A_h} \frac{1}{m_{hki}(m_{hki}-1)} \left[\sum_{j=1}^{m_{hki}} (Z''_{hkij})^2 - m_{hki} \cdot (Z'_{hki})^2\right] \quad \text{.......................... (27)}$$

where $Z''_{hkij} = Y'_{hkij} - r_{hi} \cdot H'_{hkij}$

$$Z'_{hki} = Y'_{hki} - r_{hi} \cdot H'_{hki}$$

(2.3) The estimate variance of average $\overline{Y}_h$ is

$$\hat{V}(\overline{Y}_h) = \left[\frac{1}{H'_h}\right]^2 \sum_{i=1}^{3} \sum_{k=1}^{A_h} \frac{1}{m_{hki}(m_{hki}-1)} \left[\sum_{j=1}^{m_{hki}} (Z'''_{hkij})^2 - m_{hki} \cdot (Z''_{hki})^2\right] \quad \text{.................... (28)}$$

where $Z'''_{hkij} = Y'_{hkij} - r_h \cdot H'_{hkij}$

$$Z''_{hki} = Y'_{hki} - r_h \cdot H'_{hki}$$

(2.4) The estimate variance of average $\overline{Y}_i$ is

$$\hat{V}(\overline{Y}_i) = \left[\frac{1}{H'_i}\right]^2 \sum_{h=2}^{5} \sum_{k=1}^{A_h} \frac{1}{m_{hki}(m_{hki}-1)} \left[\sum_{j=1}^{m_{hki}} (Z''''_{hkij})^2 - m_{hki} \cdot (Z'''_{hki})^2\right] \quad \text{.................. (29)}$$

where $Z''''_{hkij} = Y'_{hkij} - r_i \cdot H'_{hkij}$

$$Z'''_{hki} = Y'_{hki} - r_i \cdot H'_{hki}$$

(2.5) The estimate variance of average $\overline{Y}$ is

$$\hat{V}(\overline{Y}) = \left[\frac{1}{H'}\right]^2 \sum_{h=1}^{5} \sum_{i=1}^{3} \sum_{k=1}^{A_h} \frac{1}{m_{hki}(m_{hki}-1)} \left[\sum_{j=1}^{m_{hki}} (Z'''''_{hkij})^2 - m_{hki} \cdot (Z''''_{hki})^2\right] \quad \text{........................ (30)}$$

where $Z'''''_{hkij} = Y'_{hkij} - r \cdot H'_{hkij}$

$$Z''''_{hki} = Y'_{hki} - r \cdot H'_{hki}$$

(3) Coefficient of variation (CV) of the average of characteristic Y per household

(3.1) The formula of CV of $\overline{Y}_{hk}$ is

$$CV(\overline{Y}_{hk}) = \frac{\sqrt{\hat{V}(\overline{Y}_{hk})}}{\overline{Y}_{hk}} \times 100\ \% \qquad \text{.........................} (31)$$

(3.2) The formula of CV of $\overline{Y}_{hi}$ is

$$CV(\overline{Y}_{hi}) = \frac{\sqrt{\hat{V}(\overline{Y}_{hi})}}{\overline{Y}_{hi}} \times 100\ \% \qquad \text{.........................} (32)$$

(3.3) The formula of CV of $\overline{Y}_{h}$ is

$$CV(\overline{Y}_{h}) = \frac{\sqrt{\hat{V}(\overline{Y}_{h})}}{\overline{Y}_{h}} \times 100\ \% \qquad \text{.........................} (33)$$

(3.4) The formula of CV of $\overline{Y}_{i}$ is

$$CV(\overline{Y}_{i}) = \frac{\sqrt{\hat{V}(\overline{Y}_{i})}}{\overline{Y}_{i}} \times 100\ \% \qquad \text{.........................} (34)$$

(3.5) The formula of CV of $\overline{Y}$ is

$$CV(\overline{Y}) = \frac{\sqrt{\hat{V}(\overline{Y})}}{\overline{Y}} \times 100\ \% \qquad \text{.........................} (35)$$